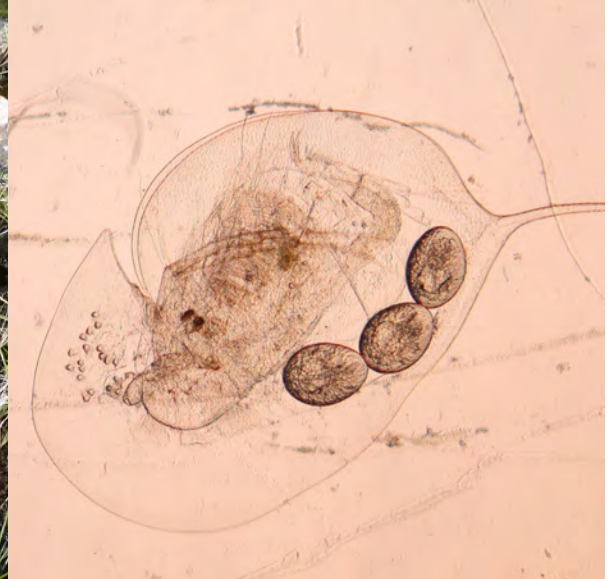


Ekati Diamond Mine

2014 Aquatic Effects Monitoring Program Part 3 - Statistical Report



Volume II
Pigeon-Fay and Upper Exeter Watershed



Dominion Diamond Ekati Corporation

EKATI DIAMOND MINE

**2014 Aquatic Effects Monitoring Program
Part 3 - Statistical Report**

March 2015

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3. Pigeon-Fay and Upper Exeter Watershed

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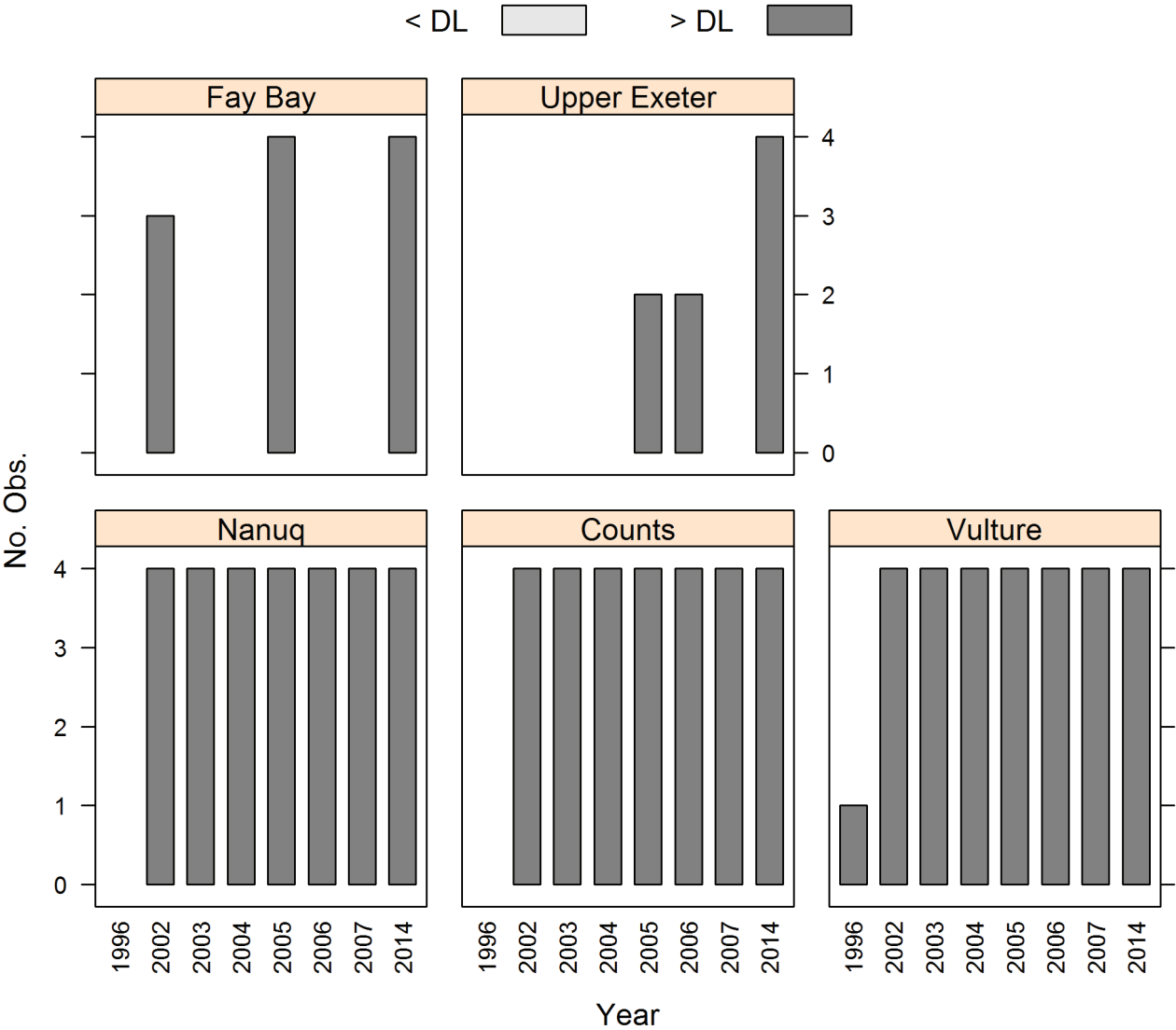
2014 Aquatic Effects Monitoring Program Part 3 - Statistical Report

Analysis of Winter pH Values in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

No censored data were identified.

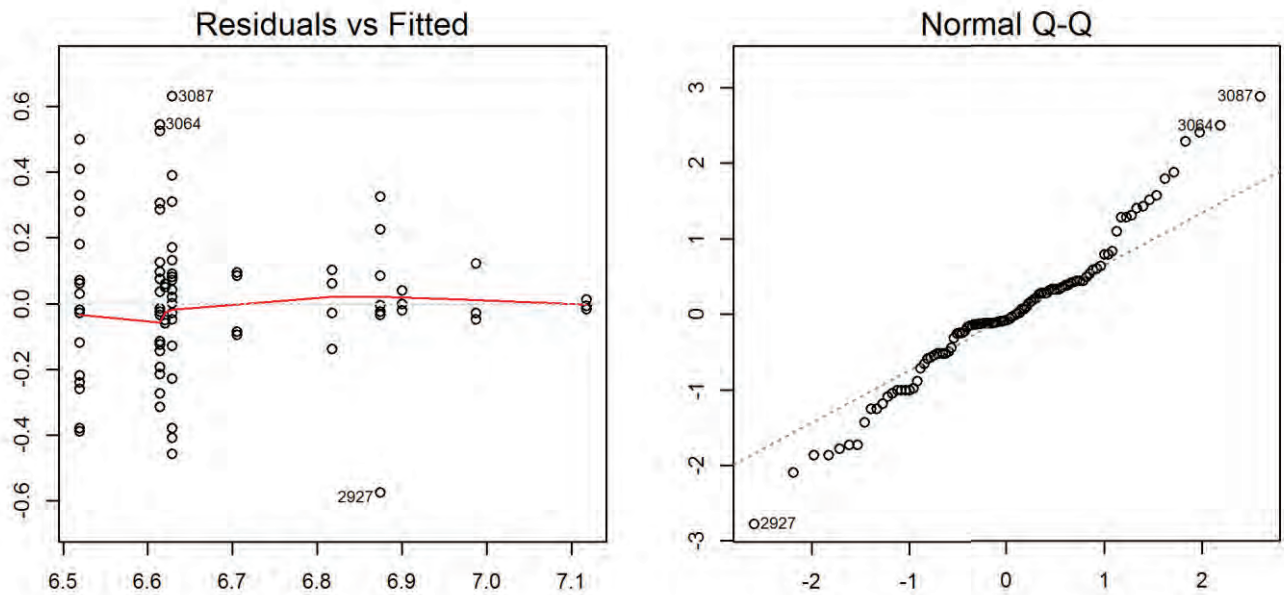
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

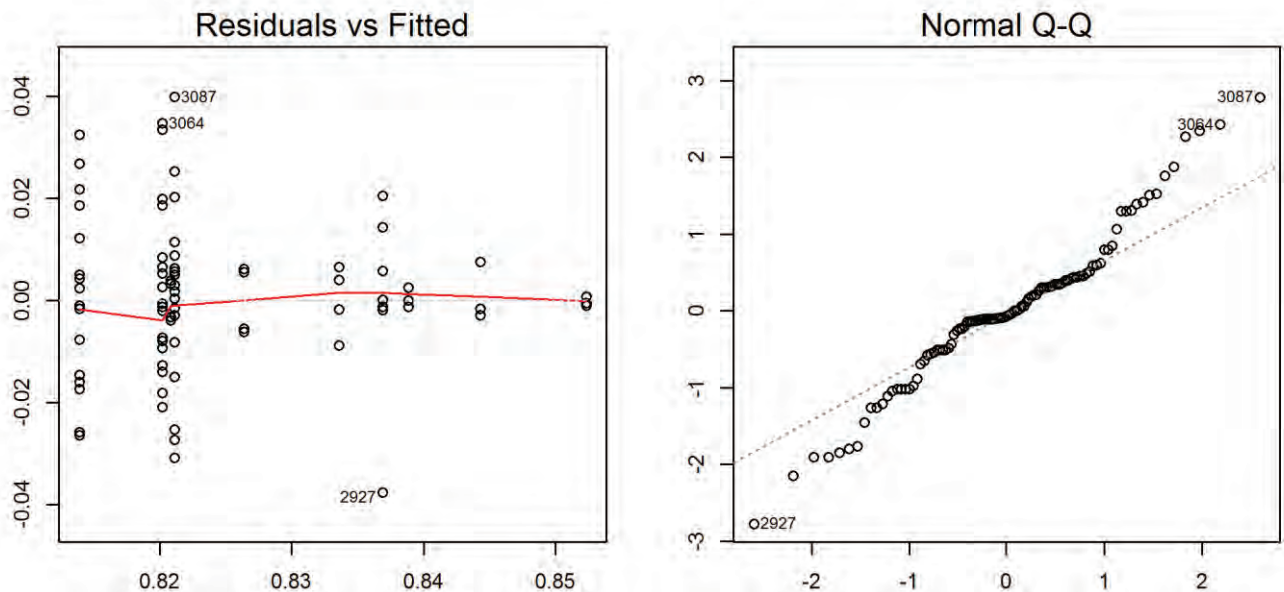
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.22	0.34	0.28
Log-10	0.01	0.34	0.28

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

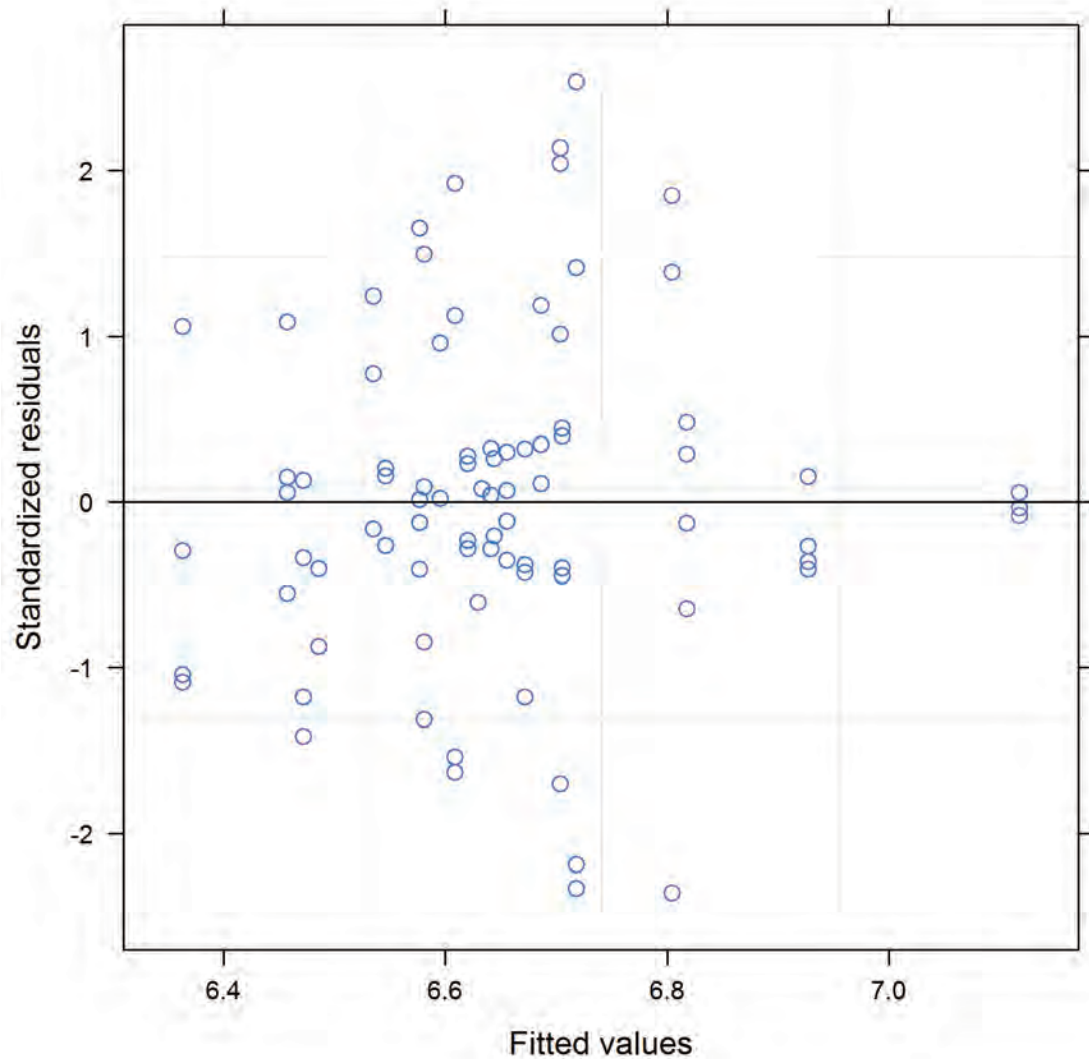
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	26.54	-4.27		
LME	10	22.03	-1.01	6.51	0.01

Conclusion:

The most appropriate model for pH at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p = 0.011$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	82	24063	<.0001
## site	3	82	7	0.0003
## period	1	6	2	0.2520
## site:period	3	82	1	0.2214

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.27	-0.62	0.08	not sig.
Counts	0.02	-0.34	0.38	not sig.
Vulture	-0.2	-0.55	0.15	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

pH at the Fay Bay site were not significantly ($p = 0.221$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

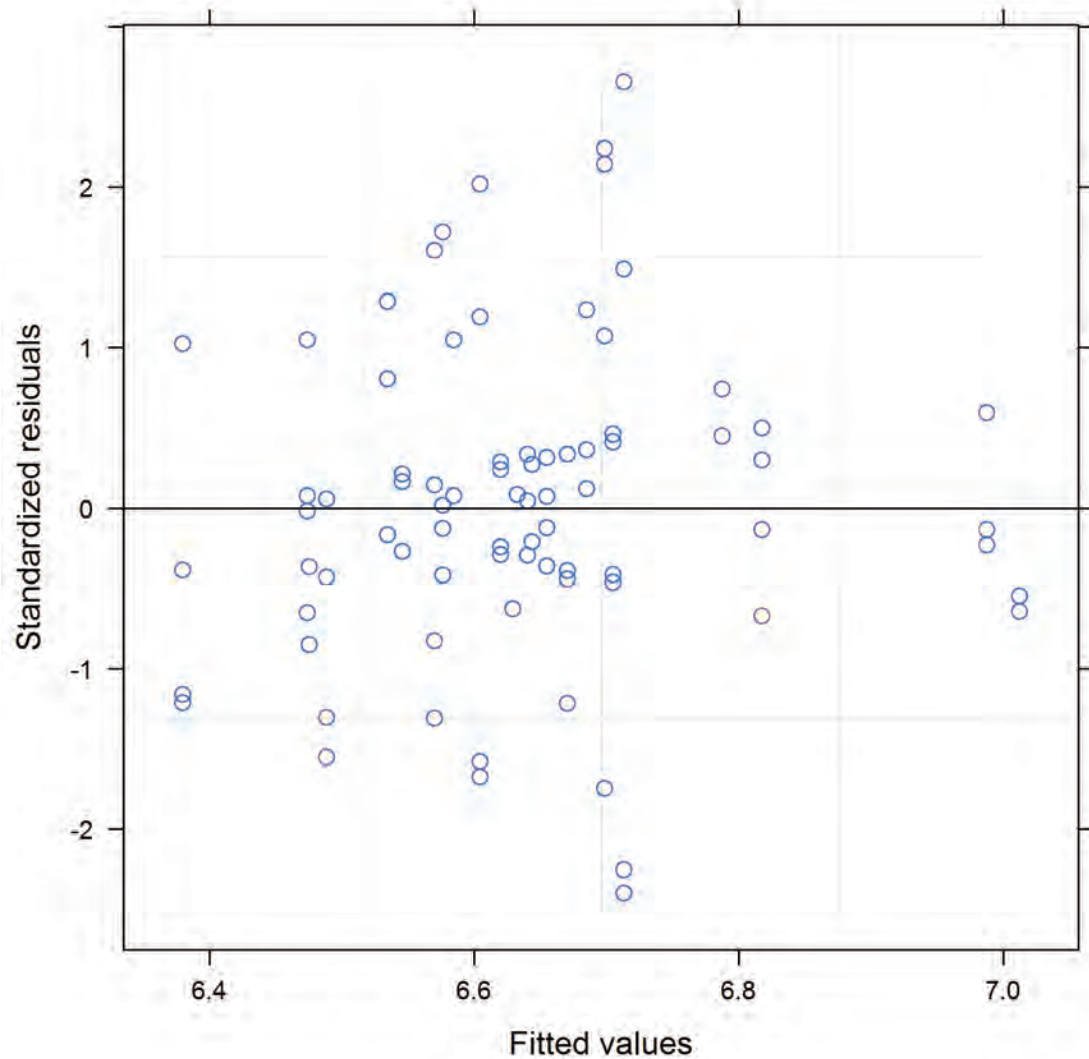
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	20.13	-1.07		
LME	10	15.46	2.27	6.67	0.01

Conclusion:

The most appropriate model for pH at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p = 0.01$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	26601	<.0001
## site	3	79	6	0.0009
## period	1	6	1	0.3586
## site:period	3	79	1	0.2764

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.05	-0.44	0.32	not sig.
Counts	0.24	-0.13	0.6	not sig.
Vulture	0.02	-0.36	0.38	not sig.

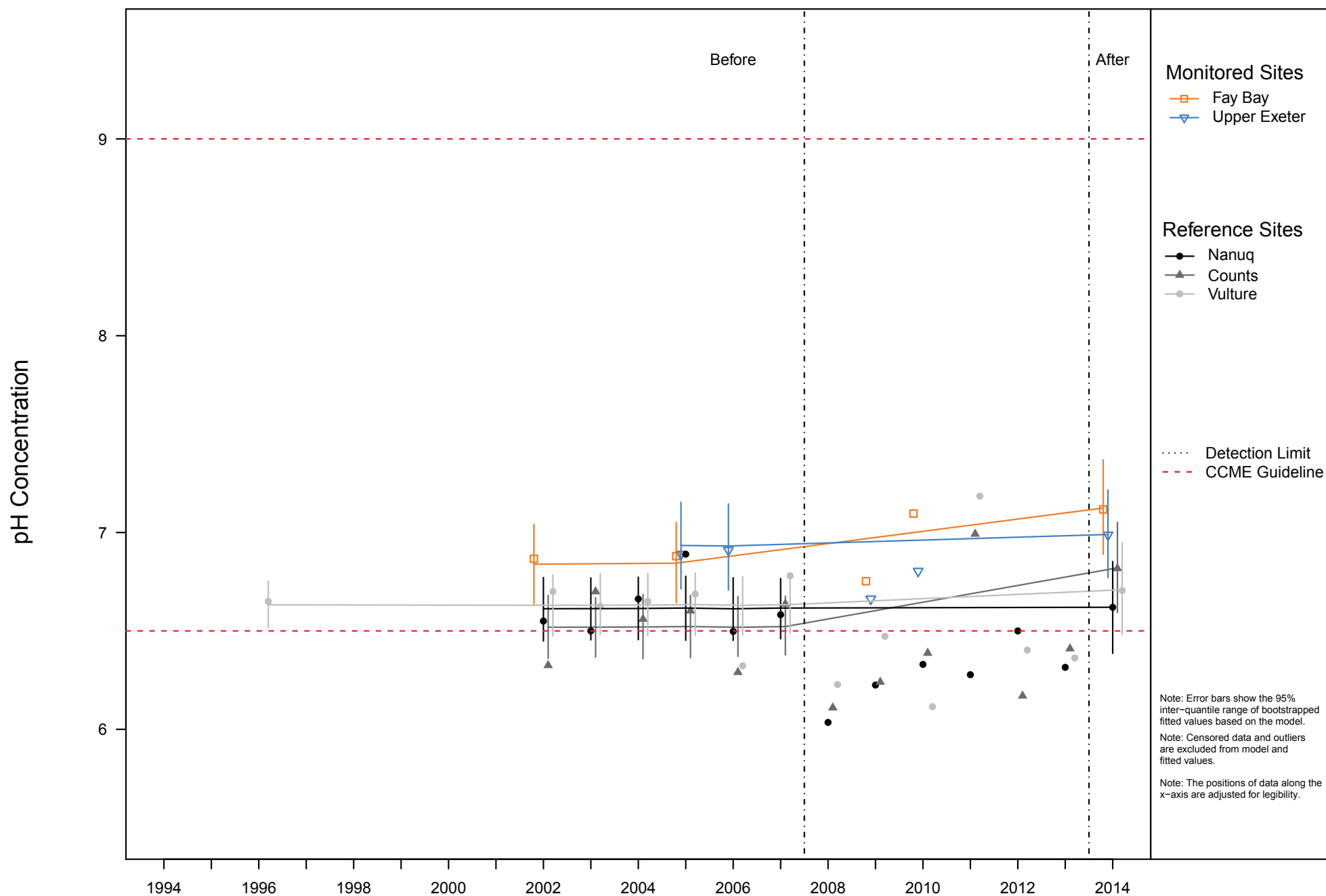
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

pH at the Upper Exeter site were not significantly ($p = 0.276$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

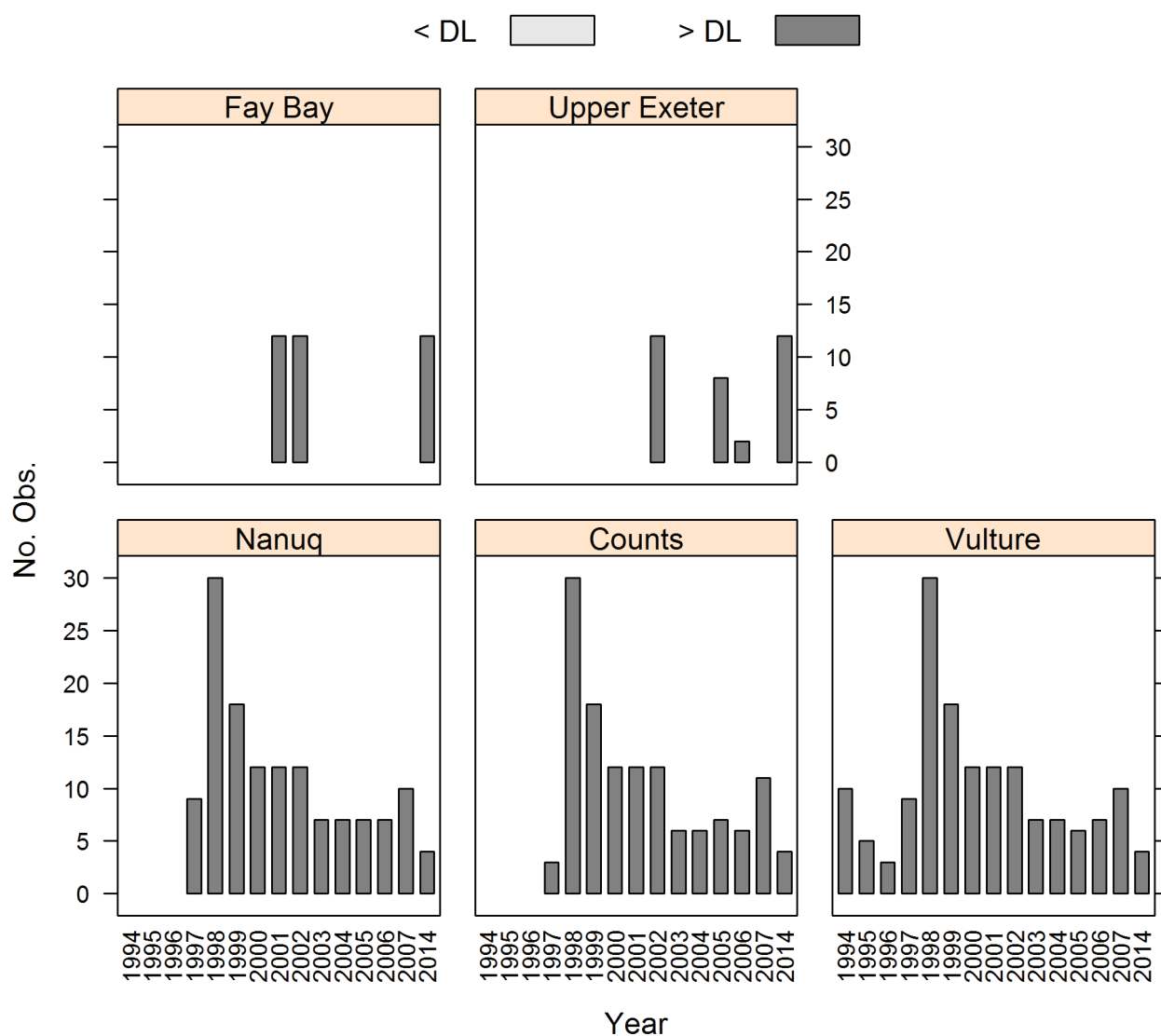


Analysis of Summer pH Values in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

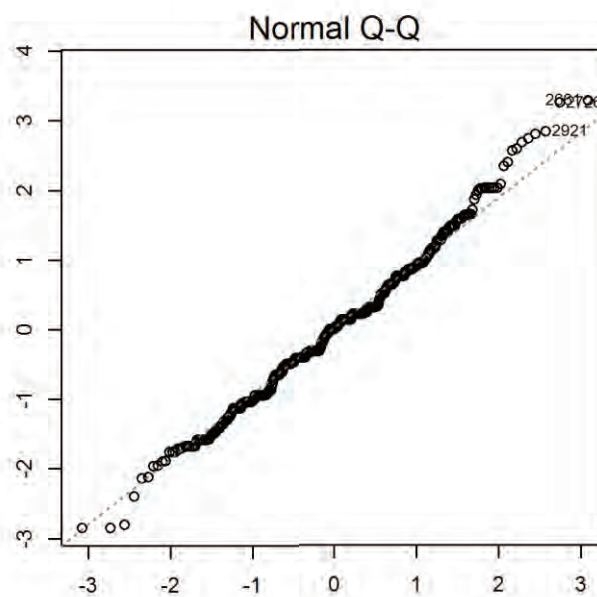
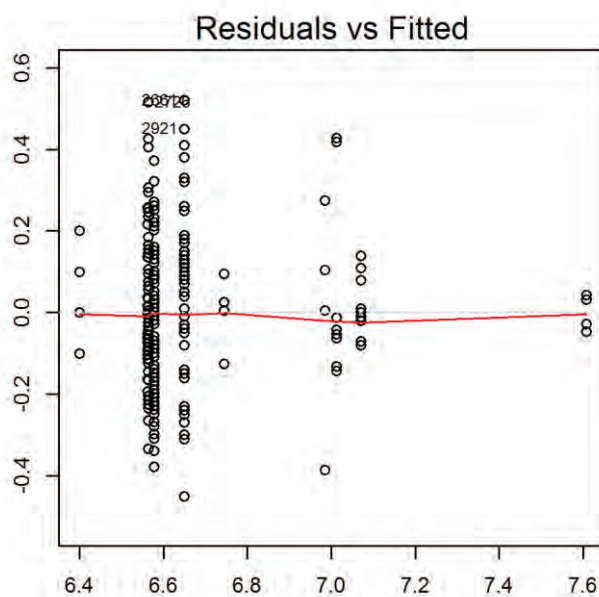
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

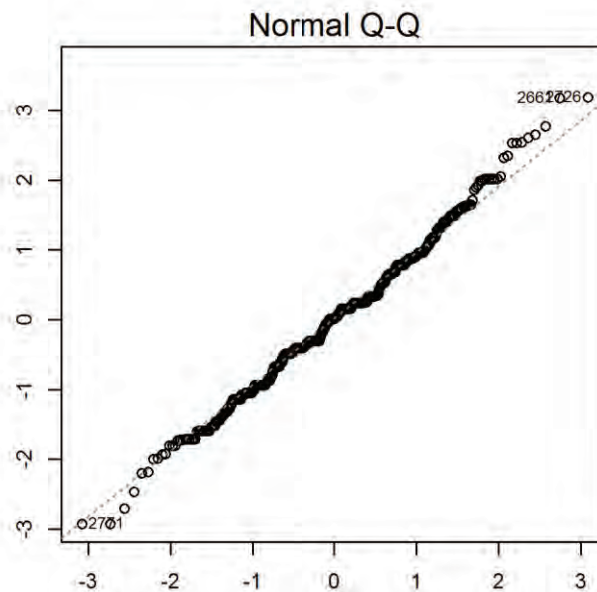
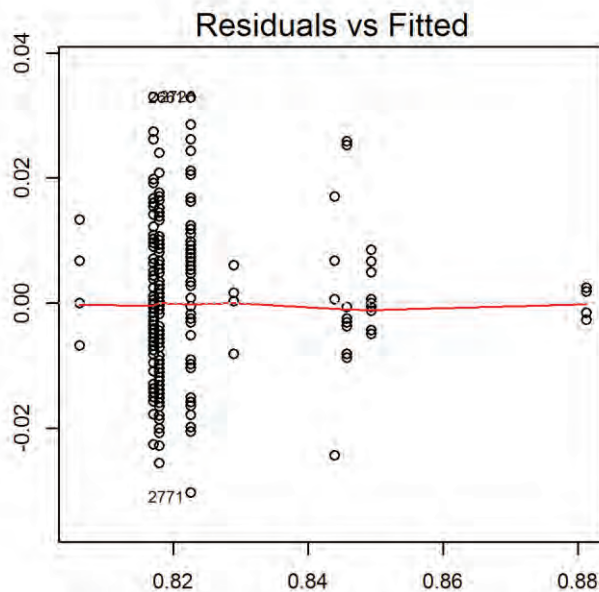
```
## No outliers were identified.
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.16	0.47	0.46
Log-10	0.01	0.46	0.45

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

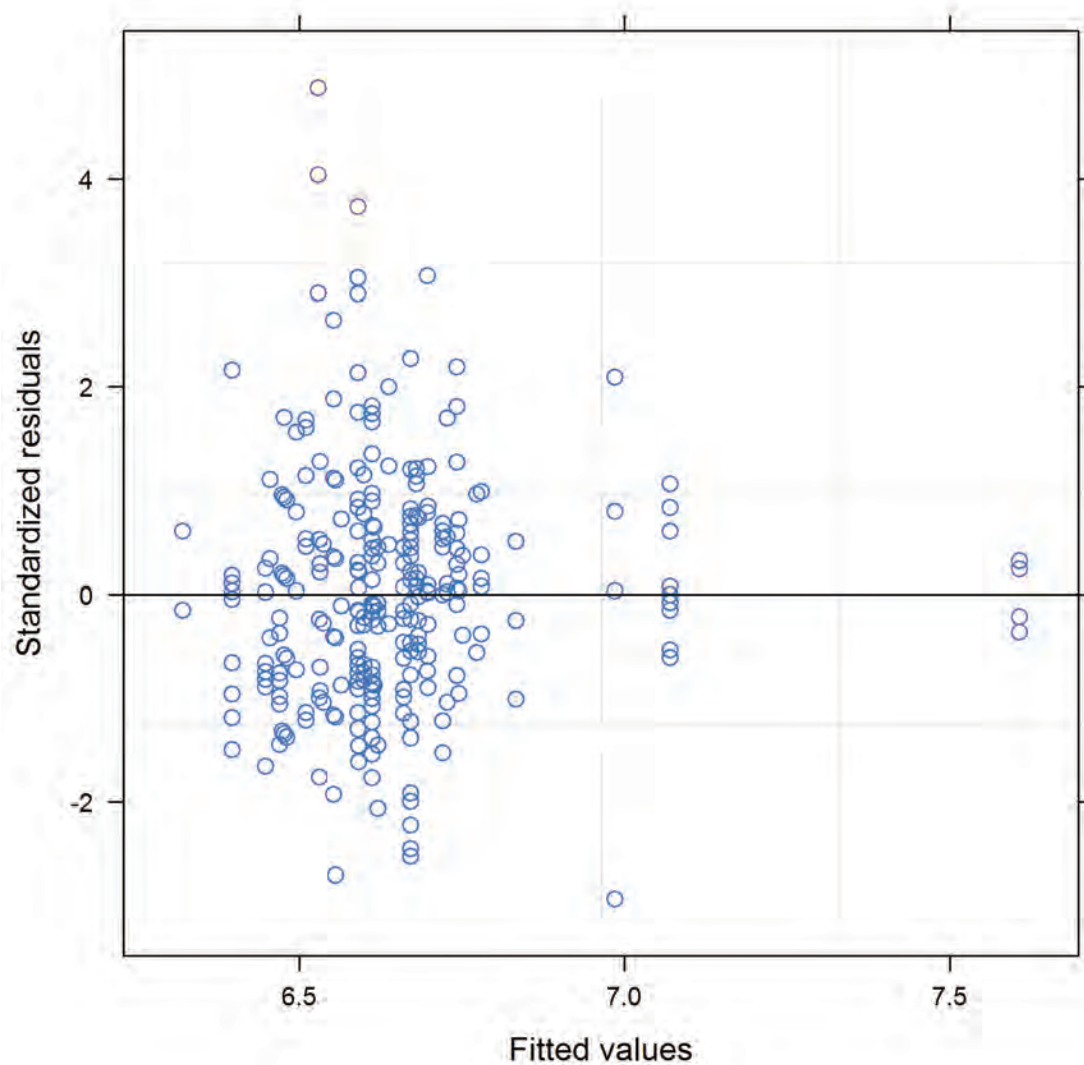
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-326.88	172.44		
LME	10	-458.21	239.1	133.33	0

Conclusion:

The most appropriate model for pH at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	429	45339	<.0001
## site	3	429	22	<.0001
## period	1	13	20	6e-04
## site:period	3	429	26	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.46	-0.62	-0.3	sig.
Counts	0.32	0.16	0.48	sig.
Vulture	-0.24	-0.4	-0.08	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

pH concentrations at the Fay Bay site were significantly ($p < 0.0001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

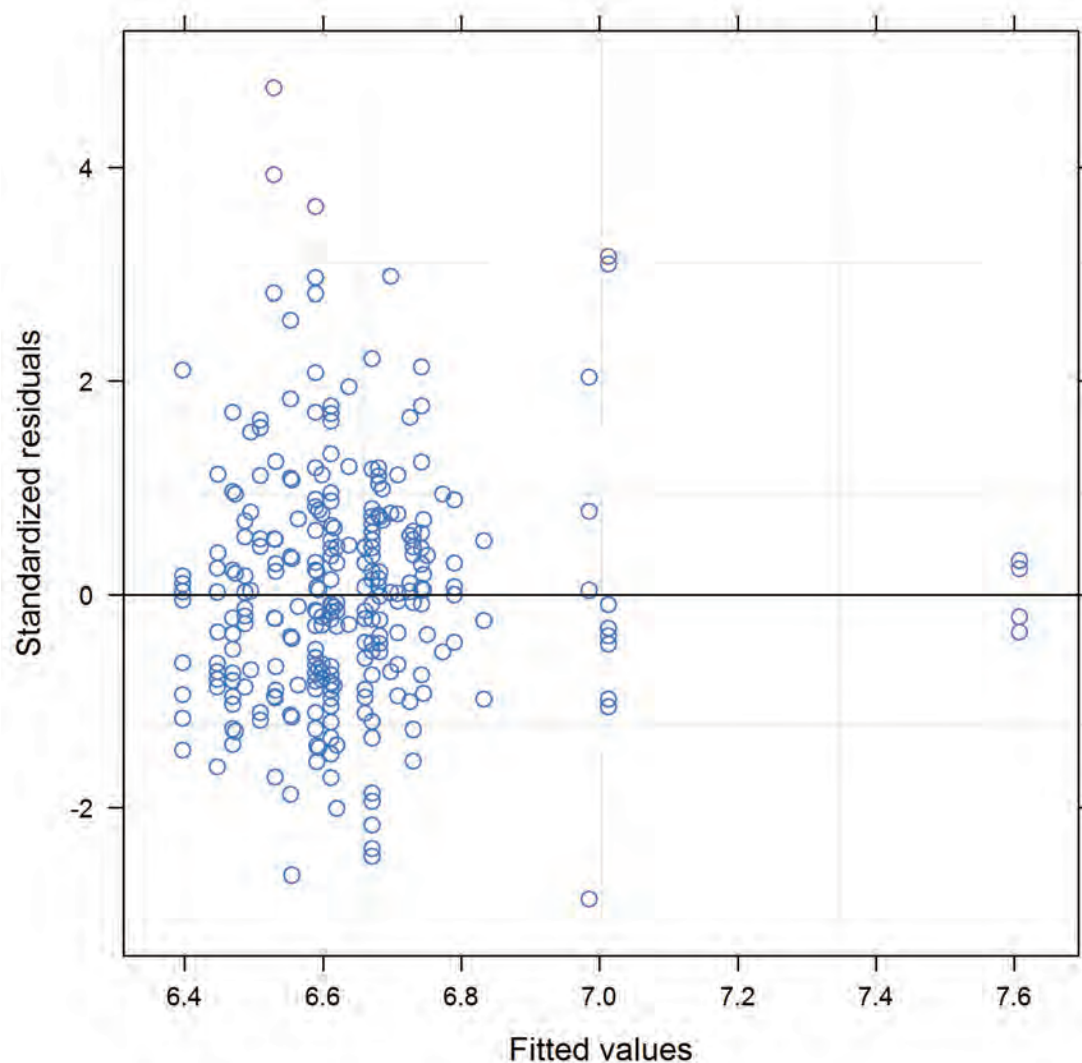
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-306.22	162.11		
LME	10	-432.15	226.07	127.93	0

Conclusion:

The most appropriate model for pH at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	427	44200	<.0001
## site	3	427	16	<.0001
## period	1	13	15	0.0018
## site:period	3	427	23	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.29	-0.46	-0.11	sig.
Counts	0.49	0.32	0.66	sig.
Vulture	-0.07	-0.24	0.1	not sig.

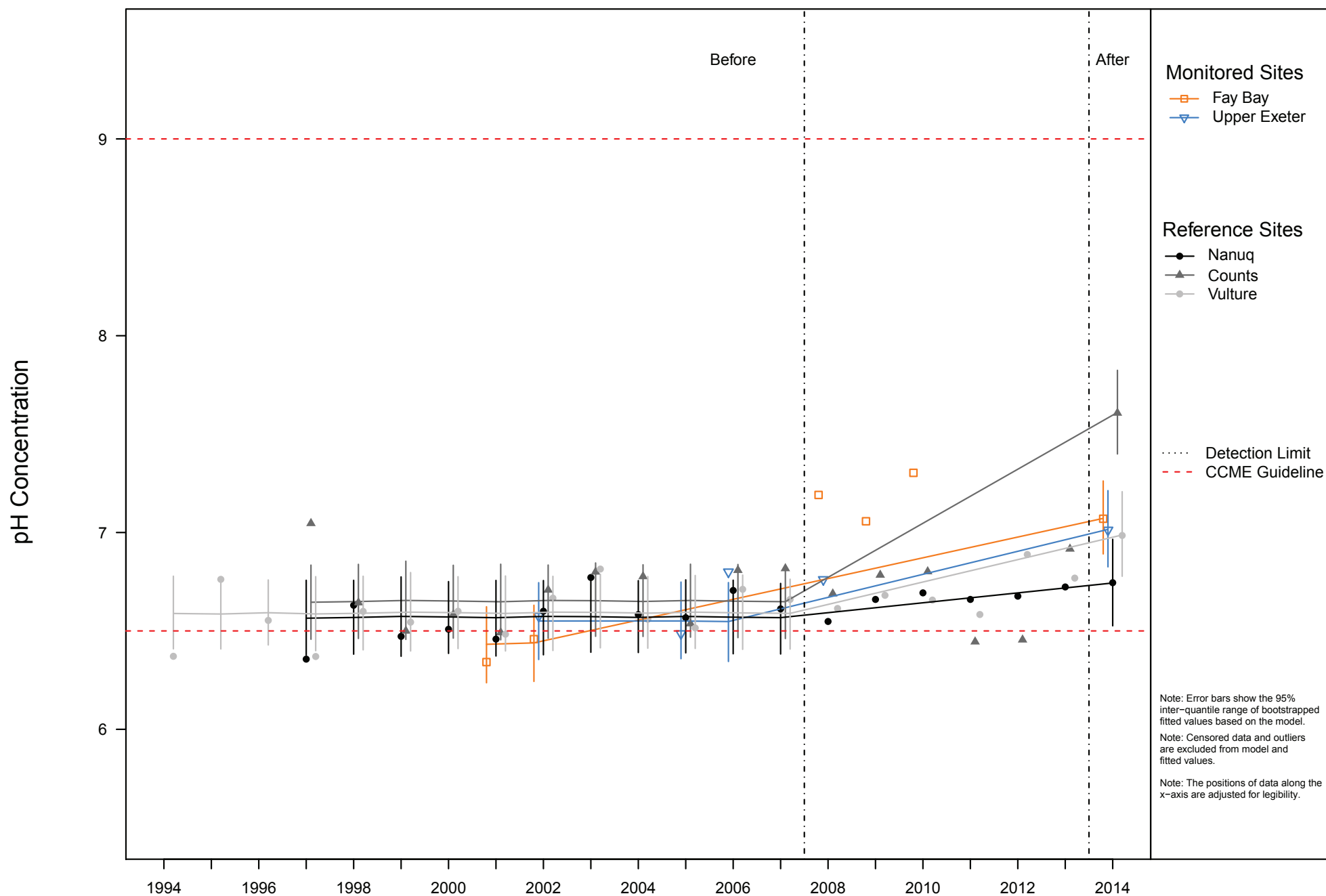
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

pH at the Upper Exeter site were significantly ($p < 0.0001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

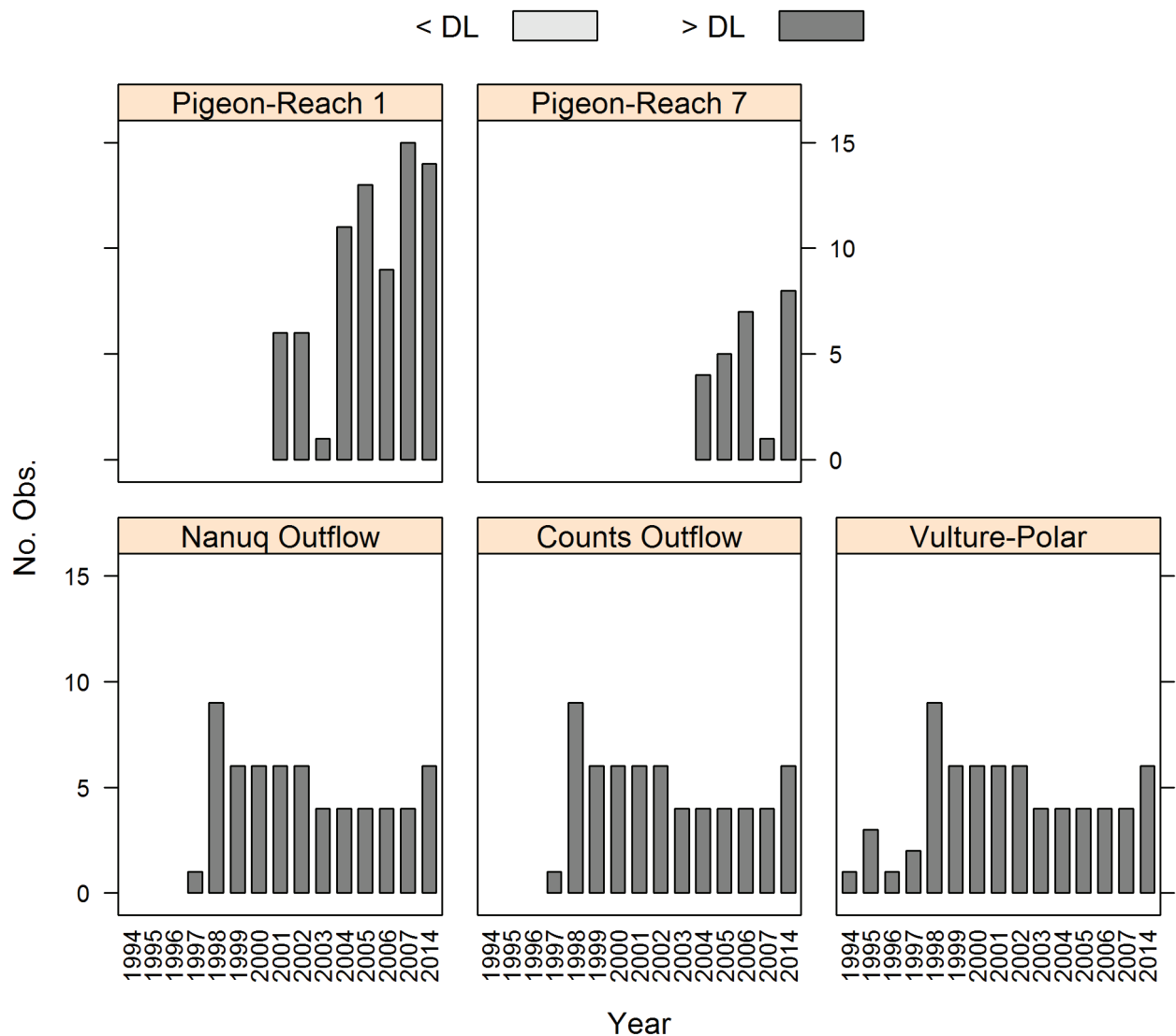


Analysis of Summer pH Values in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

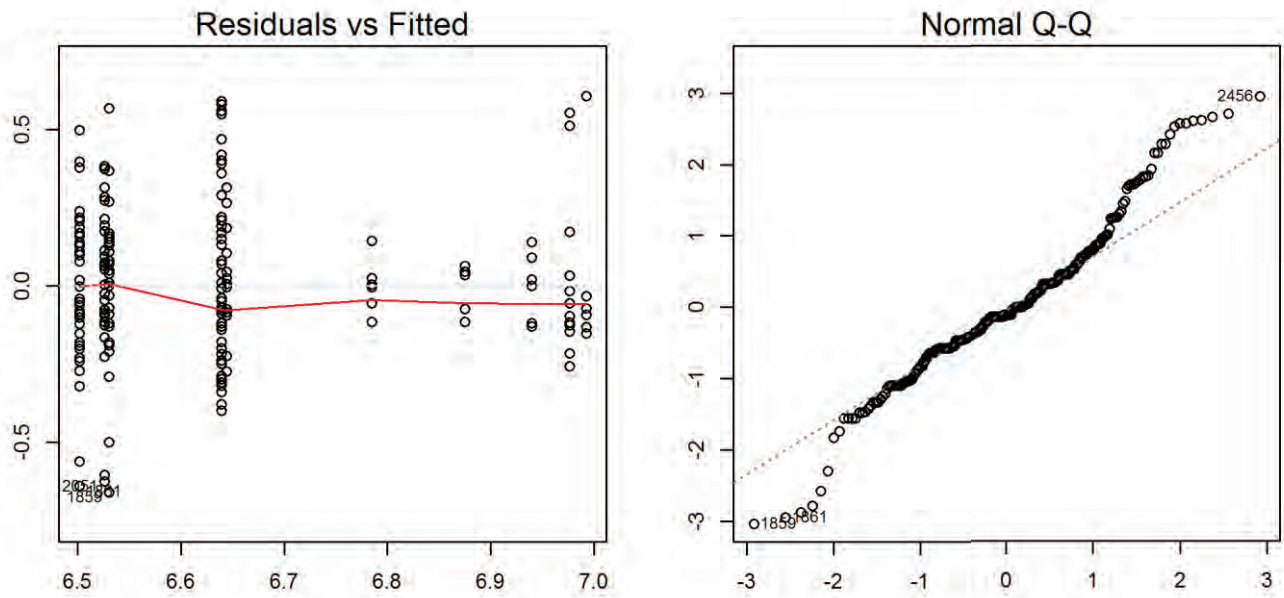
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

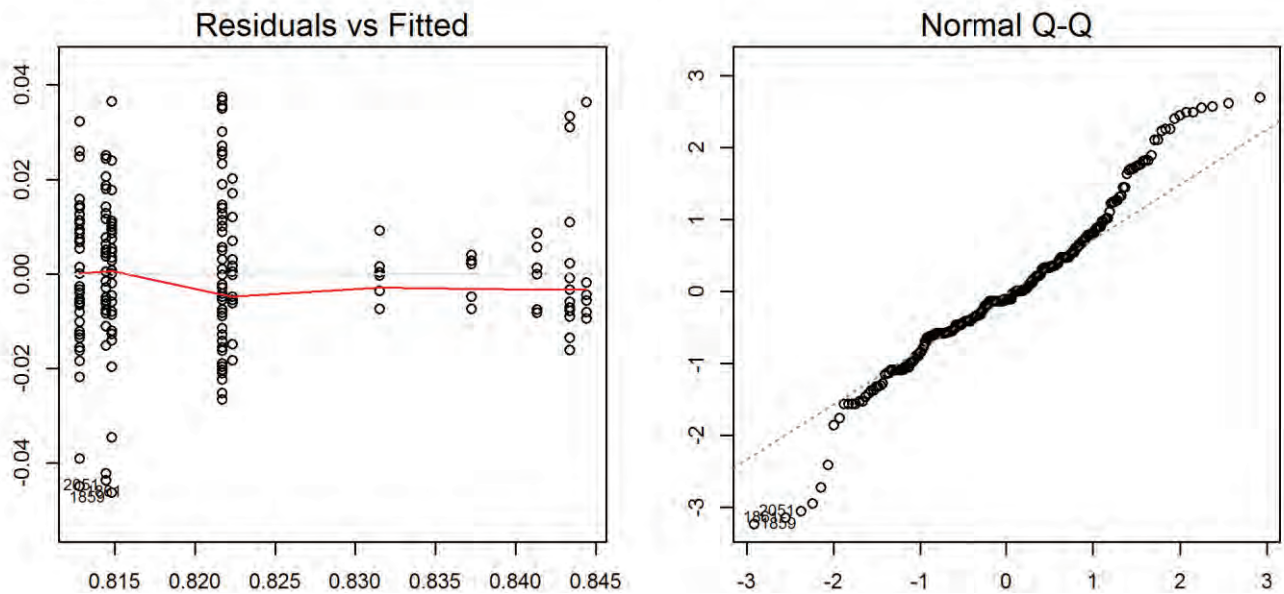
```
##           site year      month season
## 2064 Pigeon-Reach 1 2004      July  summer
## 2110 Pigeon-Reach 1 2005 September summer
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.22	0.3	0.28
Log-10	0.01	0.3	0.28

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

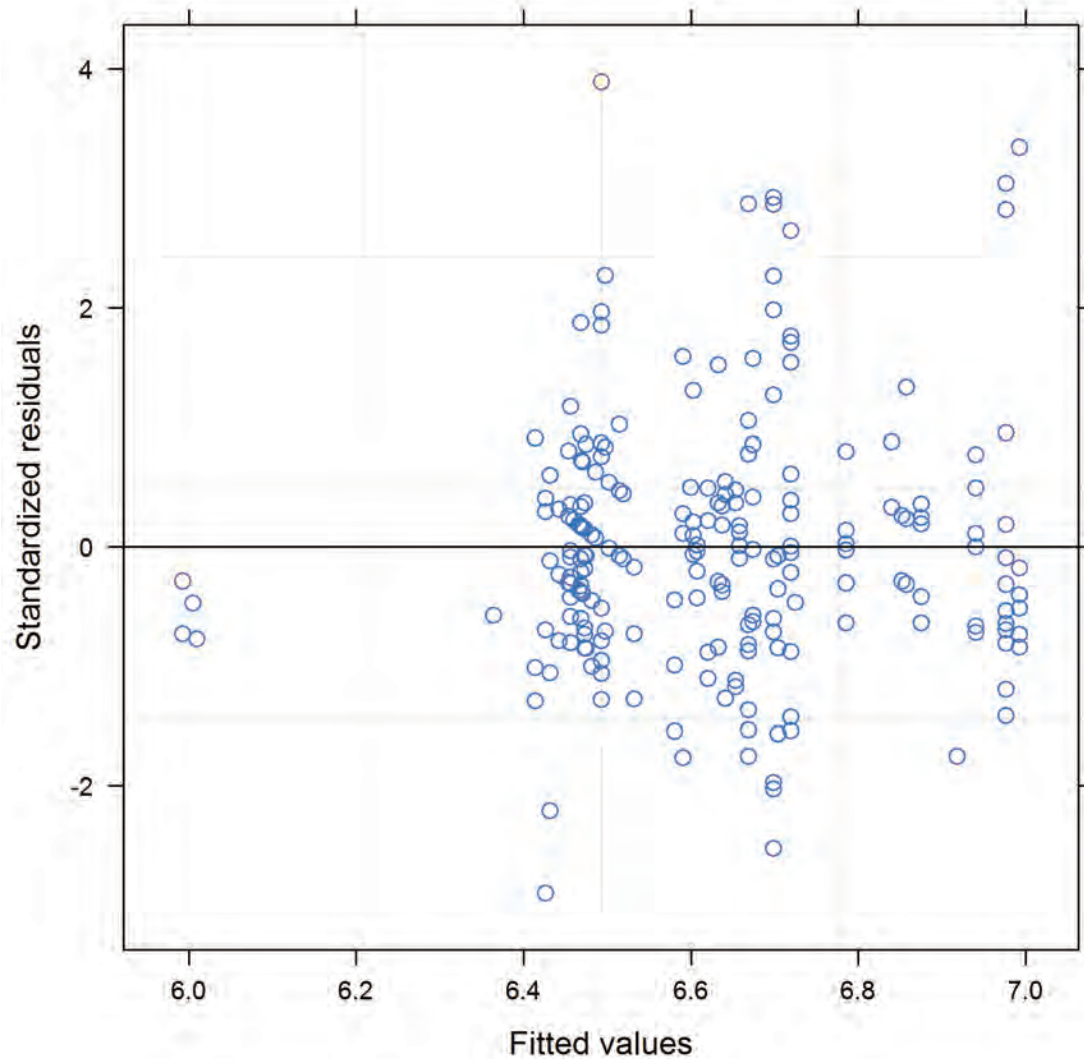
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-1.11	11.56		
LME	12	-69	46.5	69.89	1.11×10 ⁻¹⁶

Conclusion:

The most appropriate model for pH at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	261	14208	<.0001
## site	4	261	2	0.044
## period	1	13	3	0.088
## site:period	4	261	1	0.619

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.13	-0.32	0.05	not sig.
Counts Outflow	0.03	-0.16	0.22	not sig.
Vulture-Polar	-0.02	-0.21	0.16	not sig.
Pigeon-Reach 7	0.01	-0.18	0.19	not sig.

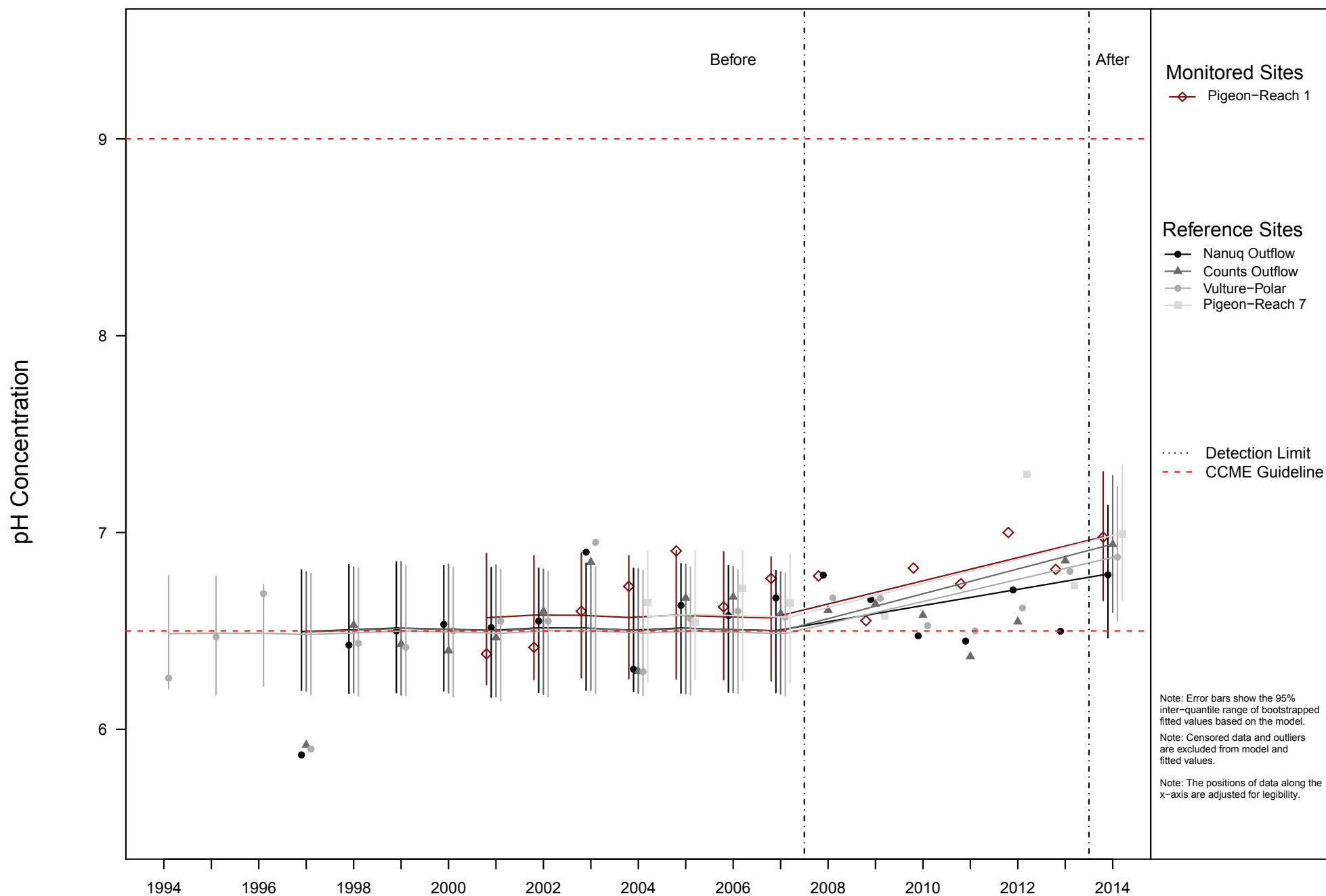
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

pH at the Pigeon-Reach 1 site were not significantly ($p = 0.619$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

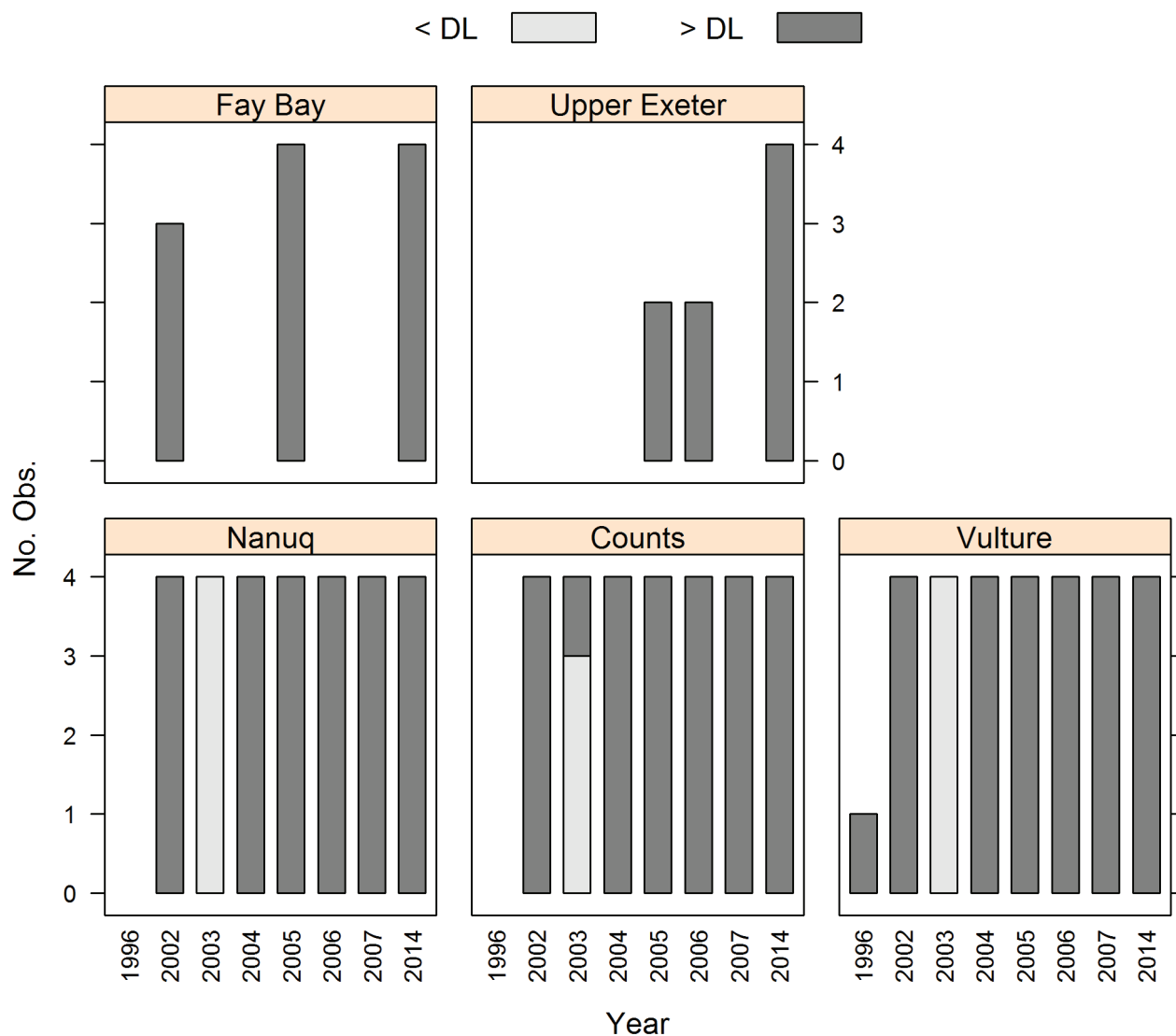


Analysis of Winter Total Alkalinity Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year month season
## 6504 Counts 2003 April winter
## 6505 Counts 2003 April winter
## 6506 Counts 2003 April winter
## 6507 Counts 2003 April winter
## 6514 Nanuq 2003 April winter
## 6515 Nanuq 2003 April winter
## 6516 Nanuq 2003 April winter
## 6517 Nanuq 2003 April winter
## 6525 Vulture 2003 April winter
## 6526 Vulture 2003 April winter
## 6527 Vulture 2003 April winter
## 6528 Vulture 2003 April winter
```

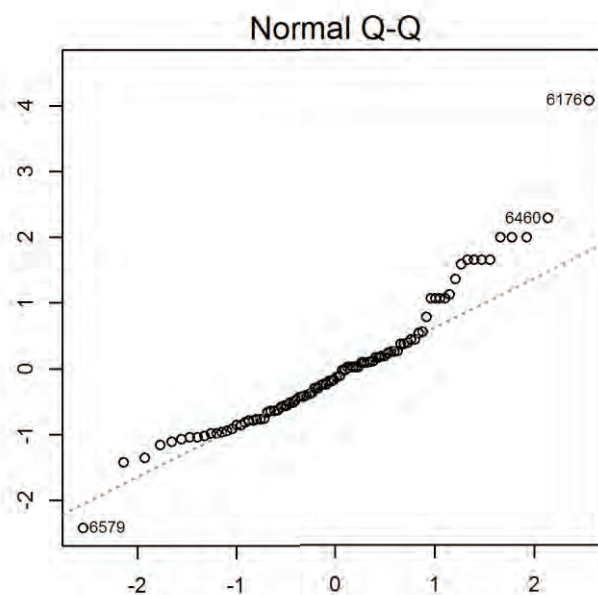
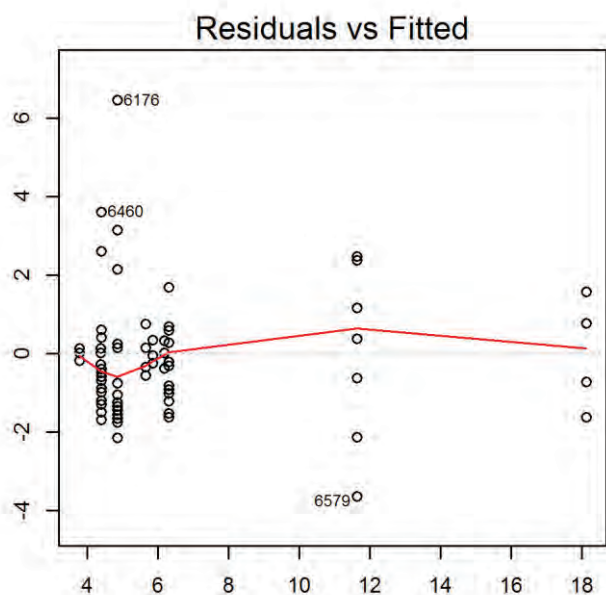
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

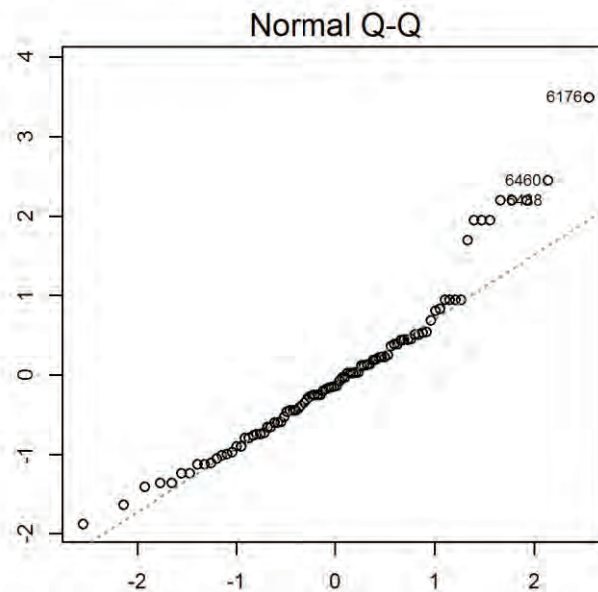
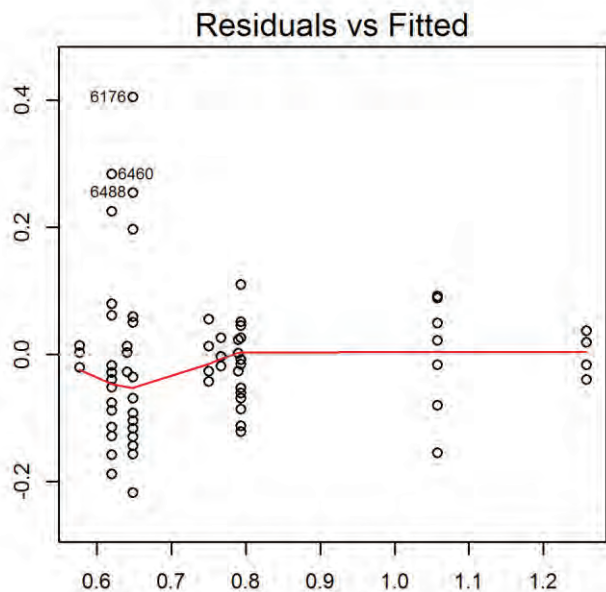
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.62	0.81	0.79
Log-10	0.12	0.68	0.65

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

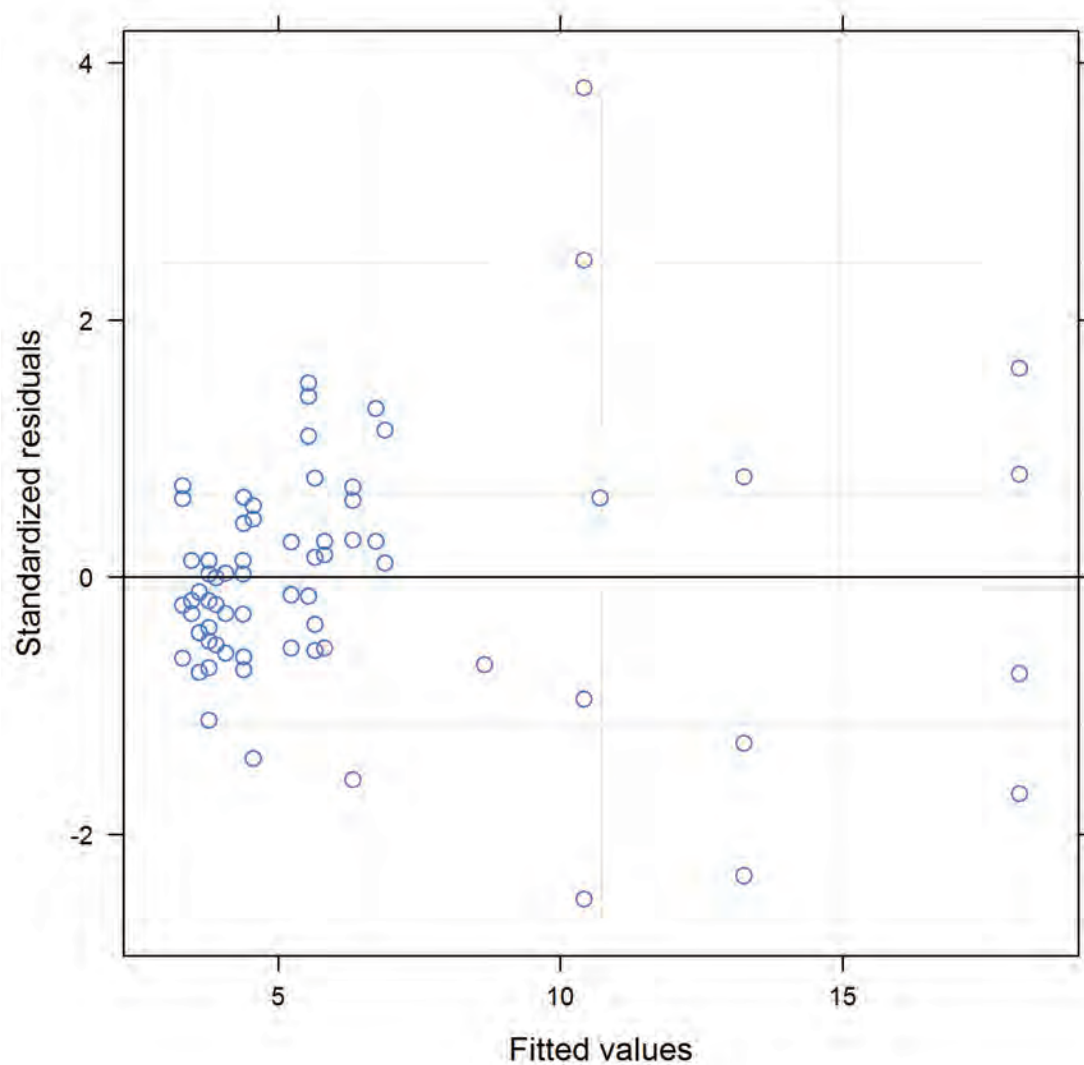
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	329.31	-155.66		
LME	10	268.36	-124.18	62.95	2.11×10 ⁻¹⁵

Conclusion:

The most appropriate model for Total Alkalinity at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	71	38	<.0001
## site	3	71	239	<.0001
## period	1	5	0	0.99
## site:period	3	71	41	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-7.84	-9.43	-6.26	sig.
Counts	-7.89	-9.44	-6.31	sig.
Vulture	-7.4	-9.02	-5.77	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total alkalinity concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

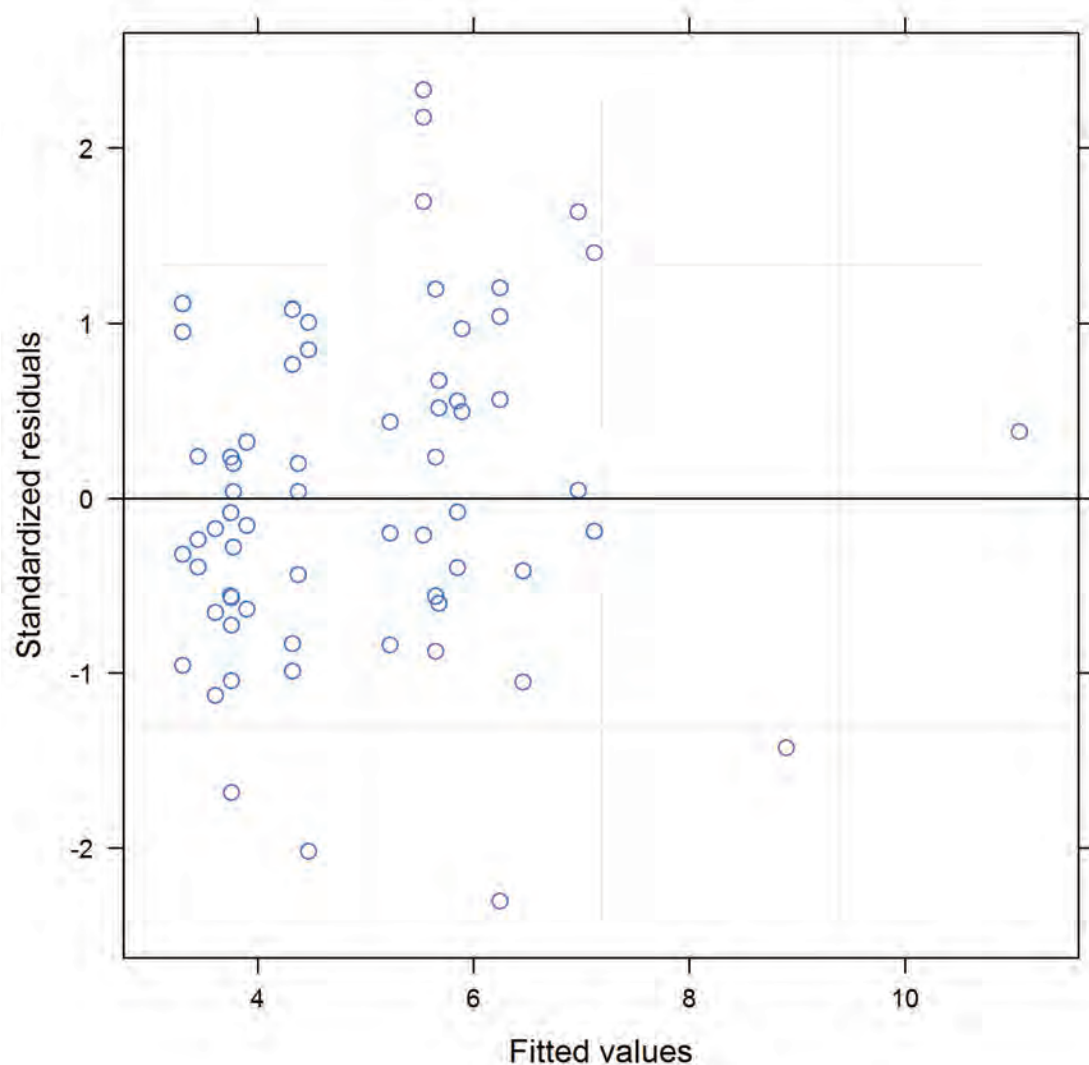
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	306.22	-144.11		
LME	10	201.12	-90.56	107.1	0

Conclusion:

The most appropriate model for Total Alkalinity at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	68	28	<.0001
## site	3	68	55	<.0001
## period	1	5	0	0.64
## site:period	3	68	0	0.69

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.06	-1.08	1.22	not sig.
Counts	0.01	-1.13	1.13	not sig.
Vulture	0.52	-0.61	1.63	not sig.

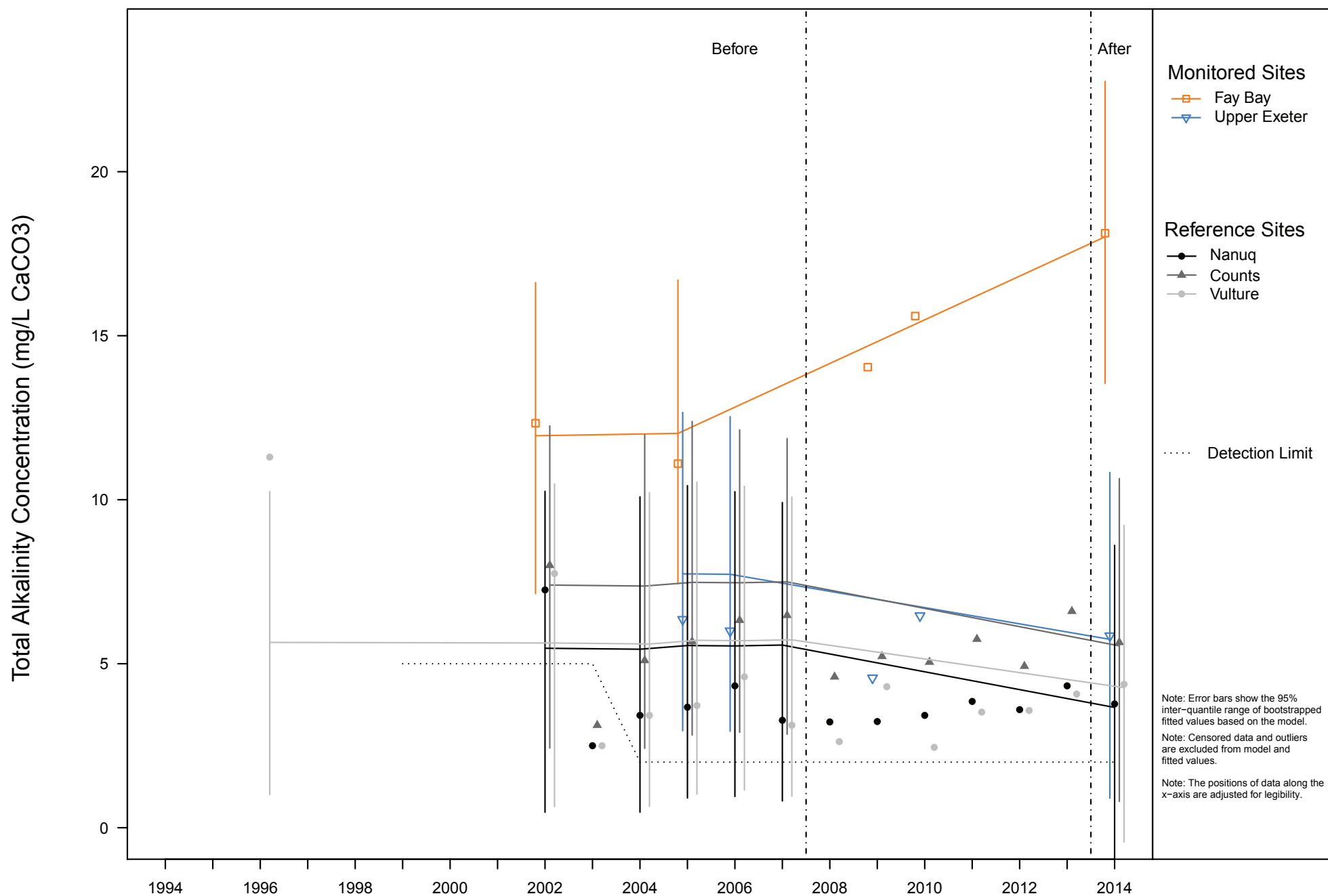
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total alkalinity concentrations at the Upper Exeter site were not significantly ($p = 0.693$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

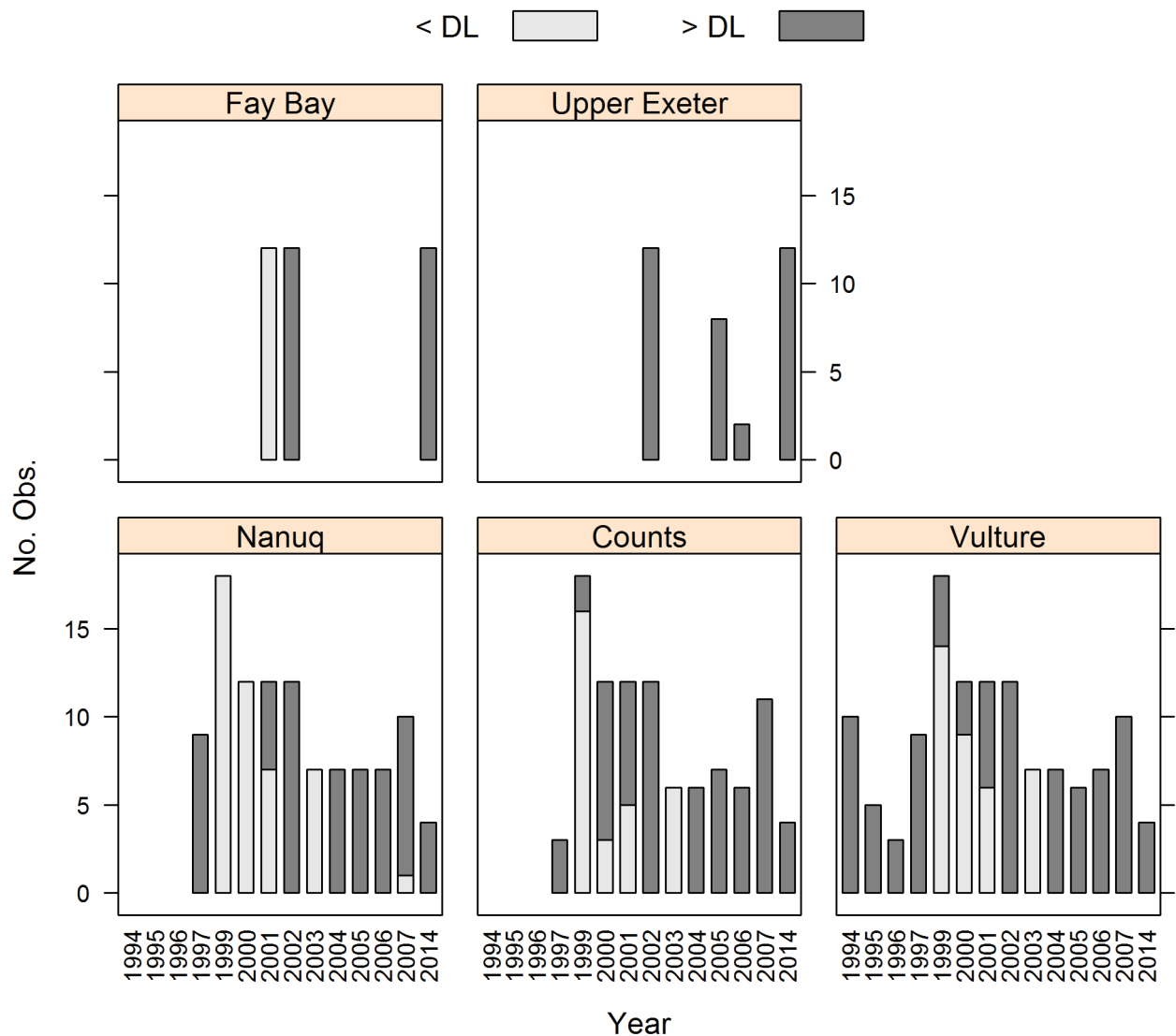


Analysis of Summer Total Alkalinity Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 6291	Counts	1999	July	summer
## 6292	Counts	1999	July	summer
## 6293	Counts	1999	July	summer
## 6294	Counts	1999	July	summer
## 6295	Counts	1999	July	summer
## 6296	Counts	1999	July	summer
## 6297	Counts	1999	August	summer
## 6298	Counts	1999	August	summer
## 6299	Counts	1999	August	summer
## 6300	Counts	1999	August	summer
## 6301	Counts	1999	August	summer
## 6302	Counts	1999	August	summer
## 6303	Counts	1999	September	summer
## 6304	Counts	1999	September	summer
## 6305	Counts	1999	September	summer
## 6306	Counts	1999	September	summer
## 6307	Counts	1999	September	summer
## 6308	Counts	1999	September	summer
## 6309	Nanuq	1999	July	summer
## 6310	Nanuq	1999	July	summer
## 6311	Nanuq	1999	July	summer
## 6312	Nanuq	1999	July	summer
## 6313	Nanuq	1999	July	summer
## 6314	Nanuq	1999	July	summer
## 6315	Nanuq	1999	August	summer
## 6316	Nanuq	1999	August	summer
## 6317	Nanuq	1999	August	summer
## 6318	Nanuq	1999	August	summer
## 6319	Nanuq	1999	August	summer
## 6320	Nanuq	1999	August	summer
## 6321	Nanuq	1999	September	summer
## 6322	Nanuq	1999	September	summer
## 6323	Nanuq	1999	September	summer
## 6324	Nanuq	1999	September	summer
## 6325	Nanuq	1999	September	summer
## 6326	Nanuq	1999	September	summer
## 6327	Vulture	1999	July	summer
## 6328	Vulture	1999	July	summer
## 6329	Vulture	1999	July	summer
## 6330	Vulture	1999	July	summer
## 6331	Vulture	1999	July	summer
## 6332	Vulture	1999	July	summer

## 6333	Vulture	1999	August	summer
## 6334	Vulture	1999	August	summer
## 6335	Vulture	1999	August	summer
## 6336	Vulture	1999	August	summer
## 6337	Vulture	1999	August	summer
## 6338	Vulture	1999	August	summer
## 6339	Vulture	1999	September	summer
## 6340	Vulture	1999	September	summer
## 6341	Vulture	1999	September	summer
## 6342	Vulture	1999	September	summer
## 6343	Vulture	1999	September	summer
## 6344	Vulture	1999	September	summer
## 6357	Nanuq	2000	July	summer
## 6358	Nanuq	2000	July	summer
## 6359	Nanuq	2000	July	summer
## 6360	Nanuq	2000	July	summer
## 6361	Nanuq	2000	August	summer
## 6362	Nanuq	2000	August	summer
## 6363	Nanuq	2000	August	summer
## 6364	Nanuq	2000	August	summer
## 6365	Nanuq	2000	September	summer
## 6366	Nanuq	2000	September	summer
## 6367	Nanuq	2000	September	summer
## 6368	Nanuq	2000	September	summer
## 6369	Vulture	2000	July	summer
## 6370	Vulture	2000	July	summer
## 6371	Vulture	2000	July	summer
## 6372	Vulture	2000	July	summer
## 6373	Vulture	2000	August	summer
## 6374	Vulture	2000	August	summer
## 6375	Vulture	2000	August	summer
## 6376	Vulture	2000	August	summer
## 6377	Vulture	2000	September	summer
## 6378	Vulture	2000	September	summer
## 6379	Vulture	2000	September	summer
## 6380	Vulture	2000	September	summer
## 6393	Fay Bay	2001	July	summer
## 6394	Fay Bay	2001	July	summer
## 6395	Fay Bay	2001	July	summer
## 6396	Fay Bay	2001	July	summer
## 6397	Fay Bay	2001	August	summer
## 6398	Fay Bay	2001	August	summer
## 6399	Fay Bay	2001	August	summer
## 6400	Fay Bay	2001	August	summer
## 6401	Fay Bay	2001	September	summer
## 6402	Fay Bay	2001	September	summer
## 6403	Fay Bay	2001	September	summer
## 6404	Fay Bay	2001	September	summer
## 6508	Counts	2003	July	summer
## 6509	Counts	2003	July	summer

```
## 6510 Counts 2003 August summer
## 6511 Counts 2003 August summer
## 6512 Counts 2003 September summer
## 6513 Counts 2003 September summer
## 6518 Nanuq 2003 July summer
## 6519 Nanuq 2003 July summer
## 6520 Nanuq 2003 August summer
## 6521 Nanuq 2003 August summer
## 6522 Nanuq 2003 August summer
## 6523 Nanuq 2003 September summer
## 6524 Nanuq 2003 September summer
## 6529 Vulture 2003 July summer
## 6530 Vulture 2003 July summer
## 6531 Vulture 2003 July summer
## 6532 Vulture 2003 August summer
## 6533 Vulture 2003 August summer
## 6534 Vulture 2003 September summer
## 6535 Vulture 2003 September summer
```

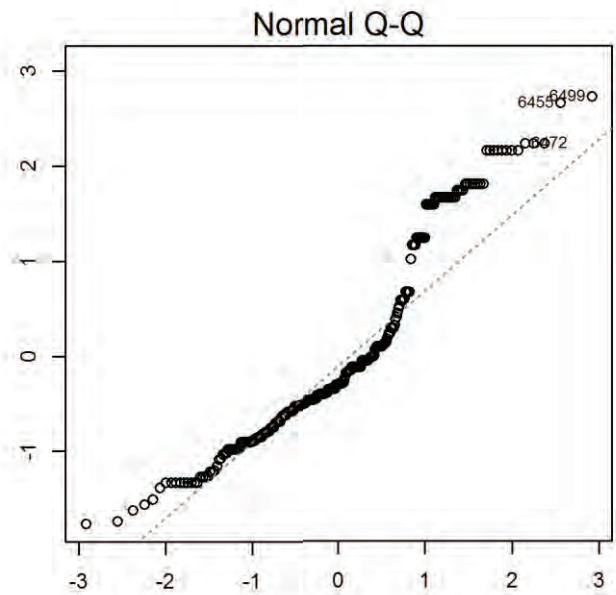
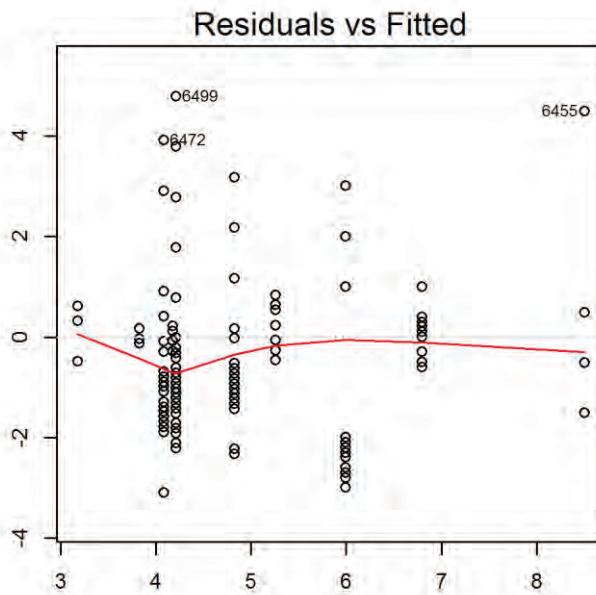
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

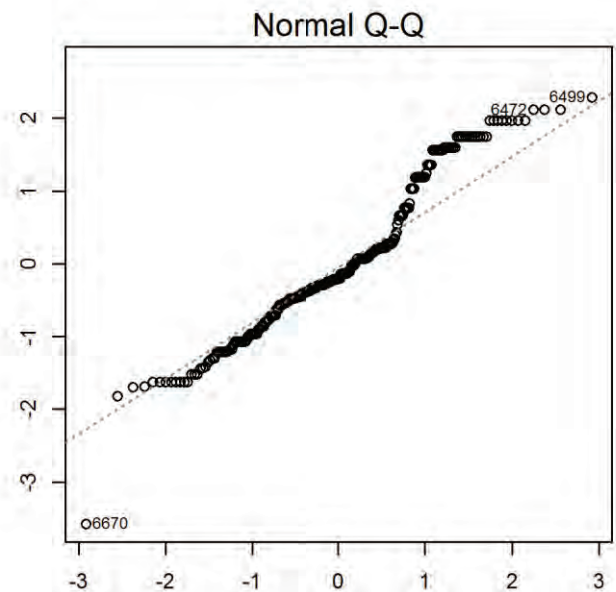
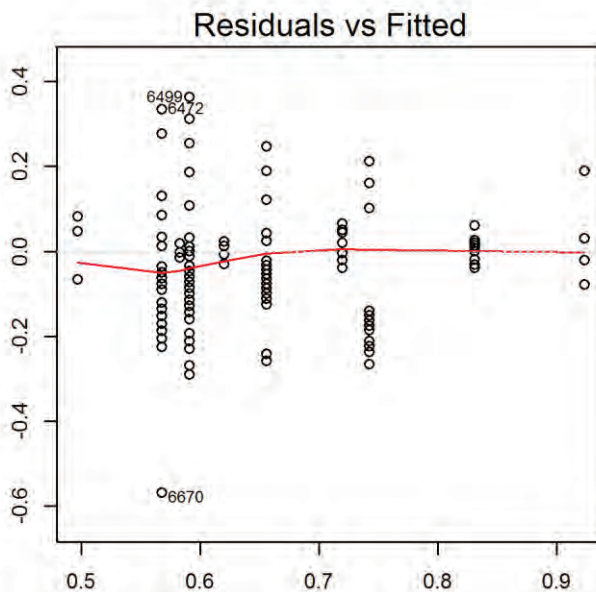
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.77	0.27	0.25
Log-10	0.16	0.25	0.23

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling

4.1 Fay Bay Monitoring Location

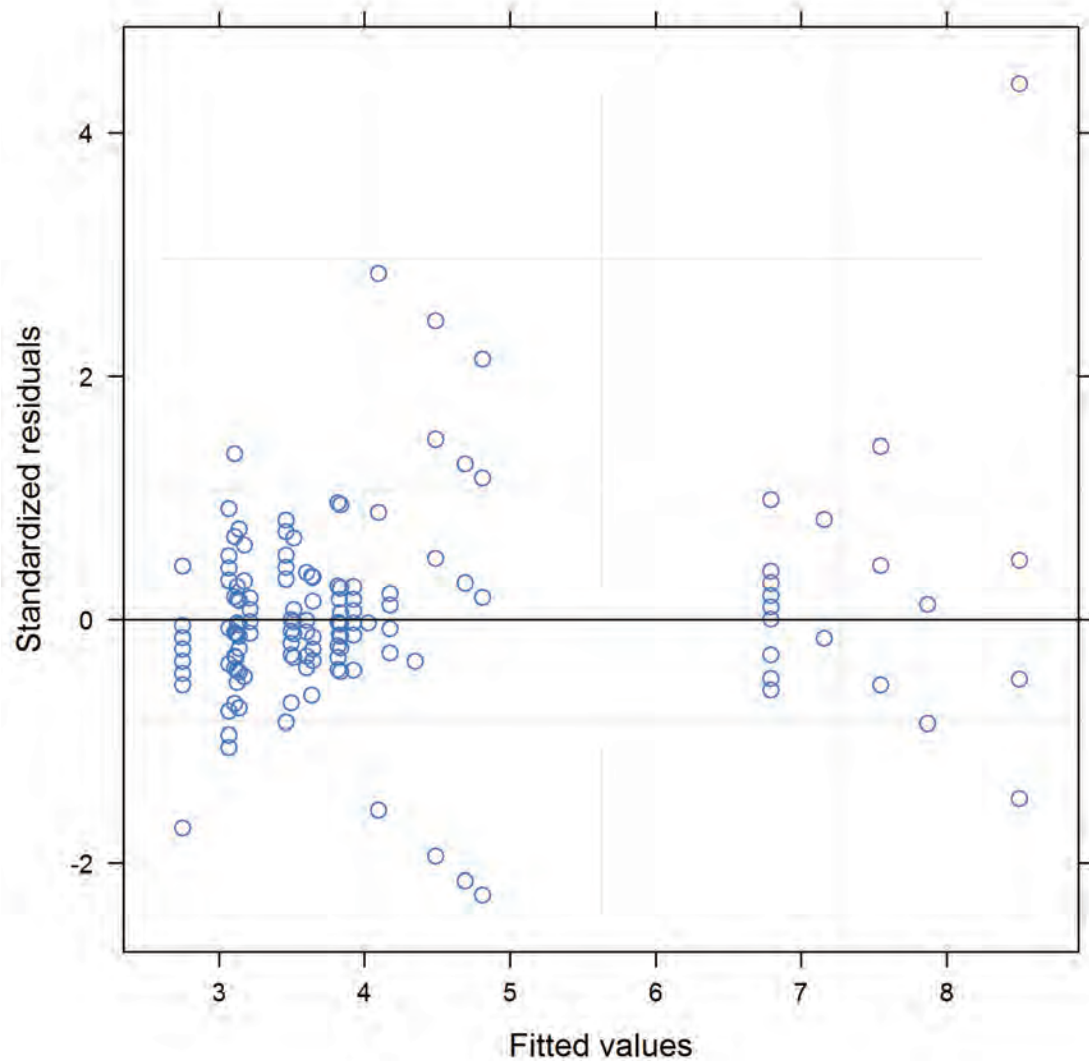
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	996.3	-489.15		
LME	10	771	-375.5	227.29	0

Conclusion:

The most appropriate model for Total Alkalinity at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	232	115	<.0001
## site	3	232	21	<.0001
## period	1	10	0	0.781
## site:period	3	232	5	0.002

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-2.27	-3.6	-0.94	sig.
Counts	-1.98	-3.25	-0.66	sig.
Vulture	-2.01	-3.31	-0.74	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total alkalinity concentrations at the Fay Bay site were significantly ($p = 0.002$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

4.2 Upper Exeter Monitoring Location

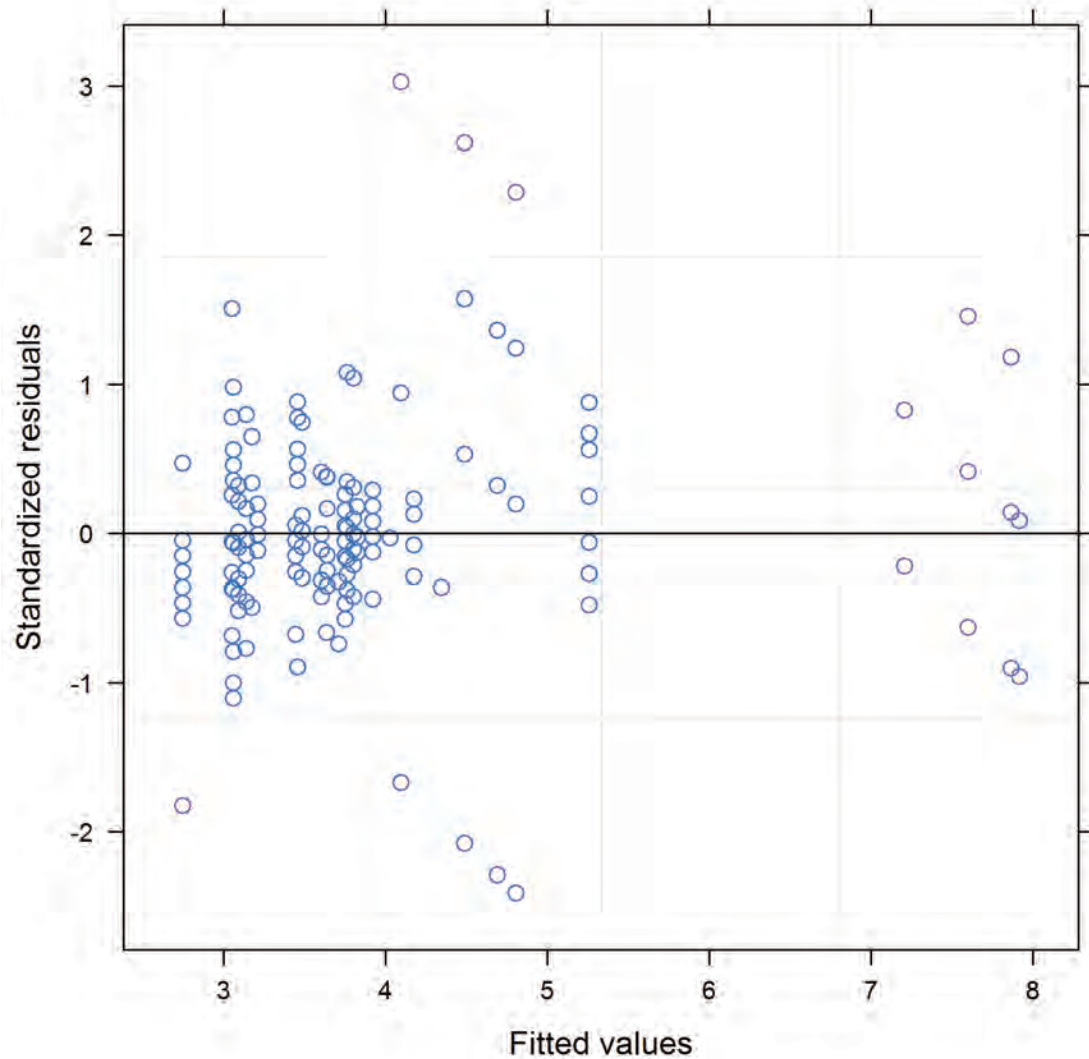
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	1054.15	-518.07		
LME	10	770.18	-375.09	285.96	0

Conclusion:

The most appropriate model for Total Alkalinity at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	242	108	<.0001
## site	3	242	9	<.0001
## period	1	10	0	0.872
## site:period	3	242	3	0.057

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-1.43	-2.63	-0.22	sig.
Counts	-1.14	-2.33	0.04	not sig.
Vulture	-1.17	-2.34	0	not sig.

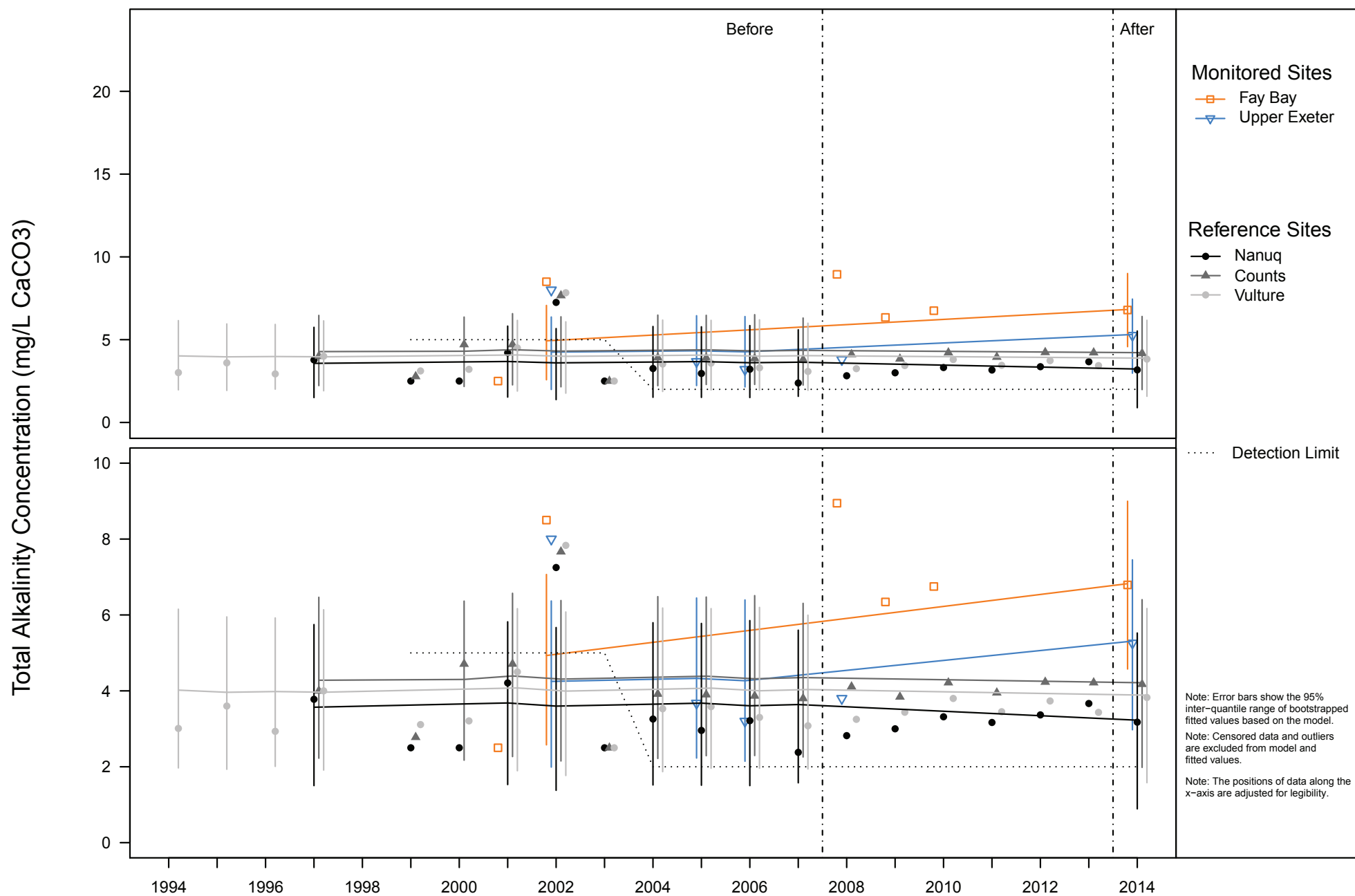
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total alkalinity concentrations at the Upper Exeter site were not significantly ($p = 0.057$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

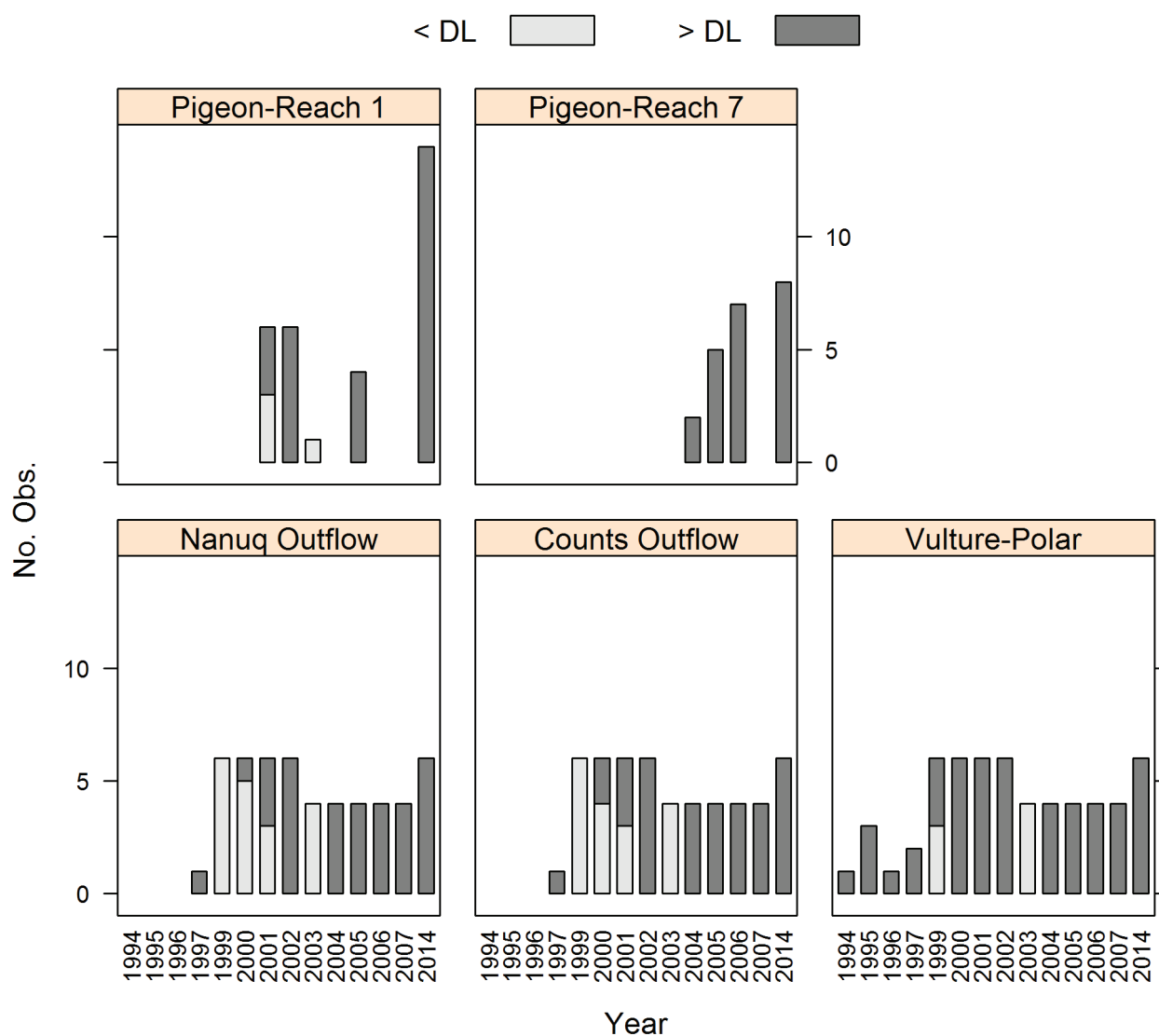


Analysis of Summer Total Alkalinity Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##		site	year	month	season
## 4368	Counts	Outflow	1999	August	summer
## 4369	Counts	Outflow	1999	August	summer
## 4370	Counts	Outflow	1999	August	summer
## 4371	Counts	Outflow	1999	September	summer
## 4372	Counts	Outflow	1999	September	summer
## 4373	Counts	Outflow	1999	September	summer
## 4377	Nanuq	Outflow	1999	August	summer
## 4378	Nanuq	Outflow	1999	August	summer
## 4379	Nanuq	Outflow	1999	August	summer
## 4380	Nanuq	Outflow	1999	September	summer
## 4381	Nanuq	Outflow	1999	September	summer
## 4382	Nanuq	Outflow	1999	September	summer
## 4395	Counts	Outflow	2000	August	summer
## 4396	Counts	Outflow	2000	August	summer
## 4397	Counts	Outflow	2000	August	summer
## 4398	Counts	Outflow	2000	September	summer
## 4399	Counts	Outflow	2000	September	summer
## 4400	Counts	Outflow	2000	September	summer
## 4404	Nanuq	Outflow	2000	August	summer
## 4405	Nanuq	Outflow	2000	August	summer
## 4406	Nanuq	Outflow	2000	August	summer
## 4407	Nanuq	Outflow	2000	September	summer
## 4408	Nanuq	Outflow	2000	September	summer
## 4409	Nanuq	Outflow	2000	September	summer
## 4492	Counts	Outflow	2003	August	summer
## 4493	Counts	Outflow	2003	August	summer
## 4494	Counts	Outflow	2003	September	summer
## 4495	Counts	Outflow	2003	September	summer
## 4498	Nanuq	Outflow	2003	August	summer
## 4499	Nanuq	Outflow	2003	August	summer
## 4500	Nanuq	Outflow	2003	September	summer
## 4501	Nanuq	Outflow	2003	September	summer
## 4503	Pigeon-Reach 1		2003	September	summer
## 4506	Vulture-Polar		2003	August	summer
## 4507	Vulture-Polar		2003	August	summer
## 4508	Vulture-Polar		2003	September	summer
## 4509	Vulture-Polar		2003	September	summer

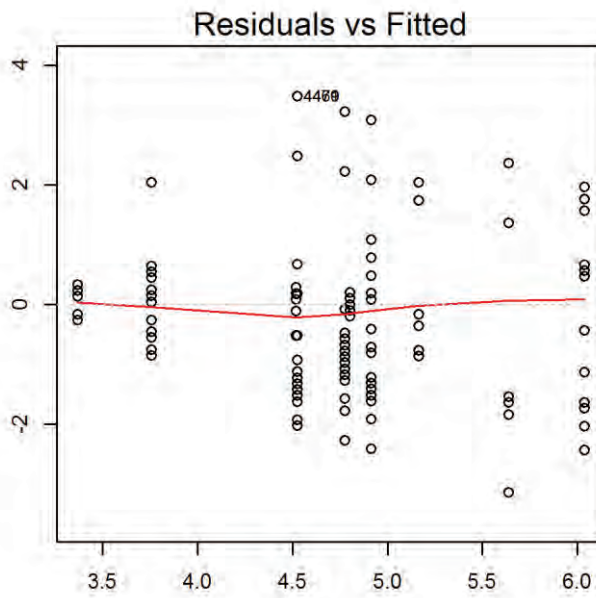
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

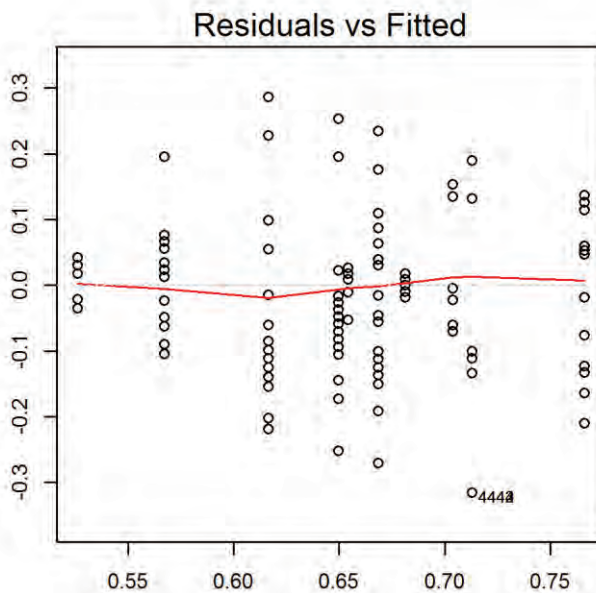
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.66	0.12	0.08
Log-10	0.15	0.13	0.08

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

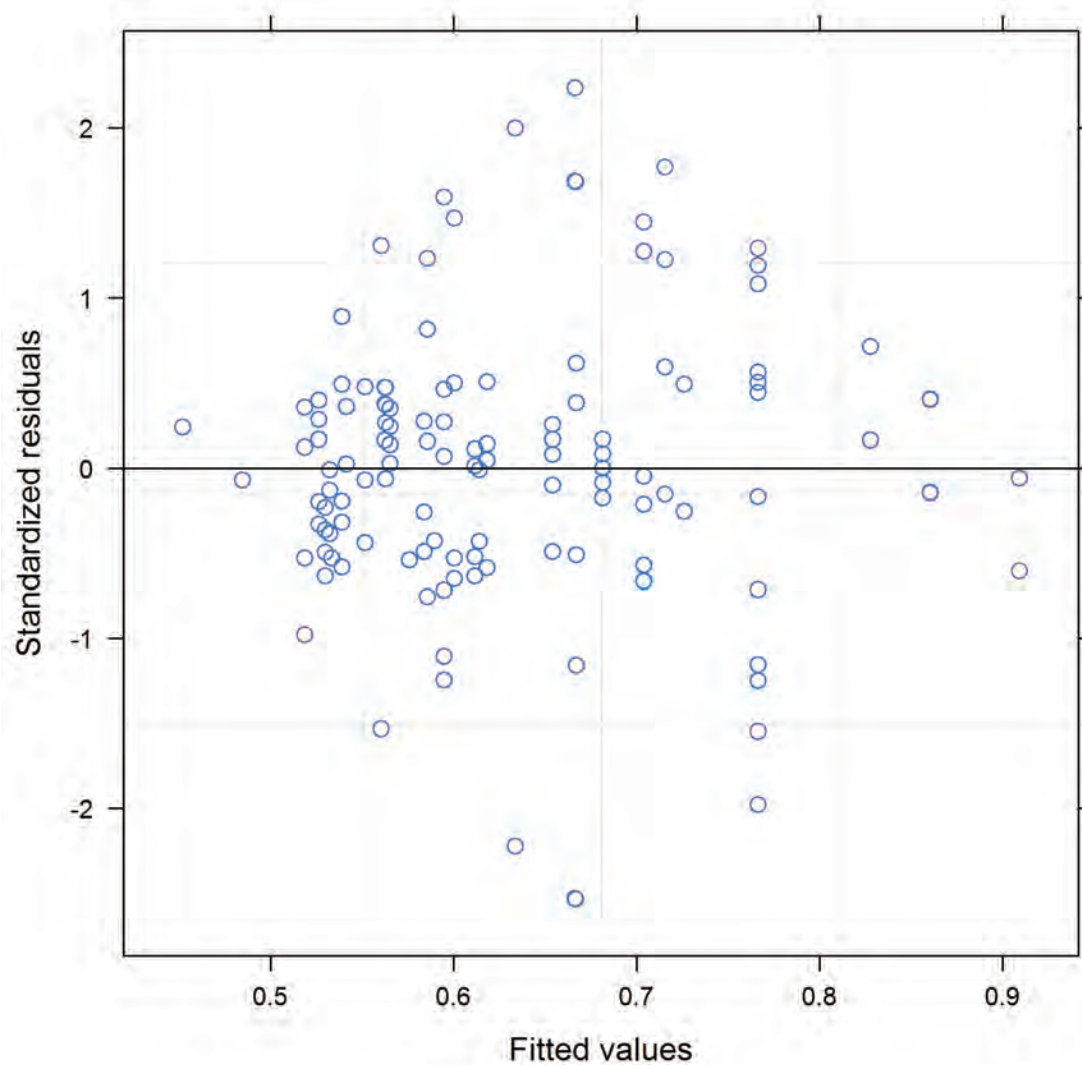
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-116.69	69.34		
LME	12	-198.51	111.26	83.83	0

Conclusion:

The most appropriate model for Total Alkalinity at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	154	333	<.0001
## site	4	154	4	0.002
## period	1	11	0	0.524
## site:period	4	154	4	0.007

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.21	-0.33	-0.08	sig.
Counts Outflow	-0.09	-0.2	0.03	not sig.
Vulture-Polar	-0.16	-0.28	-0.05	sig.
Pigeon-Reach 7	-0.04	-0.16	0.08	not sig.

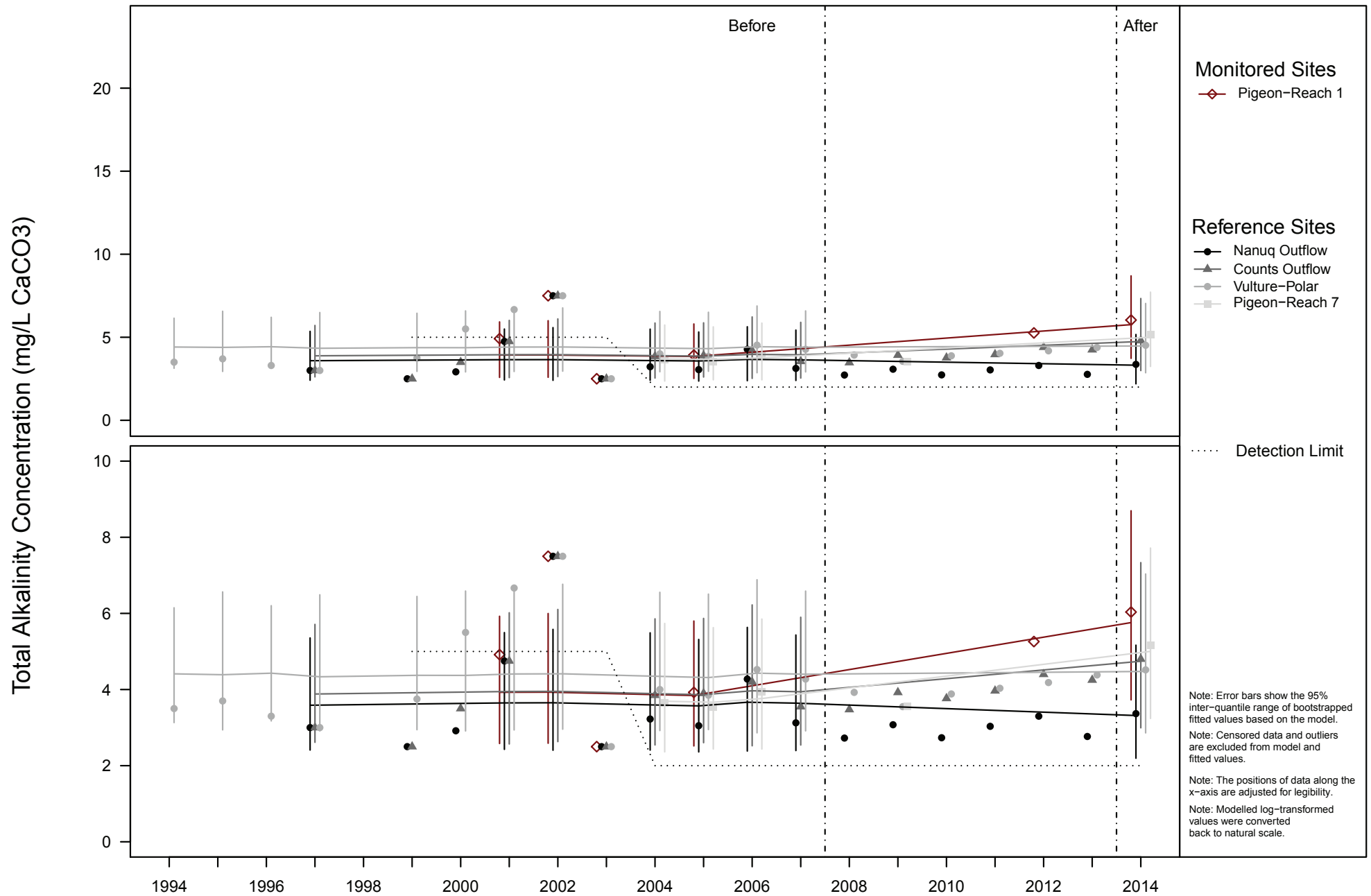
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total alkalinity concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.007$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

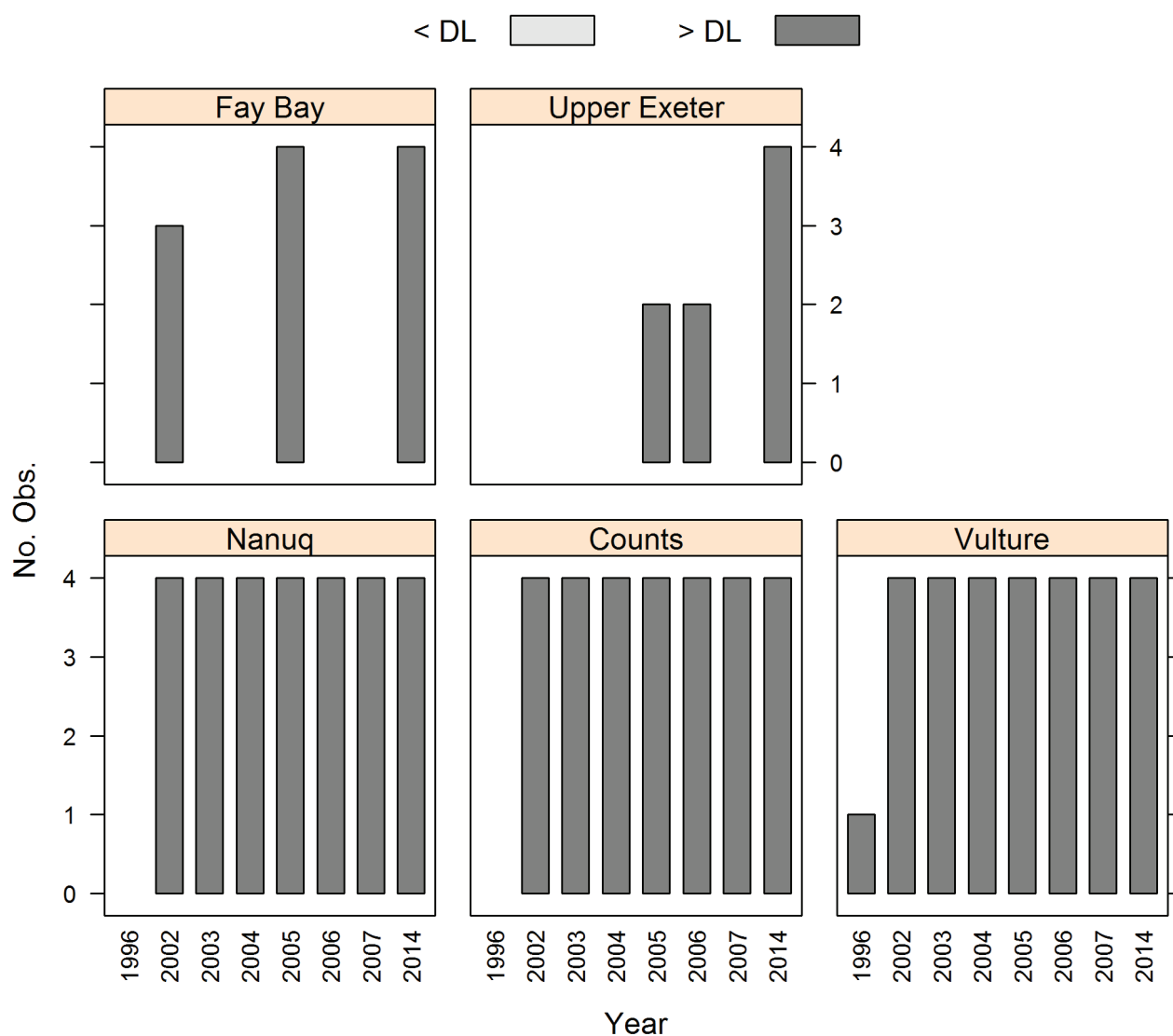


Analysis of Winter Water Hardness Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

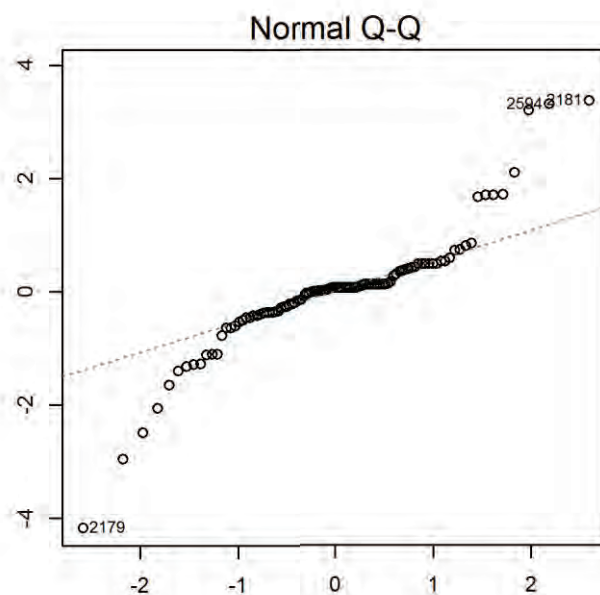
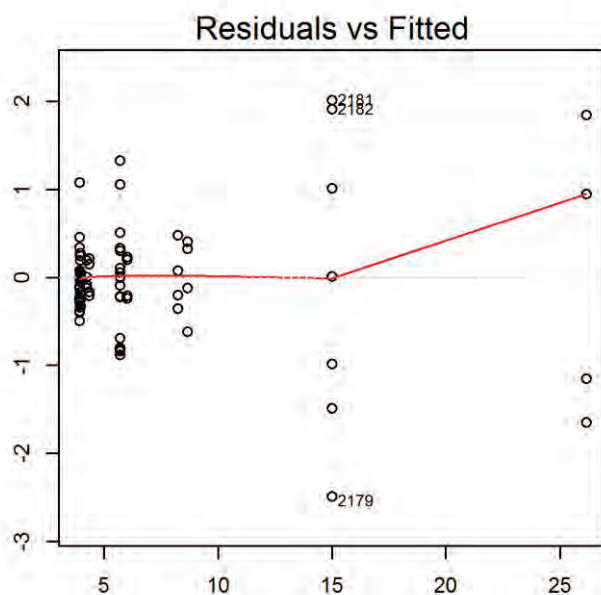
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

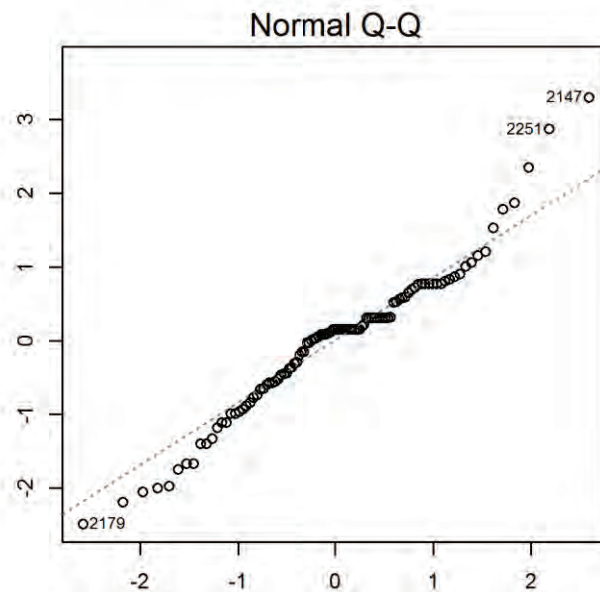
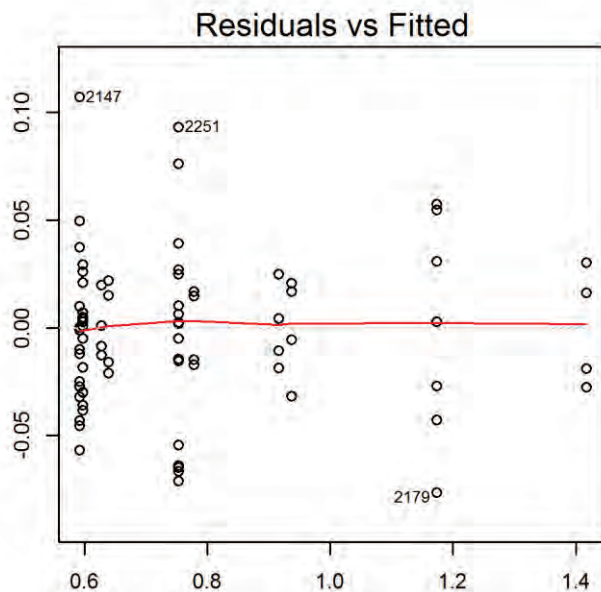
```
##      site year month season
## 1776 Vulture 1996 April winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.64	0.98	0.98
Log-10	0.03	0.98	0.98

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

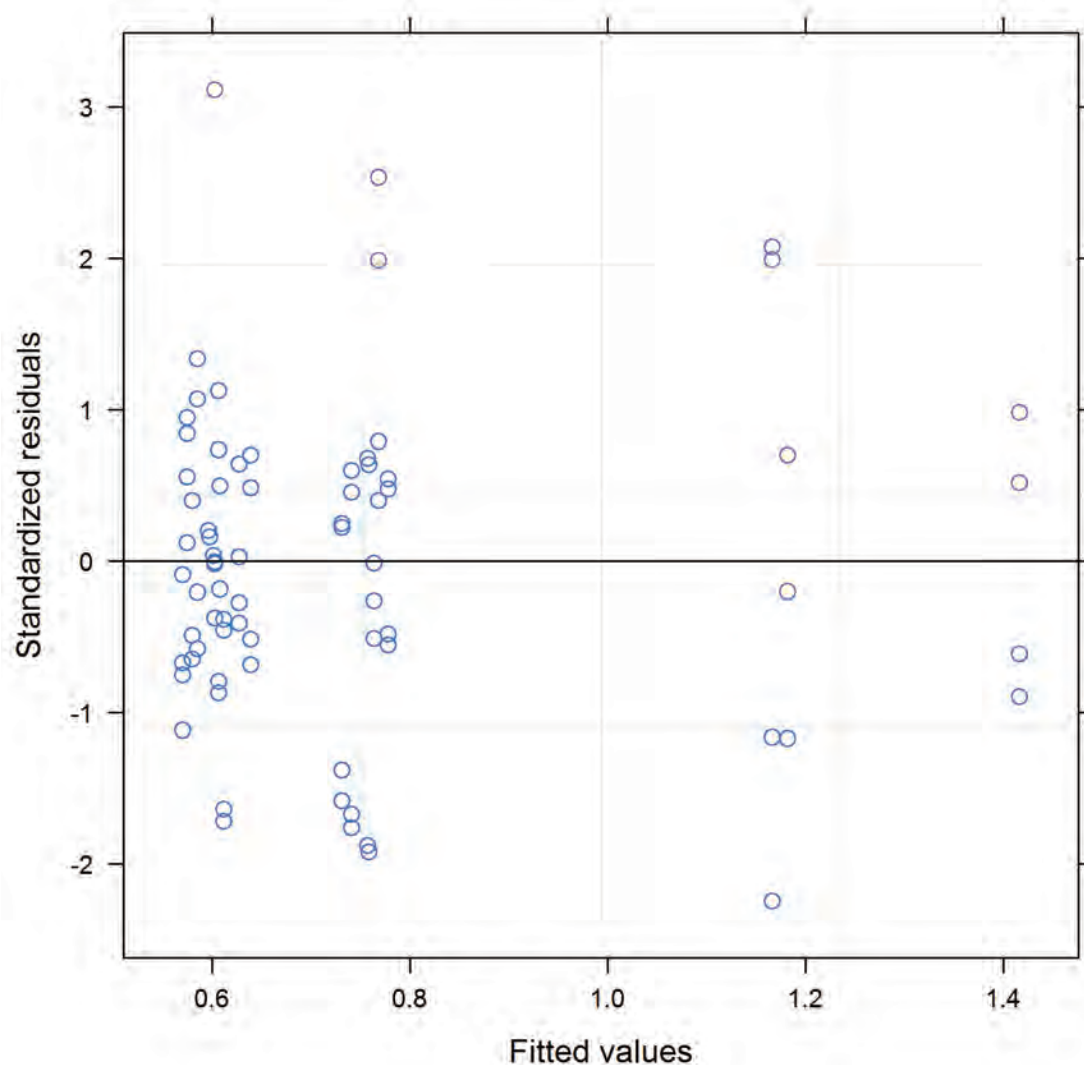
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-307.44	162.72		
LME	10	-313.54	166.77	8.1	0

Conclusion:

The most appropriate model for Water Hardness at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p = 0.004$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	82	10752	<.0001
## site	3	82	1271	<.0001
## period	1	5	14	0.013
## site:period	3	82	29	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.19	-0.24	-0.14	sig.
Counts	-0.21	-0.26	-0.16	sig.
Vulture	-0.21	-0.26	-0.15	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Water hardness concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

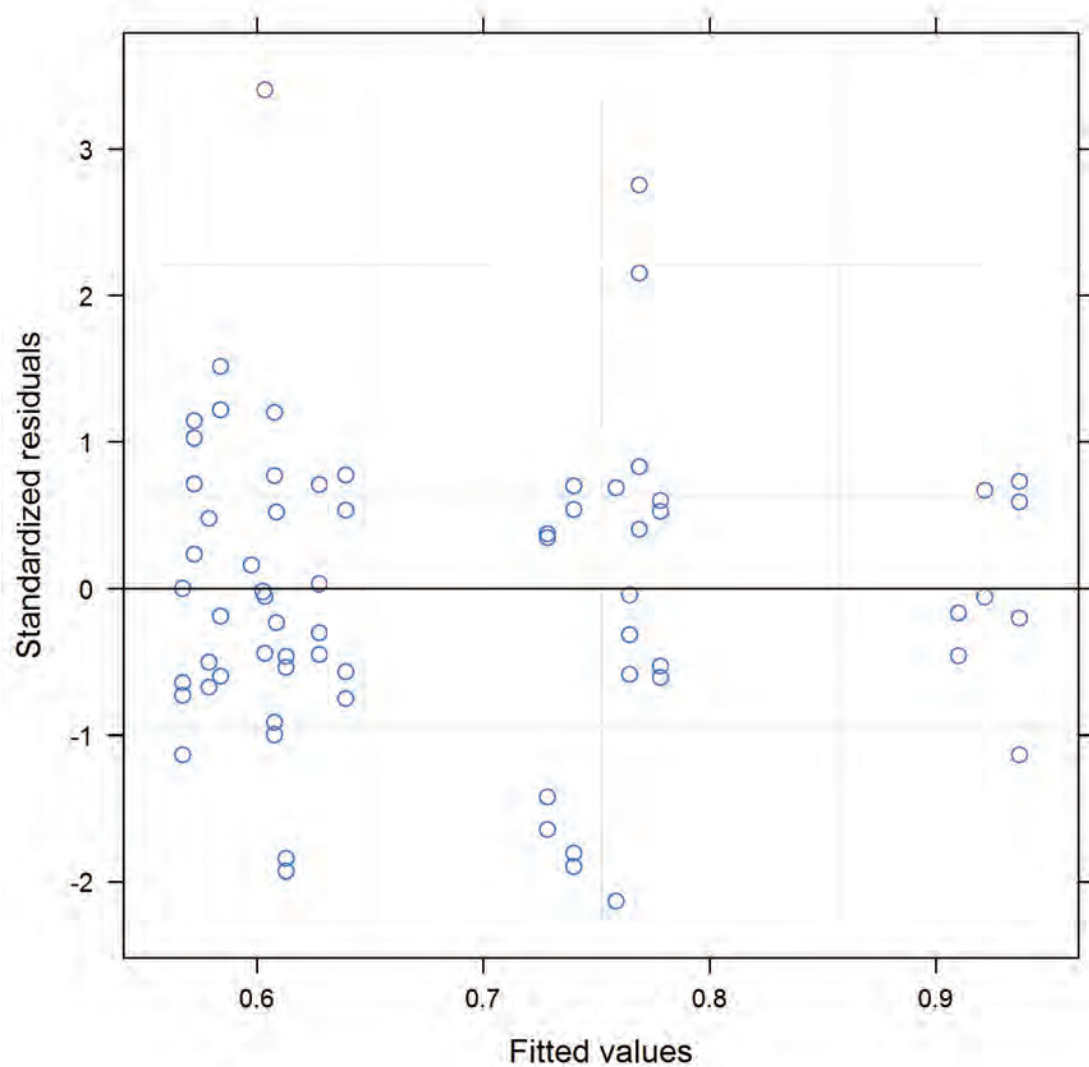
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-307.07	162.54		
LME	10	-316.83	168.41	11.75	6.08×10^{-4}

Conclusion:

The most appropriate model for Water Hardness at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	8812	<.0001
## site	3	79	404	<.0001
## period	1	5	2	0.21
## site:period	3	79	1	0.36

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.04	0	0.09	not sig.
Counts	0.02	-0.03	0.07	not sig.
Vulture	0.03	-0.02	0.08	not sig.

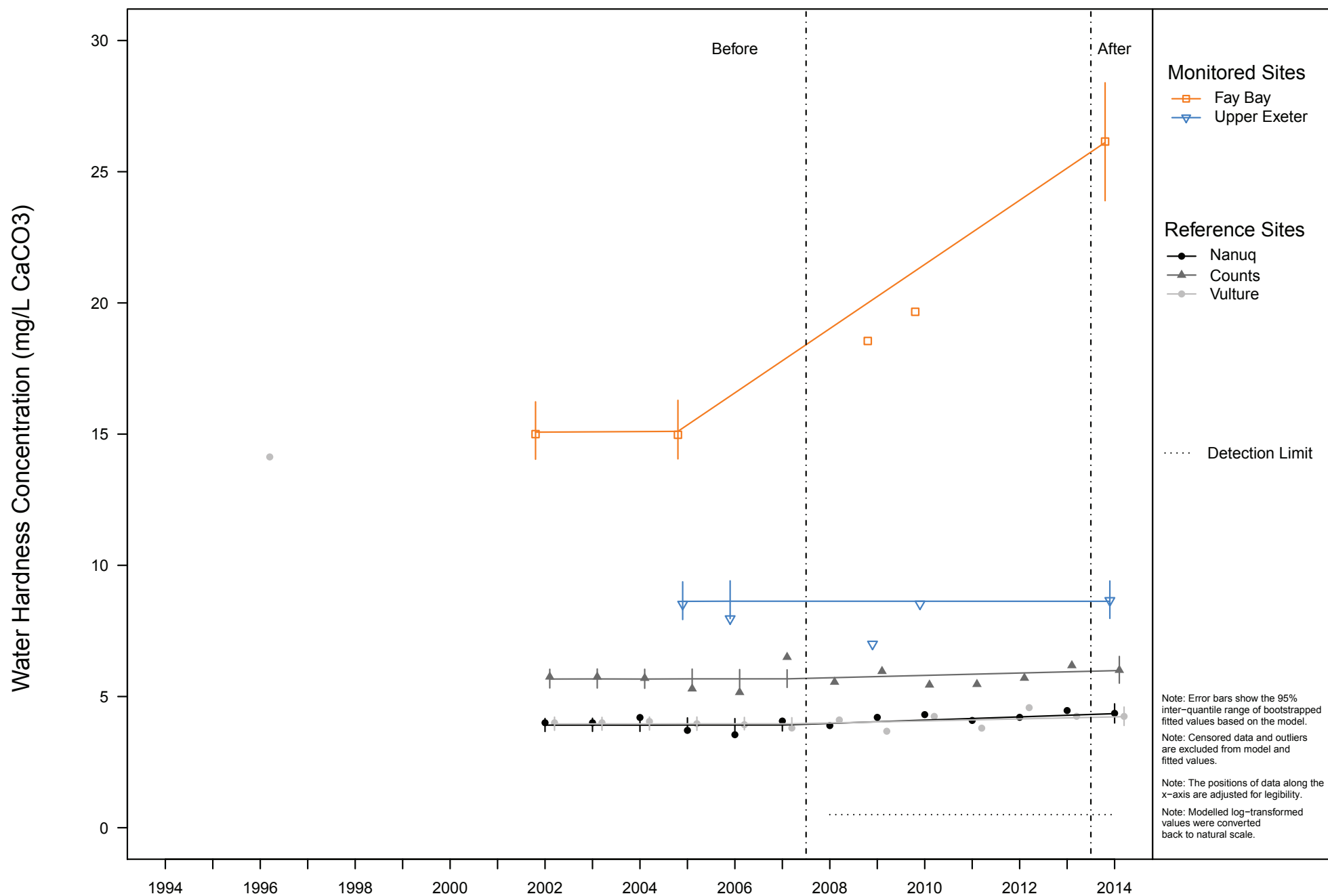
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Water hardness concentrations at the Upper Exeter site were not significantly ($p = 0.36$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

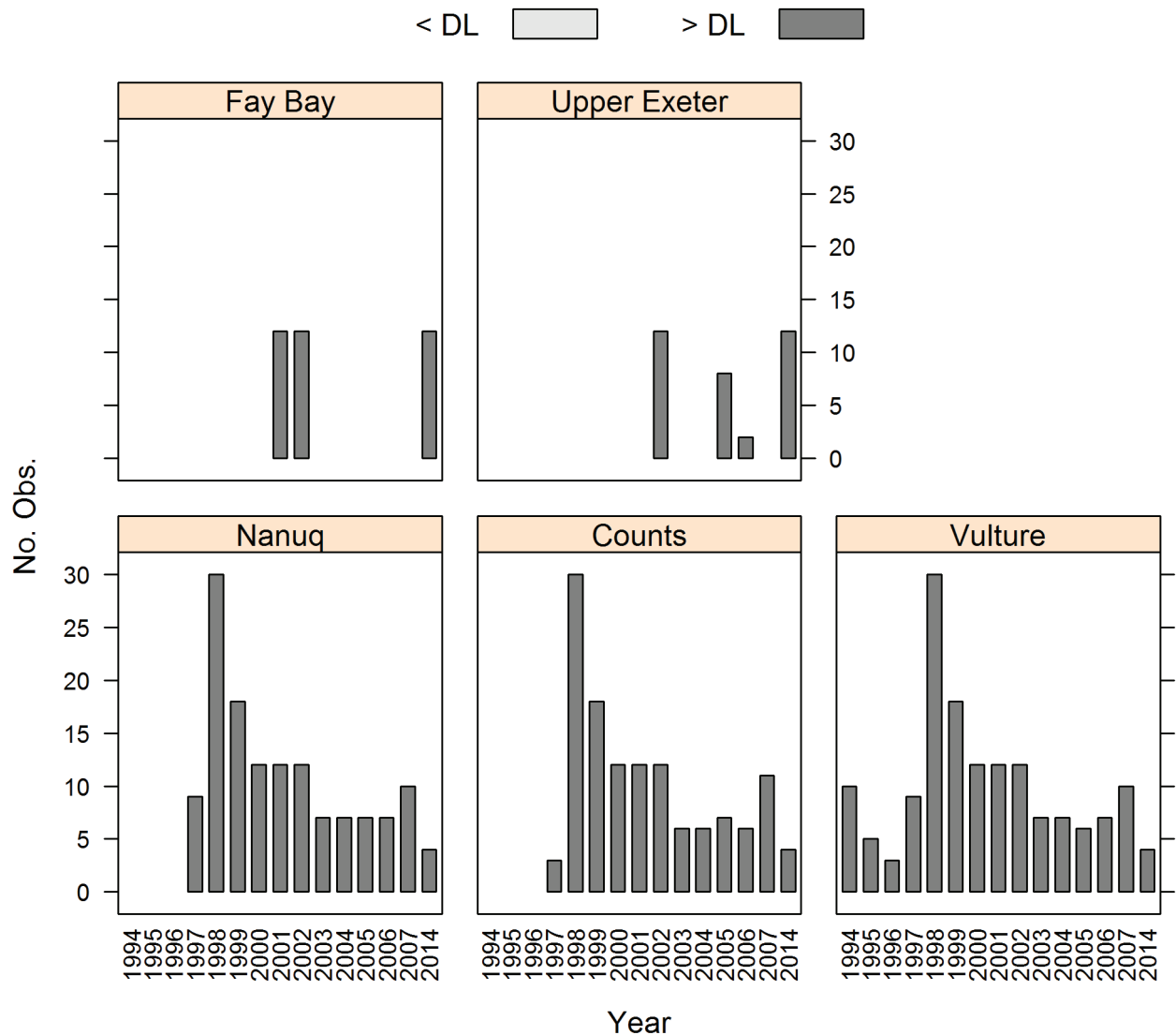


Analysis of Summer Water Hardness Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

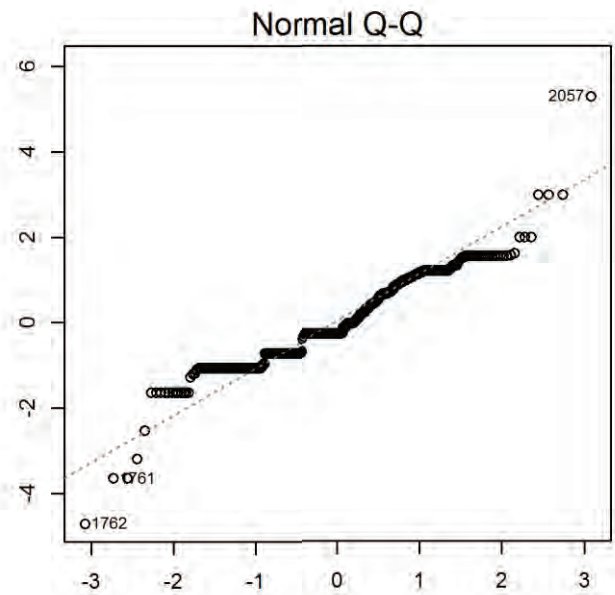
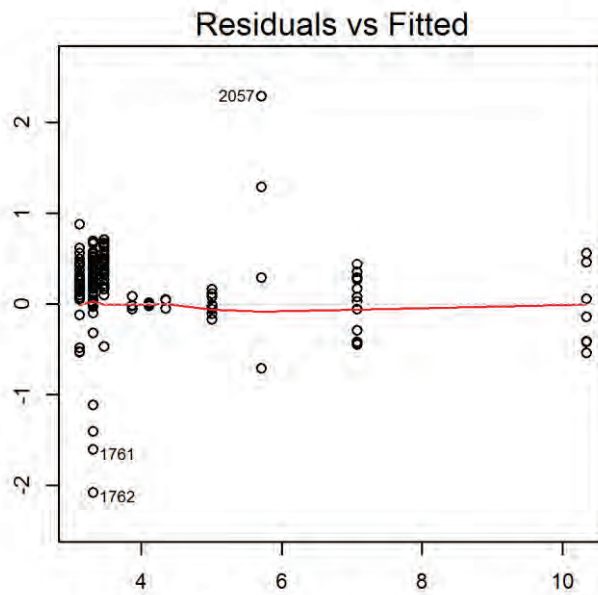
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

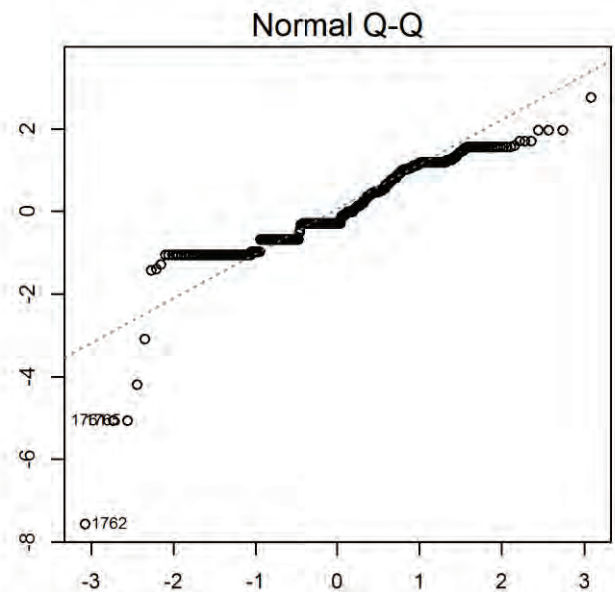
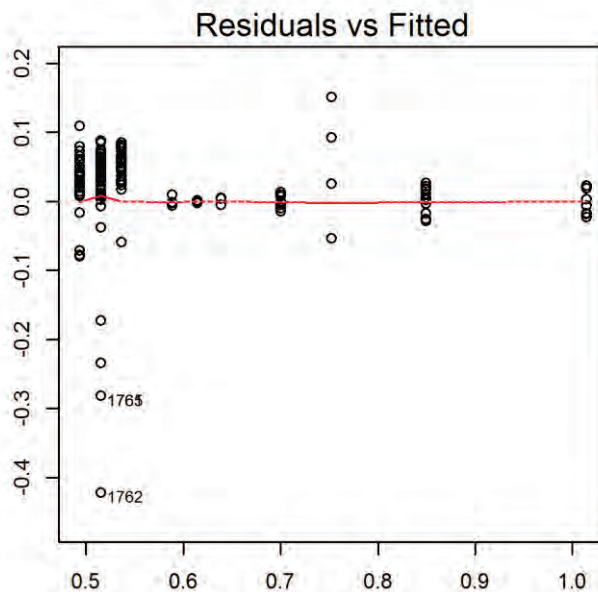
```
##      site year  month season
## 2099 Vulture 2002 August  summer
## 2190  Nanuq 2005 August  summer
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.44	0.9	0.9
Log-10	0.06	0.8	0.79

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

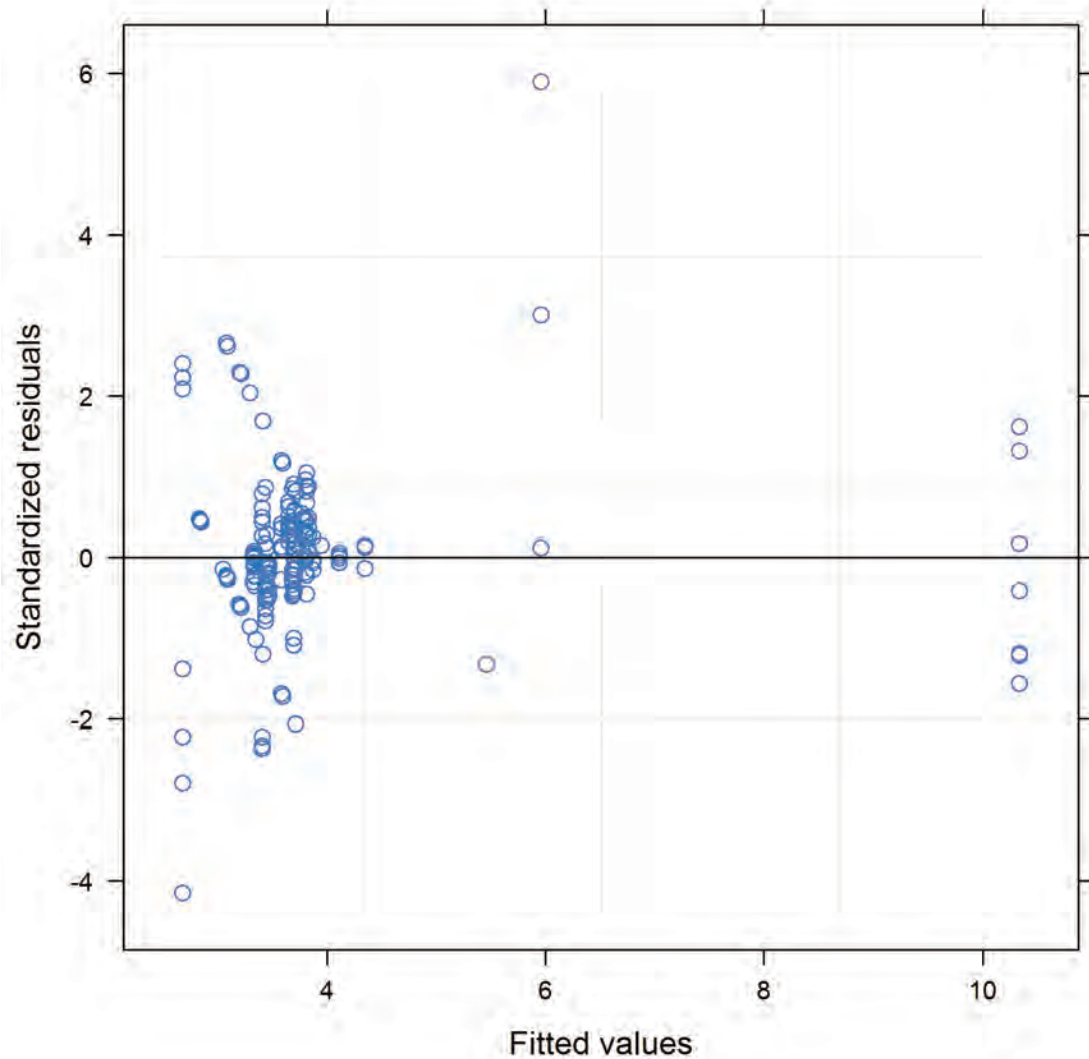
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	597.24	-289.62		
LME	10	399.02	-189.51	200.22	0

Conclusion:

The most appropriate model for Water Hardness at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	427	1655	<.0001
## site	3	427	806	<.0001
## period	1	13	37	<.0001
## site:period	3	427	183	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-3.86	-4.28	-3.43	sig.
Counts	-3.75	-4.17	-3.32	sig.
Vulture	-3.86	-4.29	-3.43	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Water hardness concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

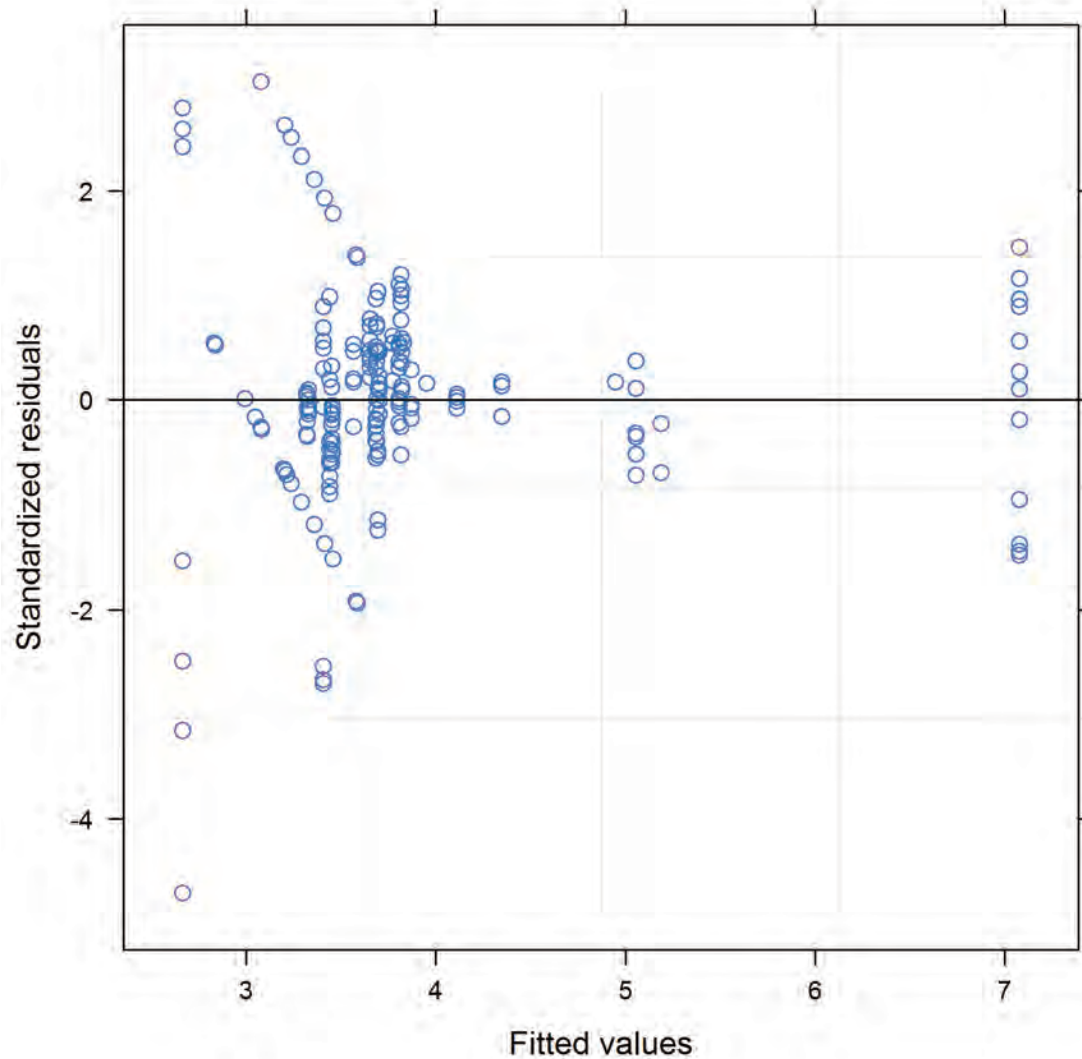
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	501.75	-241.87		
LME	10	283.61	-131.8	220.14	0

Conclusion:

The most appropriate model for Water Hardness at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	425	1681	<.0001
## site	3	425	340	<.0001
## period	1	13	14	0.0026
## site:period	3	425	33	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-1.47	-1.84	-1.1	sig.
Counts	-1.36	-1.72	-1	sig.
Vulture	-1.48	-1.85	-1.08	sig.

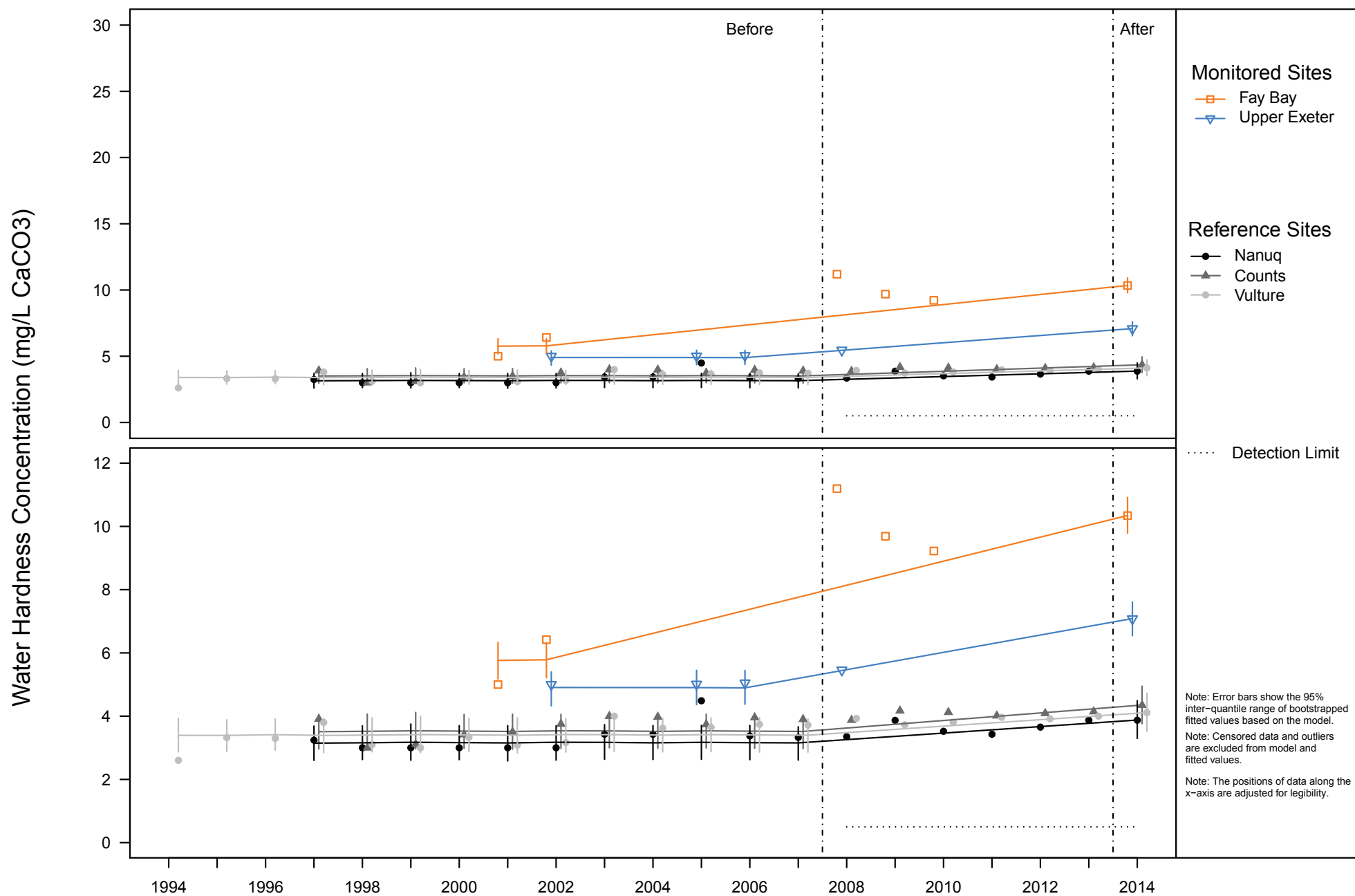
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Water hardness concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

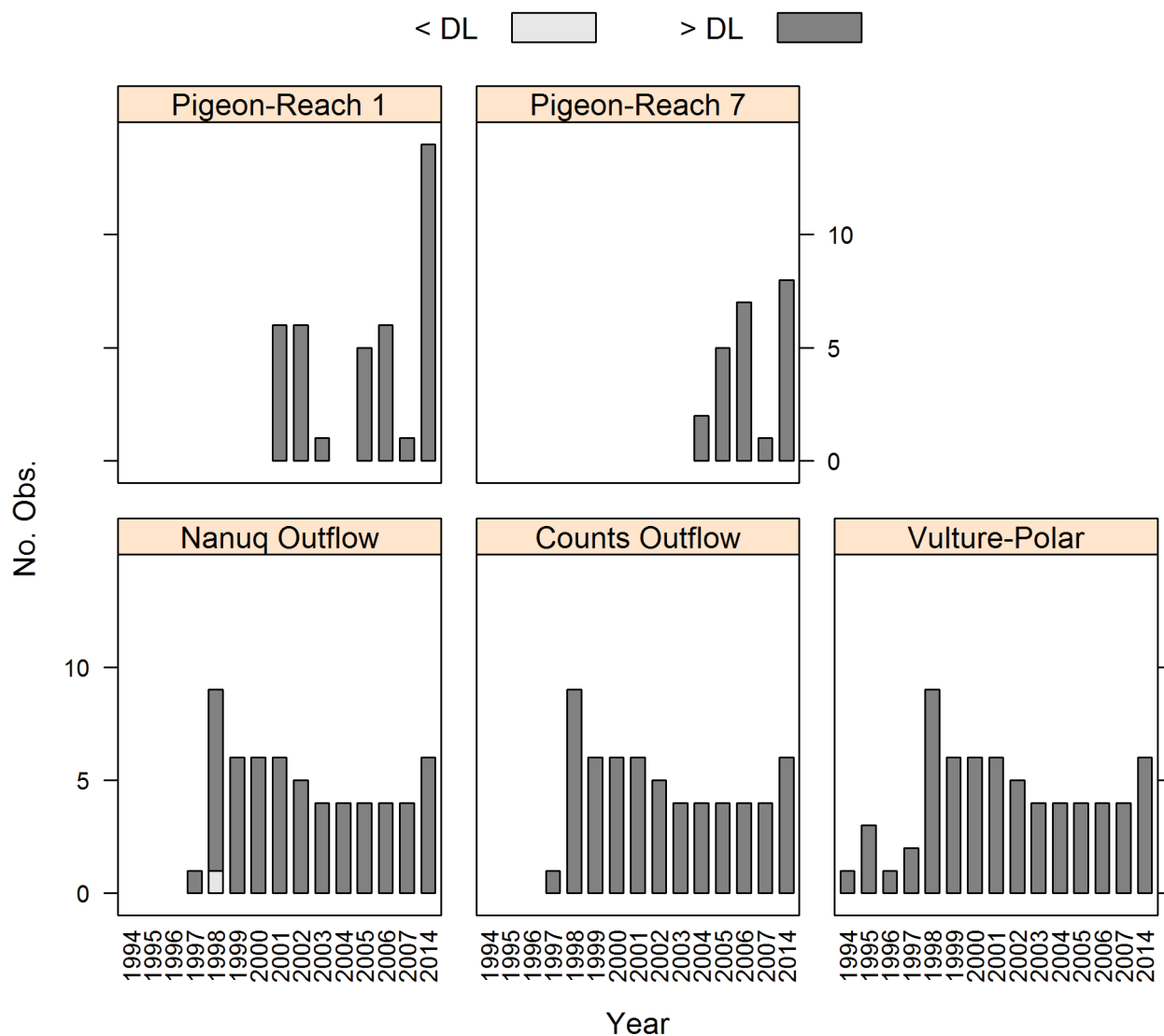


Analysis of Summer Water Hardness Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

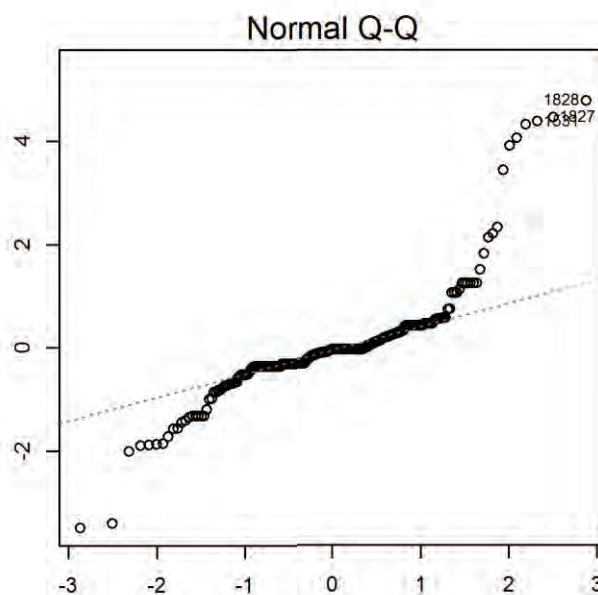
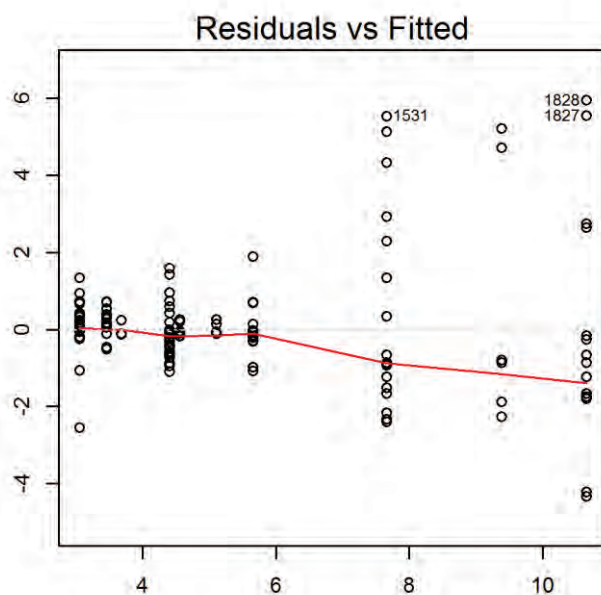
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

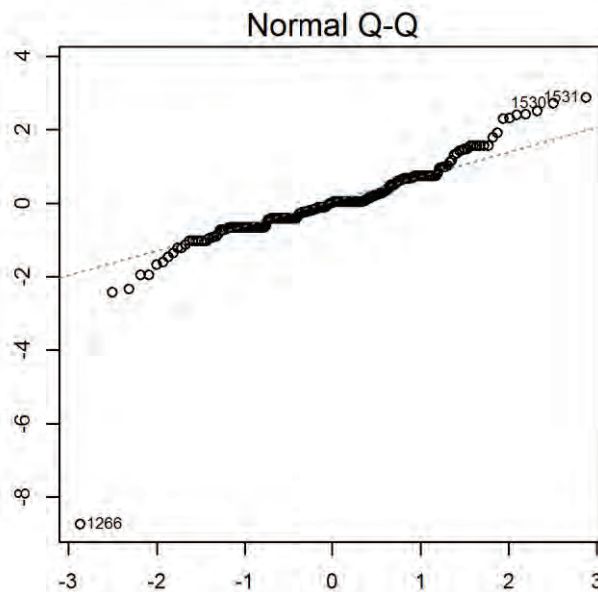
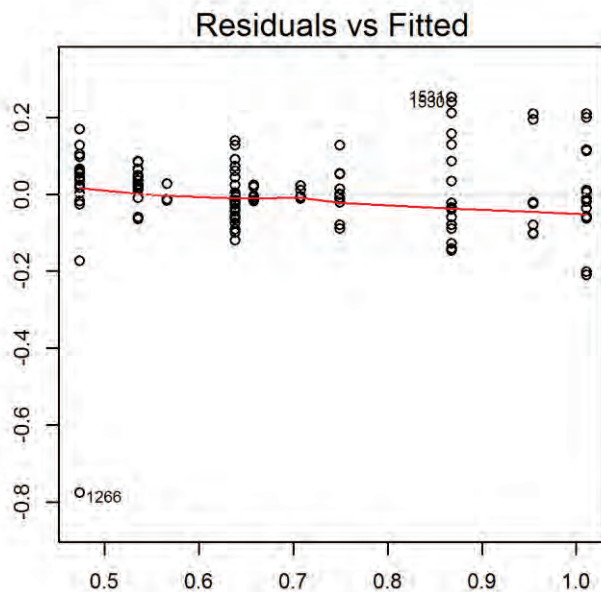
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.29	0.74	0.73
Log-10	0.09	0.77	0.76

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

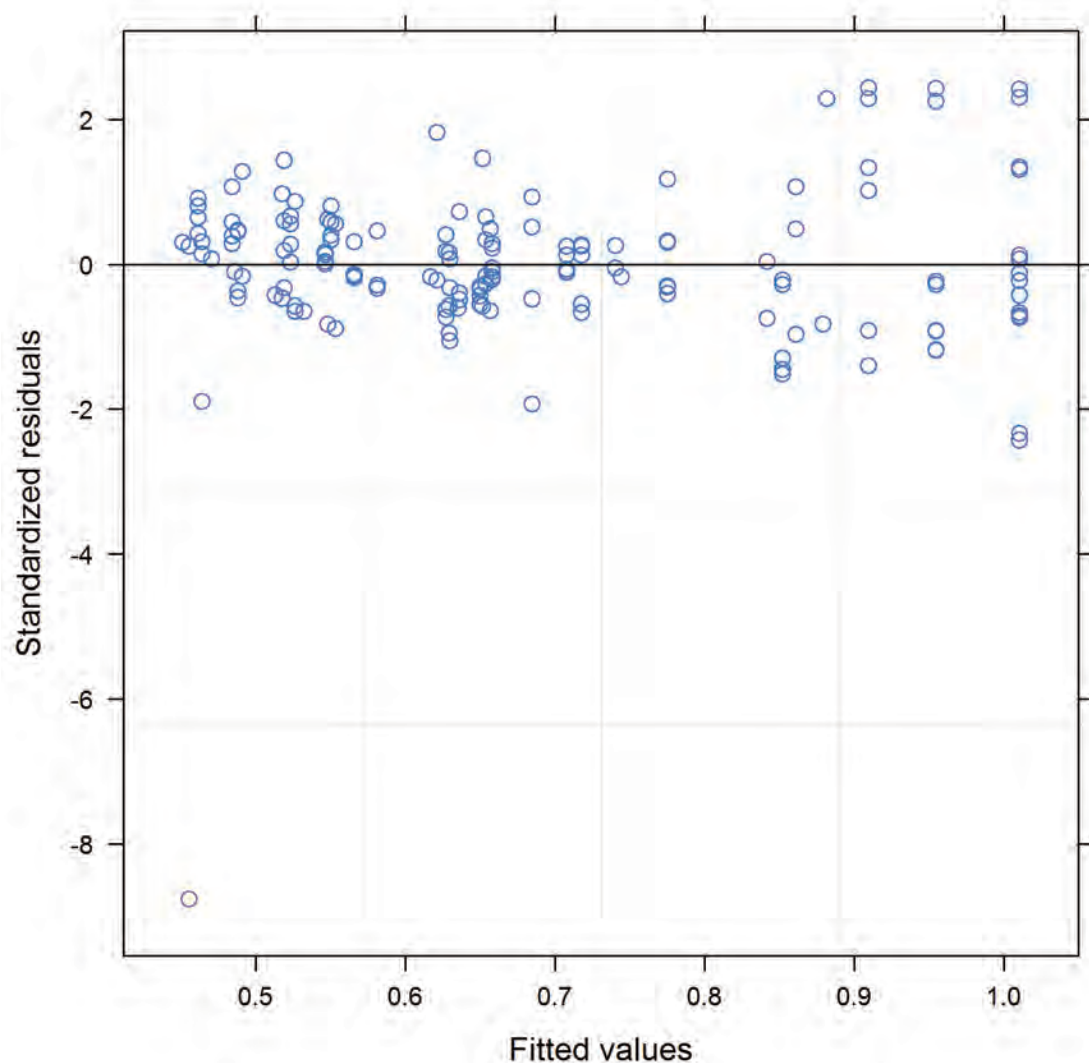
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-417.25	219.62		
LME	12	-422.6	223.3	7.35	0.01

Conclusion:

The most appropriate model for water hardness at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p = 0.007$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	222	4525	<.0001
## site	4	222	145	<.0001
## period	1	13	17	0.0011
## site:period	4	222	2	0.0439

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.05	-0.15	0.04	not sig.
Counts Outflow	-0.02	-0.12	0.07	not sig.
Vulture-Polar	-0.08	-0.17	0.01	not sig.
Pigeon-Reach 7	0.08	-0.02	0.17	not sig.

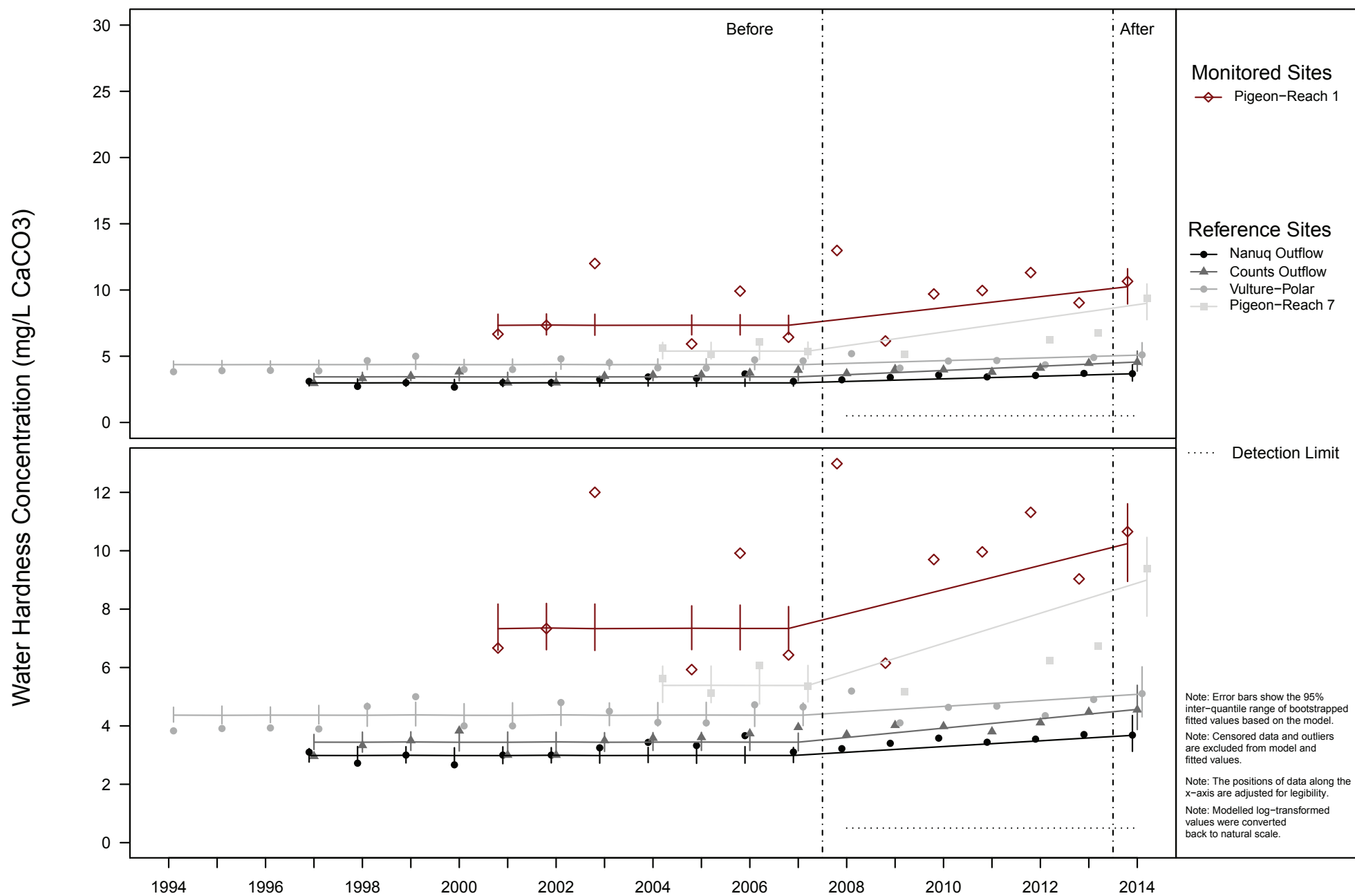
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Water hardness concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.044$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

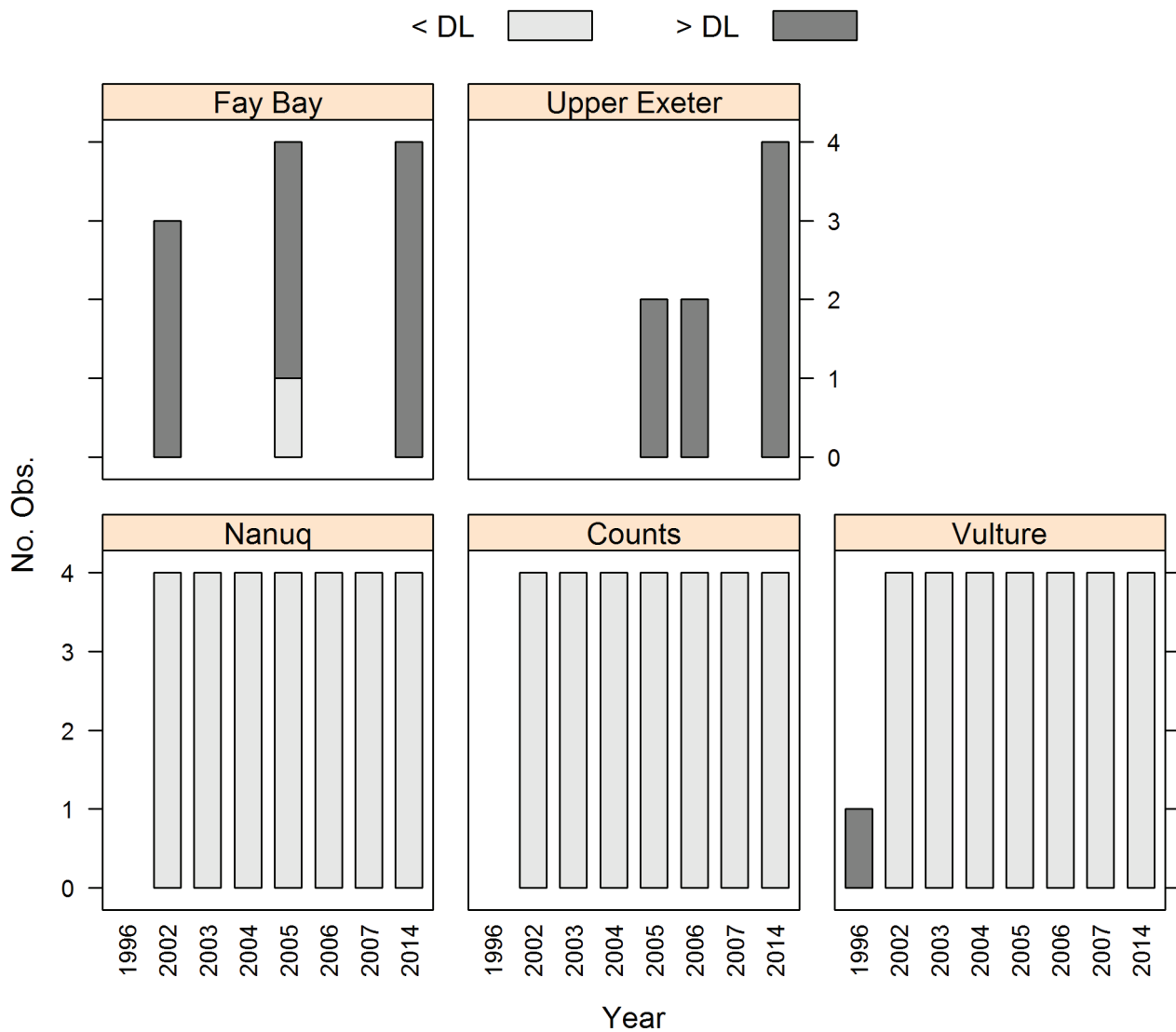


Analysis of Winter Chloride Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

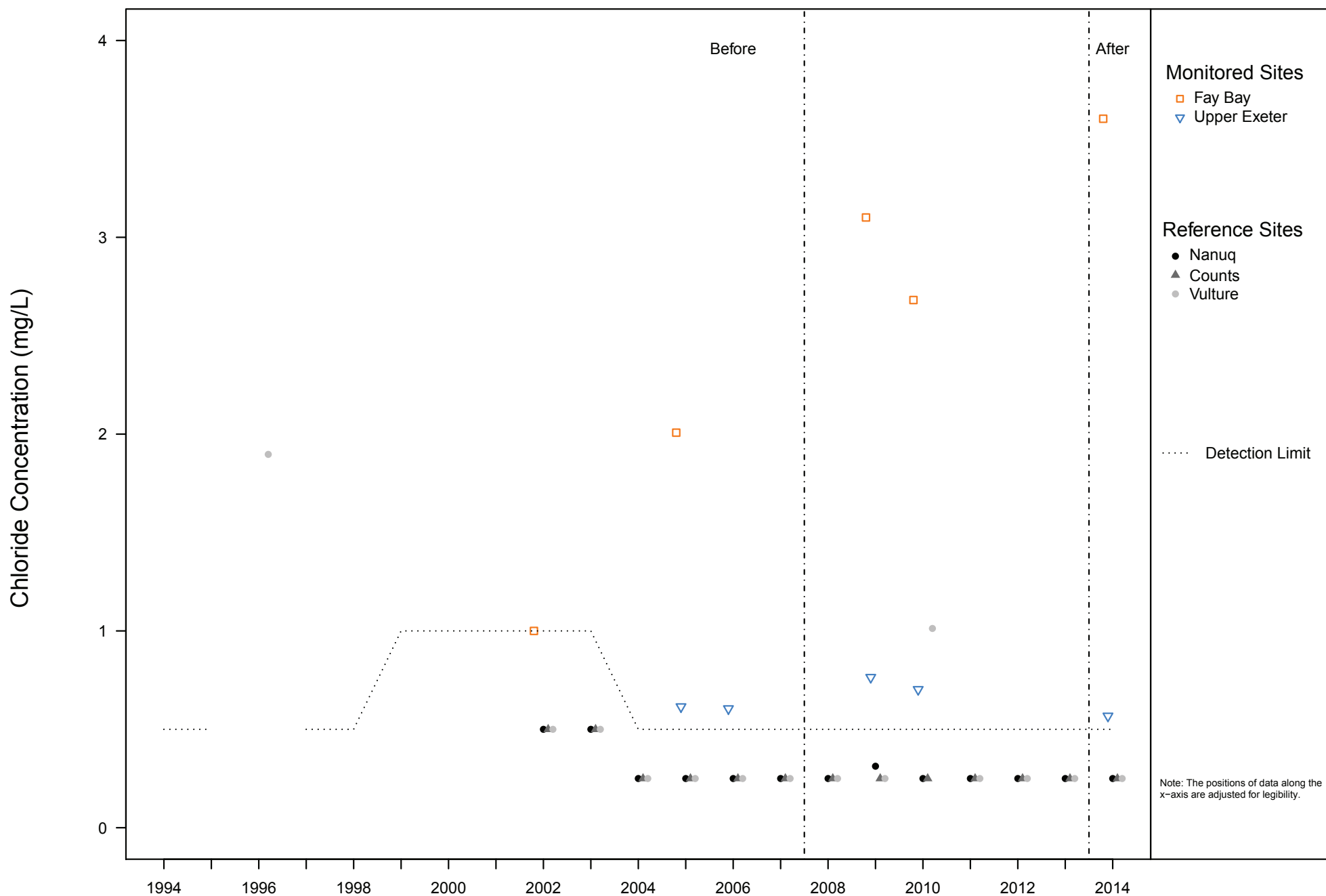
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Chloride water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

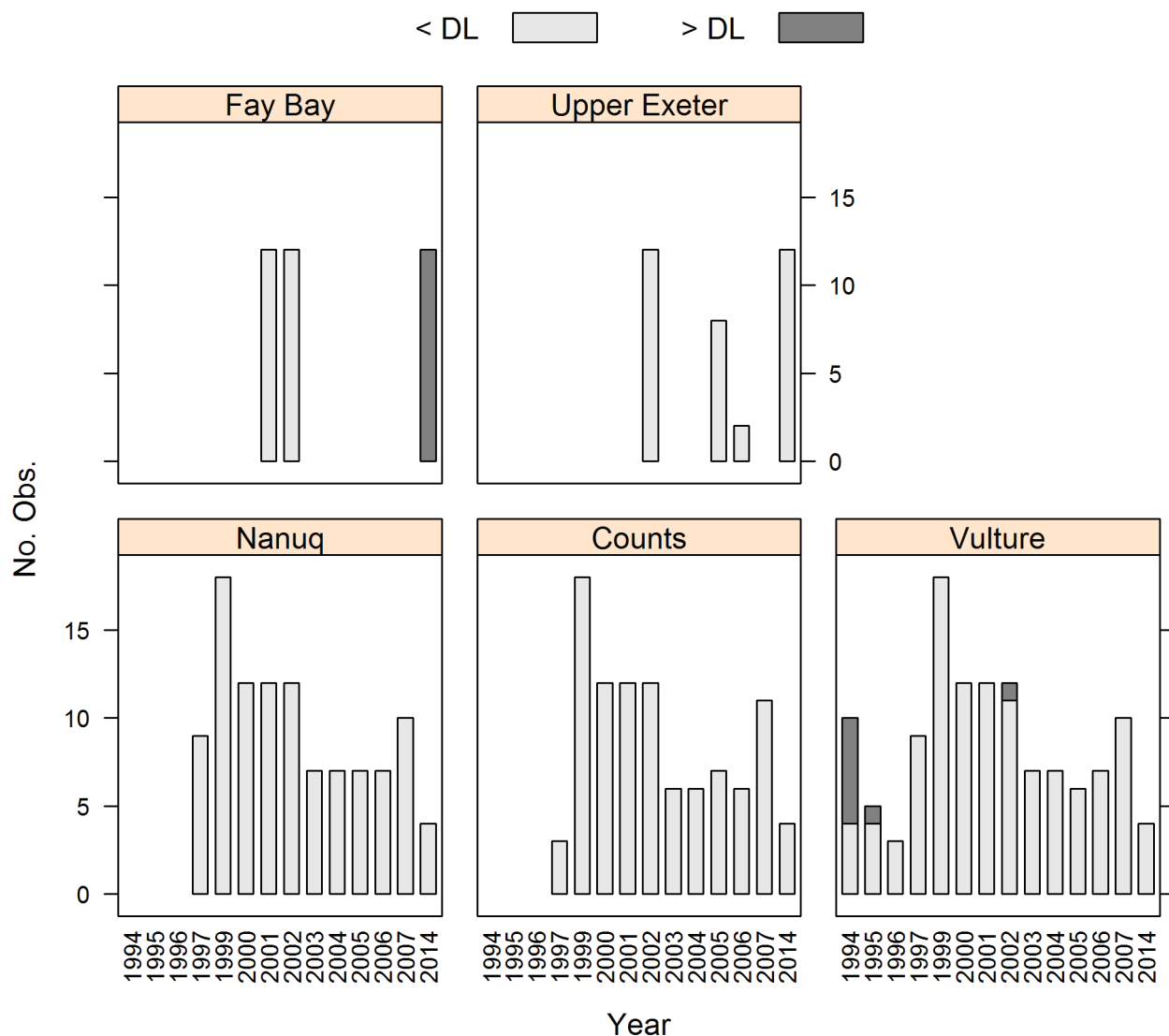


Analysis of Summer Chloride Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

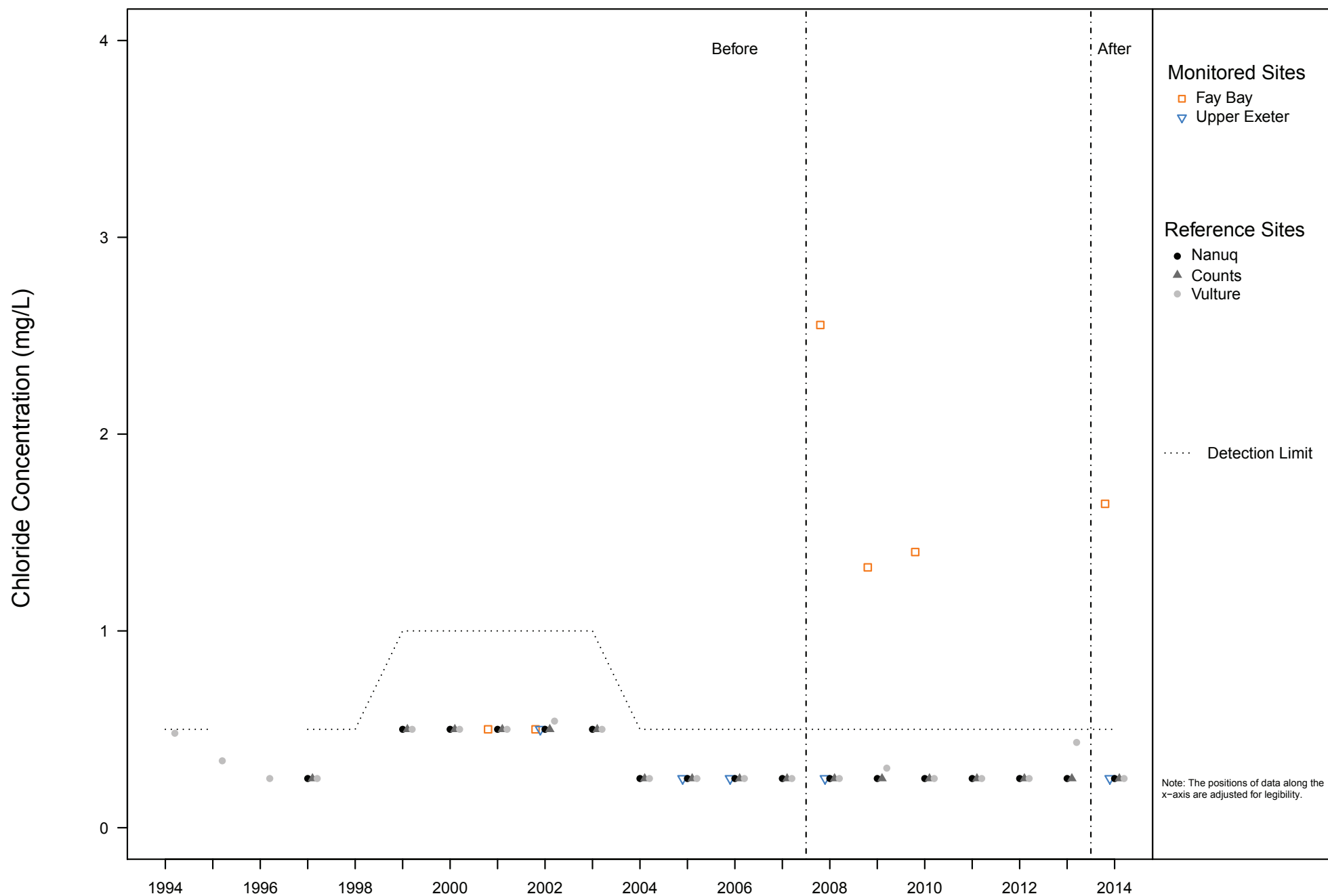
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Chloride water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

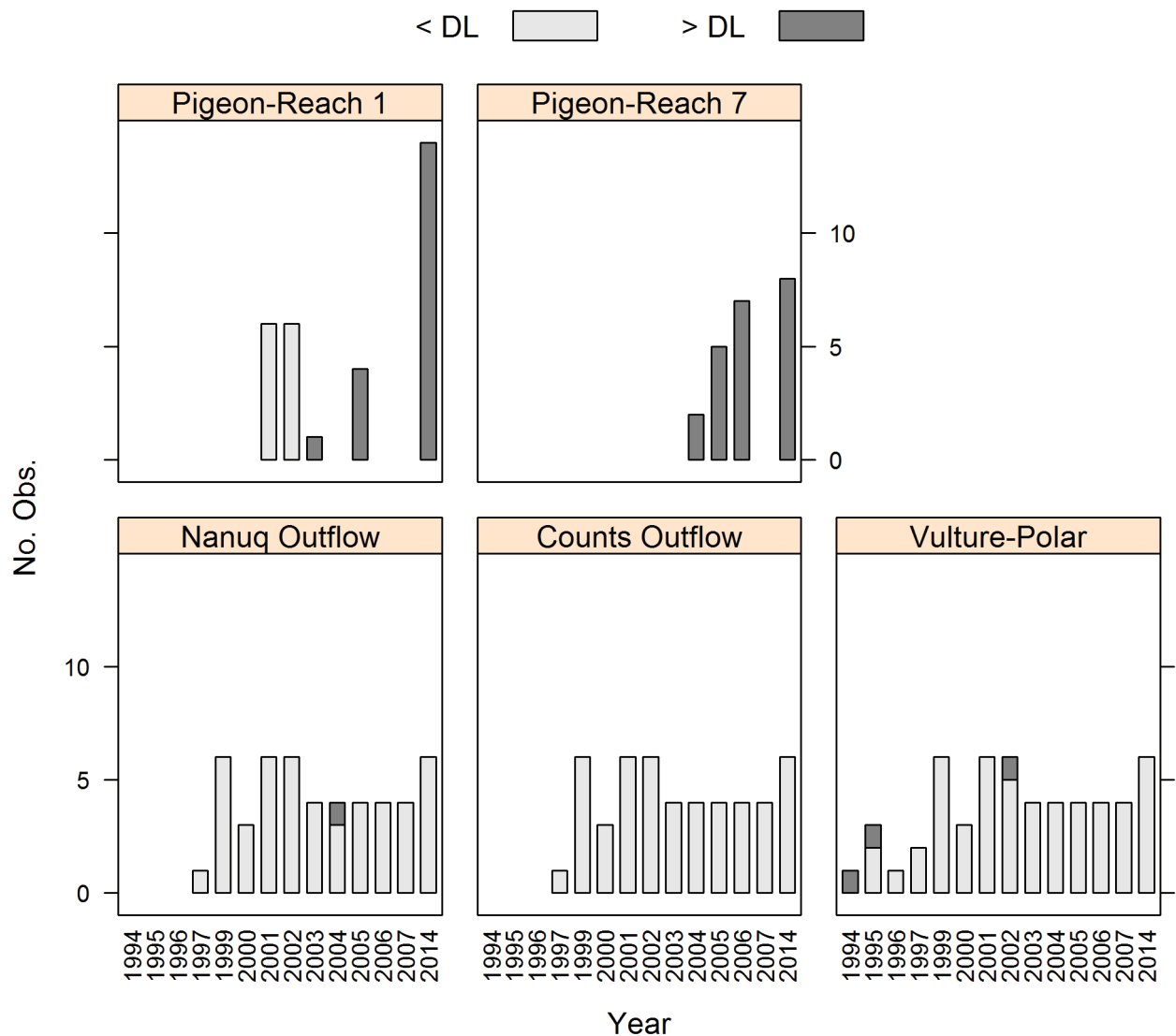


Analysis of Summer Chloride Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 6780	Vulture-Polar	1994	August	summer
## 6781	Vulture-Polar	1995	July	summer
## 6782	Vulture-Polar	1995	August	summer
## 6783	Vulture-Polar	1995	September	summer
## 6785	Vulture-Polar	1996	August	summer
## 6786	Counts Outflow	1997	September	summer
## 6787	Nanuq Outflow	1997	September	summer
## 6788	Vulture-Polar	1997	July	summer
## 6789	Vulture-Polar	1997	September	summer
## 6832	Counts Outflow	1999	August	summer
## 6833	Counts Outflow	1999	August	summer
## 6834	Counts Outflow	1999	August	summer
## 6835	Counts Outflow	1999	September	summer
## 6836	Counts Outflow	1999	September	summer
## 6837	Counts Outflow	1999	September	summer
## 6841	Nanuq Outflow	1999	August	summer
## 6842	Nanuq Outflow	1999	August	summer
## 6843	Nanuq Outflow	1999	August	summer
## 6844	Nanuq Outflow	1999	September	summer
## 6845	Nanuq Outflow	1999	September	summer
## 6846	Nanuq Outflow	1999	September	summer
## 6850	Vulture-Polar	1999	August	summer
## 6851	Vulture-Polar	1999	August	summer
## 6852	Vulture-Polar	1999	August	summer
## 6853	Vulture-Polar	1999	September	summer
## 6854	Vulture-Polar	1999	September	summer
## 6855	Vulture-Polar	1999	September	summer
## 6862	Counts Outflow	2000	September	summer
## 6863	Counts Outflow	2000	September	summer
## 6864	Counts Outflow	2000	September	summer
## 6871	Nanuq Outflow	2000	September	summer
## 6872	Nanuq Outflow	2000	September	summer
## 6873	Nanuq Outflow	2000	September	summer
## 6880	Vulture-Polar	2000	September	summer
## 6881	Vulture-Polar	2000	September	summer
## 6882	Vulture-Polar	2000	September	summer
## 6885	Counts Outflow	2001	August	summer
## 6886	Counts Outflow	2001	August	summer
## 6887	Counts Outflow	2001	August	summer
## 6888	Counts Outflow	2001	September	summer
## 6889	Counts Outflow	2001	September	summer
## 6890	Counts Outflow	2001	September	summer

## 6894	Nanuq Outflow	2001	August	summer
## 6895	Nanuq Outflow	2001	August	summer
## 6896	Nanuq Outflow	2001	August	summer
## 6897	Nanuq Outflow	2001	September	summer
## 6898	Nanuq Outflow	2001	September	summer
## 6899	Nanuq Outflow	2001	September	summer
## 6903	Pigeon-Reach 1	2001	August	summer
## 6904	Pigeon-Reach 1	2001	August	summer
## 6905	Pigeon-Reach 1	2001	August	summer
## 6906	Pigeon-Reach 1	2001	September	summer
## 6907	Pigeon-Reach 1	2001	September	summer
## 6908	Pigeon-Reach 1	2001	September	summer
## 6912	Vulture-Polar	2001	August	summer
## 6913	Vulture-Polar	2001	August	summer
## 6914	Vulture-Polar	2001	August	summer
## 6915	Vulture-Polar	2001	September	summer
## 6916	Vulture-Polar	2001	September	summer
## 6917	Vulture-Polar	2001	September	summer
## 6921	Counts Outflow	2002	August	summer
## 6922	Counts Outflow	2002	August	summer
## 6923	Counts Outflow	2002	August	summer
## 6924	Counts Outflow	2002	September	summer
## 6925	Counts Outflow	2002	September	summer
## 6926	Counts Outflow	2002	September	summer
## 6930	Nanuq Outflow	2002	August	summer
## 6931	Nanuq Outflow	2002	August	summer
## 6932	Nanuq Outflow	2002	August	summer
## 6933	Nanuq Outflow	2002	September	summer
## 6934	Nanuq Outflow	2002	September	summer
## 6935	Nanuq Outflow	2002	September	summer
## 6939	Pigeon-Reach 1	2002	August	summer
## 6940	Pigeon-Reach 1	2002	August	summer
## 6941	Pigeon-Reach 1	2002	August	summer
## 6942	Pigeon-Reach 1	2002	September	summer
## 6943	Pigeon-Reach 1	2002	September	summer
## 6944	Pigeon-Reach 1	2002	September	summer
## 6948	Vulture-Polar	2002	August	summer
## 6949	Vulture-Polar	2002	August	summer
## 6950	Vulture-Polar	2002	August	summer
## 6951	Vulture-Polar	2002	September	summer
## 6952	Vulture-Polar	2002	September	summer
## 6953	Vulture-Polar	2002	September	summer
## 6956	Counts Outflow	2003	August	summer
## 6957	Counts Outflow	2003	August	summer
## 6958	Counts Outflow	2003	September	summer
## 6959	Counts Outflow	2003	September	summer
## 6962	Nanuq Outflow	2003	August	summer
## 6963	Nanuq Outflow	2003	August	summer
## 6964	Nanuq Outflow	2003	September	summer
## 6965	Nanuq Outflow	2003	September	summer

## 6970	Vulture-Polar	2003	August	summer
## 6971	Vulture-Polar	2003	August	summer
## 6972	Vulture-Polar	2003	September	summer
## 6973	Vulture-Polar	2003	September	summer
## 6976	Counts Outflow	2004	August	summer
## 6977	Counts Outflow	2004	August	summer
## 6978	Counts Outflow	2004	September	summer
## 6979	Counts Outflow	2004	September	summer
## 6982	Nanuq Outflow	2004	August	summer
## 6983	Nanuq Outflow	2004	August	summer
## 6984	Nanuq Outflow	2004	September	summer
## 6985	Nanuq Outflow	2004	September	summer
## 7006	Vulture-Polar	2004	August	summer
## 7007	Vulture-Polar	2004	August	summer
## 7008	Vulture-Polar	2004	September	summer
## 7009	Vulture-Polar	2004	September	summer
## 7012	Counts Outflow	2005	August	summer
## 7013	Counts Outflow	2005	August	summer
## 7014	Counts Outflow	2005	September	summer
## 7015	Counts Outflow	2005	September	summer
## 7018	Nanuq Outflow	2005	August	summer
## 7019	Nanuq Outflow	2005	August	summer
## 7020	Nanuq Outflow	2005	September	summer
## 7021	Nanuq Outflow	2005	September	summer
## 7048	Vulture-Polar	2005	August	summer
## 7049	Vulture-Polar	2005	August	summer
## 7050	Vulture-Polar	2005	September	summer
## 7051	Vulture-Polar	2005	September	summer
## 7054	Counts Outflow	2006	August	summer
## 7055	Counts Outflow	2006	August	summer
## 7056	Counts Outflow	2006	September	summer
## 7057	Counts Outflow	2006	September	summer
## 7060	Nanuq Outflow	2006	August	summer
## 7061	Nanuq Outflow	2006	August	summer
## 7062	Nanuq Outflow	2006	September	summer
## 7063	Nanuq Outflow	2006	September	summer
## 7087	Vulture-Polar	2006	August	summer
## 7088	Vulture-Polar	2006	August	summer
## 7089	Vulture-Polar	2006	September	summer
## 7090	Vulture-Polar	2006	September	summer
## 7092	Counts Outflow	2007	August	summer
## 7093	Counts Outflow	2007	August	summer
## 7094	Counts Outflow	2007	September	summer
## 7095	Counts Outflow	2007	September	summer
## 7097	Nanuq Outflow	2007	August	summer
## 7098	Nanuq Outflow	2007	August	summer
## 7099	Nanuq Outflow	2007	September	summer
## 7100	Nanuq Outflow	2007	September	summer
## 7122	Vulture-Polar	2007	August	summer
## 7123	Vulture-Polar	2007	August	summer


```

## 7124 Vulture-Polar 2007 September summer
## 7125 Vulture-Polar 2007 September summer
## 7345 Counts Outflow 2014 July summer
## 7346 Counts Outflow 2014 July summer
## 7347 Counts Outflow 2014 August summer
## 7348 Counts Outflow 2014 August summer
## 7349 Counts Outflow 2014 September summer
## 7350 Counts Outflow 2014 September summer
## 7353 Nanuq Outflow 2014 July summer
## 7354 Nanuq Outflow 2014 July summer
## 7355 Nanuq Outflow 2014 August summer
## 7356 Nanuq Outflow 2014 August summer
## 7357 Nanuq Outflow 2014 September summer
## 7358 Nanuq Outflow 2014 September summer
## 7387 Vulture-Polar 2014 July summer
## 7388 Vulture-Polar 2014 July summer
## 7389 Vulture-Polar 2014 August summer
## 7390 Vulture-Polar 2014 August summer
## 7391 Vulture-Polar 2014 September summer
## 7392 Vulture-Polar 2014 September summer

```

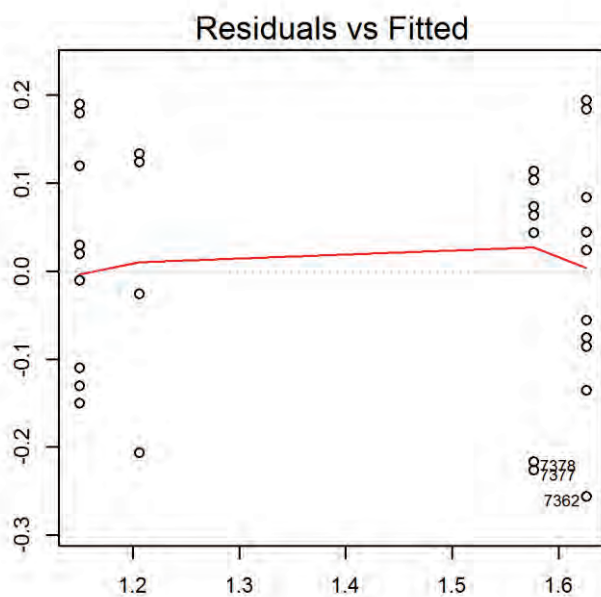
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

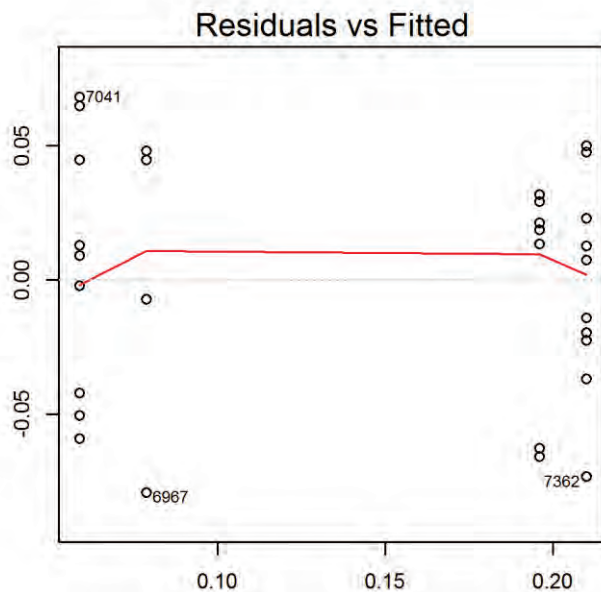
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.12	0.78	0.77
Log-10	0.04	0.78	0.76

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

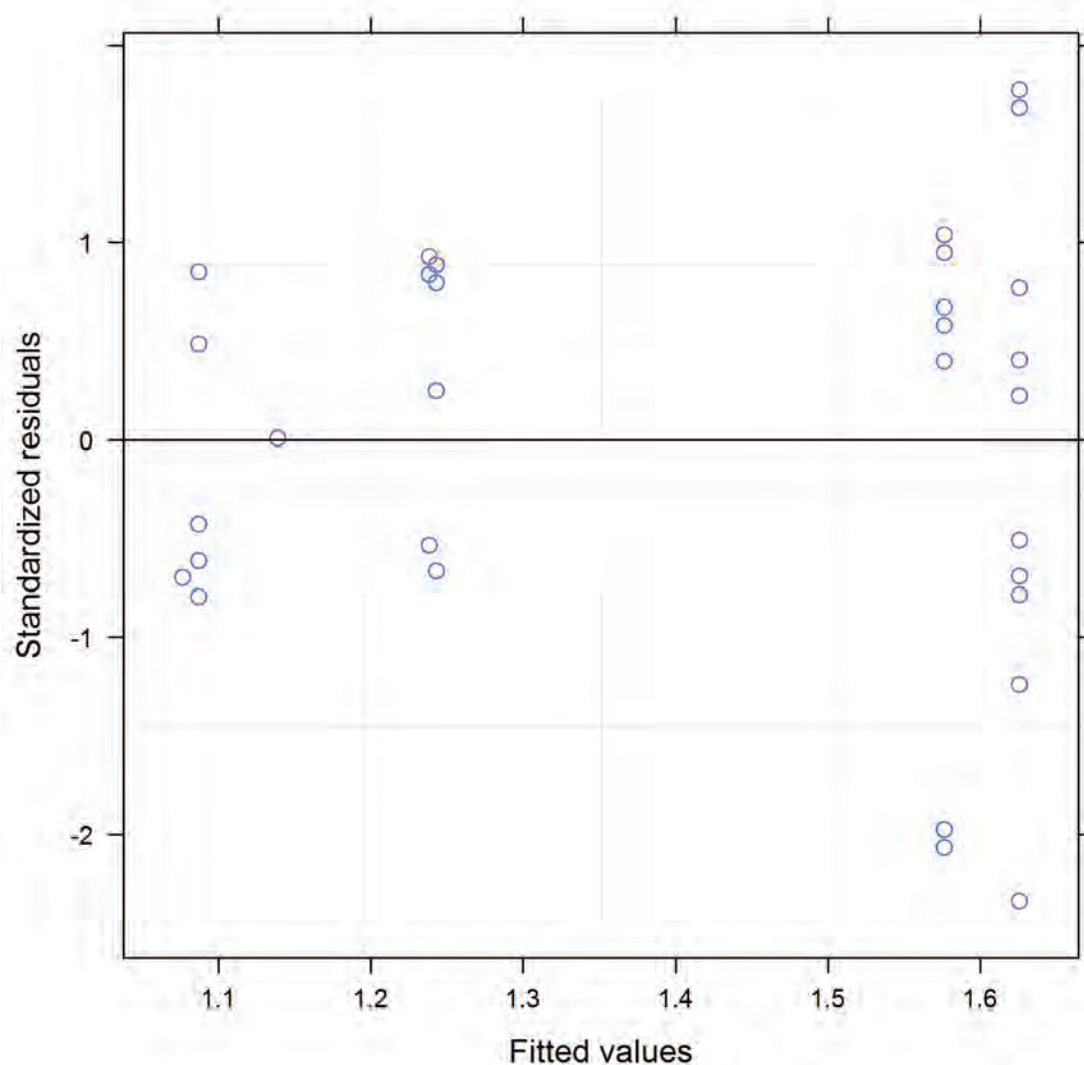
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	5	-31.2	20.6		
LME	6	-34.37	23.18	5.16	0.02

Conclusion:

The most appropriate model for Chloride at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p = 0.023$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	34	653	<.0001
## site	1	34	2	0.212
## period	1	3	17	0.027
## site:period	1	34	0	0.518

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	NA	NA	NA	NA
Counts Outflow	NA	NA	NA	NA
Vulture-Polar	NA	NA	NA	NA
Pigeon-Reach 7	-0.05	-0.22	0.11	not sig.

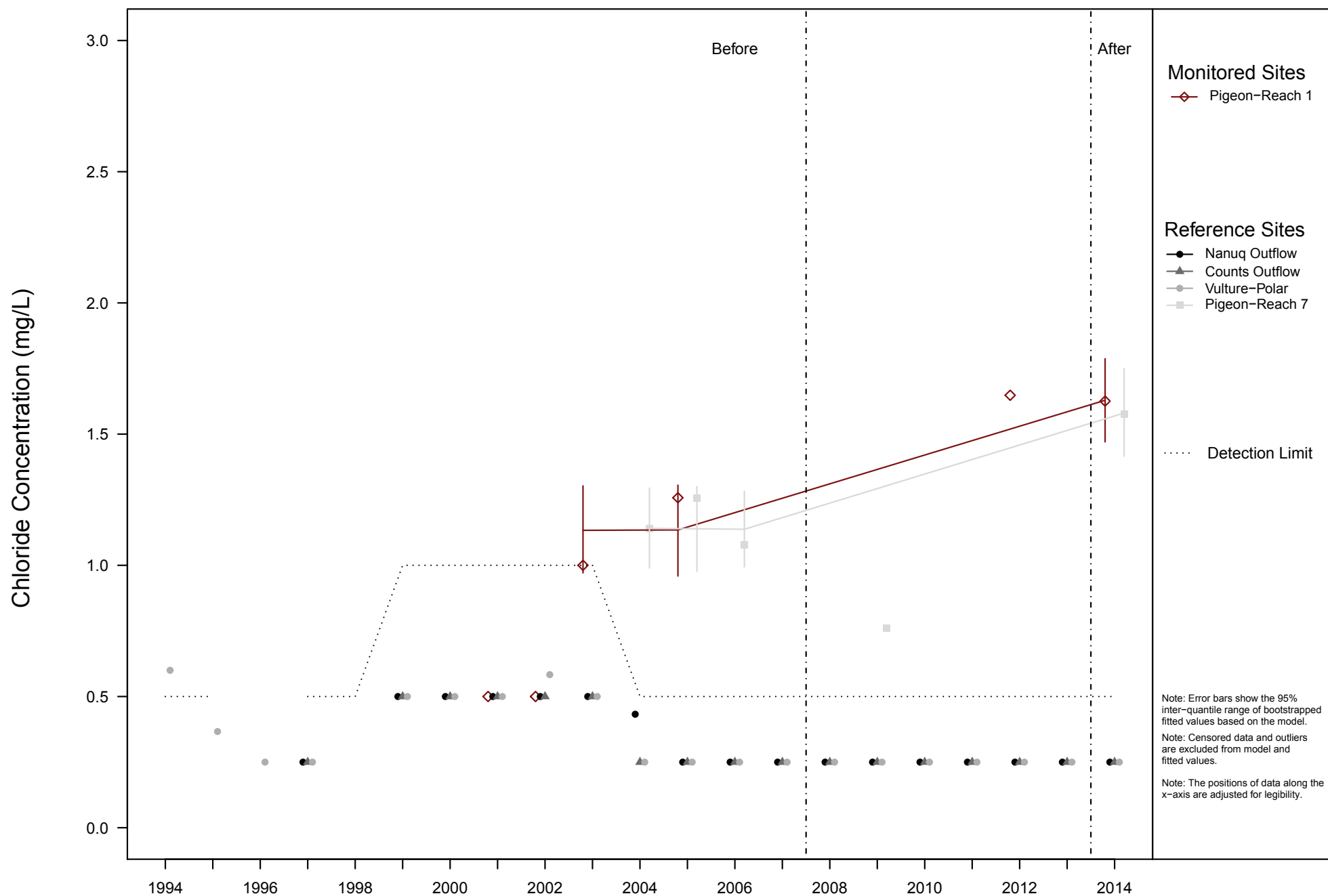
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Chloride concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.518$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

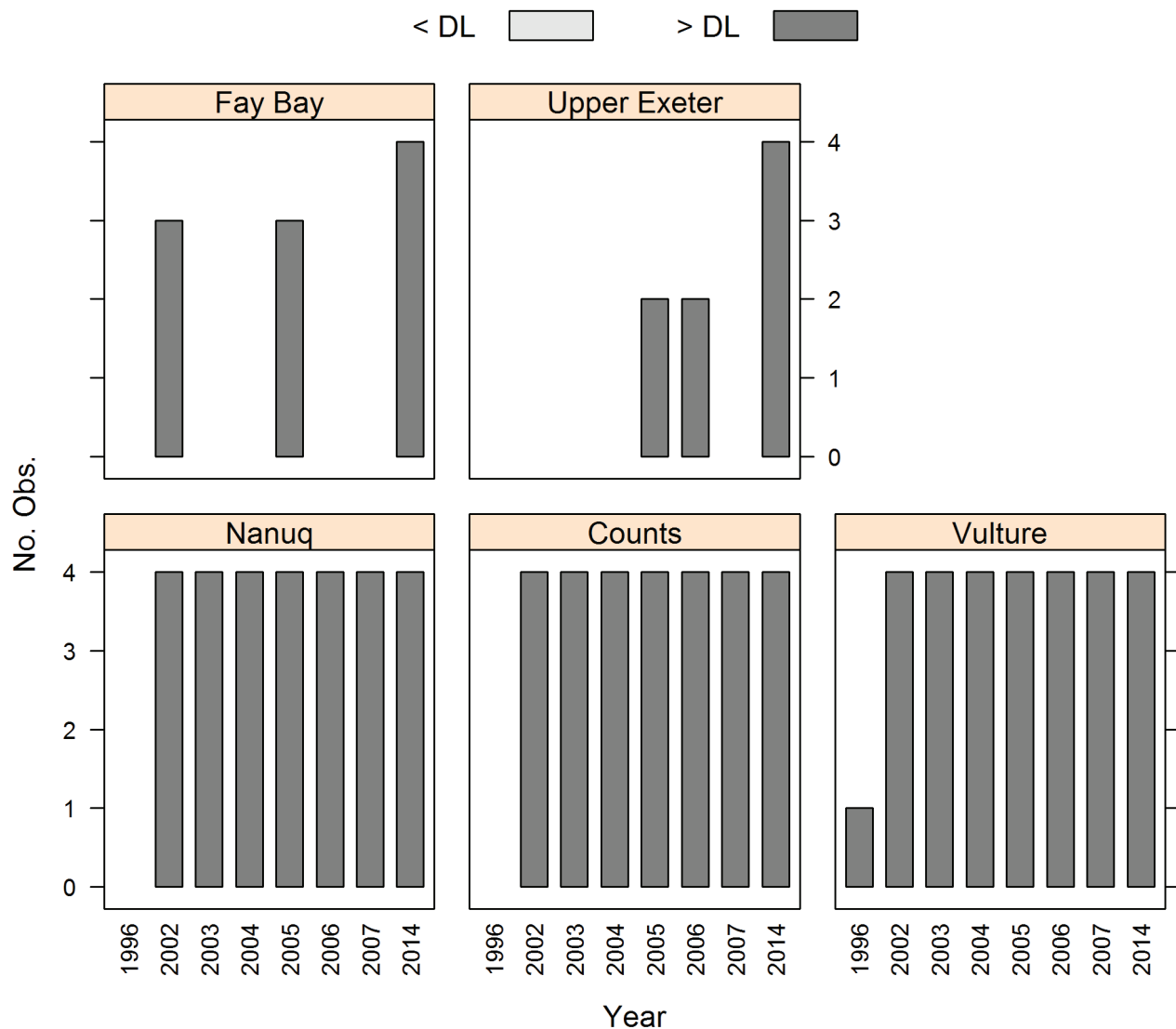


Analysis of Winter Sulphate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##          site year month season
## 11456 Vulture 1996 April  winter
```

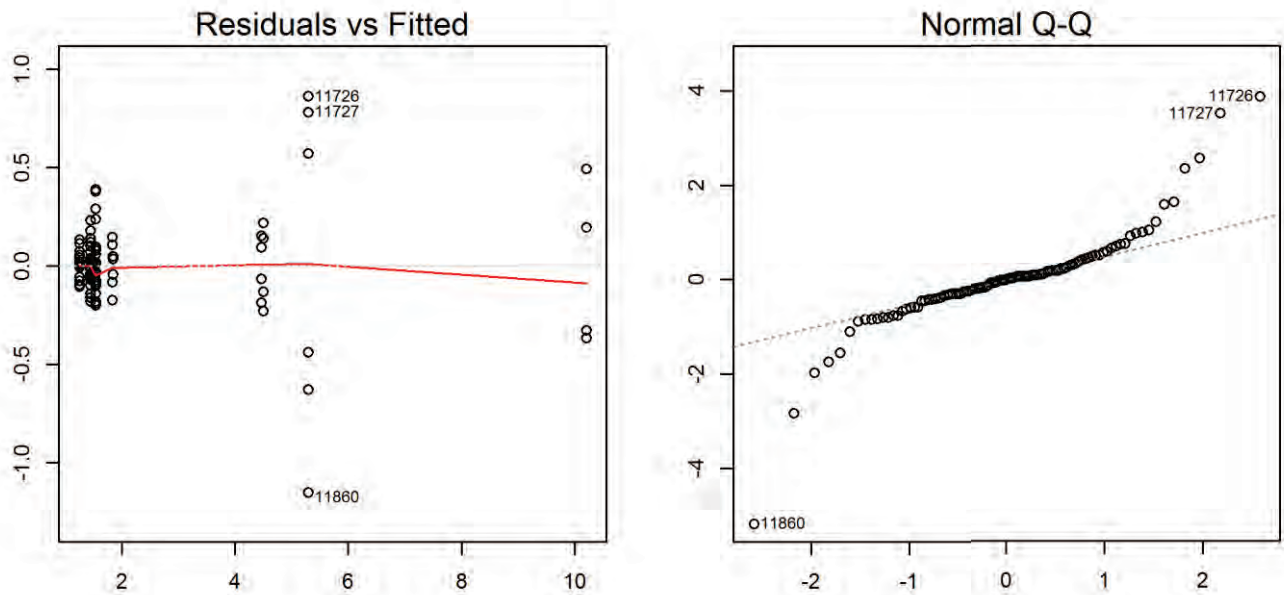
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

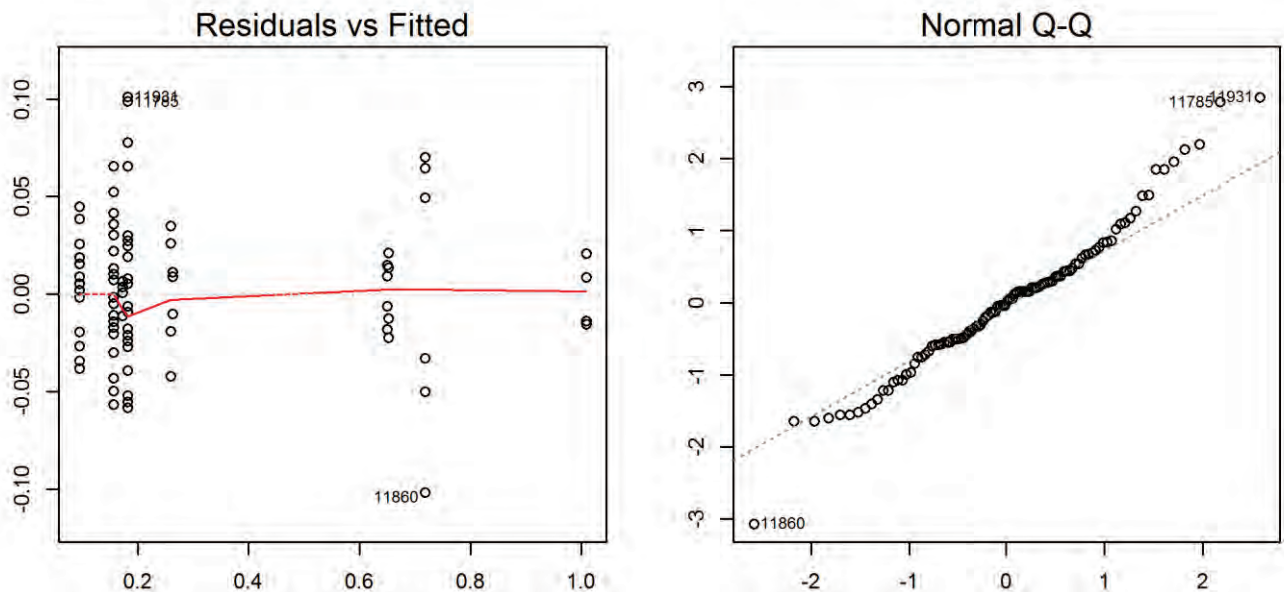
```
## No outliers were identified.
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.24	0.99	0.99
Log-10	0.04	0.98	0.98

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

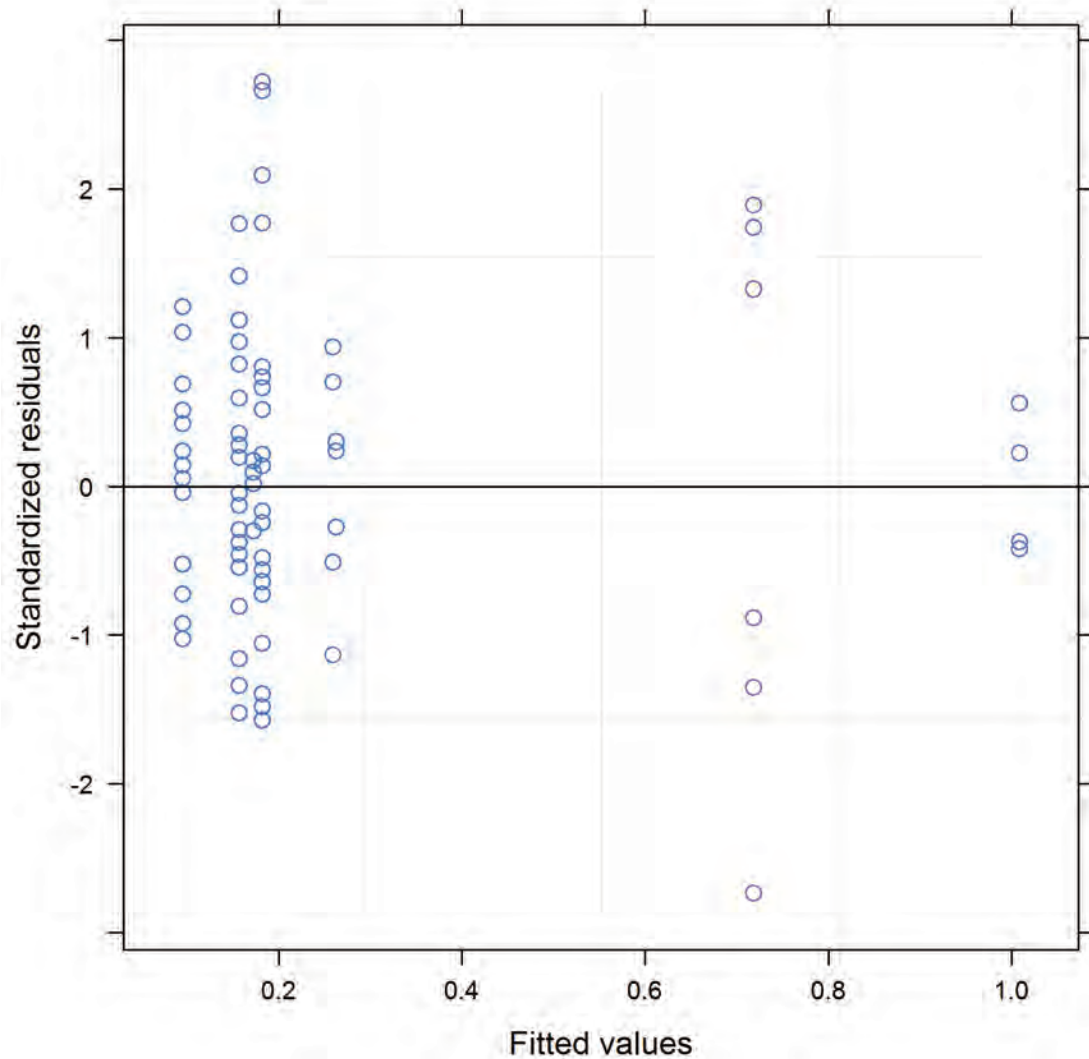
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-287.46	152.73		
LME	10	-287.99	154	2.53	0.11

Conclusion:

The most appropriate model for sulphate at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.111$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 86
##          numDF F-value p-value
## (Intercept)      1    3579  <.0001
## site            3    1019  <.0001
## period          1     144  <.0001
## site:period      3      20  <.0001
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.18	-0.25	-0.12	sig.
Counts	-0.21	-0.27	-0.15	sig.
Vulture	-0.21	-0.27	-0.15	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Sulphate concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

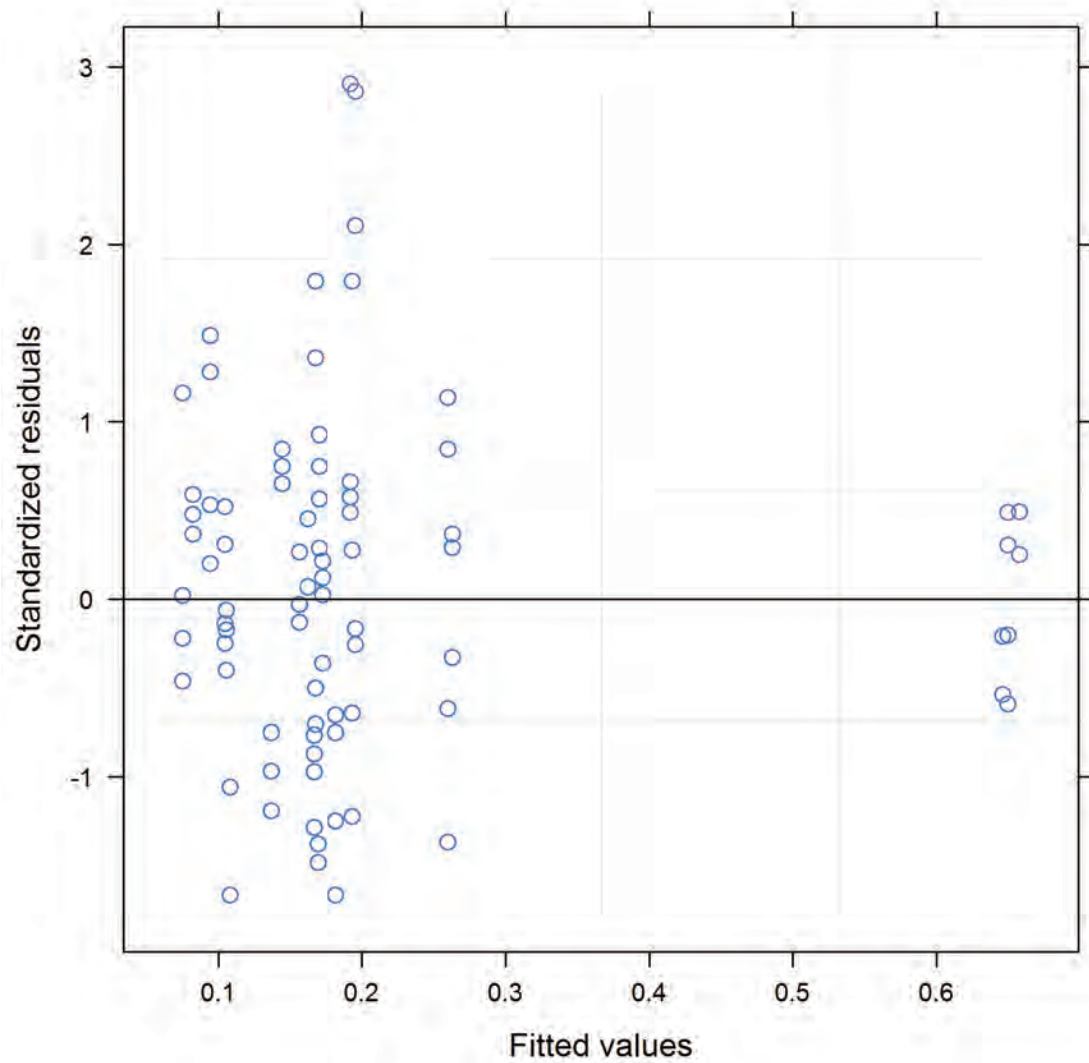
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-297.75	157.88		
LME	10	-303.17	161.58	7.41	0.01

Conclusion:

The most appropriate model for sulphate at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p = 0.006$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	830	<.0001
## site	3	79	570	<.0001
## period	1	5	14	0.0132
## site:period	3	79	6	0.0011

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.11	0.06	0.17	sig.
Counts	0.09	0.03	0.14	sig.
Vulture	0.09	0.03	0.14	sig.

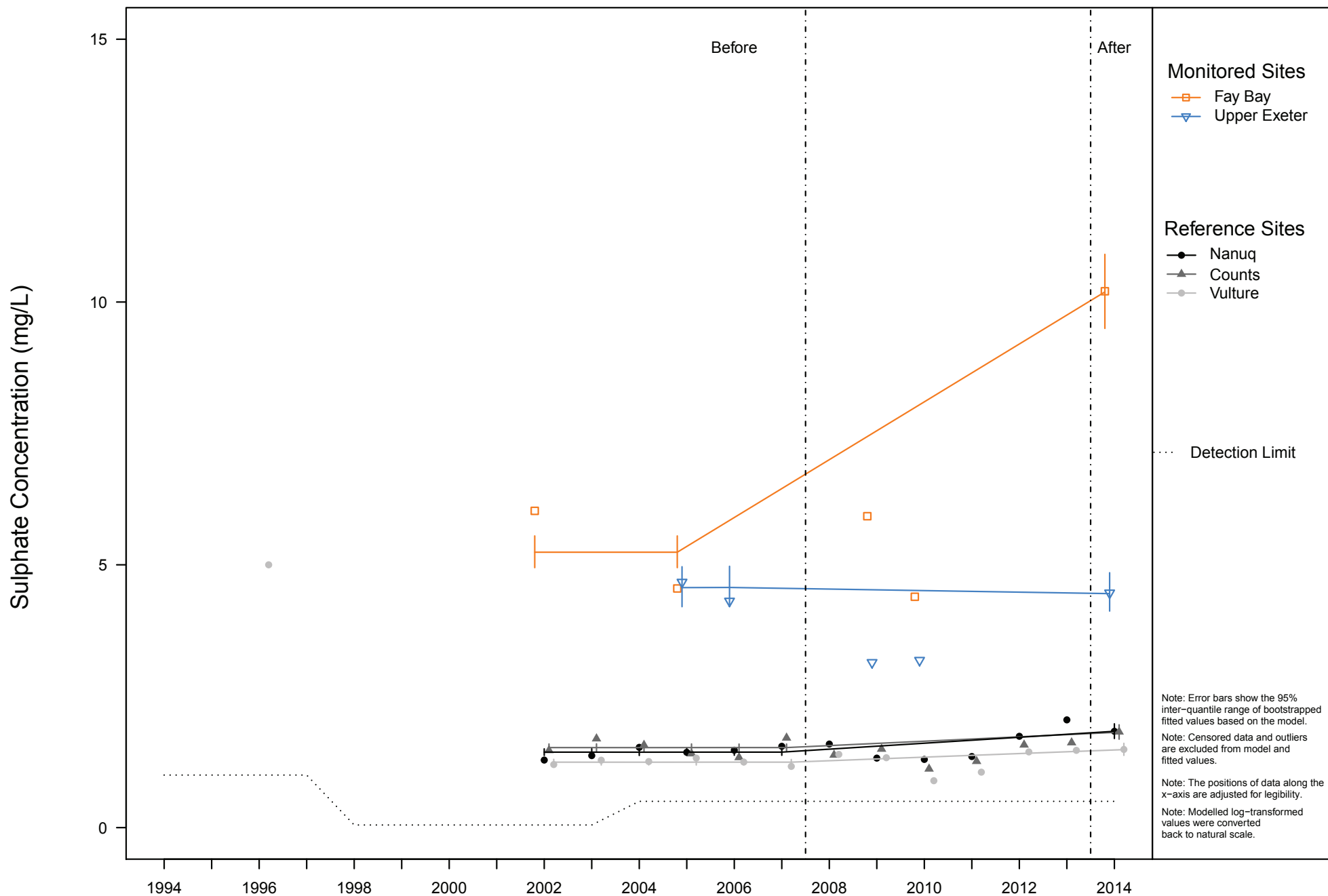
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Sulphate concentrations at the Upper Exeter site were significantly ($p = 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

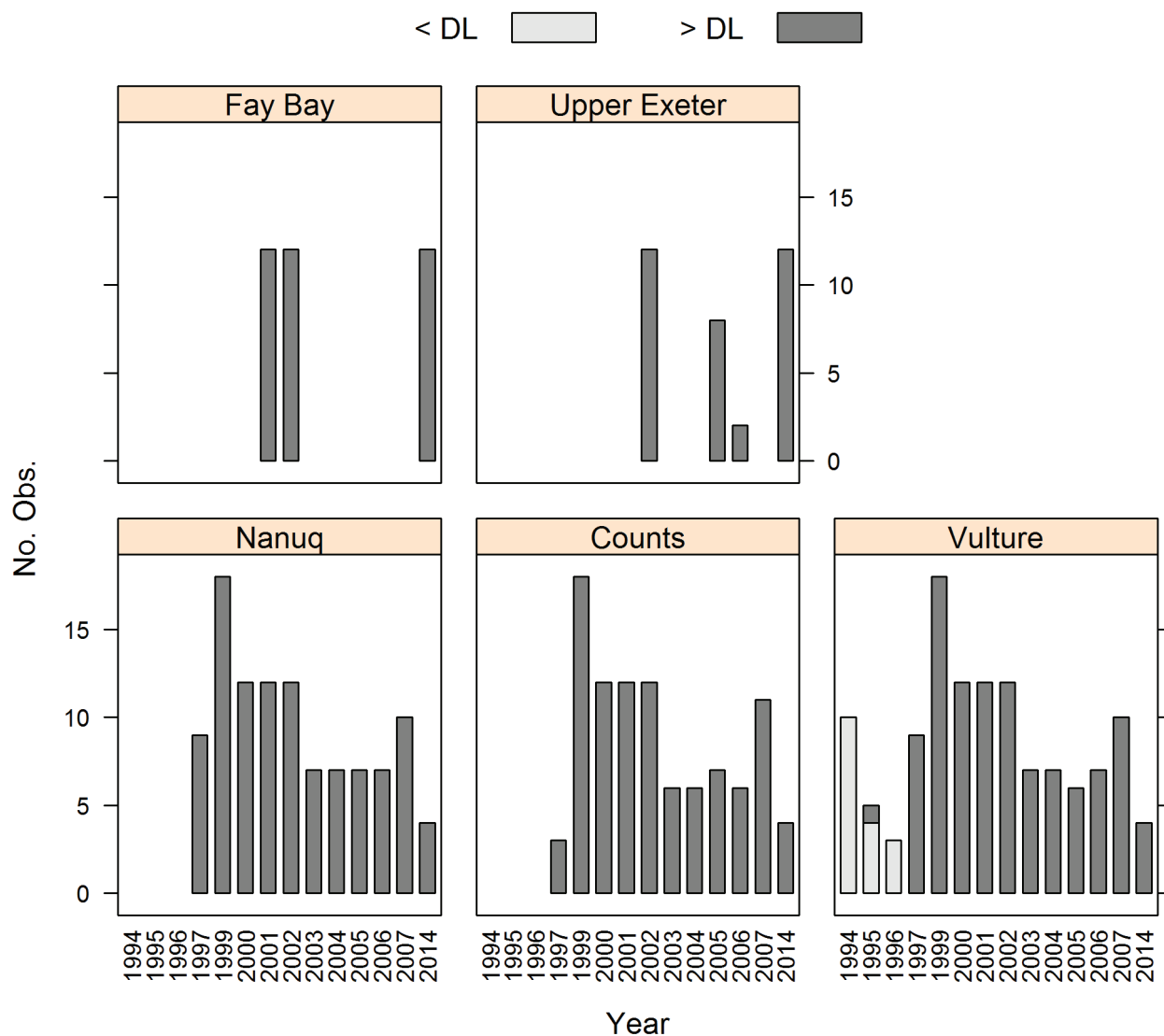


Analysis of Summer Sulphate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year  month season
## 11441 Vulture 1994   July  summer
## 11442 Vulture 1994   July  summer
## 11443 Vulture 1994   July  summer
## 11444 Vulture 1994   July  summer
## 11445 Vulture 1994   July  summer
## 11446 Vulture 1994  August  summer
## 11447 Vulture 1994  August  summer
## 11448 Vulture 1994  August  summer
## 11449 Vulture 1994  August  summer
## 11450 Vulture 1994  August  summer
## 11451 Vulture 1995  August  summer
## 11452 Vulture 1995  August  summer
## 11453 Vulture 1995  August  summer
## 11454 Vulture 1995  August  summer
## 11455 Vulture 1995  August  summer
## 11457 Vulture 1996  August  summer
## 11458 Vulture 1996  August  summer
## 11459 Vulture 1996  August  summer
```

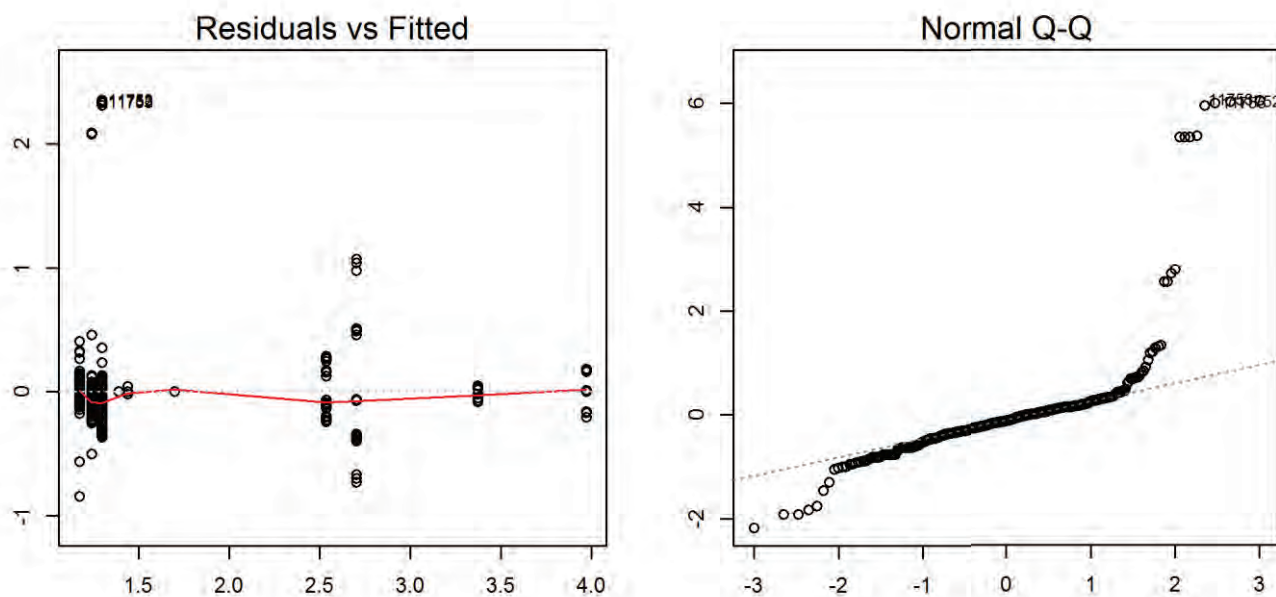
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

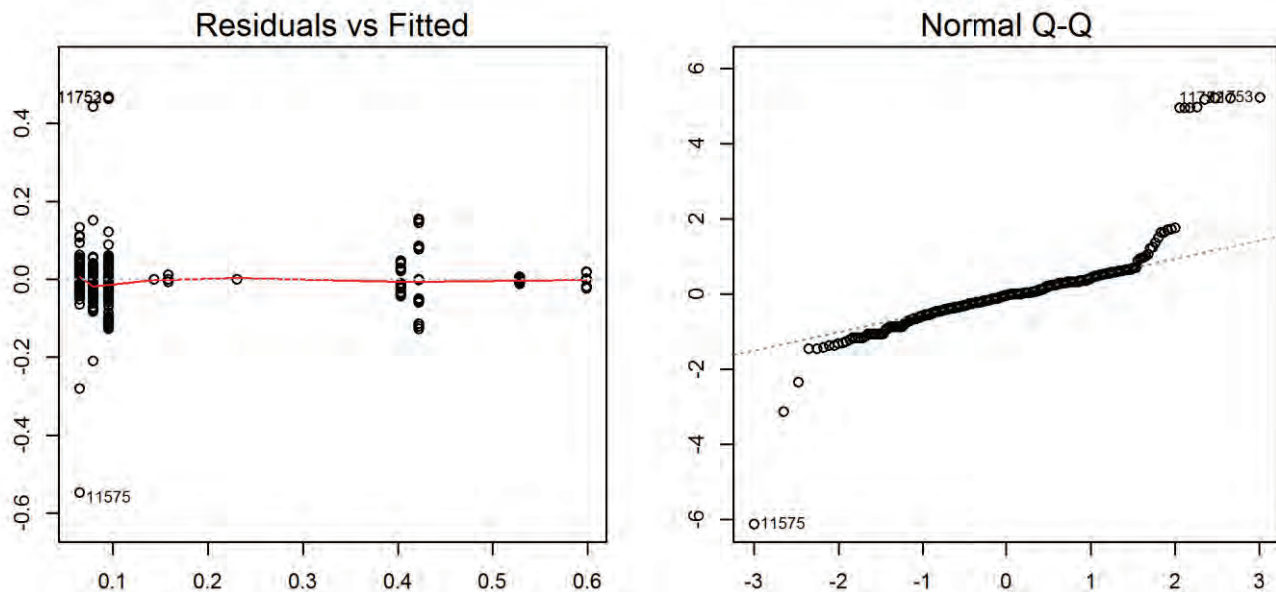
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.39	0.78	0.77
Log-10	0.09	0.75	0.74

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

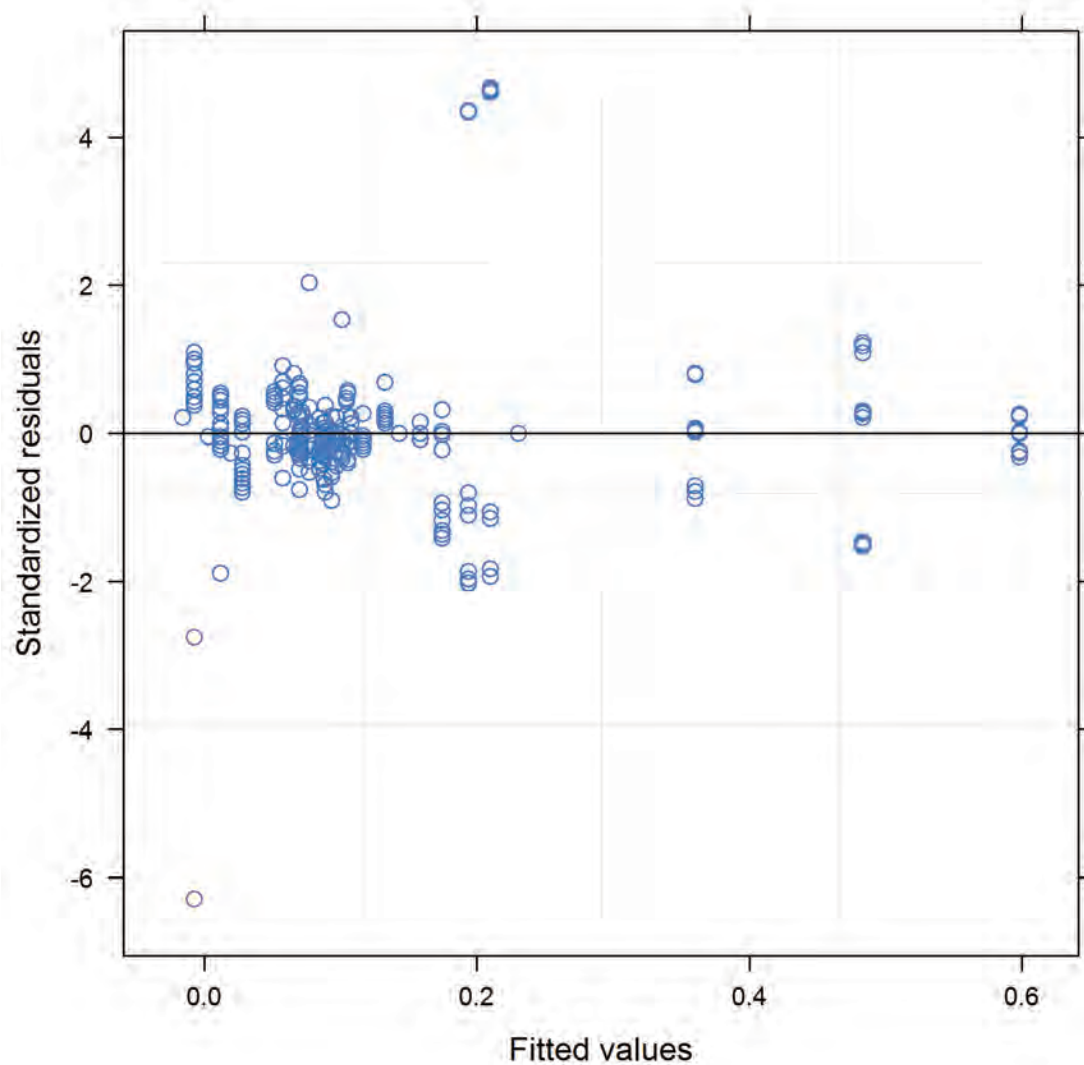
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-592.86	305.43		
LME	10	-710.7	365.35	119.83	0

Conclusion:

The most appropriate model for sulphate at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	325	52	<.0001
## site	3	325	158	<.0001
## period	1	9	6	0.0371
## site:period	3	325	5	0.0023

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.09	-0.19	0	sig.
Counts	-0.15	-0.24	-0.05	sig.
Vulture	-0.15	-0.24	-0.06	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Sulphate concentrations at the Fay Bay site were significantly ($p = 0.002$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

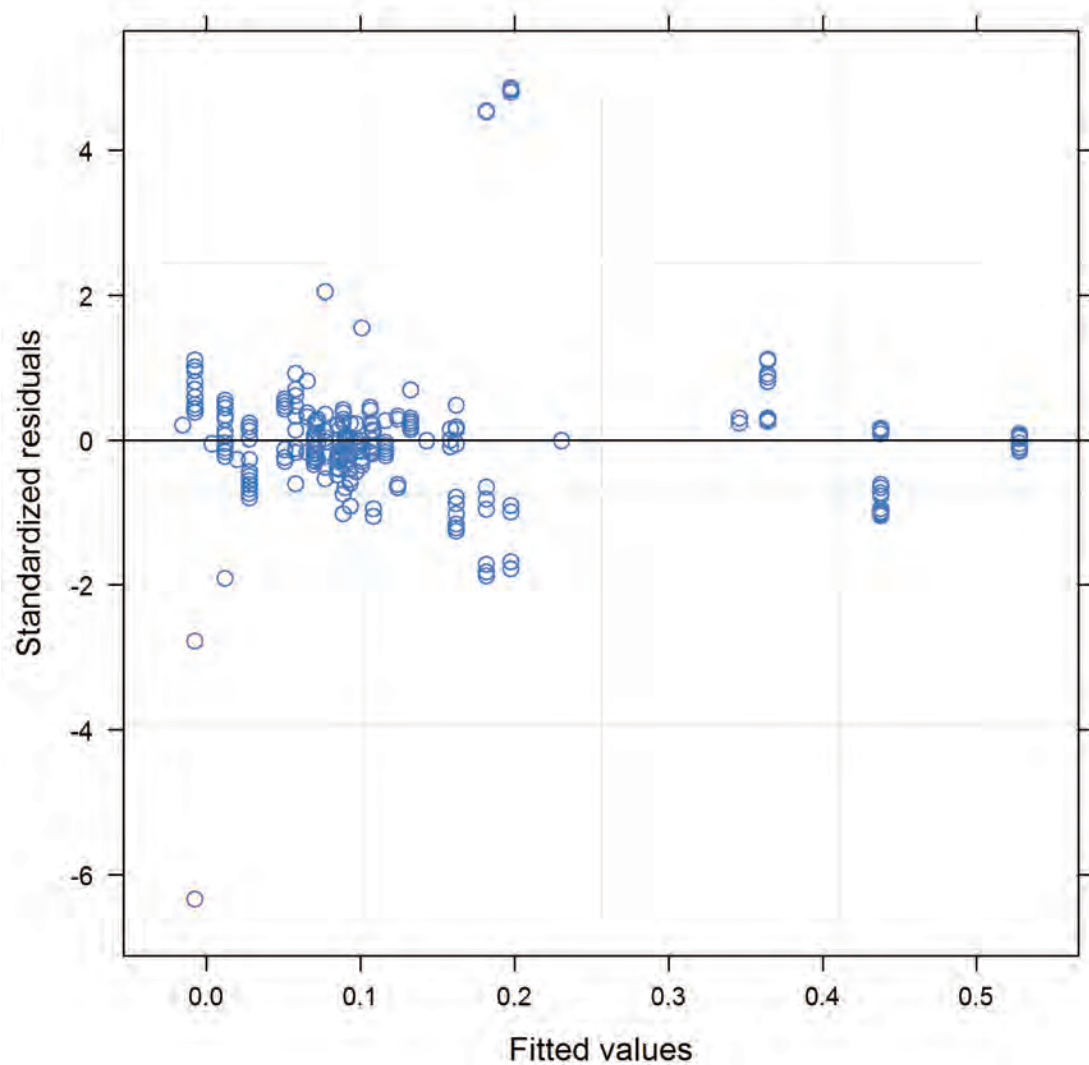
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-607.74	312.87		
LME	10	-710.74	365.37	105	0

Conclusion:

The most appropriate model for sulphate at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	323	55	<.0001
## site	3	323	116	<.0001
## period	1	9	5	0.050
## site:period	3	323	3	0.044

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.06	-0.15	0.04	not sig.
Counts	-0.11	-0.2	-0.02	sig.
Vulture	-0.11	-0.2	-0.02	sig.

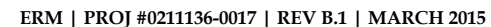
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Sulphate concentrations at the Upper Exeter site were significantly ($p = 0.044$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

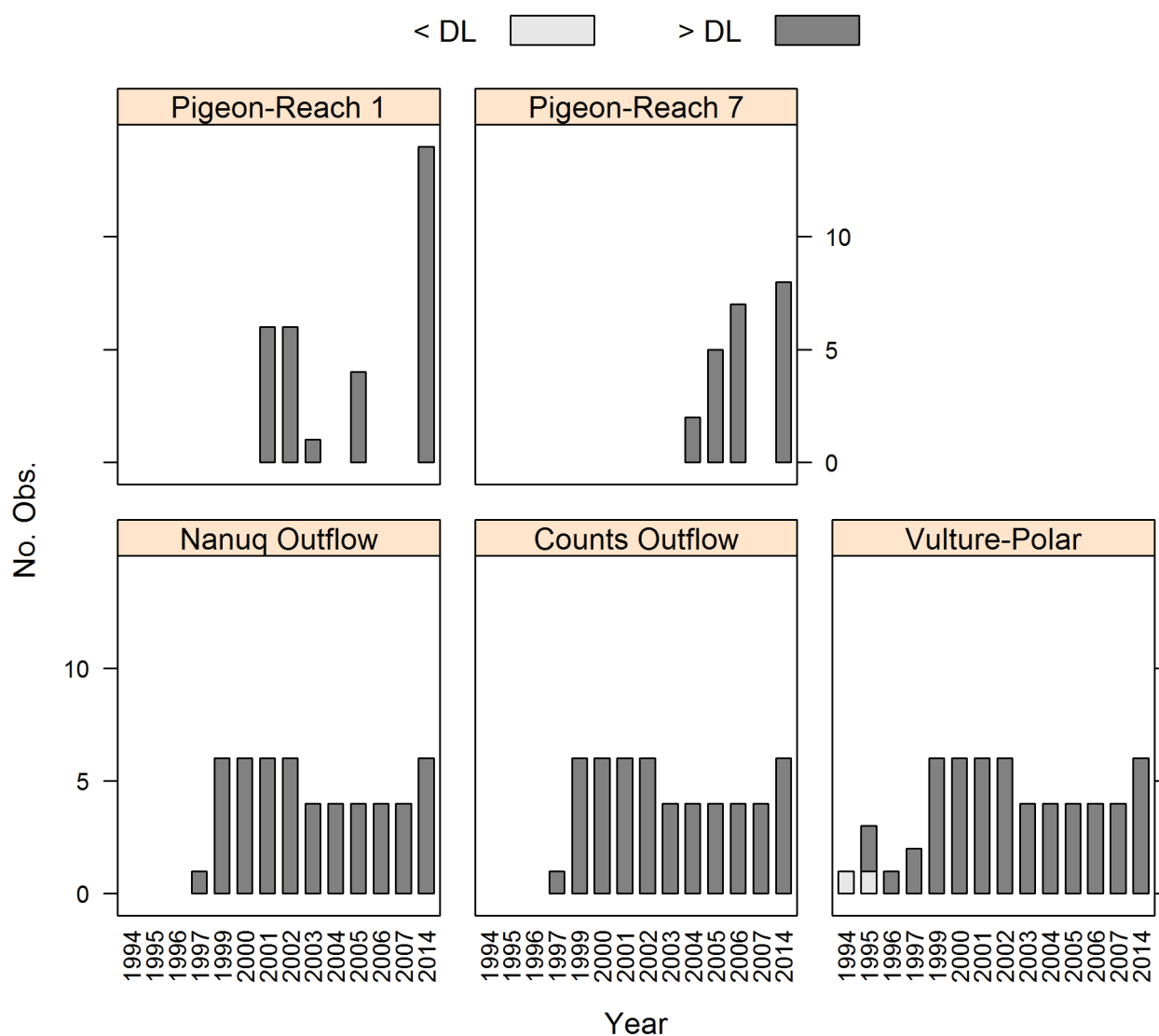


Analysis of Summer Sulphate Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##           site year  month season
## 8012 Vulture-Polar 1994 August summer
```

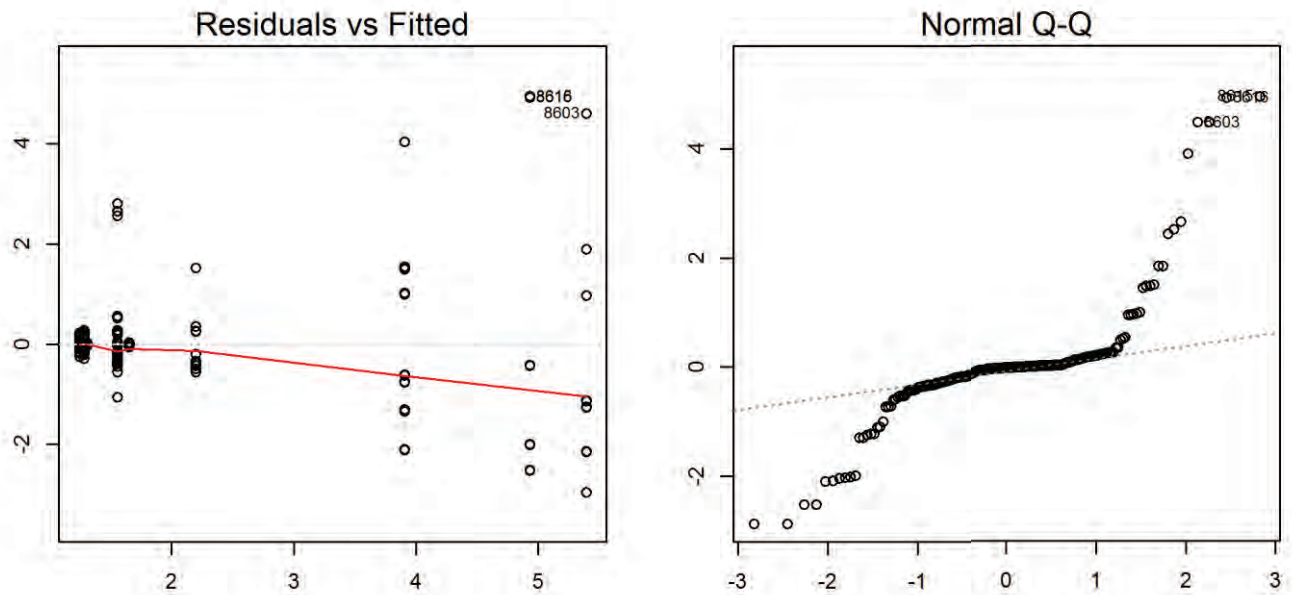
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

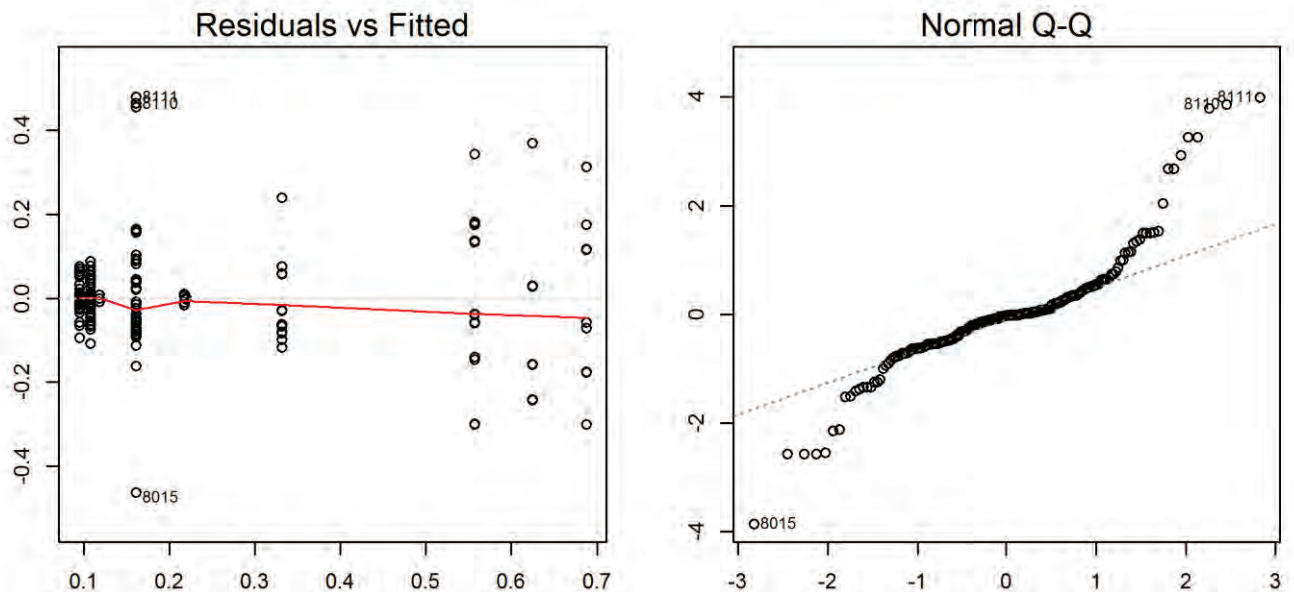
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.07	0.61	0.59
Log-10	0.12	0.73	0.72

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

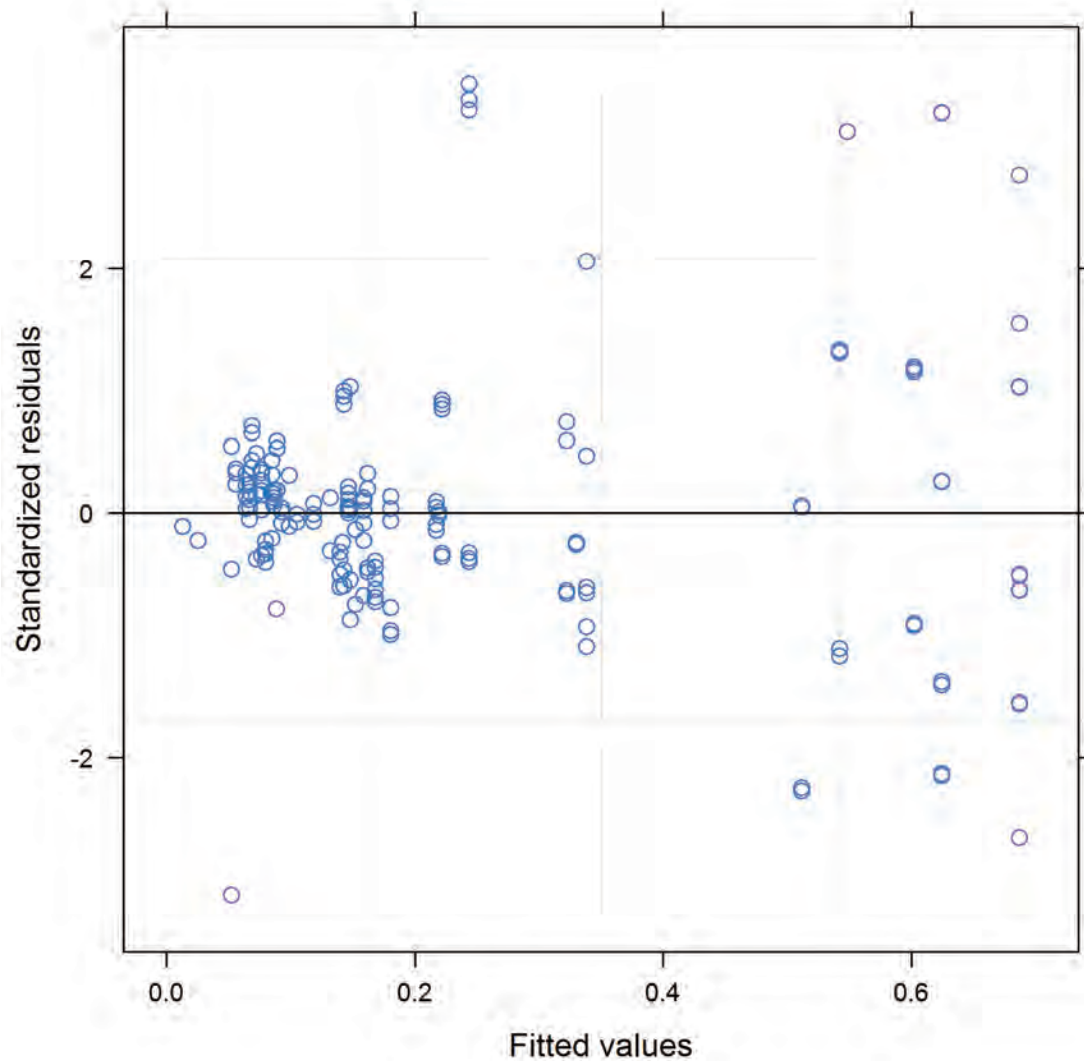
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-228.81	125.41		
LME	12	-239.33	131.67	12.52	4.03×10 ⁻⁴

Conclusion:

The most appropriate model for sulphate at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	190	91	<.0001
## site	4	190	105	<.0001
## period	1	11	4	0.0662
## site:period	4	190	3	0.0098

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.02	-0.15	0.11	not sig.
Counts Outflow	-0.11	-0.24	0.01	not sig.
Vulture-Polar	-0.09	-0.22	0.03	not sig.
Pigeon-Reach 7	0.13	0	0.26	not sig.

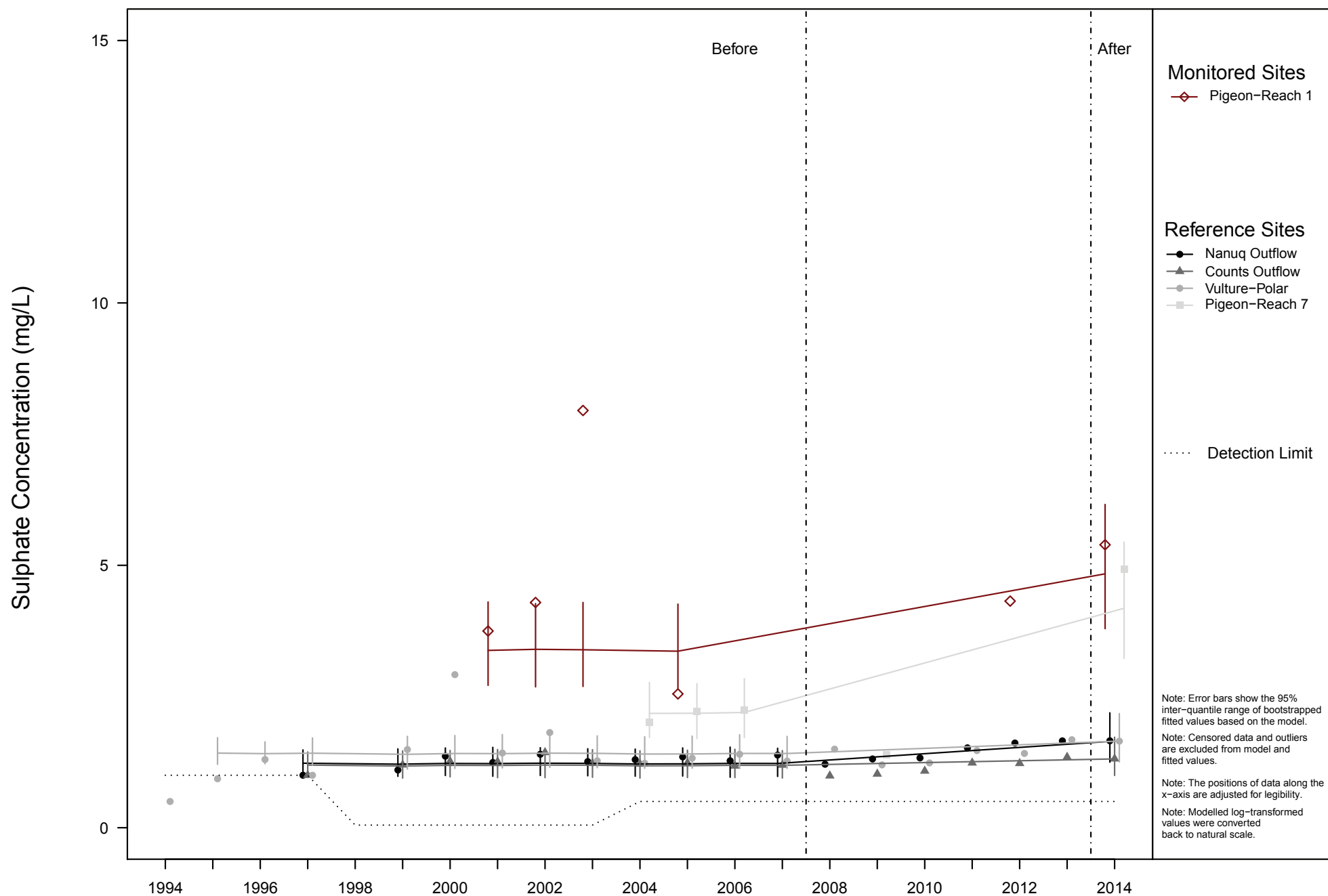
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Sulphate concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

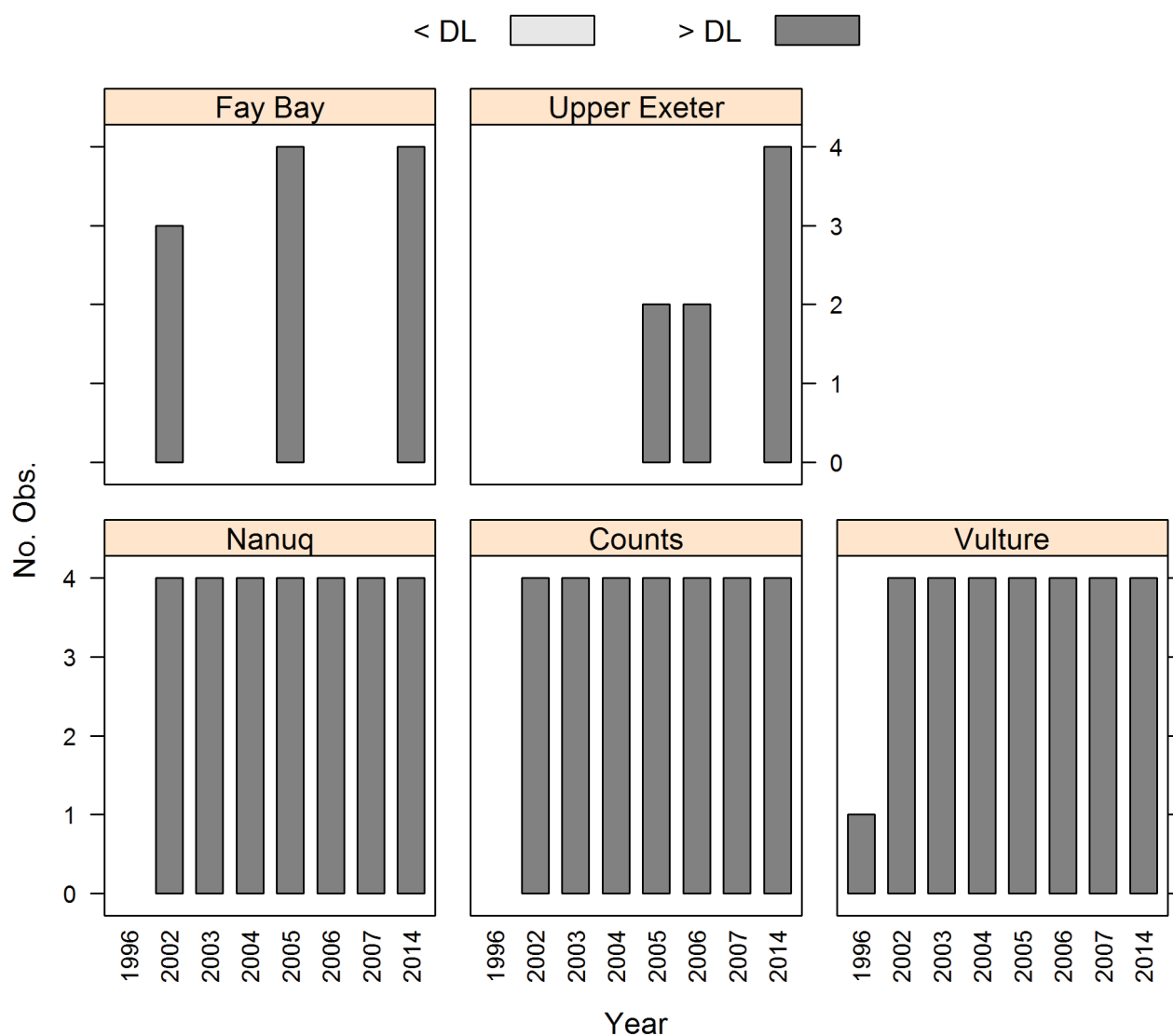


Analysis of Winter Total Potassium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

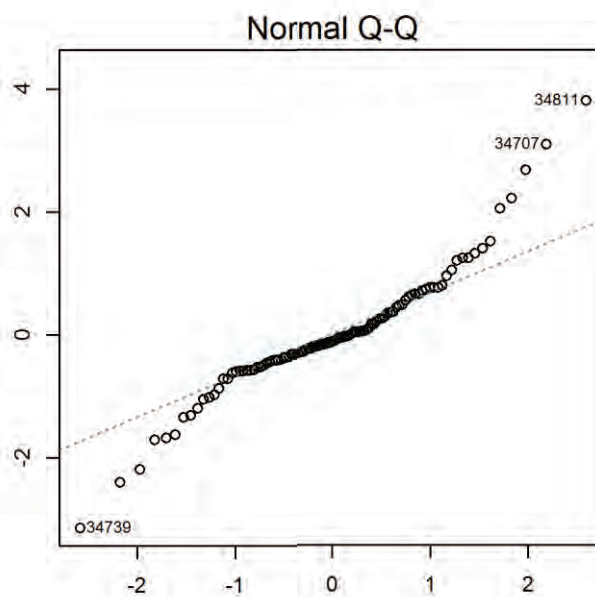
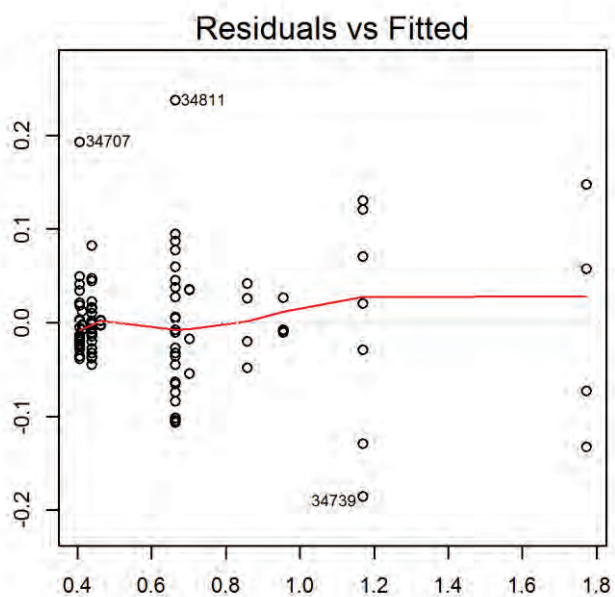
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

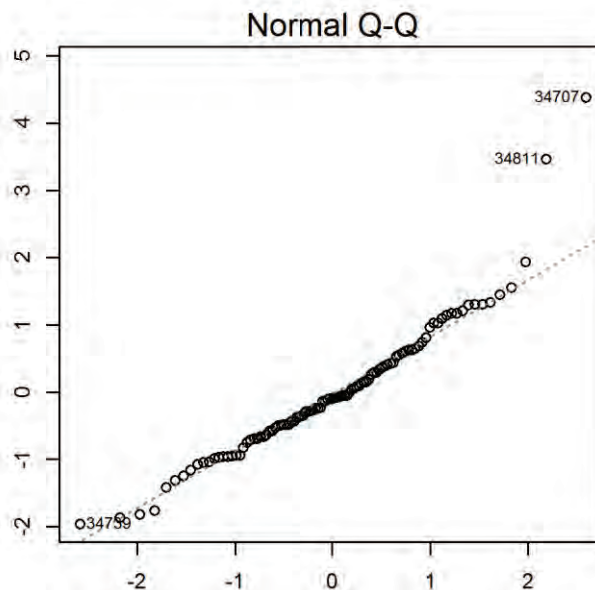
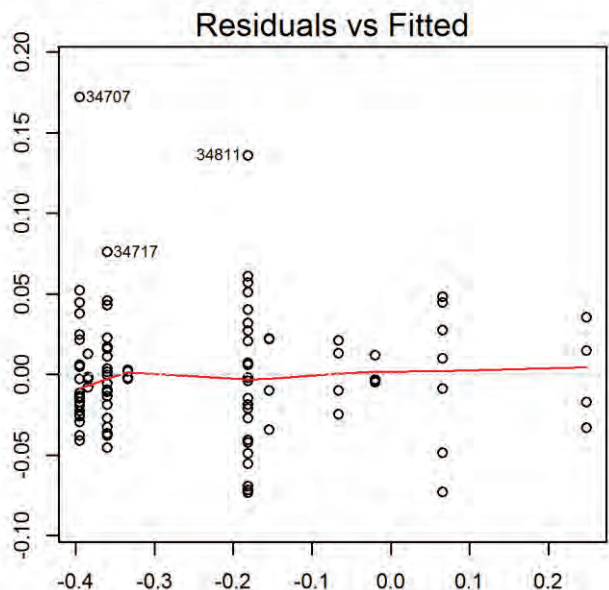
```
##           site year month season
## 34336 Vulture 1996 April  winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.06	0.96	0.96
Log-10	0.04	0.95	0.95

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

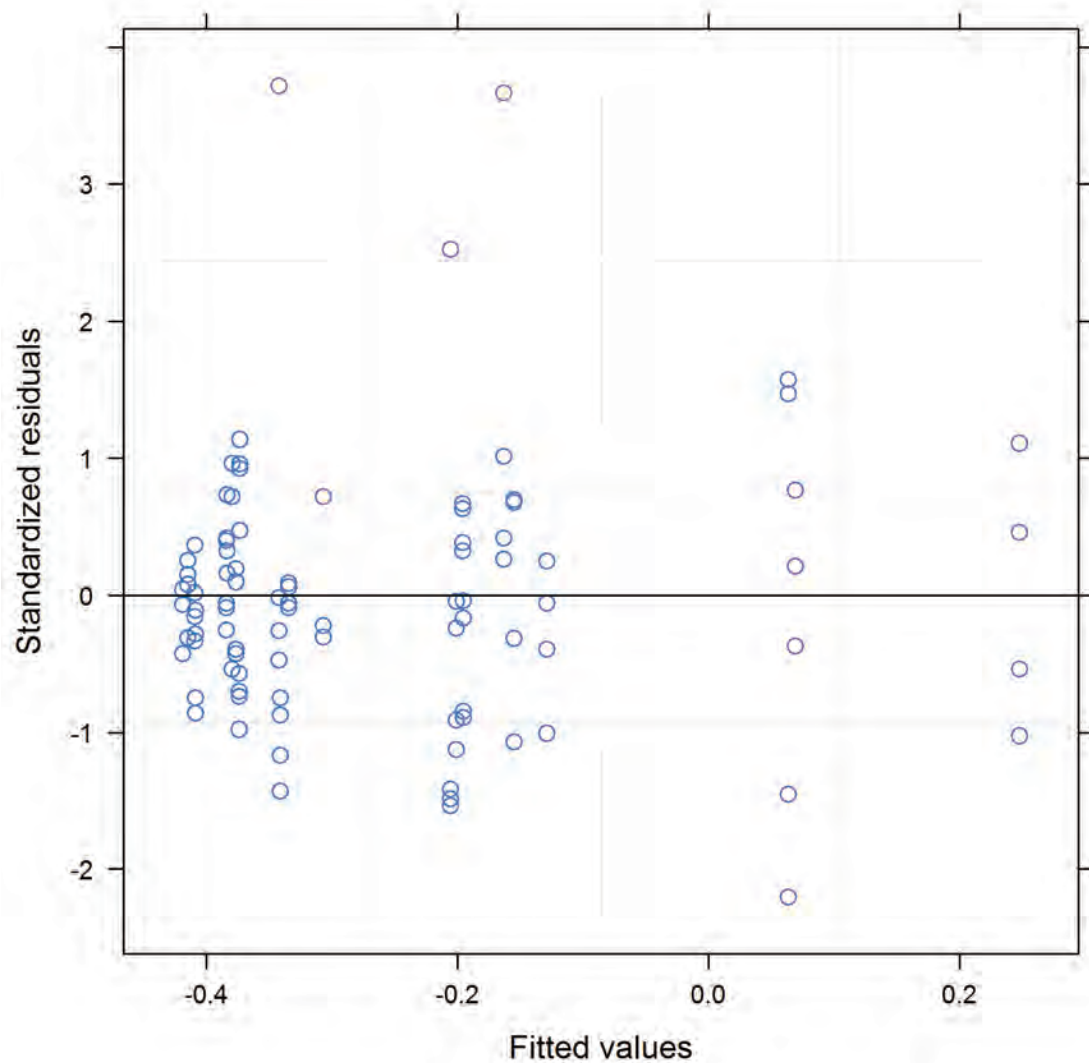
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-272.89	145.45		
LME	10	-302	161	31.1	2.45×10 ⁻⁸

Conclusion:

The most appropriate model for total potassium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	82	465	<.0001
## site	3	82	794	<.0001
## period	1	5	2	0.23
## site:period	3	82	13	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.15	-0.21	-0.1	sig.
Counts	-0.14	-0.19	-0.08	sig.
Vulture	-0.14	-0.19	-0.08	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total potassium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

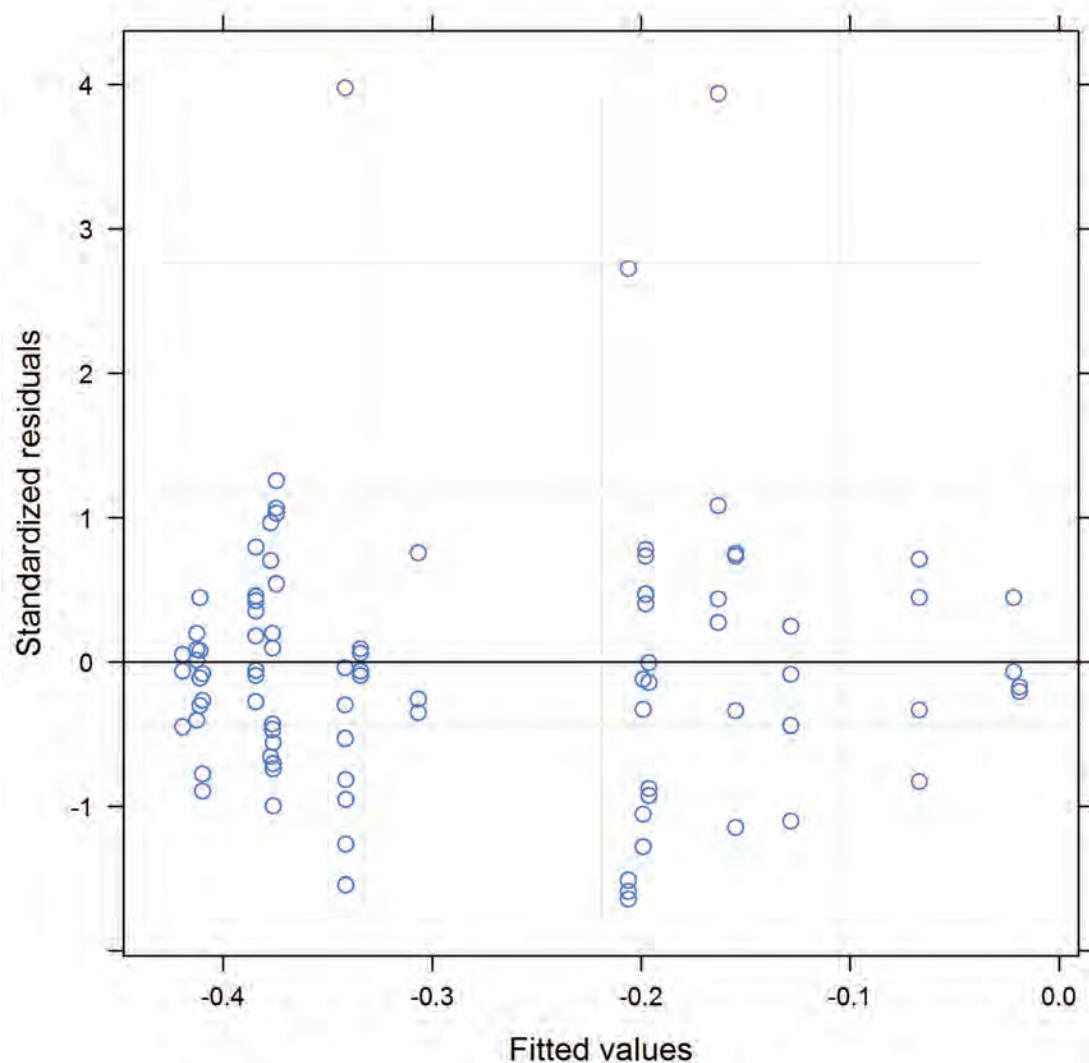
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-268.42	143.21		
LME	10	-301.96	160.98	35.54	2.5×10^{-9}

Conclusion:

The most appropriate model for total potassium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	555	<.0001
## site	3	79	456	<.0001
## period	1	5	0	0.8264
## site:period	3	79	4	0.0062

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.07	0.02	0.12	sig.
Counts	0.09	0.03	0.14	sig.
Vulture	0.09	0.04	0.14	sig.

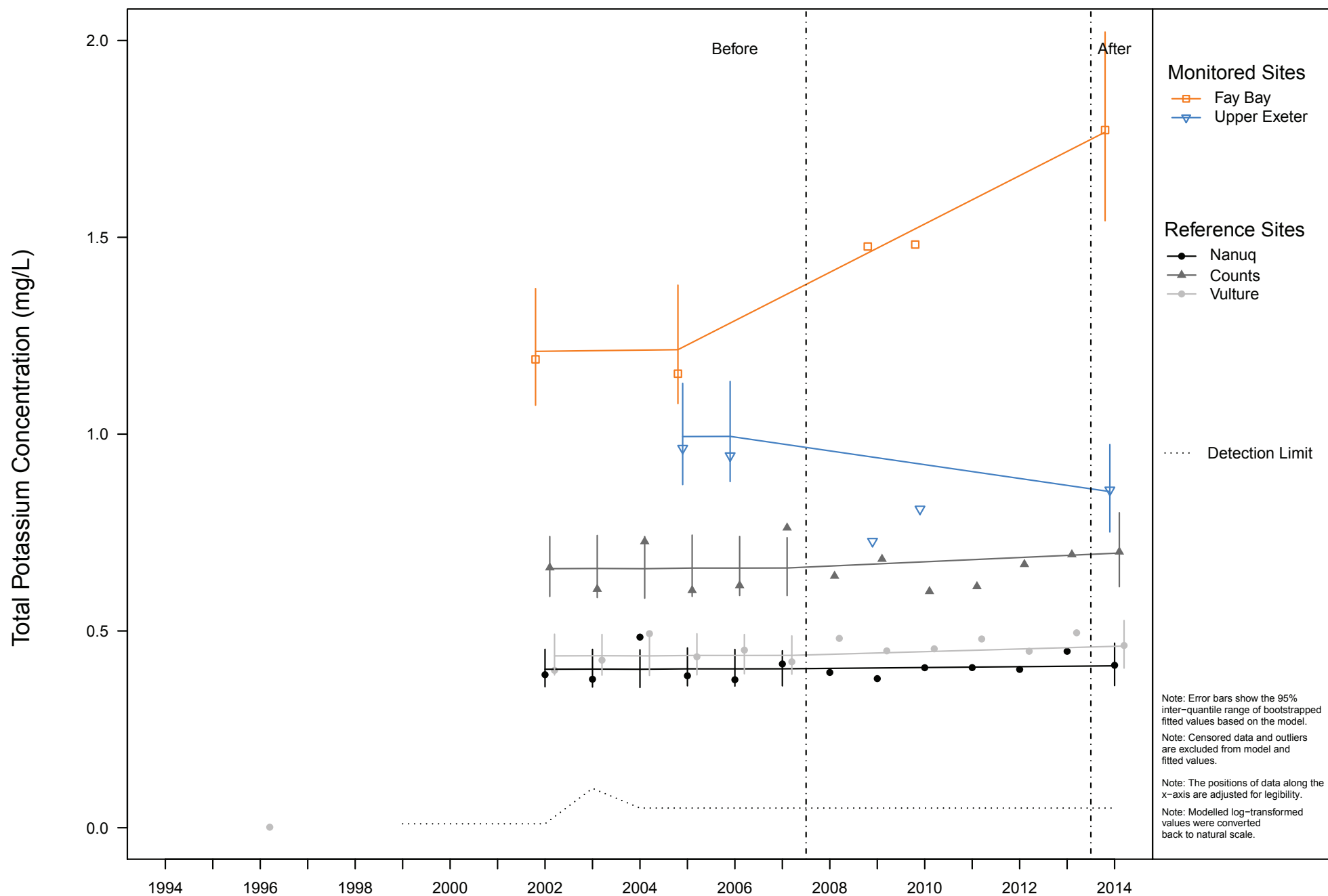
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total potassium concentrations at the Upper Exeter site were significantly ($p = 0.006$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

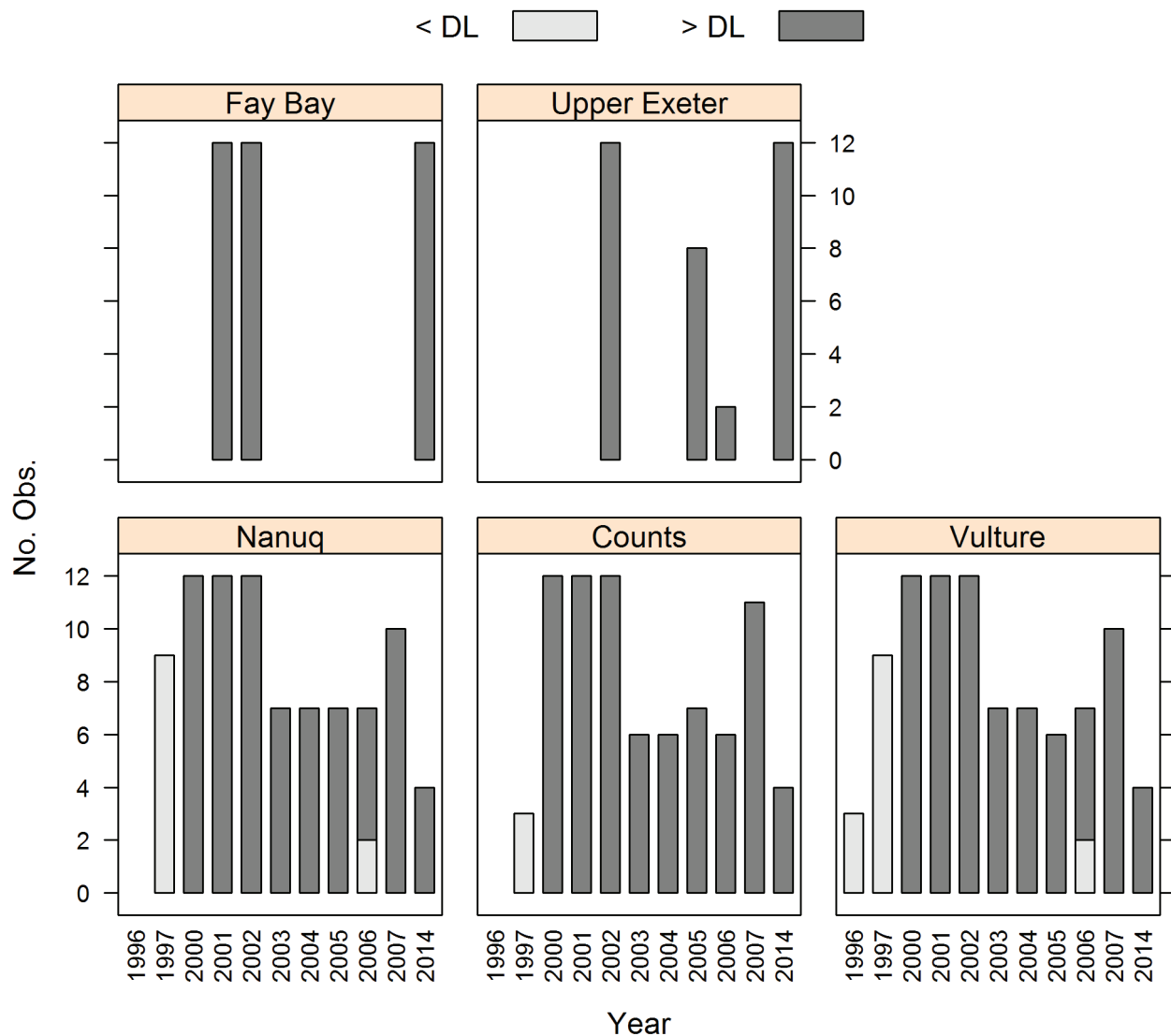


Analysis of Summer Total Potassium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year    month season
## 34337 Vulture 1996   August  summer
## 34338 Vulture 1996   August  summer
## 34339 Vulture 1996   August  summer
## 34340 Counts 1997   August  summer
## 34341 Counts 1997   August  summer
## 34342 Counts 1997   August  summer
## 34343 Nanuq  1997   August  summer
## 34344 Nanuq  1997   August  summer
## 34345 Nanuq  1997   August  summer
## 34346 Nanuq  1997   August  summer
## 34347 Nanuq  1997   August  summer
## 34348 Nanuq  1997   August  summer
## 34349 Nanuq  1997   August  summer
## 34350 Nanuq  1997   August  summer
## 34351 Nanuq  1997   August  summer
## 34352 Vulture 1997   August  summer
## 34353 Vulture 1997   August  summer
## 34354 Vulture 1997   August  summer
## 34355 Vulture 1997   August  summer
## 34356 Vulture 1997   August  summer
## 34357 Vulture 1997   August  summer
## 34358 Vulture 1997   August  summer
## 34359 Vulture 1997   August  summer
## 34360 Vulture 1997   August  summer
## 34793 Nanuq  2006 September  summer
## 34794 Nanuq  2006 September  summer
## 34808 Vulture 2006 September  summer
## 34809 Vulture 2006 September  summer
```

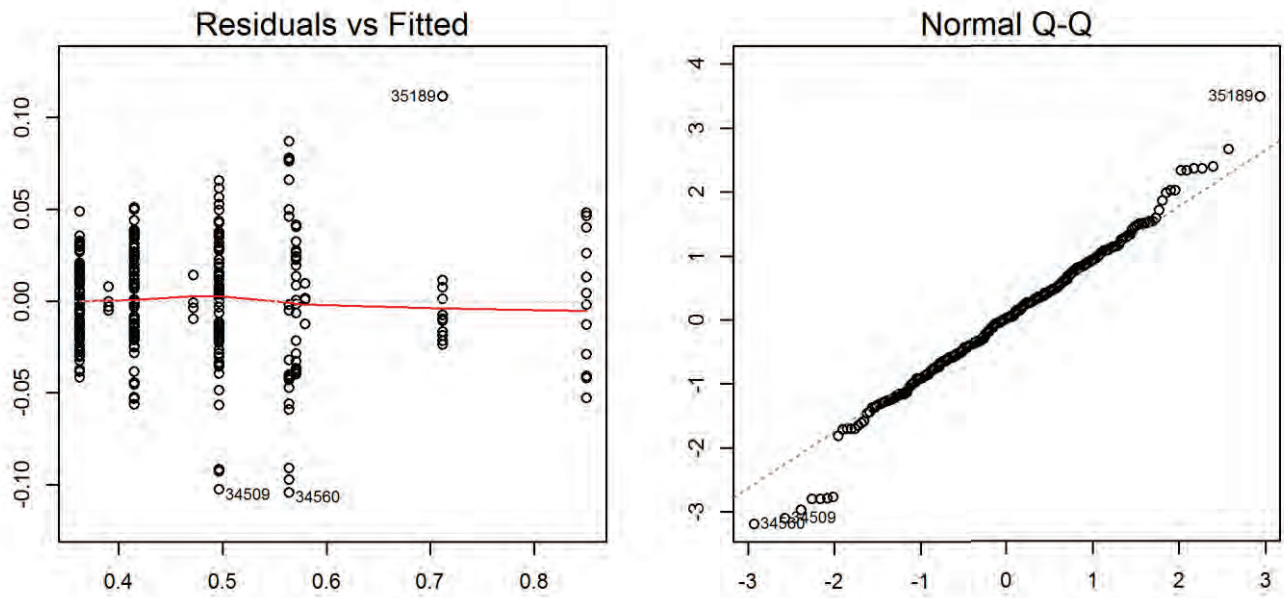
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

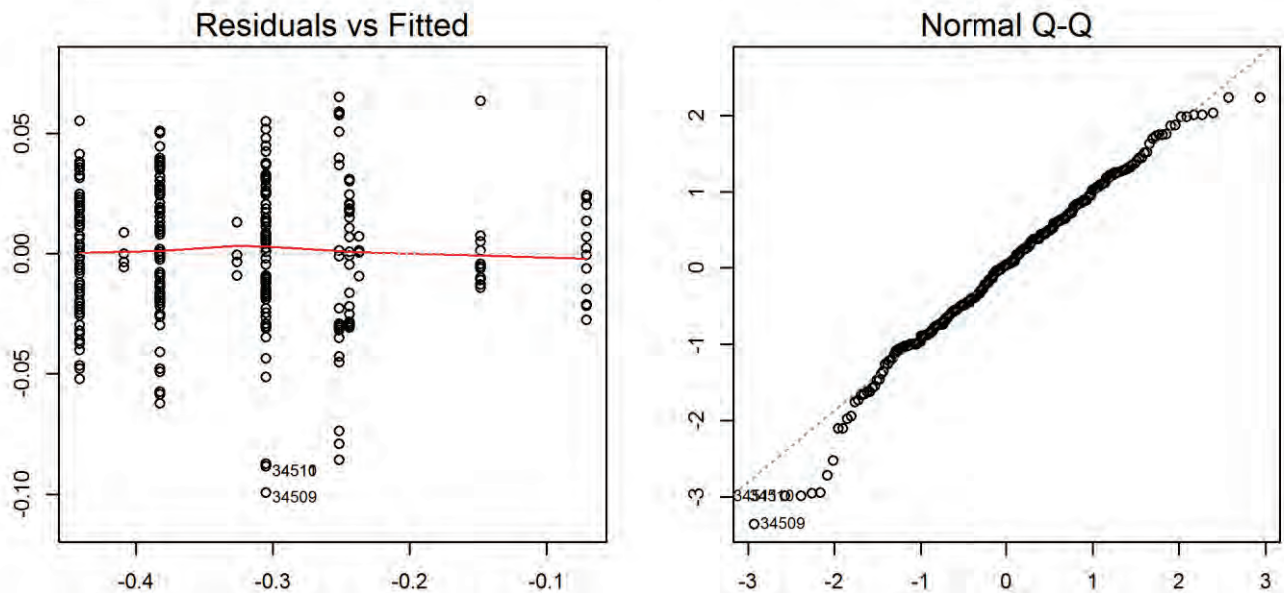
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.03	0.93	0.92
Log-10	0.03	0.91	0.91

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

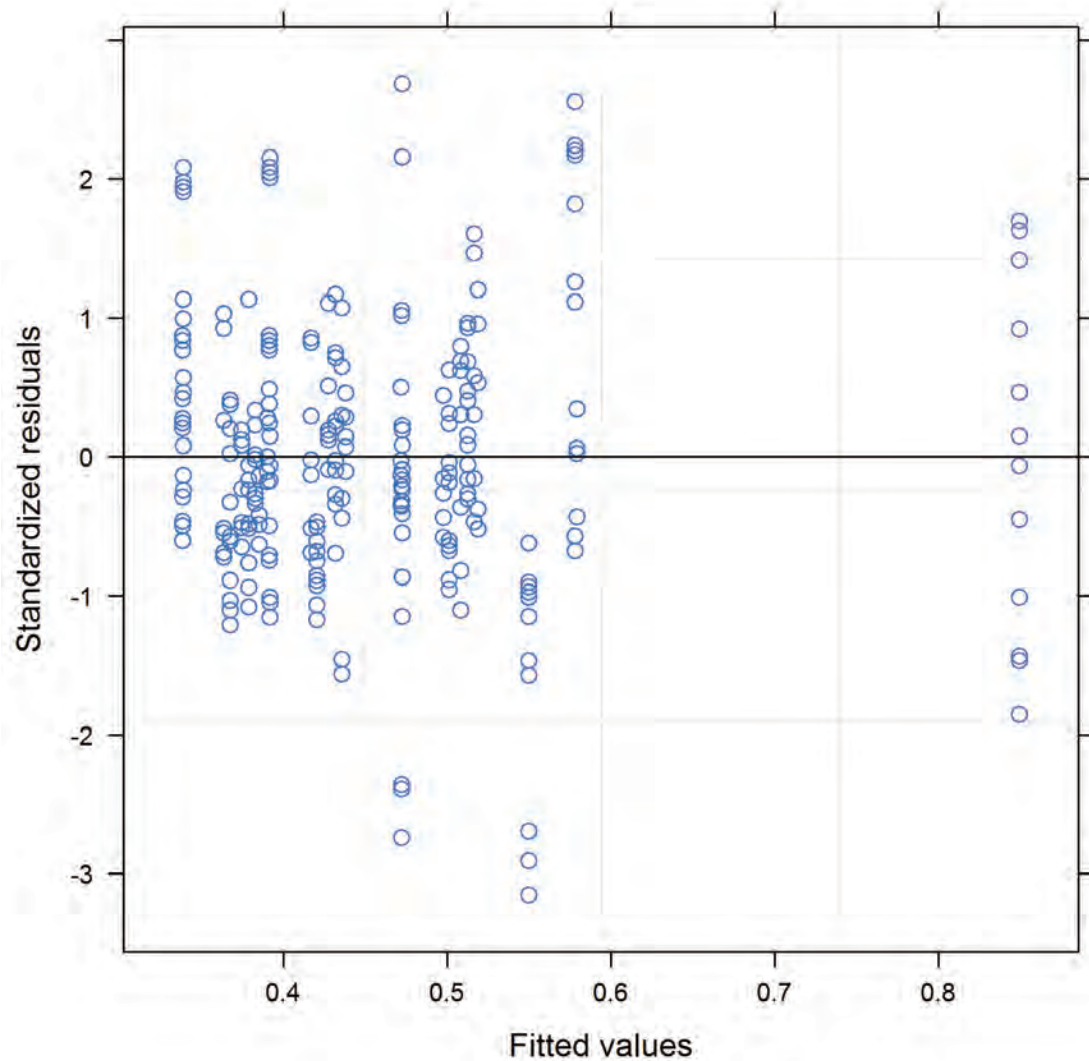
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-967.89	492.94		
LME	10	-1031.08	525.54	65.19	6.66×10 ⁻¹⁶

Conclusion:

The most appropriate model for Total Potassium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	248	4794	<.0001
## site	3	248	732	<.0001
## period	1	7	42	3e-04
## site:period	3	248	93	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.25	-0.28	-0.21	sig.
Counts	-0.19	-0.23	-0.16	sig.
Vulture	-0.22	-0.26	-0.18	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total potassium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

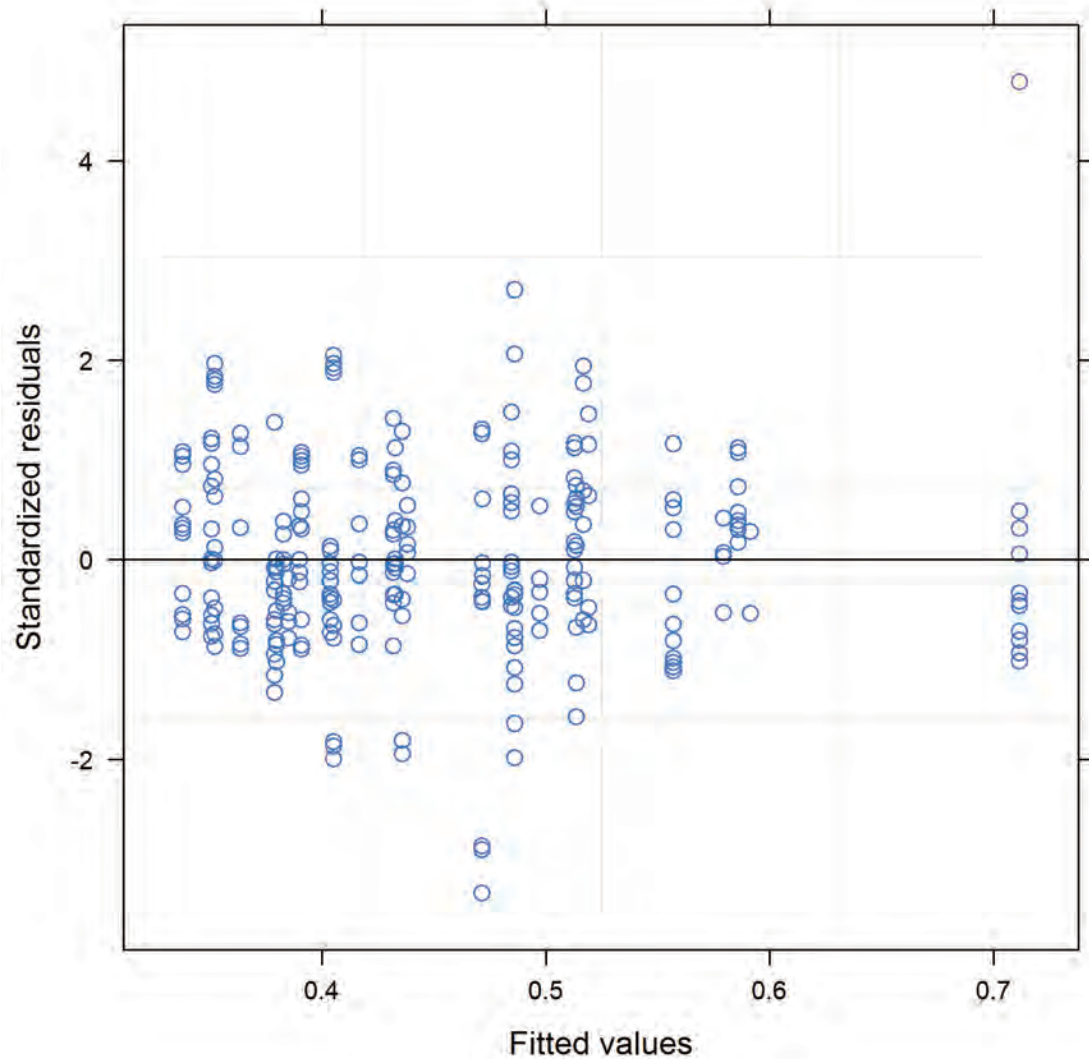
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-1039.49	528.74		
LME	10	-1122.28	571.14	84.79	0

Conclusion:

The most appropriate model for Total Potassium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	246	5229	<.0001
## site	3	246	844	<.0001
## period	1	7	18	0.0039
## site:period	3	246	24	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.12	-0.15	-0.09	sig.
Counts	-0.06	-0.09	-0.03	sig.
Vulture	-0.09	-0.12	-0.06	sig.

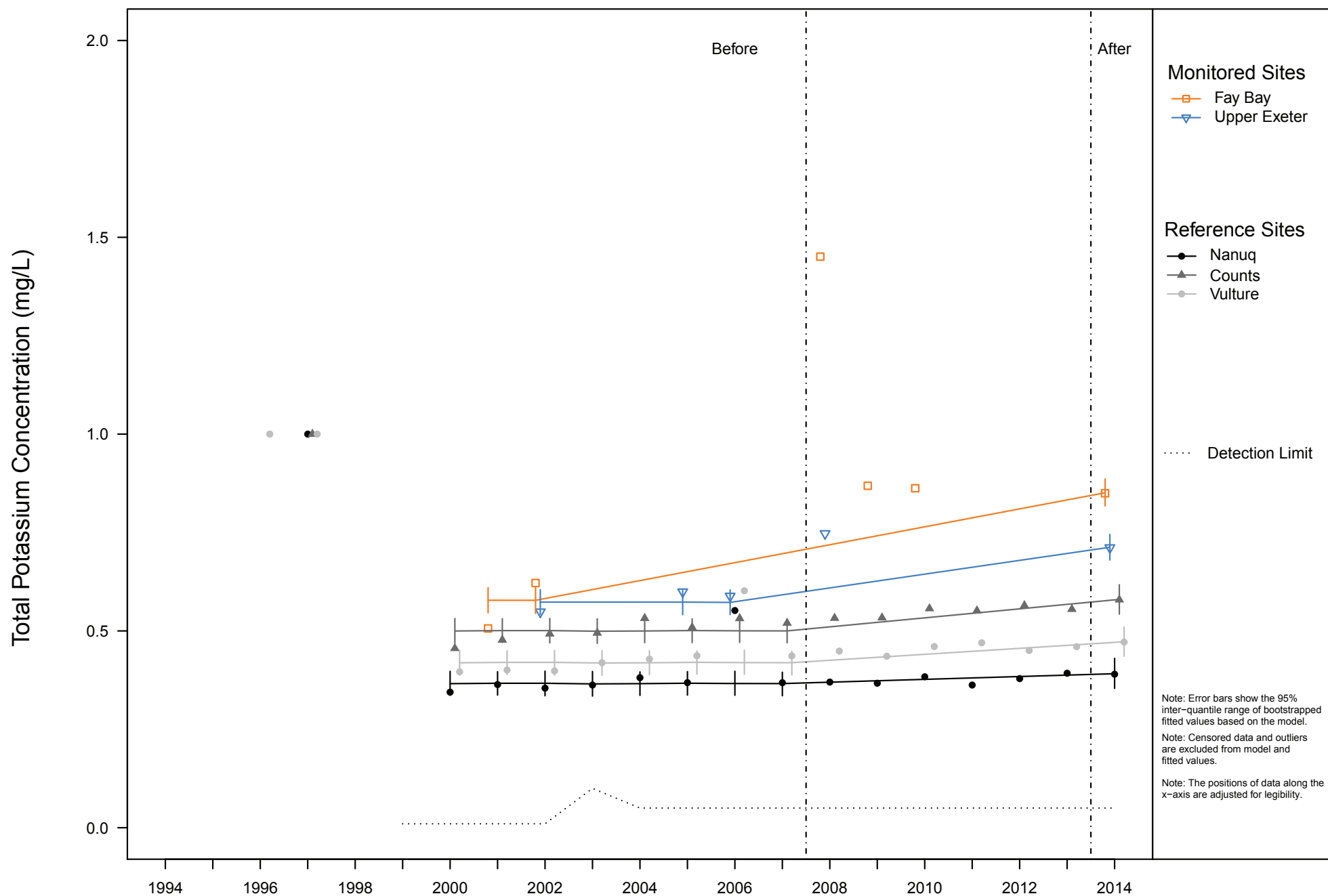
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total potassium concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

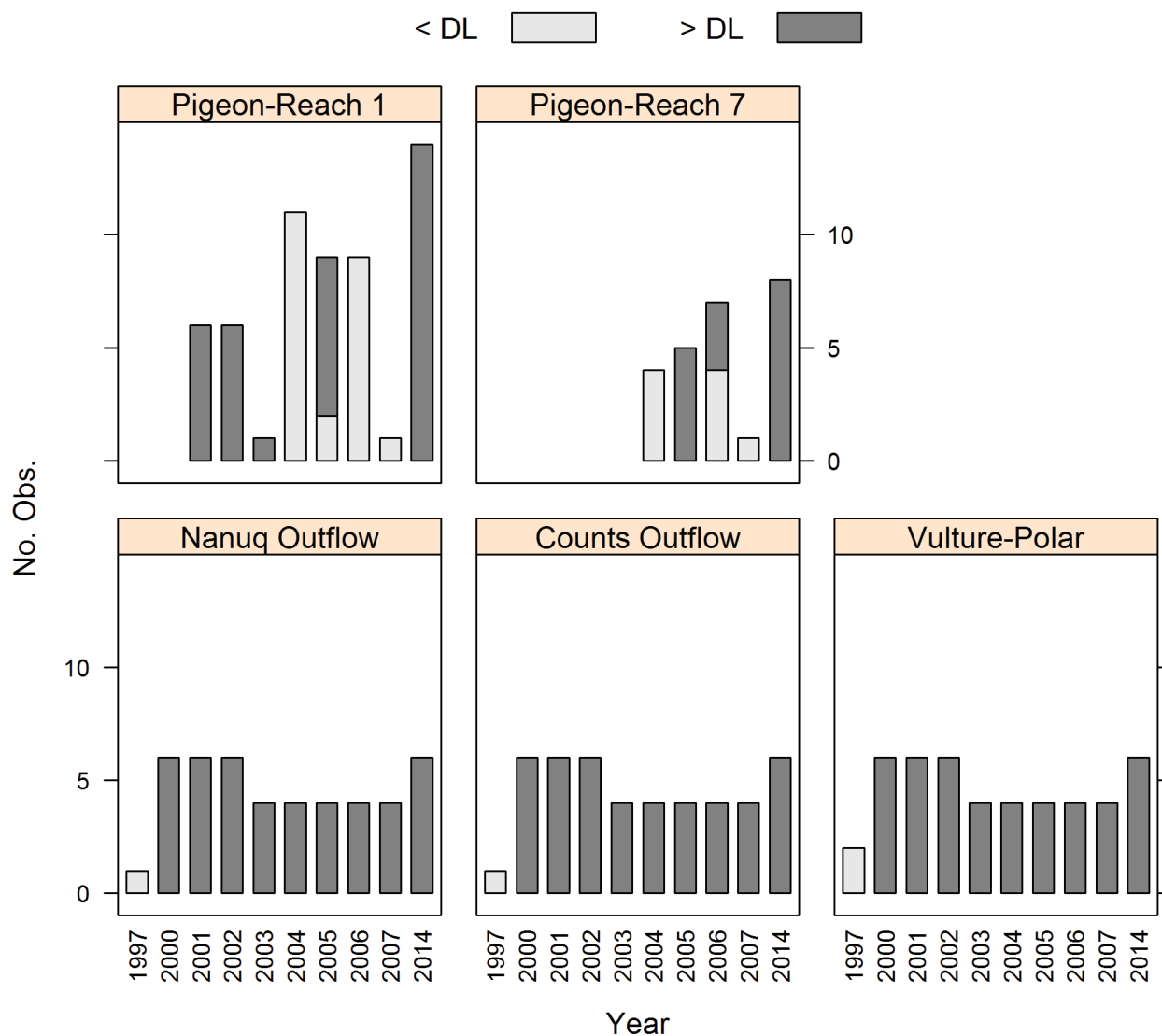


Analysis of Summer Total Potassium Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##          site year    month season
## 23418 Counts Outflow 1997 September summer
## 23419 Nanuq Outflow 1997 September summer
## 23420 Vulture-Polar 1997      July summer
## 23421 Vulture-Polar 1997 September summer
## 23621 Pigeon-Reach 1 2004      July summer
## 23622 Pigeon-Reach 1 2004      July summer
## 23623 Pigeon-Reach 1 2004      July summer
## 23624 Pigeon-Reach 1 2004      July summer
## 23625 Pigeon-Reach 1 2004      August summer
## 23626 Pigeon-Reach 1 2004      August summer
## 23627 Pigeon-Reach 1 2004      August summer
## 23628 Pigeon-Reach 1 2004      August summer
## 23629 Pigeon-Reach 1 2004 September summer
## 23630 Pigeon-Reach 1 2004 September summer
## 23631 Pigeon-Reach 1 2004 September summer
## 23632 Pigeon-Reach 7 2004      July summer
## 23633 Pigeon-Reach 7 2004      July summer
## 23634 Pigeon-Reach 7 2004      July summer
## 23635 Pigeon-Reach 7 2004      July summer
## 23699 Pigeon-Reach 1 2006      July summer
## 23700 Pigeon-Reach 1 2006      July summer
## 23701 Pigeon-Reach 1 2006      July summer
## 23702 Pigeon-Reach 1 2006      August summer
## 23703 Pigeon-Reach 1 2006      August summer
## 23704 Pigeon-Reach 1 2006      August summer
## 23705 Pigeon-Reach 1 2006 September summer
## 23706 Pigeon-Reach 1 2006 September summer
## 23707 Pigeon-Reach 1 2006 September summer
## 23738 Pigeon-Reach 1 2007      July summer
## 23752 Pigeon-Reach 7 2007      July summer
```

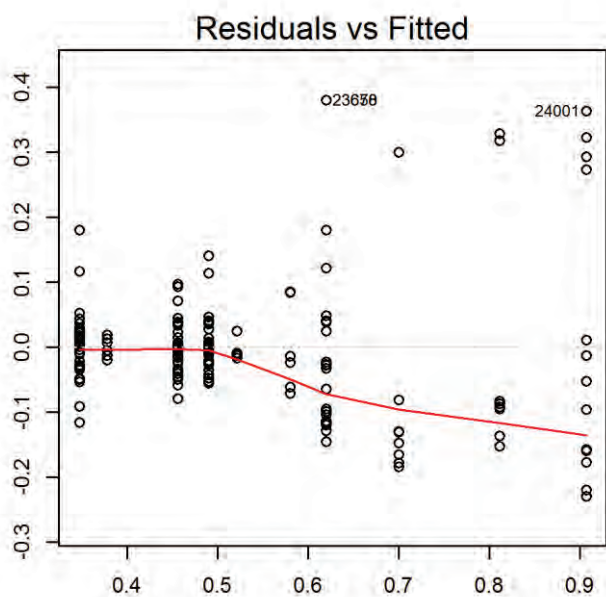
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

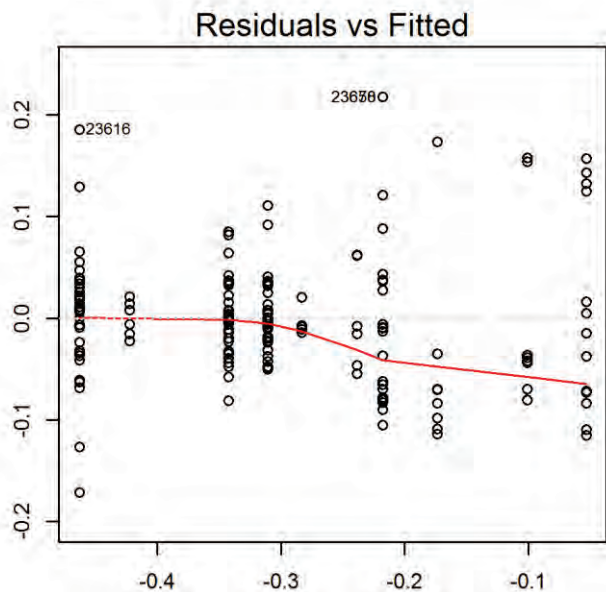
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.11	0.69	0.68
Log-10	0.07	0.77	0.76

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

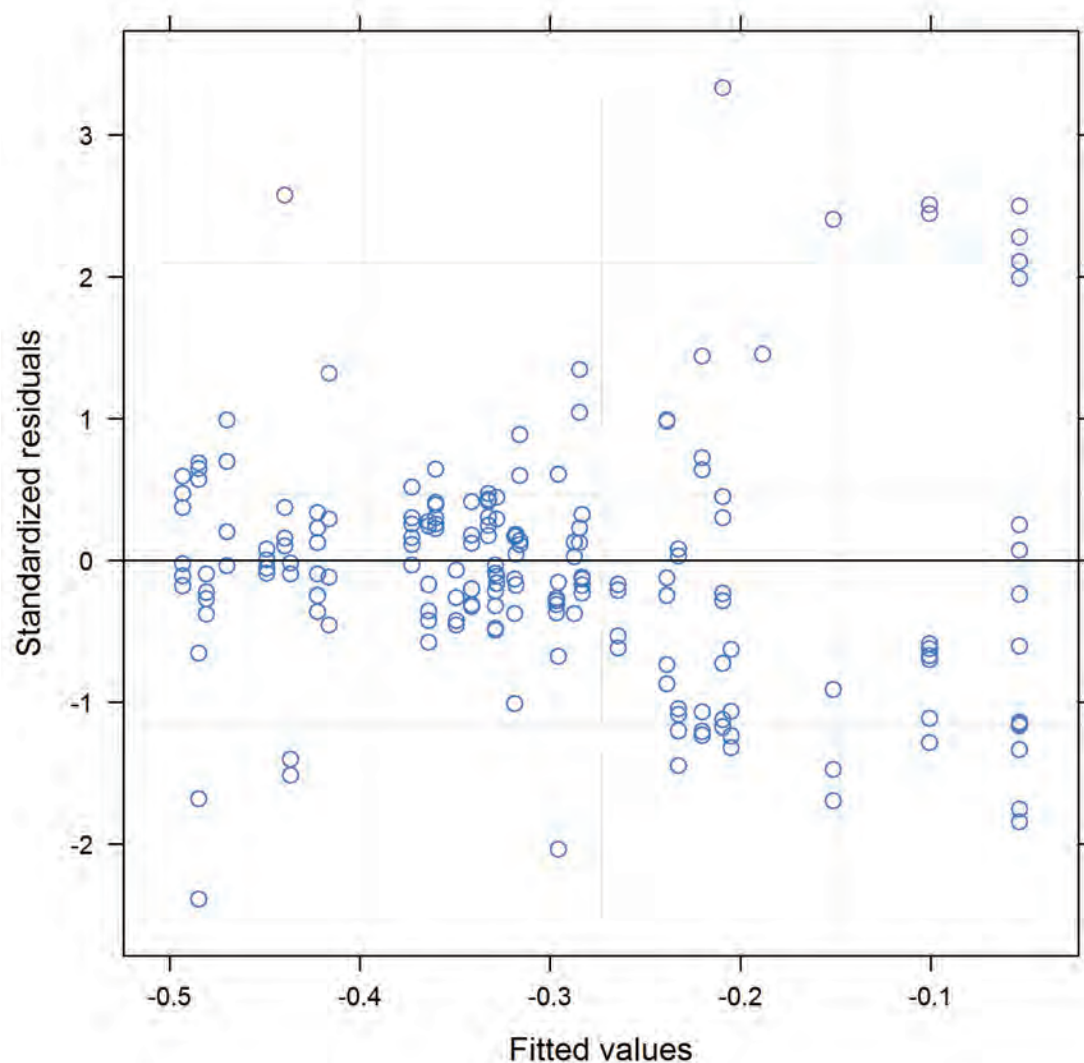
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-406.12	214.06		
LME	12	-418.38	221.19	14.26	1.59×10 ⁻⁴

Conclusion:

The most appropriate model for total potassium at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	171	775	<.0001
## site	4	171	117	<.0001
## period	1	7	6	0.044
## site:period	4	171	3	0.020

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.11	-0.18	-0.04	sig.
Counts Outflow	-0.08	-0.14	-0.01	sig.
Vulture-Polar	-0.09	-0.16	-0.02	sig.
Pigeon-Reach 7	-0.05	-0.12	0.02	not sig.

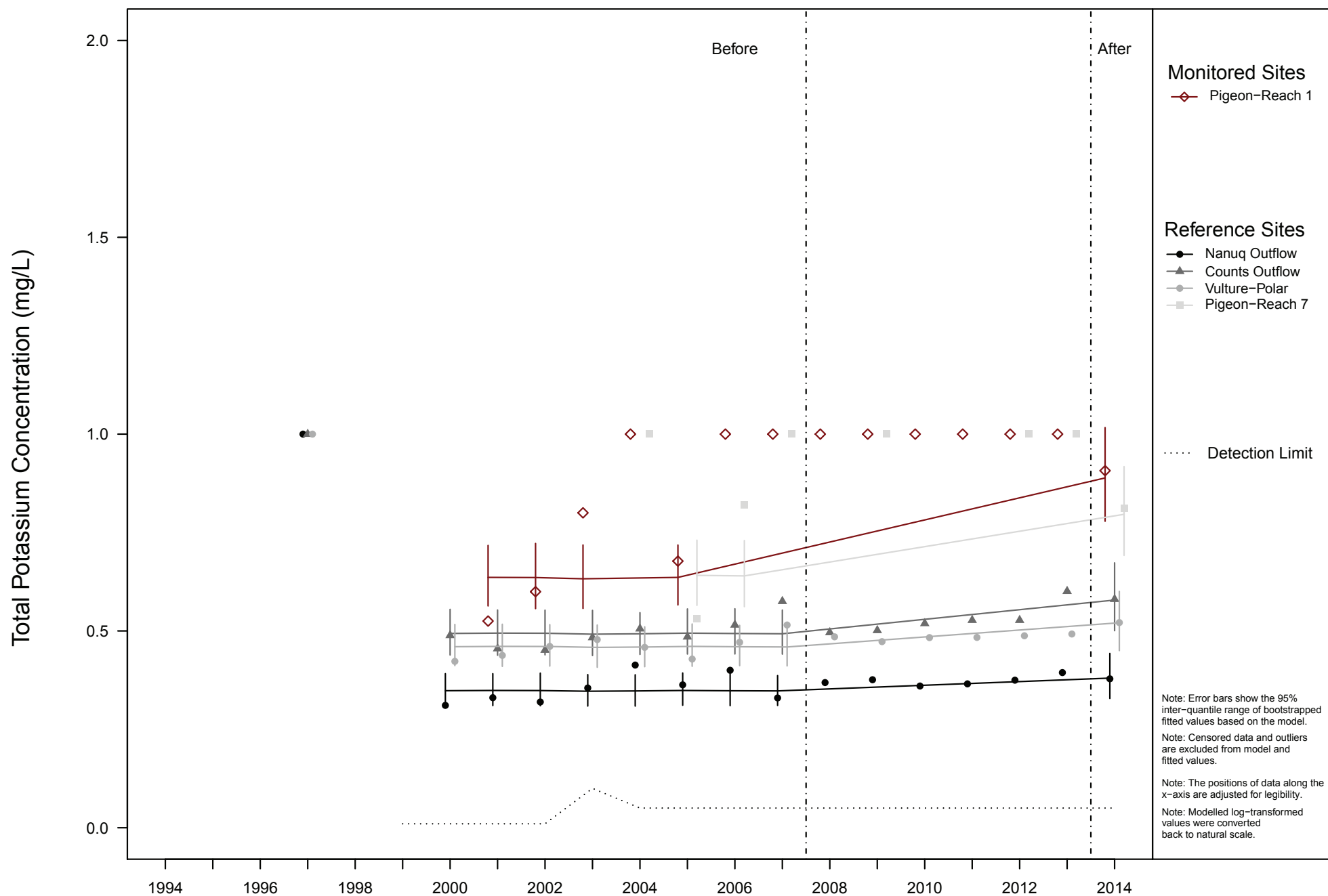
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total potassium concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.02$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

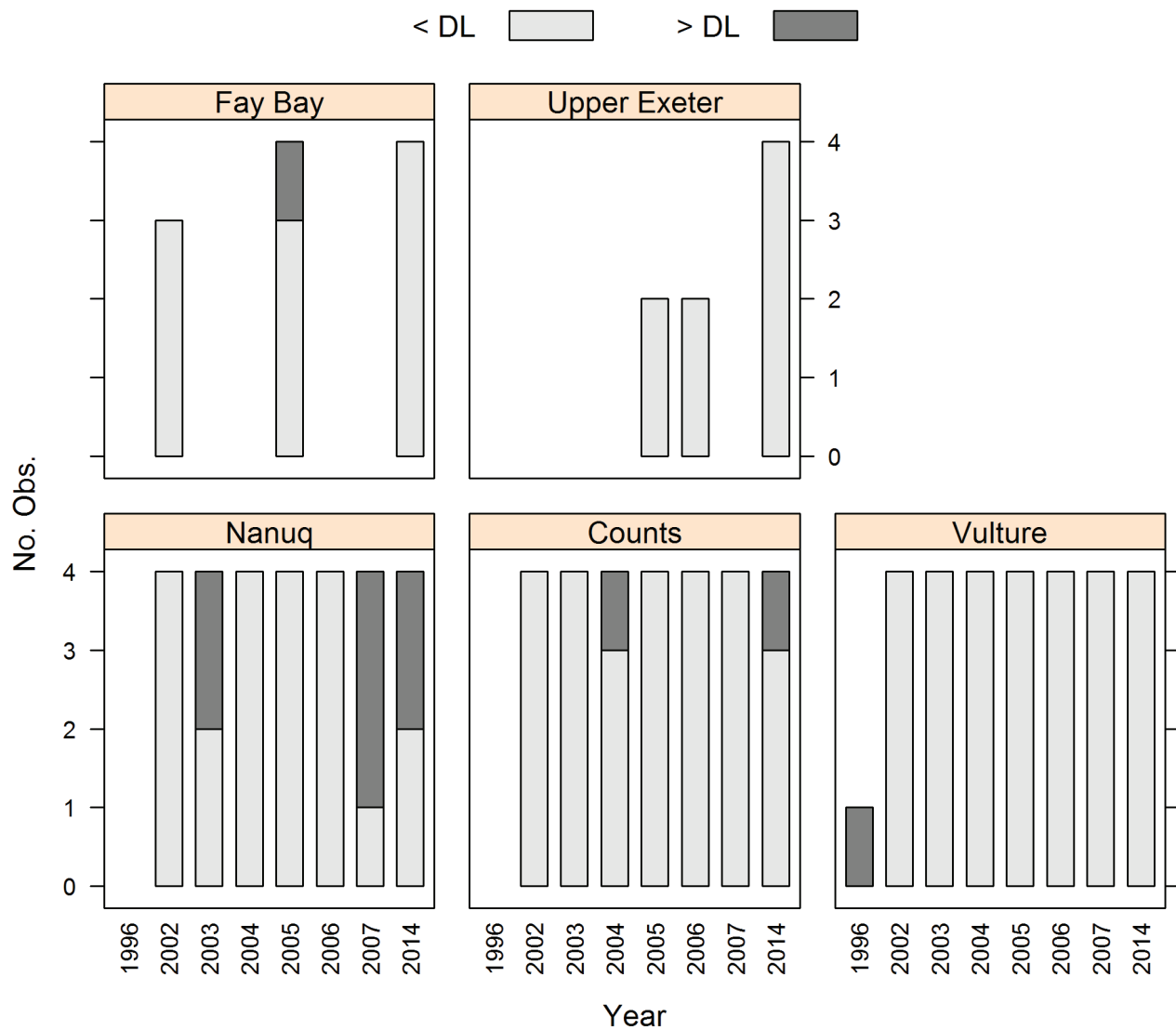


Analysis of Winter Total Suspended Solids Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

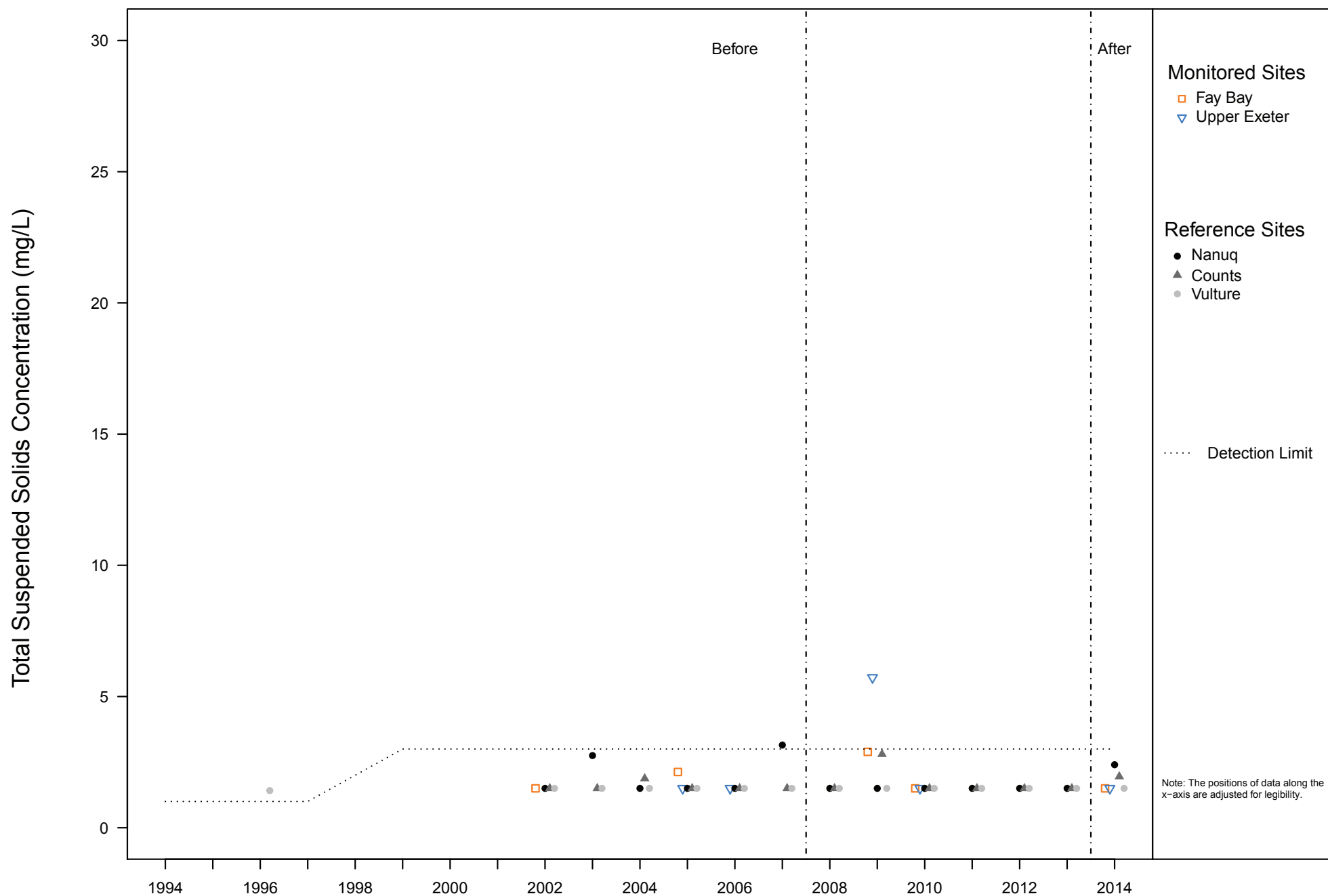
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

TSS water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

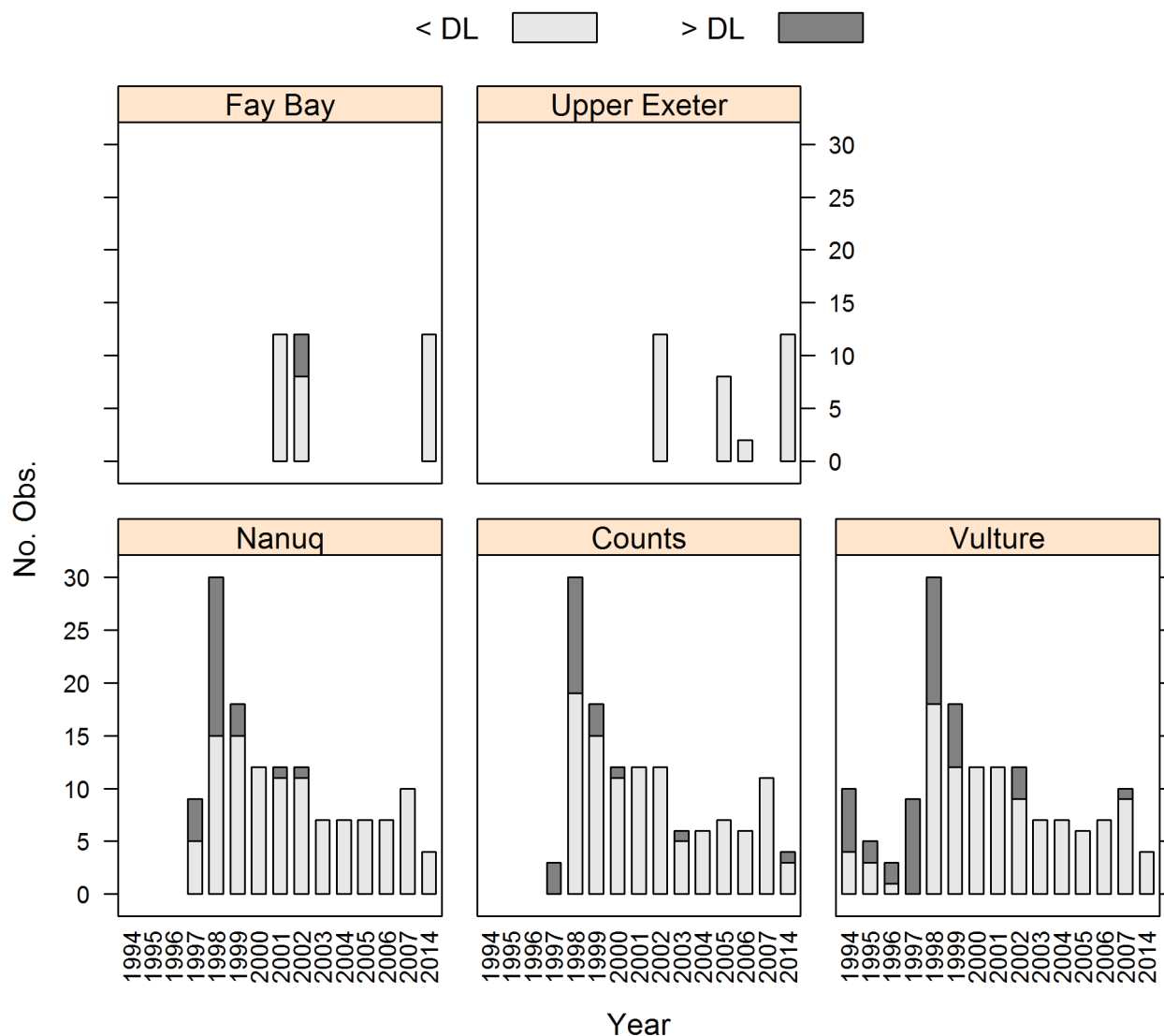


Analysis of Summer Total Suspended Solids Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

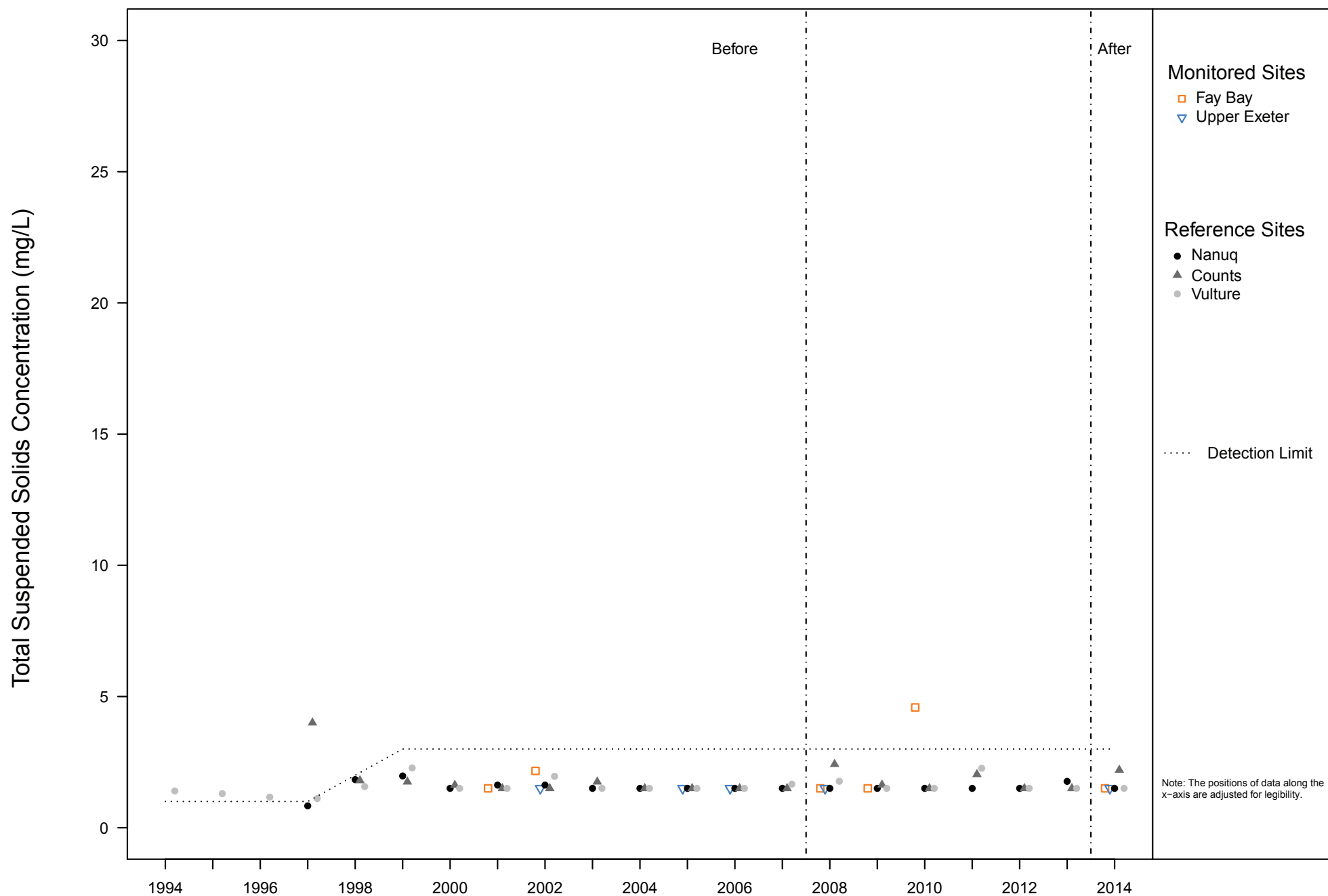
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

TSS water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

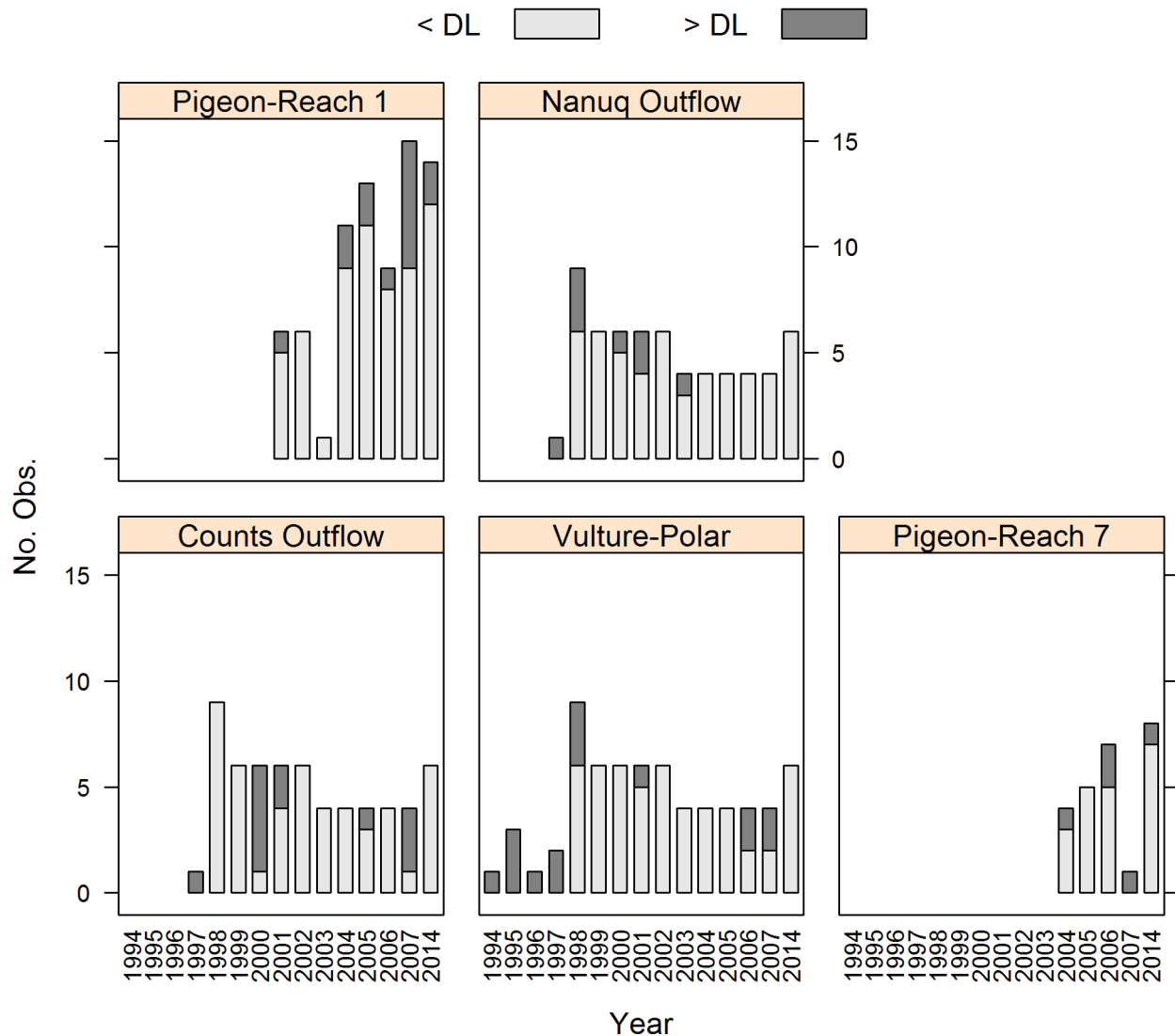


Analysis of Summer Total Suspended Sediment Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

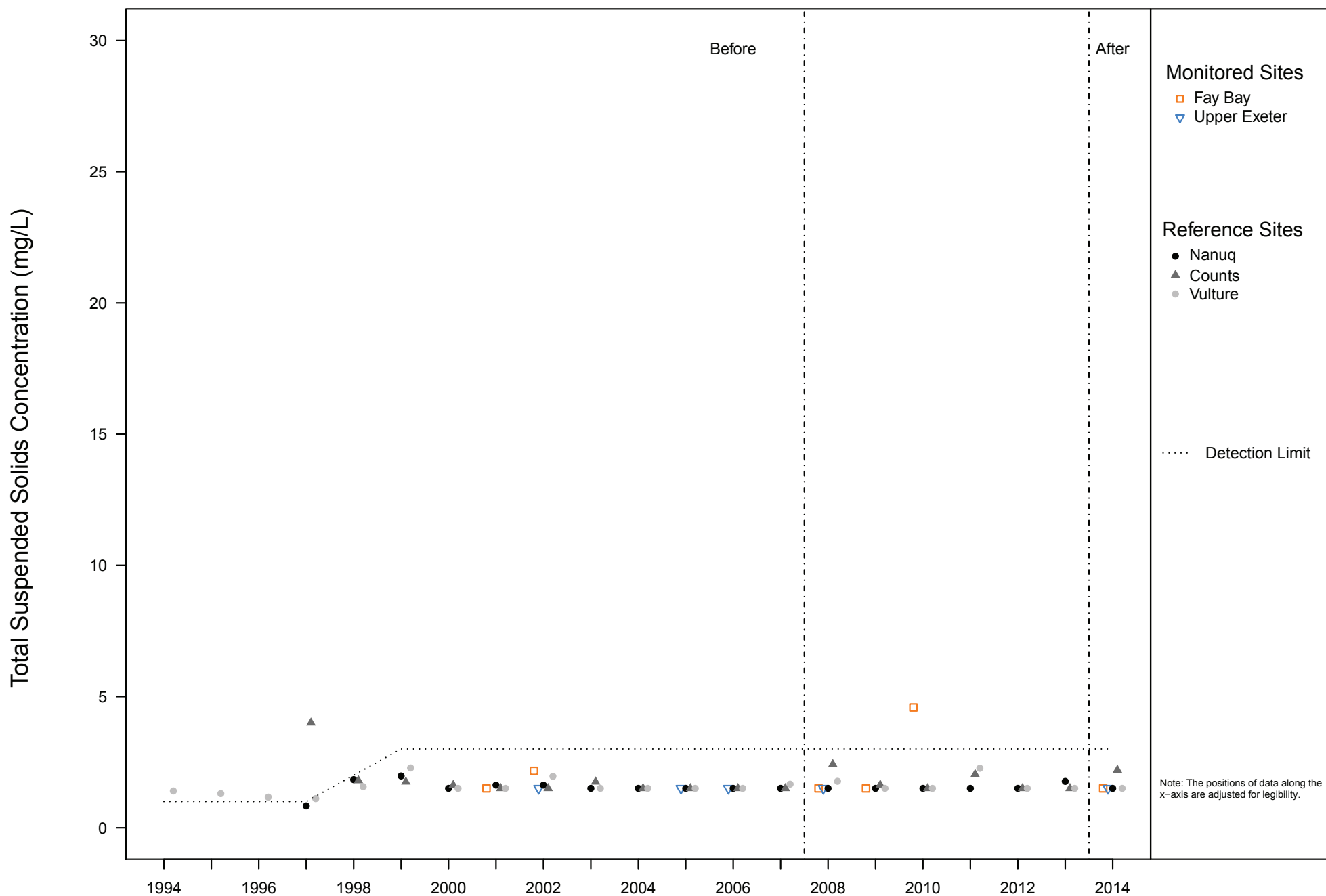
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

TSS water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

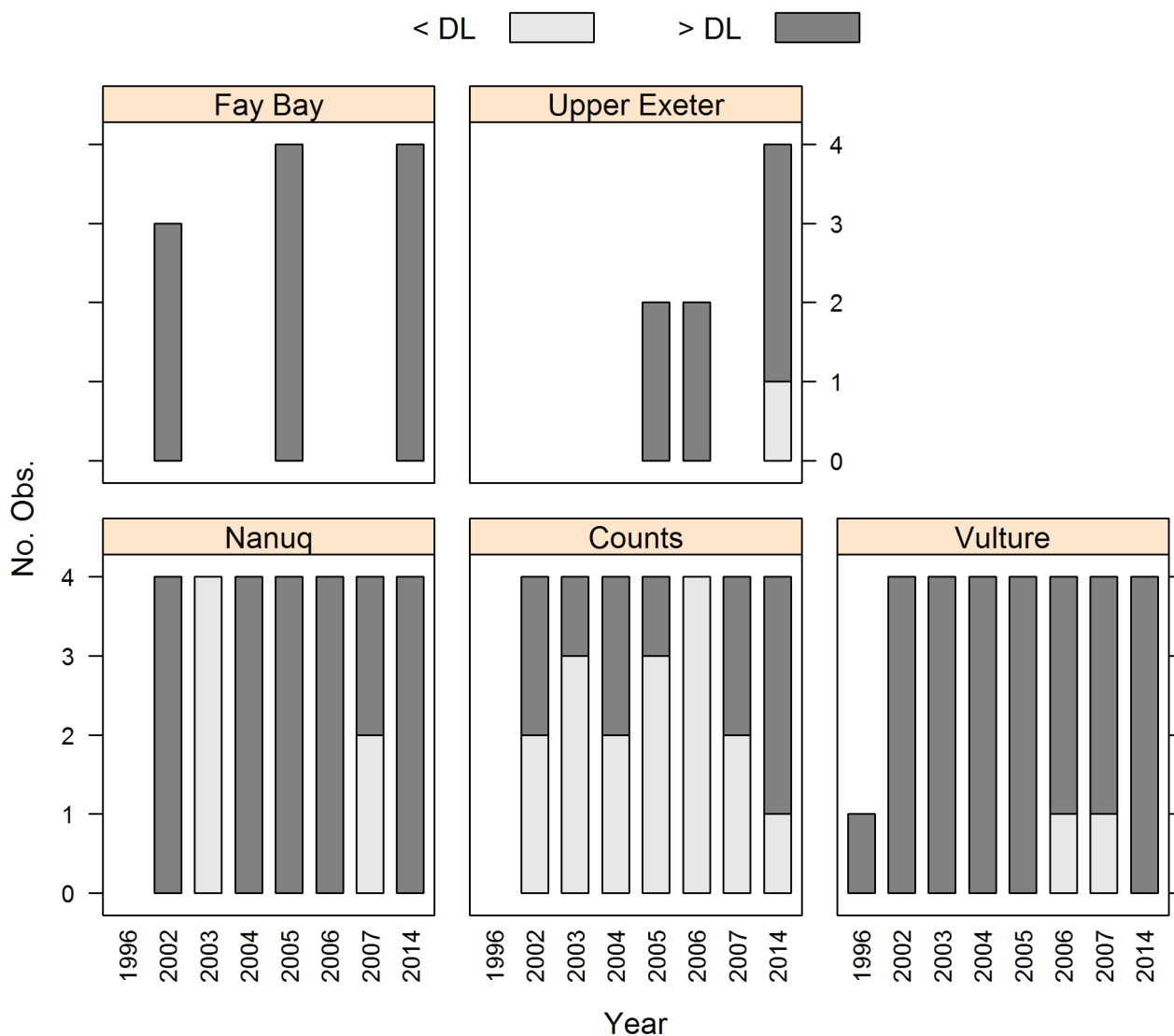


Analysis of Winter Total Ammonia Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year month season
## 12664 Counts 2003 April winter
## 12665 Counts 2003 April winter
## 12666 Counts 2003 April winter
## 12667 Counts 2003 April winter
## 12674 Nanuq 2003 April winter
## 12675 Nanuq 2003 April winter
## 12676 Nanuq 2003 April winter
## 12677 Nanuq 2003 April winter
## 12728 Counts 2005 April winter
## 12729 Counts 2005 April winter
## 12730 Counts 2005 April winter
## 12731 Counts 2005 April winter
## 12774 Counts 2006 April winter
## 12775 Counts 2006 April winter
## 12776 Counts 2006 April winter
## 12777 Counts 2006 April winter
```

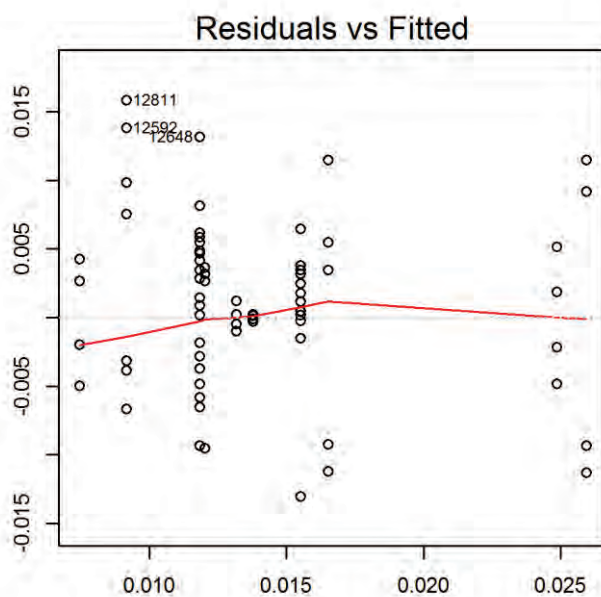
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

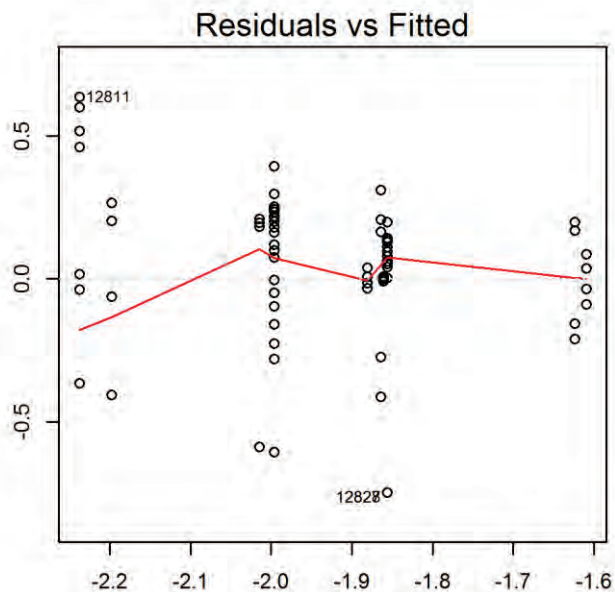
```
##      site year month season
## 12685 Vulture 2003 April winter
## 12741 Fay Bay 2005 April winter
## 12742 Fay Bay 2005 April winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.01	0.35	0.27
Log-10	0.29	0.28	0.19

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

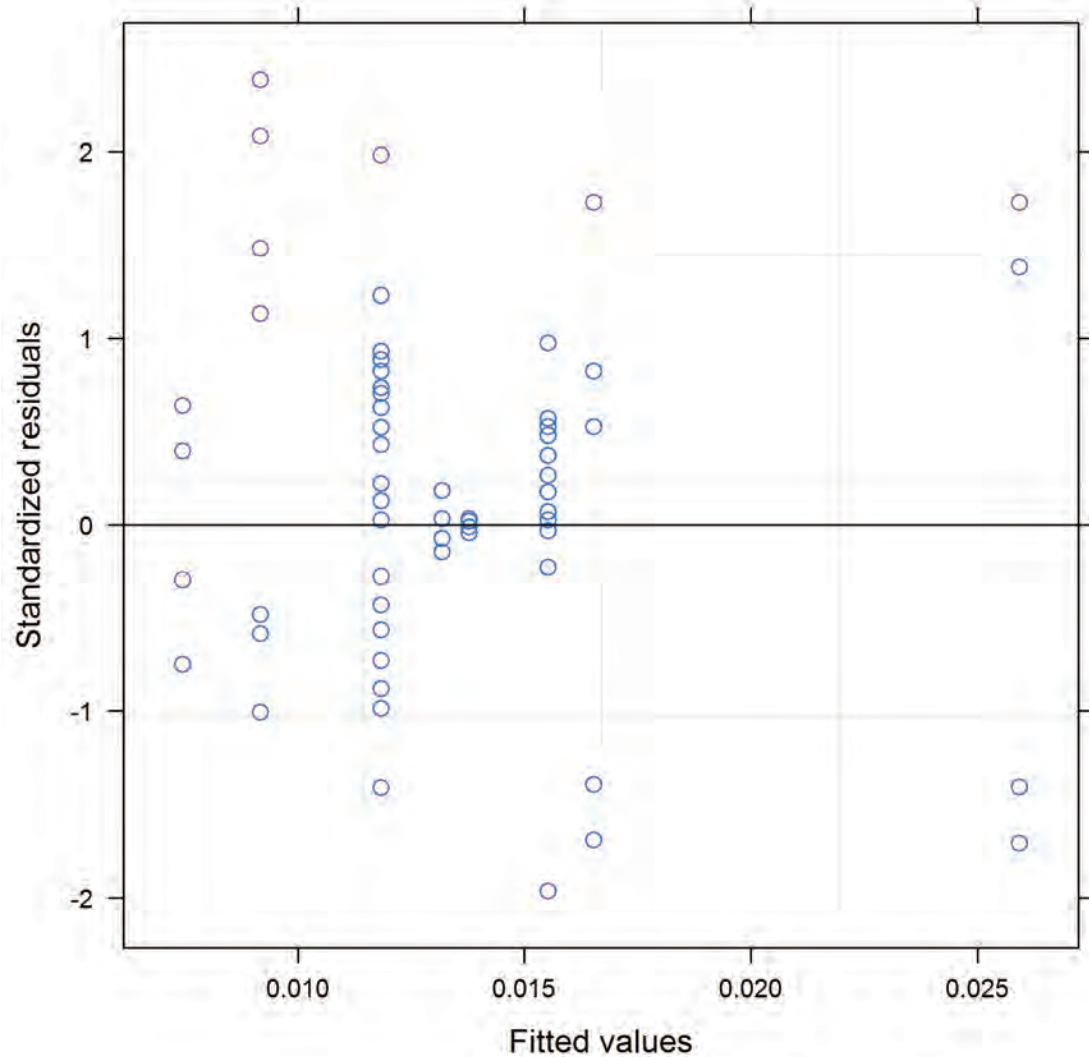
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-462.57	240.28		
LME	10	-462.1	241.05	1.53	0.22

Conclusion:

The most appropriate model for total ammonia-N at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.216$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 69
##          numDF F-value p-value
## (Intercept)    1    312 <.0001
## site           3     7 0.0003
## period         1     0 0.5279
## site:period    3     2 0.2104
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.01	-0.02	3.1210^{-4}	not sig.
Counts	-0.01	-0.02	5.8810^{-4}	not sig.
Vulture	-0.01	-0.02	0	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total ammonia-N concentrations at the Fay Bay site were not significantly ($p = 0.21$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

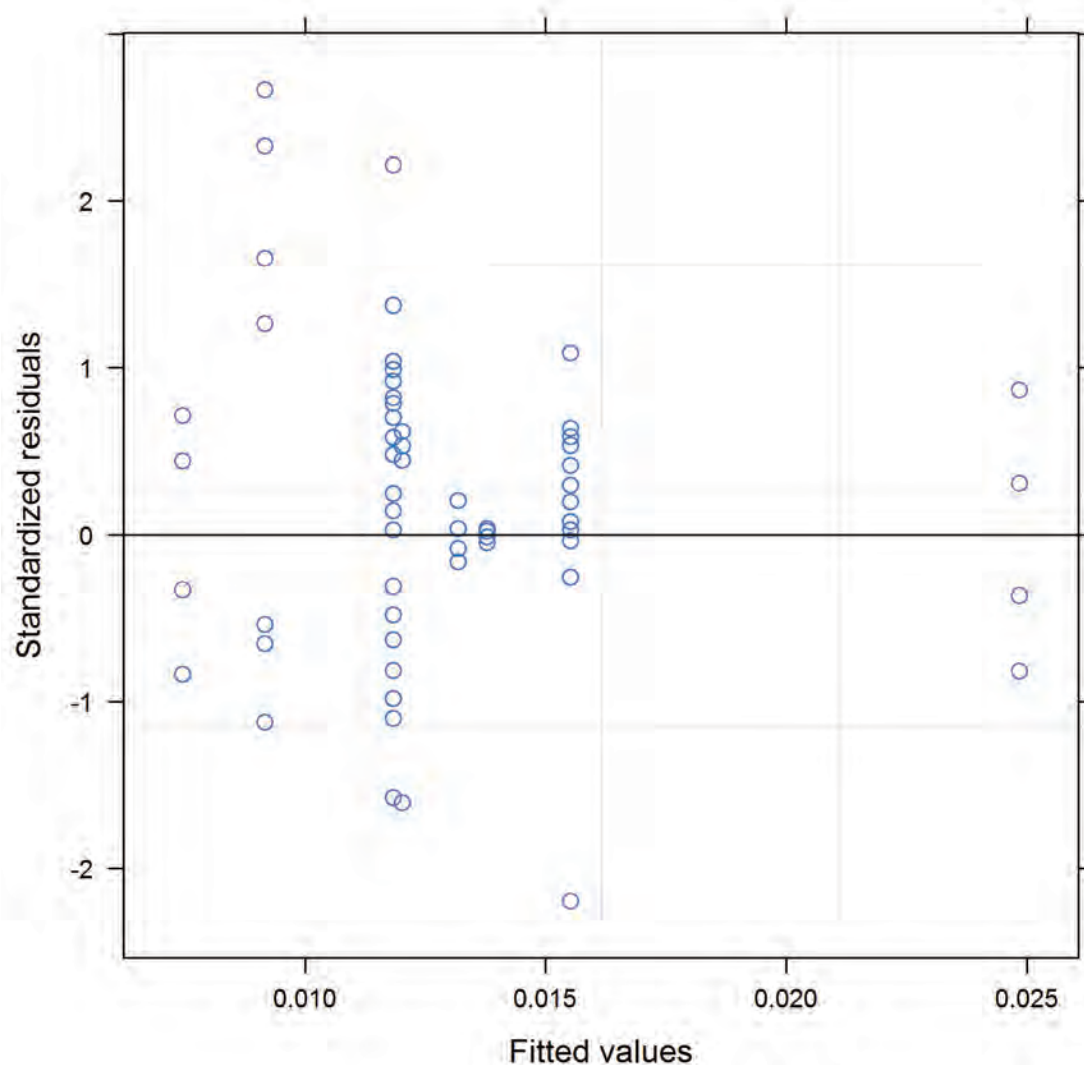
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-470.61	244.3		
LME	10	-469.24	244.62	0.63	0.43

Conclusion:

The most appropriate model for total ammonia-N at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.427$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 68
##          numDF  F-value  p-value
## (Intercept)    1      365  <.0001
## site           3         6  0.0007
## period         1         2  0.1210
## site:period    3         3  0.0648
```


Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.01	4.8610^{-4}	0.02	sig.
Counts	0.01	2.910^{-4}	0.02	sig.
Vulture	0.01	0	0.02	sig.

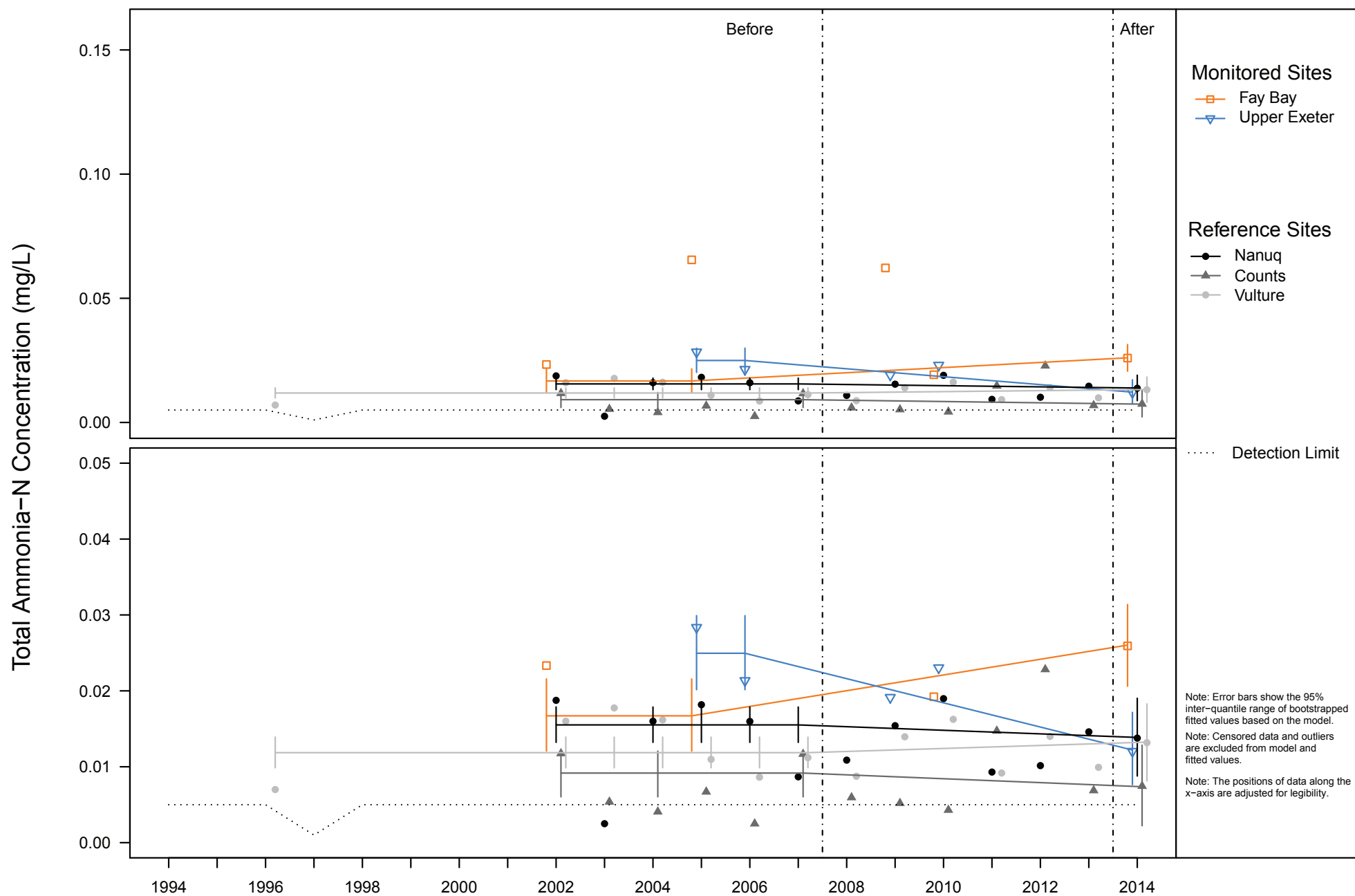
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total ammonia-N concentrations at the Upper Exeter site were not significantly ($p = 0.065$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

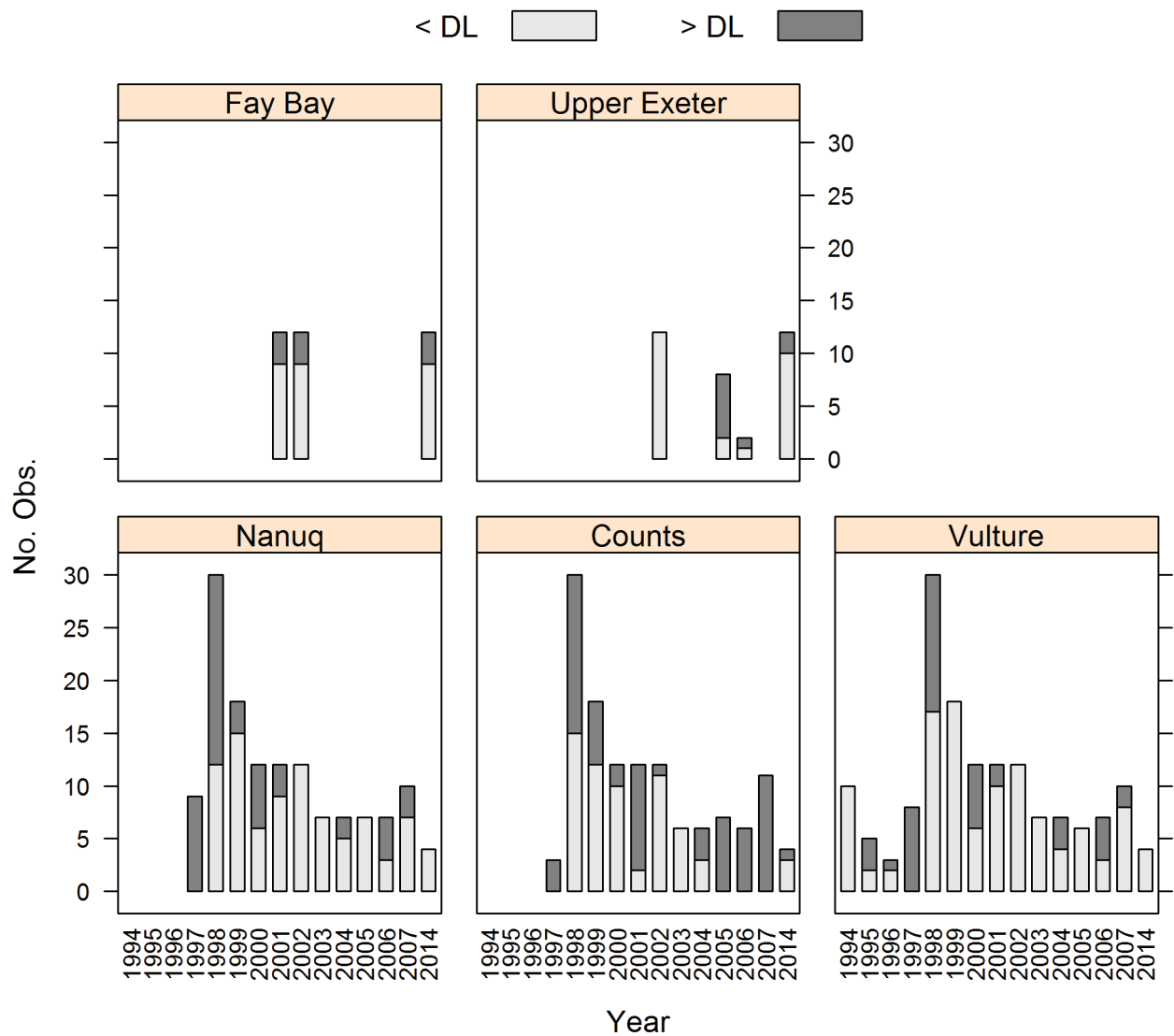


Analysis of Winter Total Suspended Solids Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

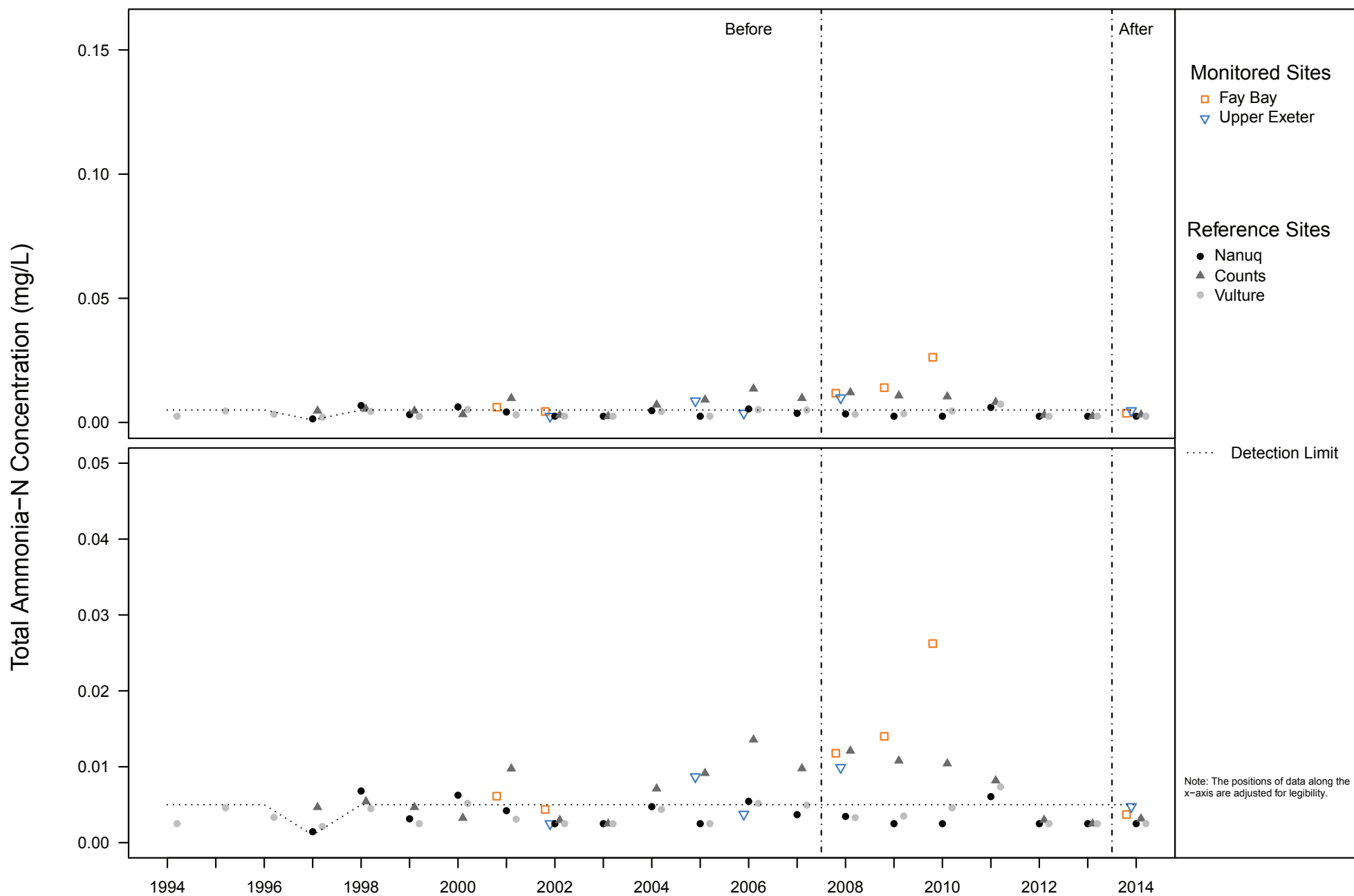
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

AmmoniaN water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

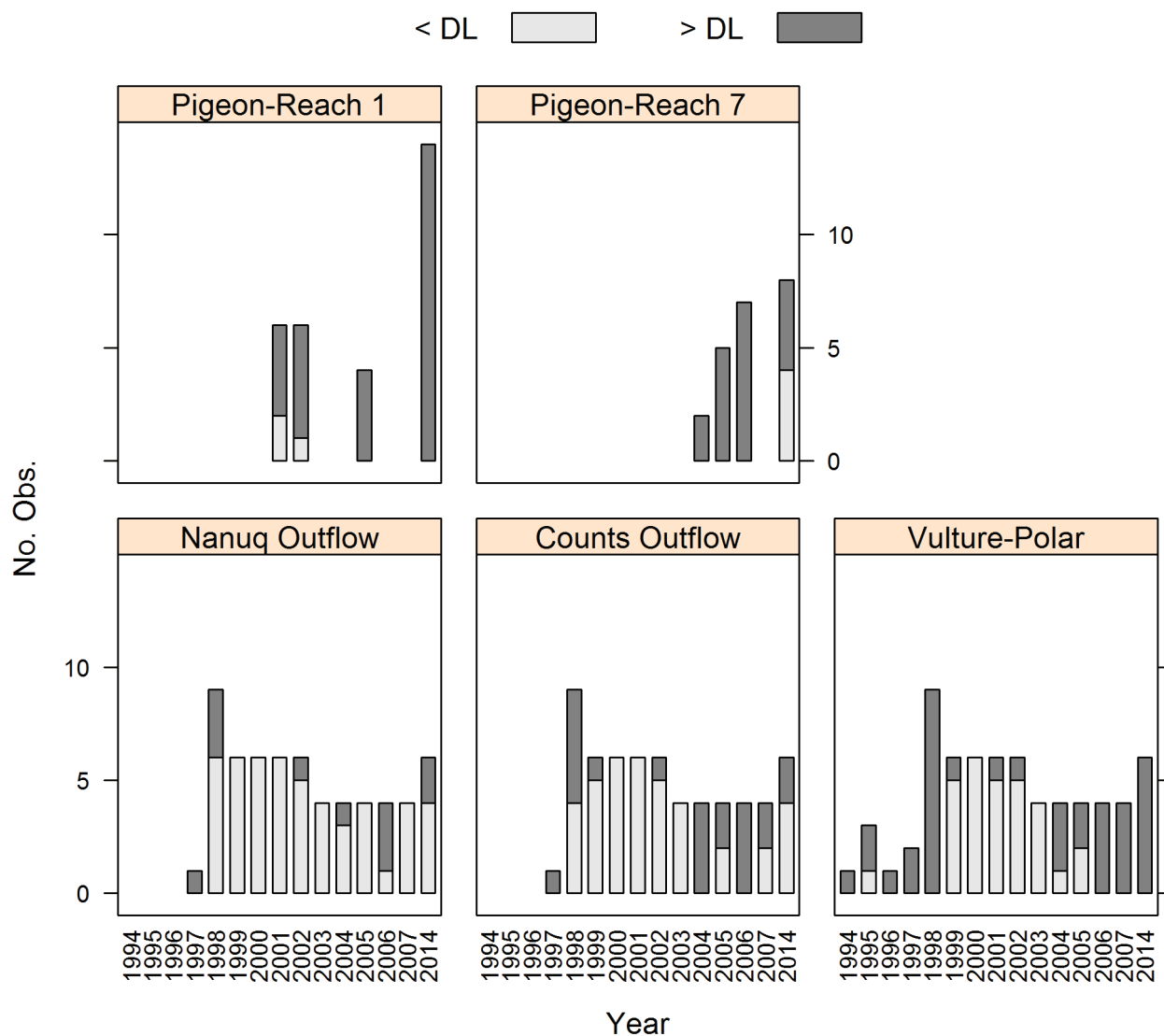


Analysis of Summer Total Ammonia Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##		site	year	month	season
## 8634	Counts	Outflow	1997	September	summer
## 8635	Nanuq	Outflow	1997	September	summer
## 8642	Counts	Outflow	1998	July	summer
## 8643	Counts	Outflow	1998	July	summer
## 8644	Counts	Outflow	1998	July	summer
## 8645	Counts	Outflow	1998	August	summer
## 8646	Counts	Outflow	1998	August	summer
## 8647	Counts	Outflow	1998	August	summer
## 8648	Counts	Outflow	1998	September	summer
## 8649	Counts	Outflow	1998	September	summer
## 8650	Counts	Outflow	1998	September	summer
## 8655	Nanuq	Outflow	1998	July	summer
## 8656	Nanuq	Outflow	1998	July	summer
## 8657	Nanuq	Outflow	1998	July	summer
## 8658	Nanuq	Outflow	1998	August	summer
## 8659	Nanuq	Outflow	1998	August	summer
## 8660	Nanuq	Outflow	1998	August	summer
## 8661	Nanuq	Outflow	1998	September	summer
## 8662	Nanuq	Outflow	1998	September	summer
## 8663	Nanuq	Outflow	1998	September	summer
## 8680	Counts	Outflow	1999	August	summer
## 8681	Counts	Outflow	1999	August	summer
## 8682	Counts	Outflow	1999	August	summer
## 8683	Counts	Outflow	1999	September	summer
## 8684	Counts	Outflow	1999	September	summer
## 8685	Counts	Outflow	1999	September	summer
## 8689	Nanuq	Outflow	1999	August	summer
## 8690	Nanuq	Outflow	1999	August	summer
## 8691	Nanuq	Outflow	1999	August	summer
## 8692	Nanuq	Outflow	1999	September	summer
## 8693	Nanuq	Outflow	1999	September	summer
## 8694	Nanuq	Outflow	1999	September	summer
## 8698	Vulture-Polar		1999	August	summer
## 8699	Vulture-Polar		1999	August	summer
## 8700	Vulture-Polar		1999	August	summer
## 8701	Vulture-Polar		1999	September	summer
## 8702	Vulture-Polar		1999	September	summer
## 8703	Vulture-Polar		1999	September	summer
## 8707	Counts	Outflow	2000	August	summer
## 8708	Counts	Outflow	2000	August	summer
## 8709	Counts	Outflow	2000	August	summer
## 8710	Counts	Outflow	2000	September	summer

```

## 8711 Counts Outflow 2000 September summer
## 8712 Counts Outflow 2000 September summer
## 8716 Nanuq Outflow 2000 August summer
## 8717 Nanuq Outflow 2000 August summer
## 8718 Nanuq Outflow 2000 August summer
## 8719 Nanuq Outflow 2000 September summer
## 8720 Nanuq Outflow 2000 September summer
## 8721 Nanuq Outflow 2000 September summer
## 8725 Vulture-Polar 2000 August summer
## 8726 Vulture-Polar 2000 August summer
## 8727 Vulture-Polar 2000 August summer
## 8728 Vulture-Polar 2000 September summer
## 8729 Vulture-Polar 2000 September summer
## 8730 Vulture-Polar 2000 September summer
## 8733 Counts Outflow 2001 August summer
## 8734 Counts Outflow 2001 August summer
## 8735 Counts Outflow 2001 August summer
## 8736 Counts Outflow 2001 September summer
## 8737 Counts Outflow 2001 September summer
## 8738 Counts Outflow 2001 September summer
## 8742 Nanuq Outflow 2001 August summer
## 8743 Nanuq Outflow 2001 August summer
## 8744 Nanuq Outflow 2001 August summer
## 8745 Nanuq Outflow 2001 September summer
## 8746 Nanuq Outflow 2001 September summer
## 8747 Nanuq Outflow 2001 September summer
## 8760 Vulture-Polar 2001 August summer
## 8761 Vulture-Polar 2001 August summer
## 8762 Vulture-Polar 2001 August summer
## 8763 Vulture-Polar 2001 September summer
## 8764 Vulture-Polar 2001 September summer
## 8765 Vulture-Polar 2001 September summer
## 8769 Counts Outflow 2002 August summer
## 8770 Counts Outflow 2002 August summer
## 8771 Counts Outflow 2002 August summer
## 8772 Counts Outflow 2002 September summer
## 8773 Counts Outflow 2002 September summer
## 8774 Counts Outflow 2002 September summer
## 8778 Nanuq Outflow 2002 August summer
## 8779 Nanuq Outflow 2002 August summer
## 8780 Nanuq Outflow 2002 August summer
## 8781 Nanuq Outflow 2002 September summer
## 8782 Nanuq Outflow 2002 September summer
## 8783 Nanuq Outflow 2002 September summer
## 8796 Vulture-Polar 2002 August summer
## 8797 Vulture-Polar 2002 August summer
## 8798 Vulture-Polar 2002 August summer
## 8799 Vulture-Polar 2002 September summer
## 8800 Vulture-Polar 2002 September summer
## 8801 Vulture-Polar 2002 September summer

```


## 8804	Counts	Outflow	2003	August	summer
## 8805	Counts	Outflow	2003	August	summer
## 8806	Counts	Outflow	2003	September	summer
## 8807	Counts	Outflow	2003	September	summer
## 8810	Nanuq	Outflow	2003	August	summer
## 8811	Nanuq	Outflow	2003	August	summer
## 8812	Nanuq	Outflow	2003	September	summer
## 8813	Nanuq	Outflow	2003	September	summer
## 8818	Vulture-Polar		2003	August	summer
## 8819	Vulture-Polar		2003	August	summer
## 8820	Vulture-Polar		2003	September	summer
## 8821	Vulture-Polar		2003	September	summer
## 8824	Counts	Outflow	2004	August	summer
## 8825	Counts	Outflow	2004	August	summer
## 8826	Counts	Outflow	2004	September	summer
## 8827	Counts	Outflow	2004	September	summer
## 8830	Nanuq	Outflow	2004	August	summer
## 8831	Nanuq	Outflow	2004	August	summer
## 8832	Nanuq	Outflow	2004	September	summer
## 8833	Nanuq	Outflow	2004	September	summer
## 8860	Counts	Outflow	2005	August	summer
## 8861	Counts	Outflow	2005	August	summer
## 8862	Counts	Outflow	2005	September	summer
## 8863	Counts	Outflow	2005	September	summer
## 8866	Nanuq	Outflow	2005	August	summer
## 8867	Nanuq	Outflow	2005	August	summer
## 8868	Nanuq	Outflow	2005	September	summer
## 8869	Nanuq	Outflow	2005	September	summer
## 8902	Counts	Outflow	2006	August	summer
## 8903	Counts	Outflow	2006	August	summer
## 8904	Counts	Outflow	2006	September	summer
## 8905	Counts	Outflow	2006	September	summer
## 8908	Nanuq	Outflow	2006	August	summer
## 8909	Nanuq	Outflow	2006	August	summer
## 8910	Nanuq	Outflow	2006	September	summer
## 8911	Nanuq	Outflow	2006	September	summer
## 8940	Counts	Outflow	2007	August	summer
## 8941	Counts	Outflow	2007	August	summer
## 8942	Counts	Outflow	2007	September	summer
## 8943	Counts	Outflow	2007	September	summer
## 8945	Nanuq	Outflow	2007	August	summer
## 8946	Nanuq	Outflow	2007	August	summer
## 8947	Nanuq	Outflow	2007	September	summer
## 8948	Nanuq	Outflow	2007	September	summer
## 9193	Counts	Outflow	2014	July	summer
## 9194	Counts	Outflow	2014	July	summer
## 9195	Counts	Outflow	2014	August	summer
## 9196	Counts	Outflow	2014	August	summer
## 9197	Counts	Outflow	2014	September	summer
## 9198	Counts	Outflow	2014	September	summer

## 9201	Nanuq Outflow 2014	July summer
## 9202	Nanuq Outflow 2014	July summer
## 9203	Nanuq Outflow 2014	August summer
## 9204	Nanuq Outflow 2014	August summer
## 9205	Nanuq Outflow 2014	September summer
## 9206	Nanuq Outflow 2014	September summer

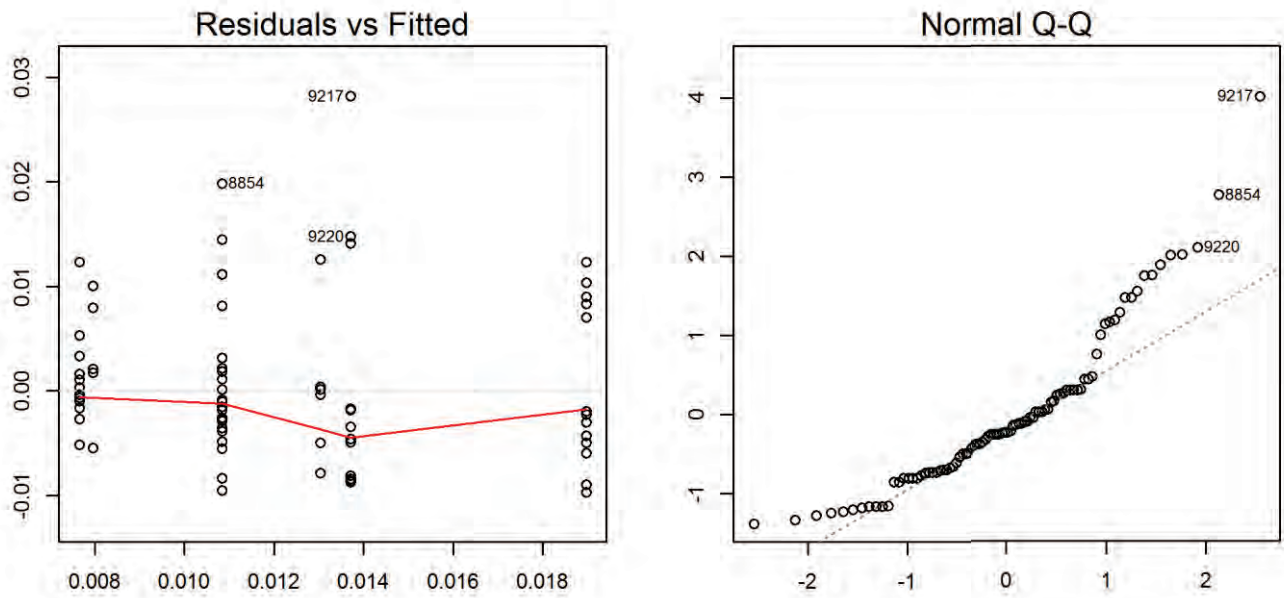
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

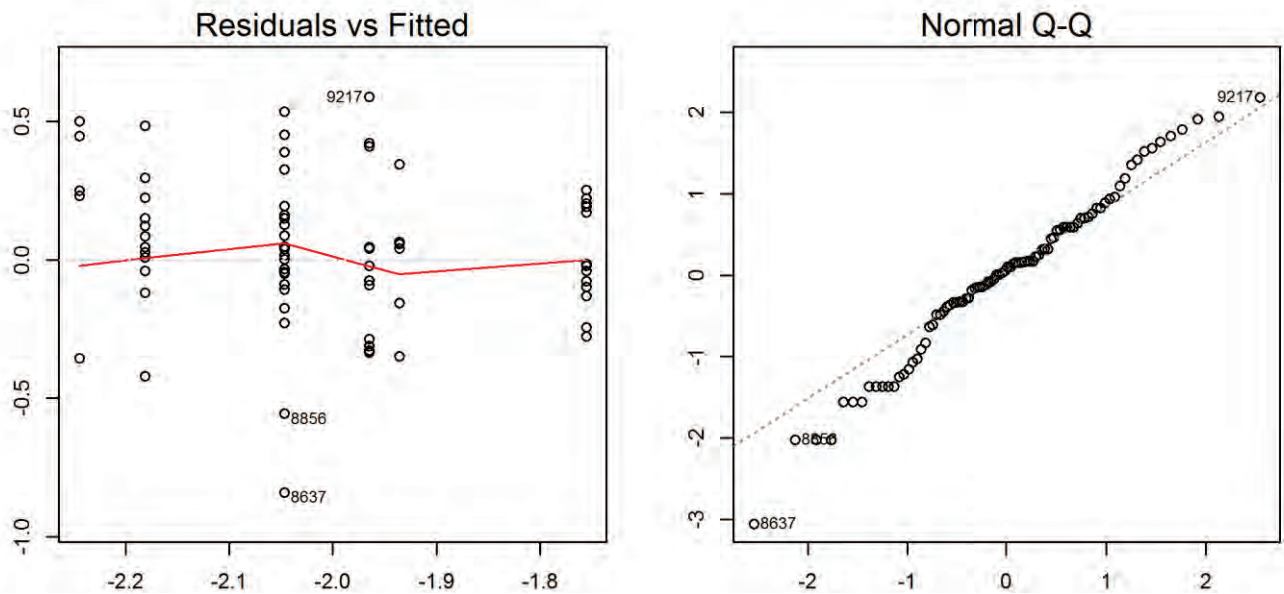
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.01	0.21	0.17
Log-10	0.28	0.23	0.18

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

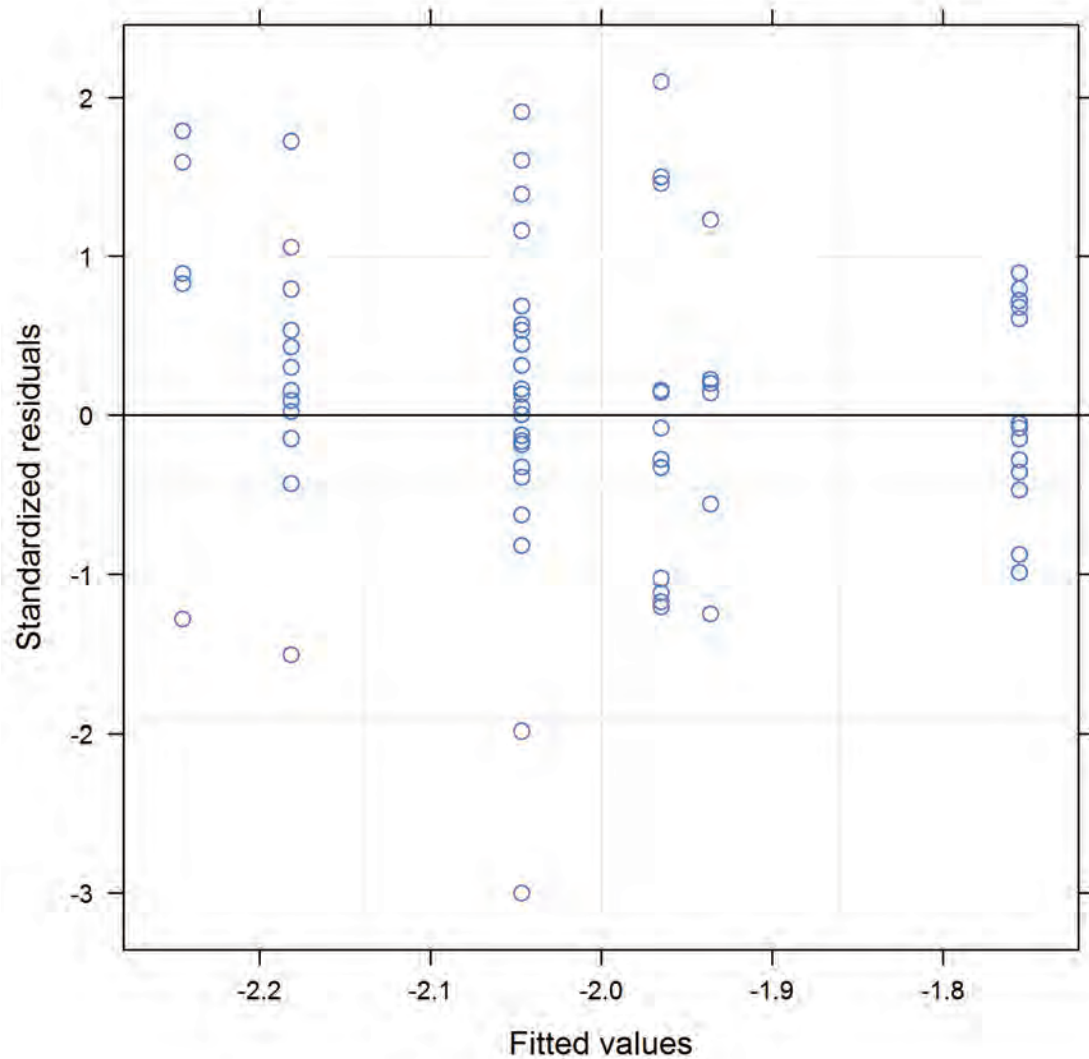
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	7	53.65	-19.82		
LME	8	55.36	-19.68	0.29	0.59

Conclusion:

The most appropriate model for total ammonia-N at the Pigeon-Reach 1 monitoring site was the simpler GLS model without a year term ($p = 0.59$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 84
##          numDF F-value p-value
## (Intercept)    1   4712 <.0001
## site           2     2  0.1759
## period         1     0  0.7873
## site:period     2    10  0.0001
```

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	NA	NA	NA	NA
Counts Outflow	NA	NA	NA	NA
Vulture-Polar	-0.11	-0.43	0.21	not sig.
Pigeon-Reach 7	-0.71	-1.03	-0.39	sig.

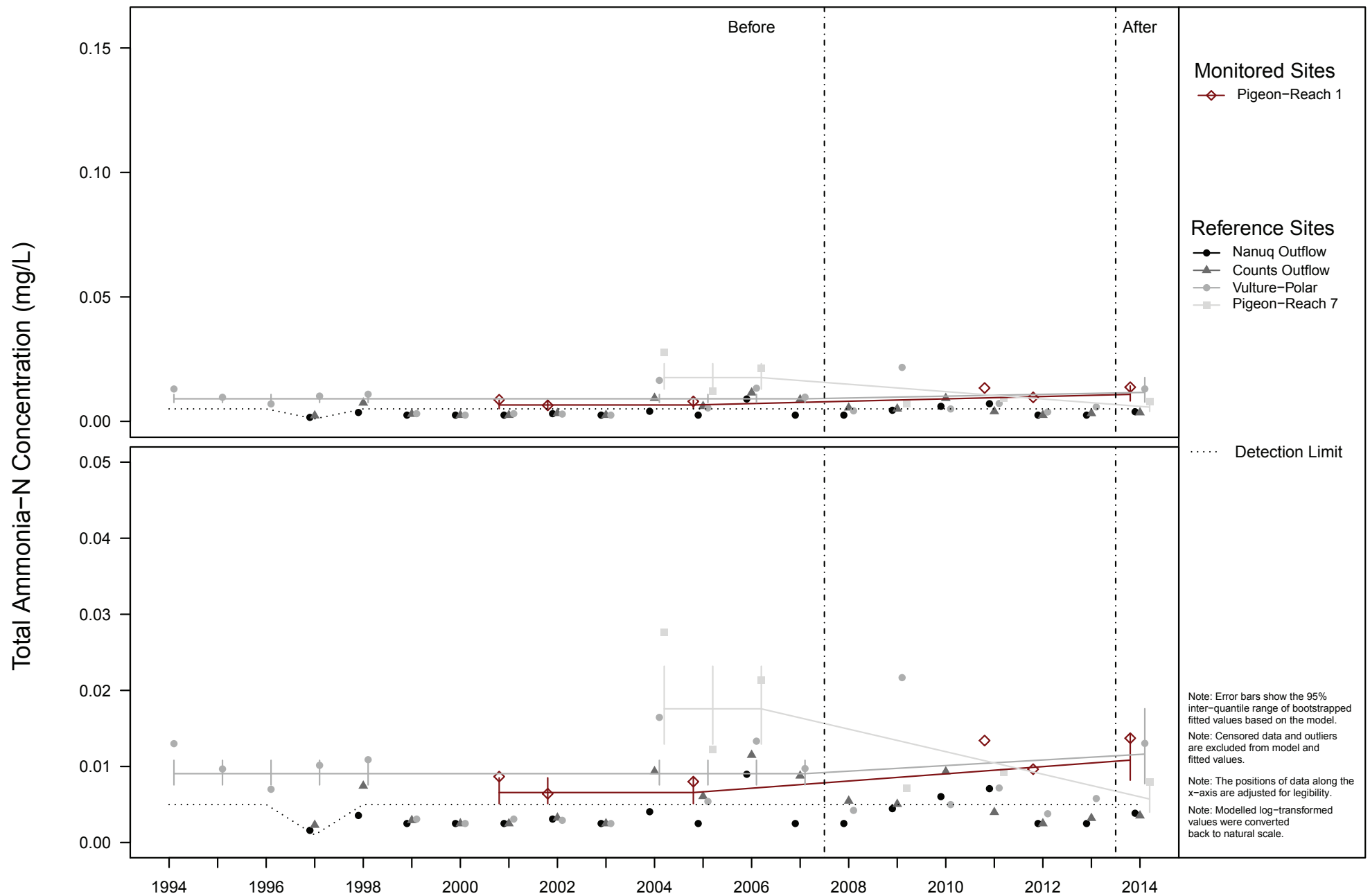
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total ammonia-N concentrations at the Pigeon-Reach 1 site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

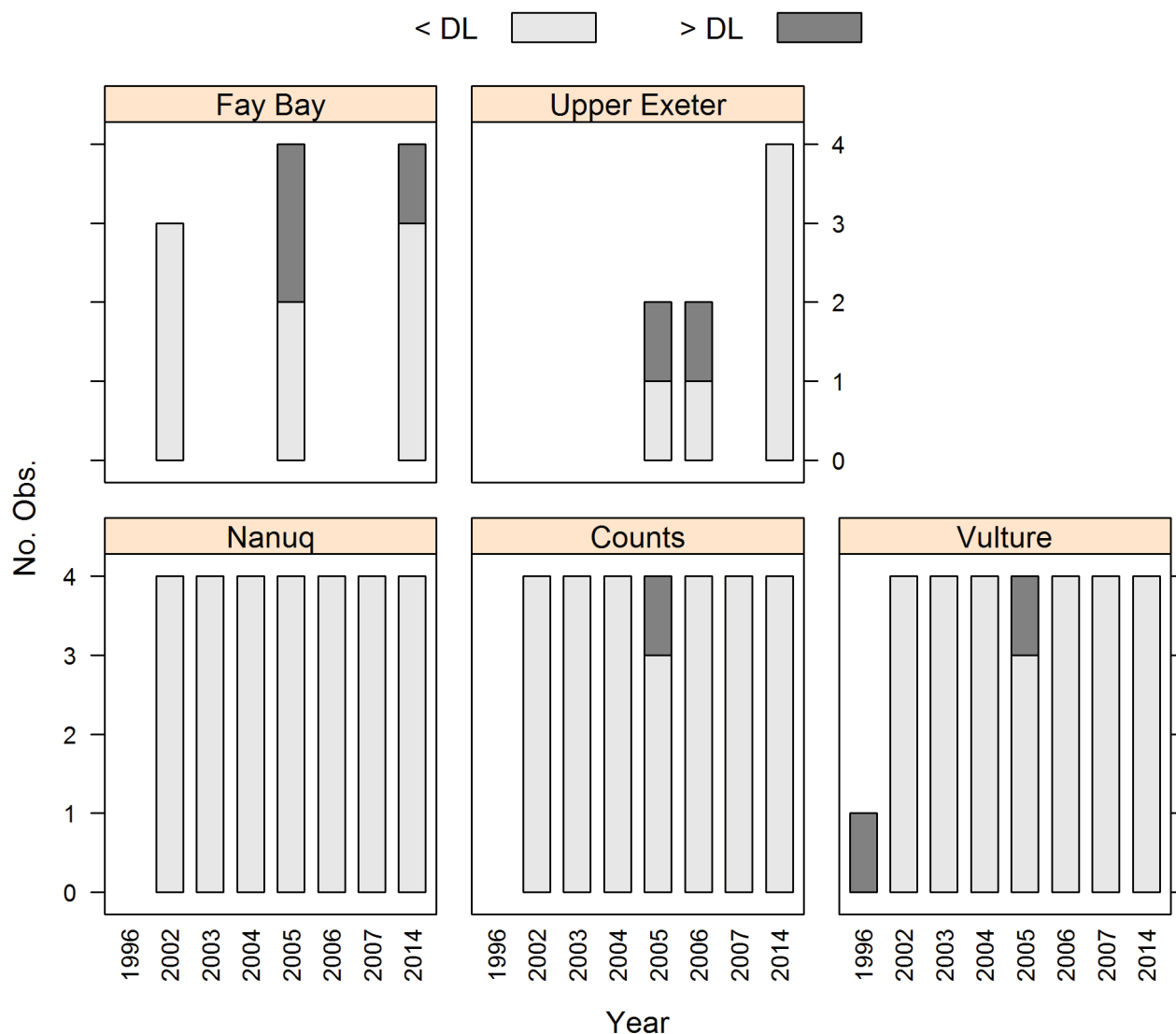


Analysis of Winter Nitrite Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

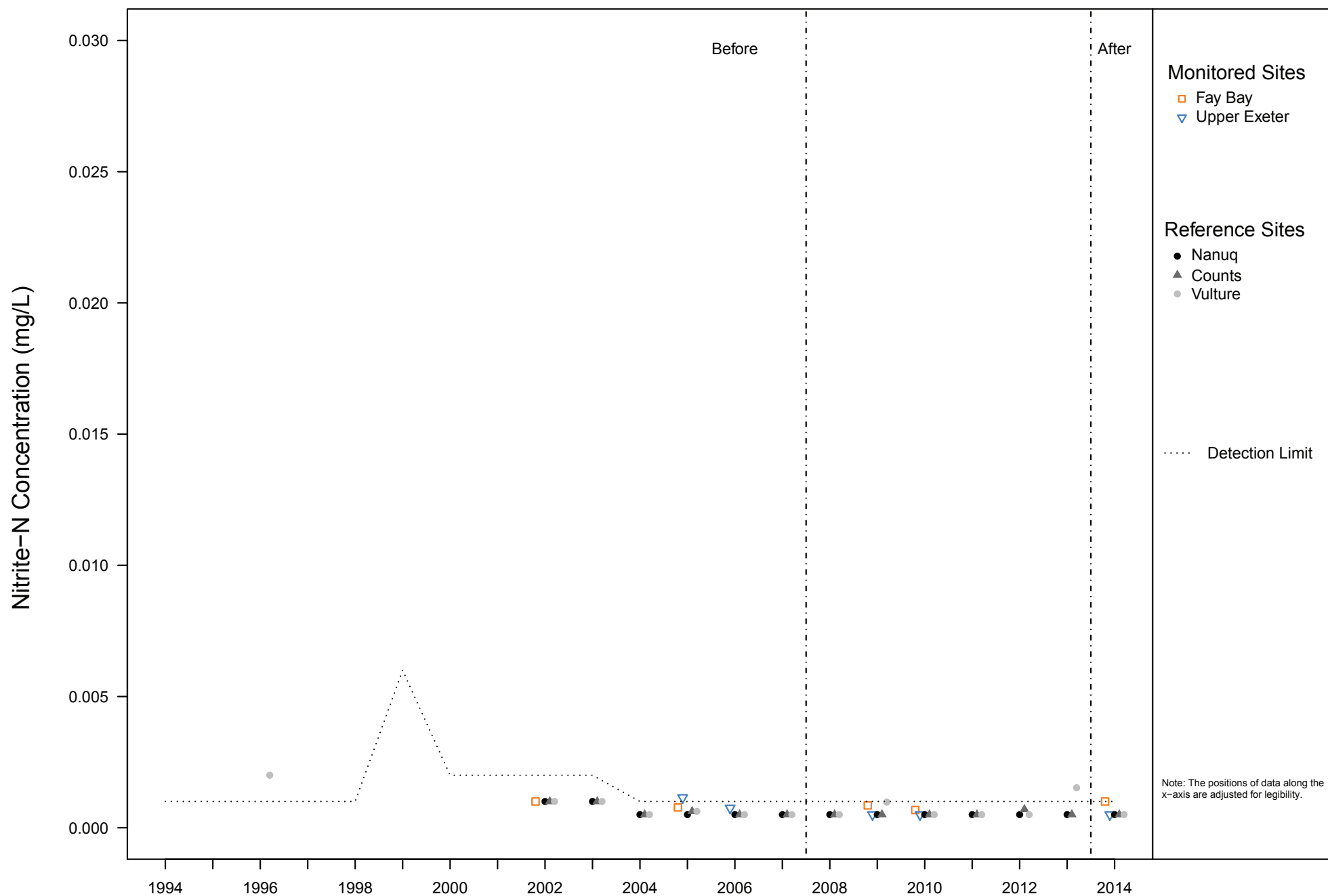
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

NitriteN water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

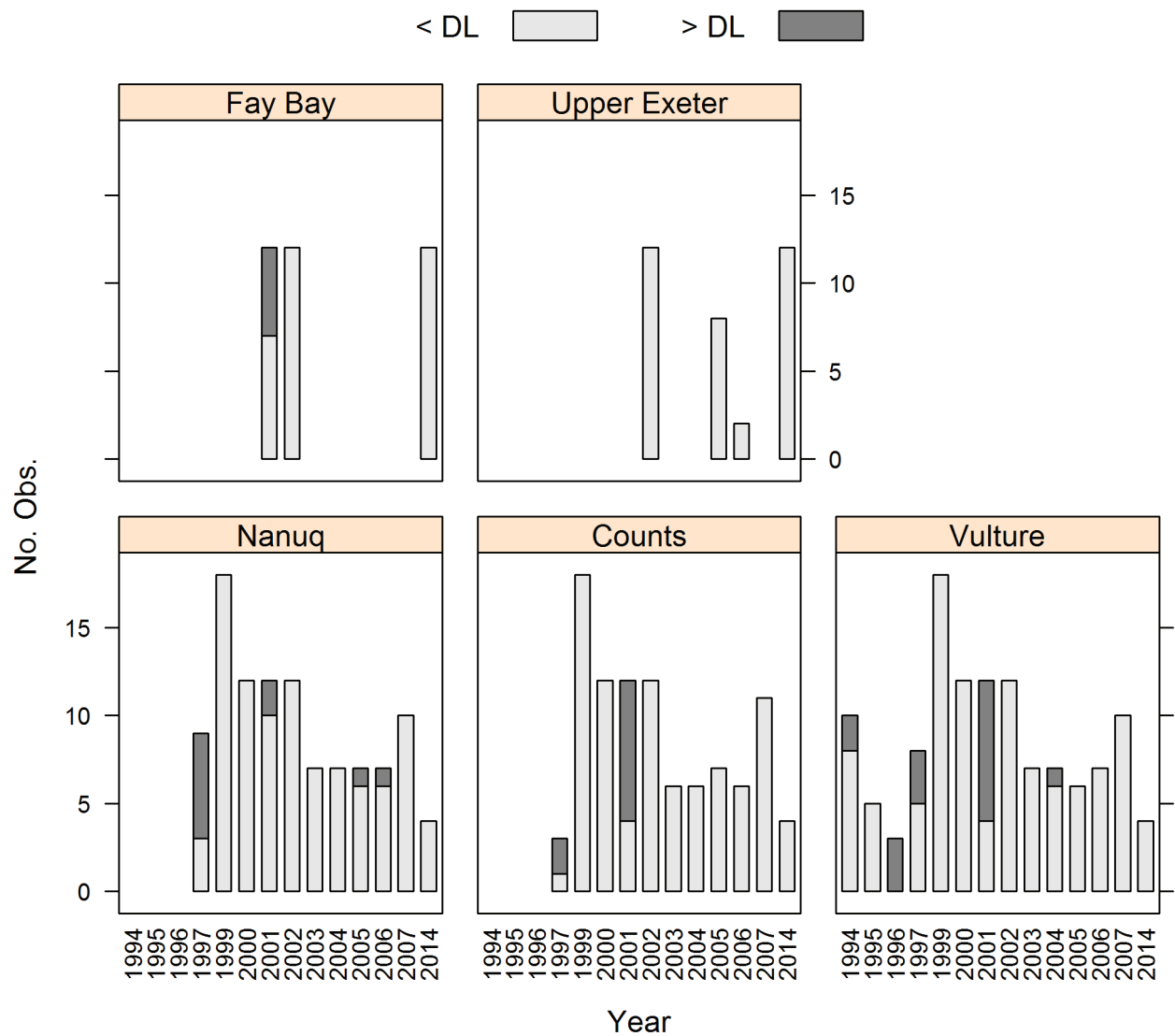


Analysis of Summer Nitrite Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

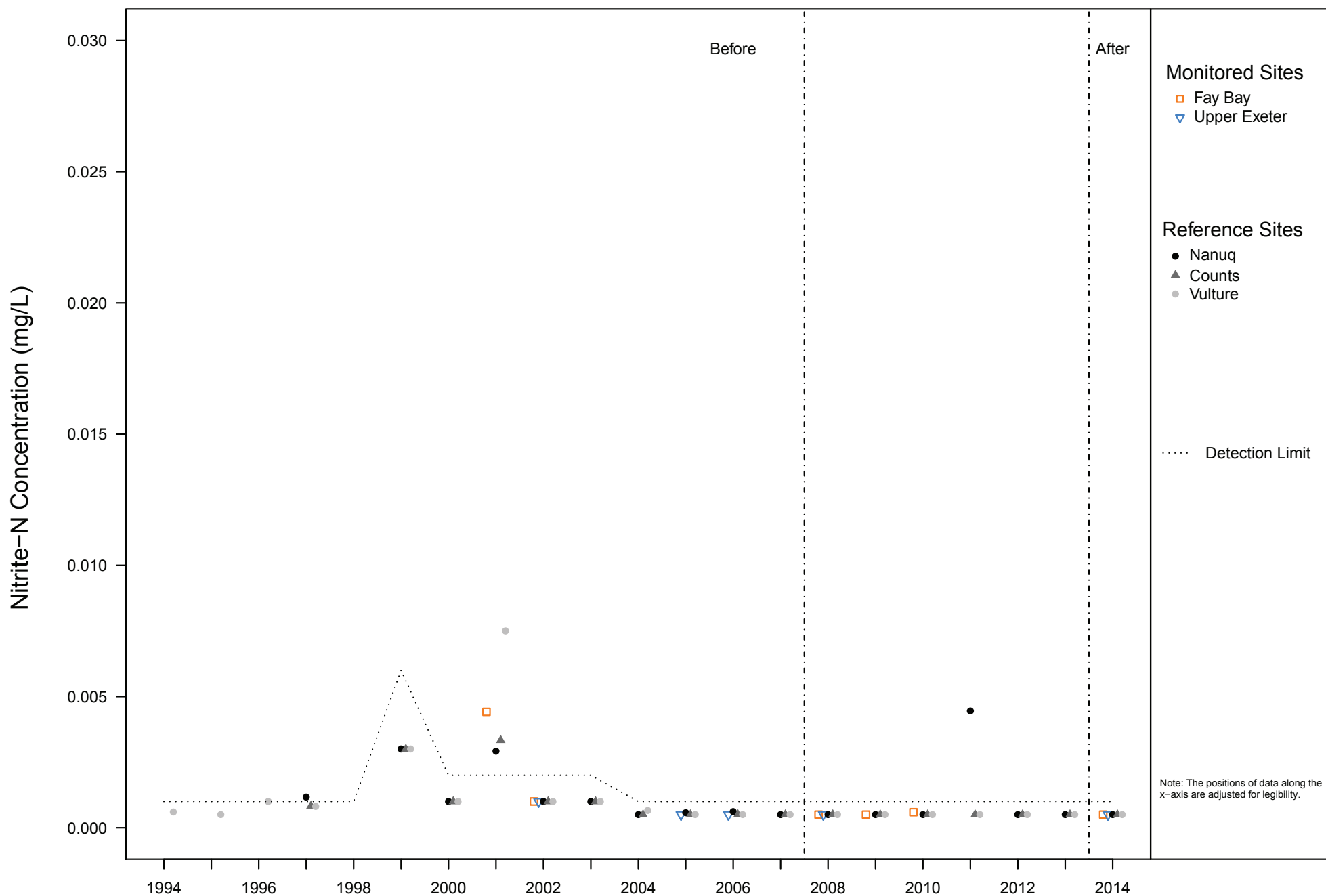
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

NitriteN water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

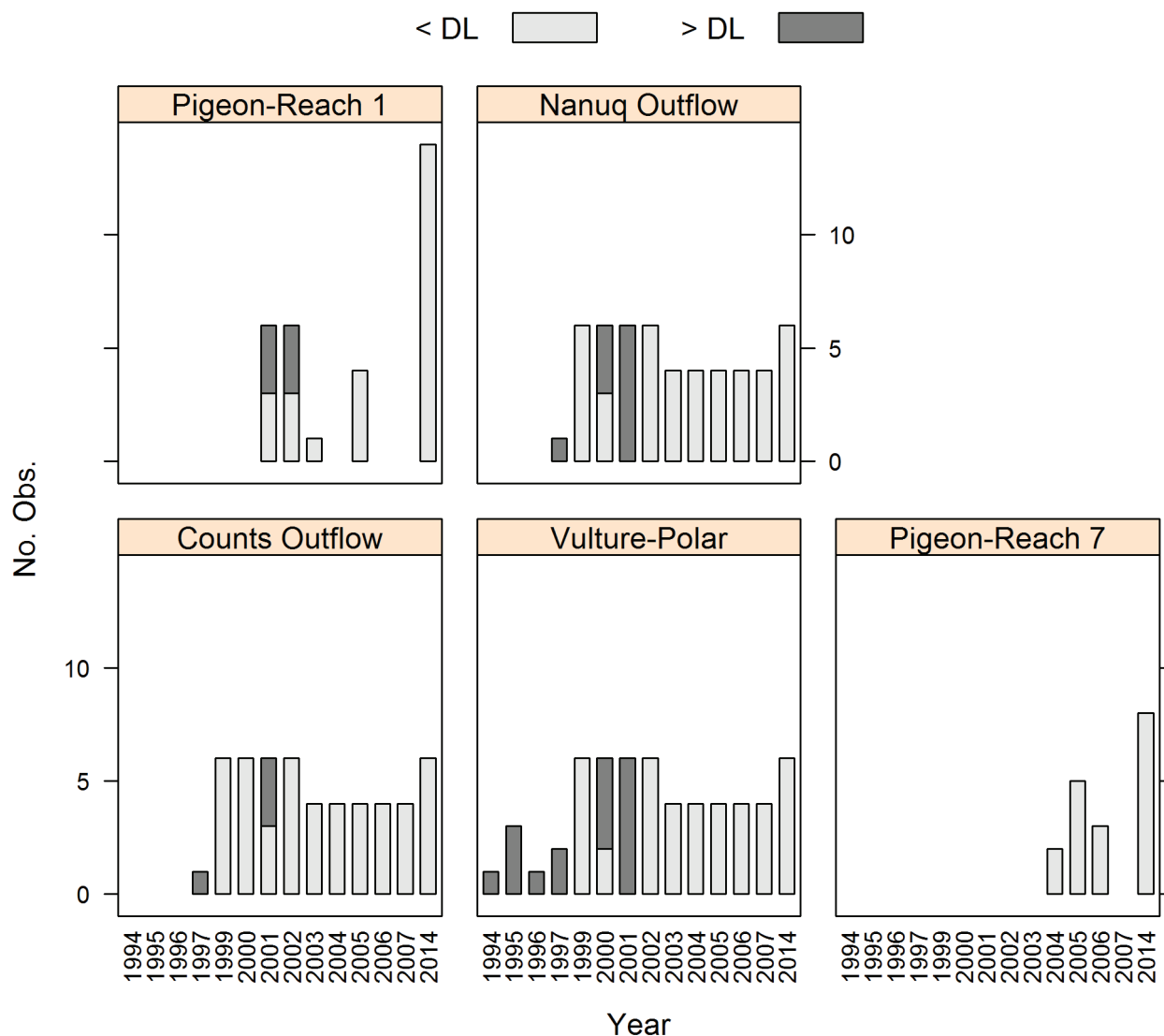


Analysis of Summer Nitrite Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

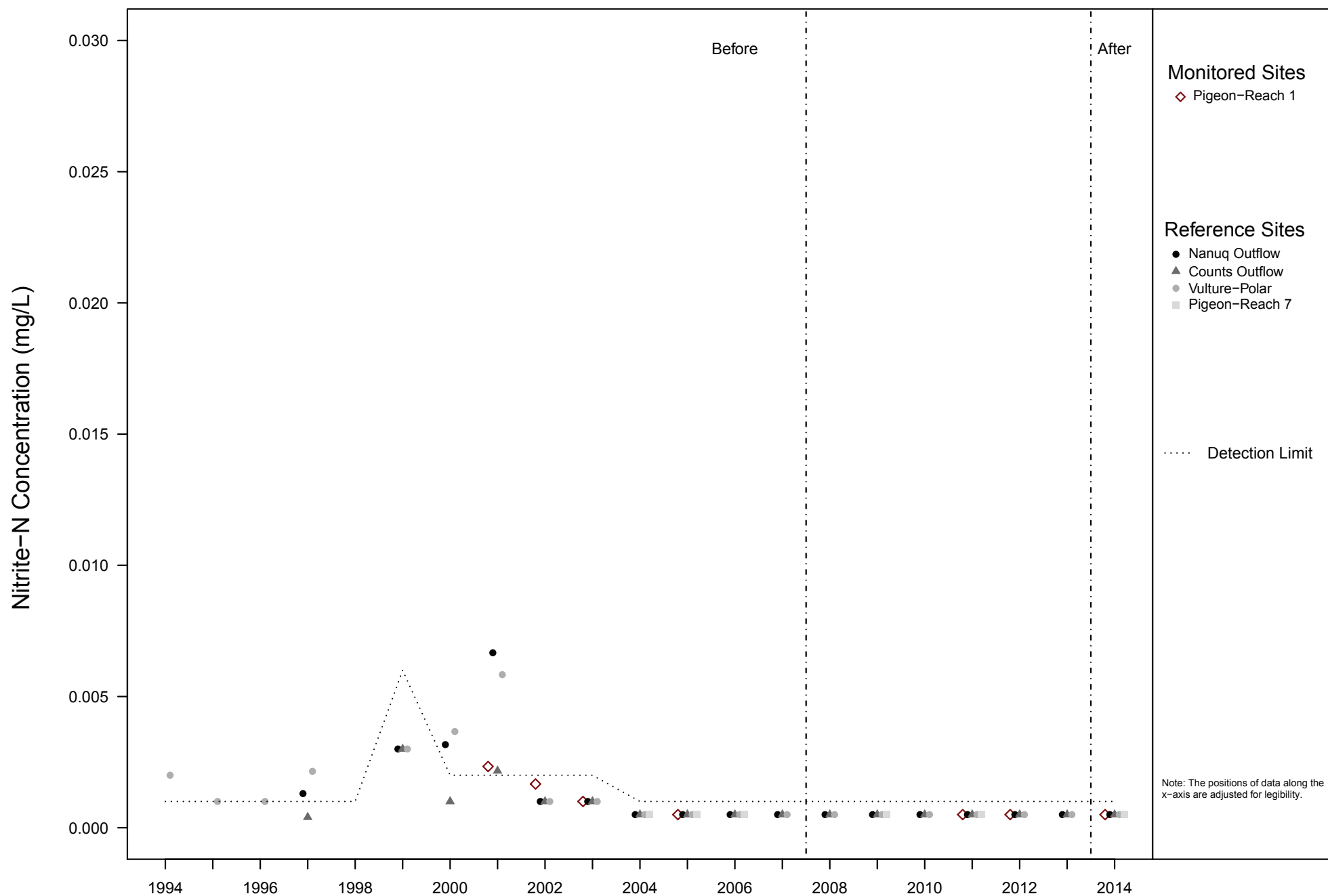
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

NitriteN water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

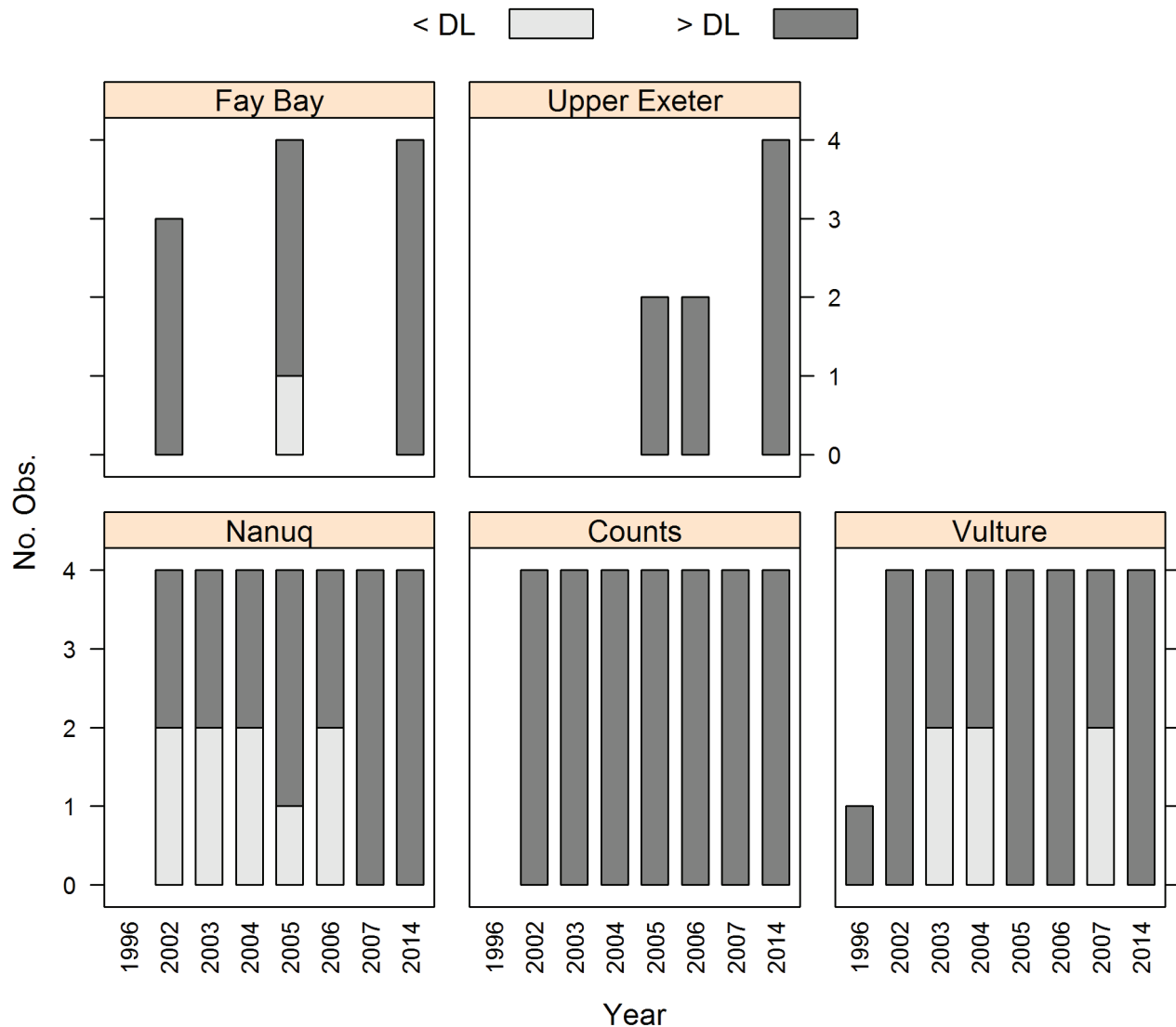


Analysis of Winter Nitrate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

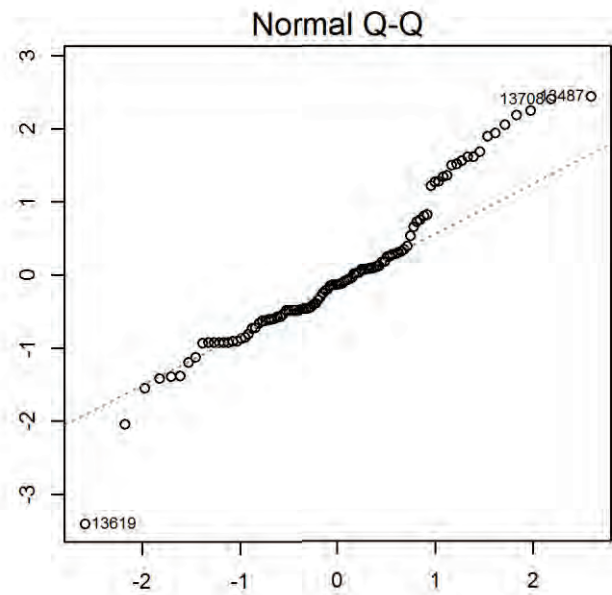
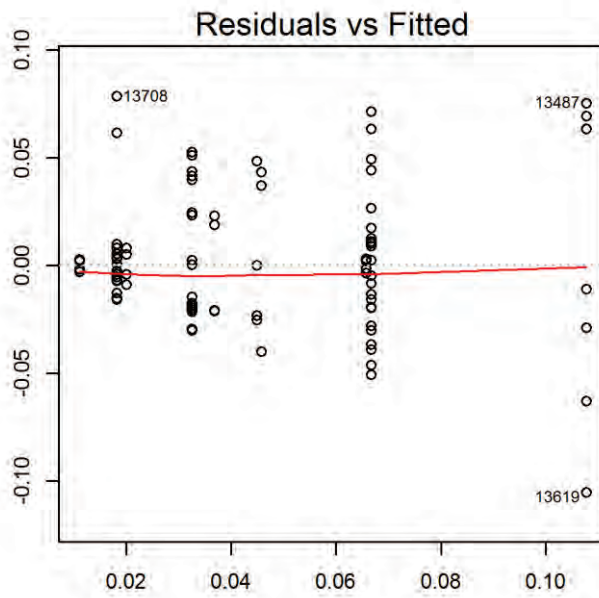
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

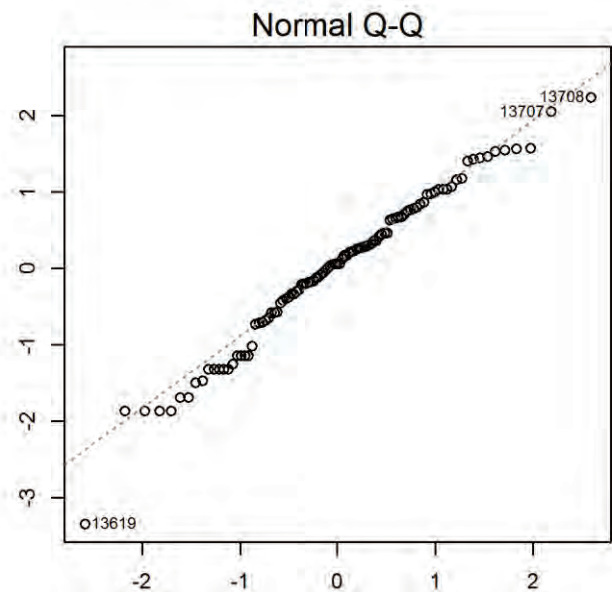
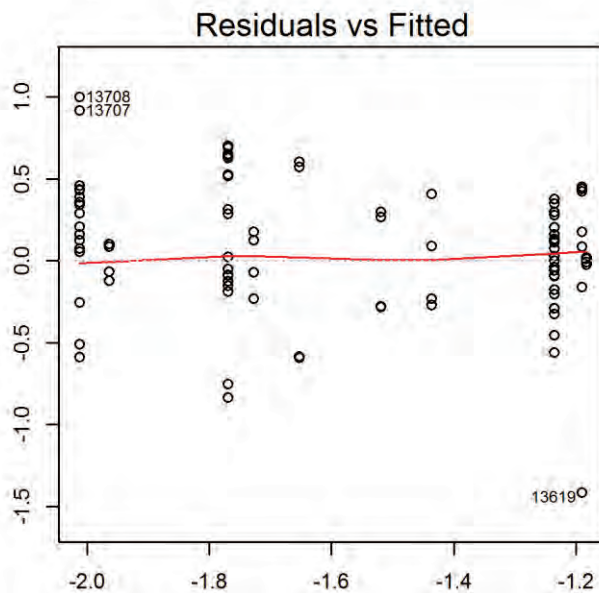
```
##          site year month season
## 13216 Vulture 1996 April  winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.03	0.4	0.34
Log-10	0.46	0.35	0.29

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

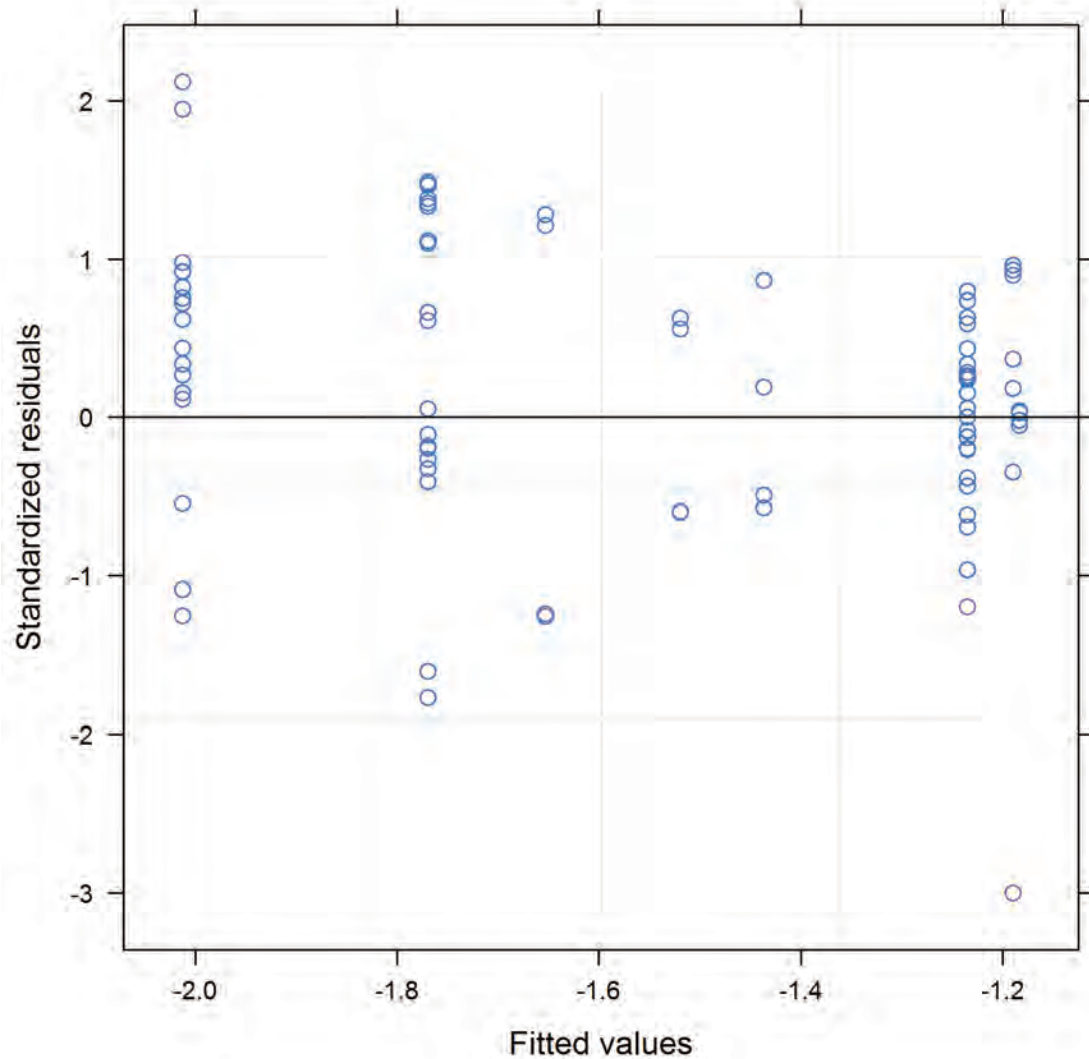
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	150.74	-66.37		
LME	10	151.95	-65.97	0.79	0.38

Conclusion:

The most appropriate model for nitrate-N at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.375$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 87
##          numDF F-value p-value
## (Intercept)      1    1097  <.0001
## site           3      14  <.0001
## period         1       1   0.40
## site:period     3       1   0.28
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.49	-0.29	1.26	not sig.
Counts	-0.21	-0.98	0.57	not sig.
Vulture	0.11	-0.66	0.88	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Nitrate-N concentrations at the Fay Bay site were not significantly ($p = 0.278$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

4.2 Upper Exeter Monitoring Location

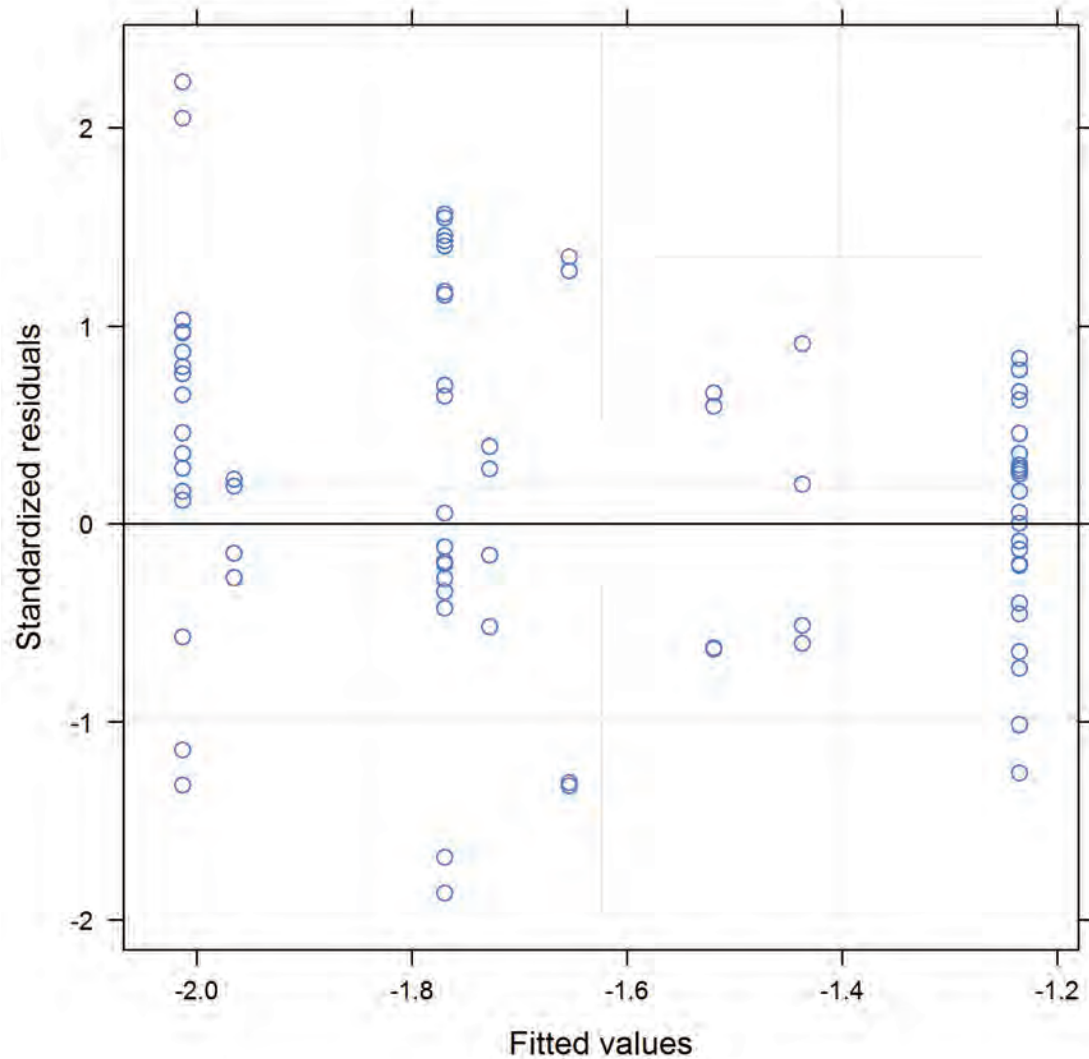
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	137.49	-59.75		
LME	10	138.36	-59.18	1.13	0.29

Conclusion:

The most appropriate model for nitrate-N at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.287$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 84
##          numDF F-value p-value
## (Intercept)    1   1285  <.0001
## site           3     12  <.0001
## period         1      1   0.23
## site:period     3      1   0.24
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.26	-0.53	1.05	not sig.
Counts	-0.44	-1.23	0.35	not sig.
Vulture	-0.12	-0.91	0.67	not sig.

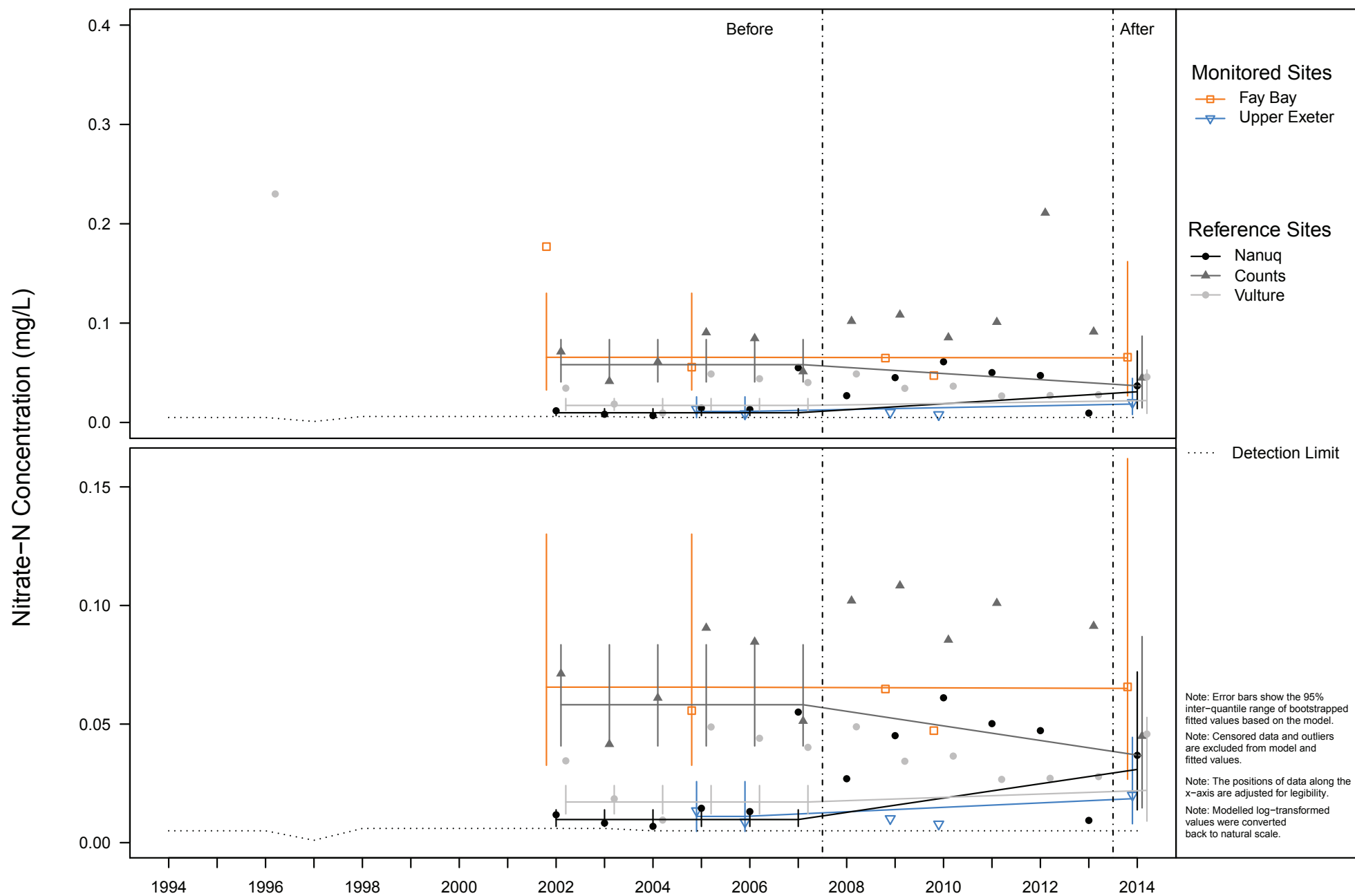
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Nitrate-N concentrations at the Upper Exeter site were not significantly ($p = 0.243$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

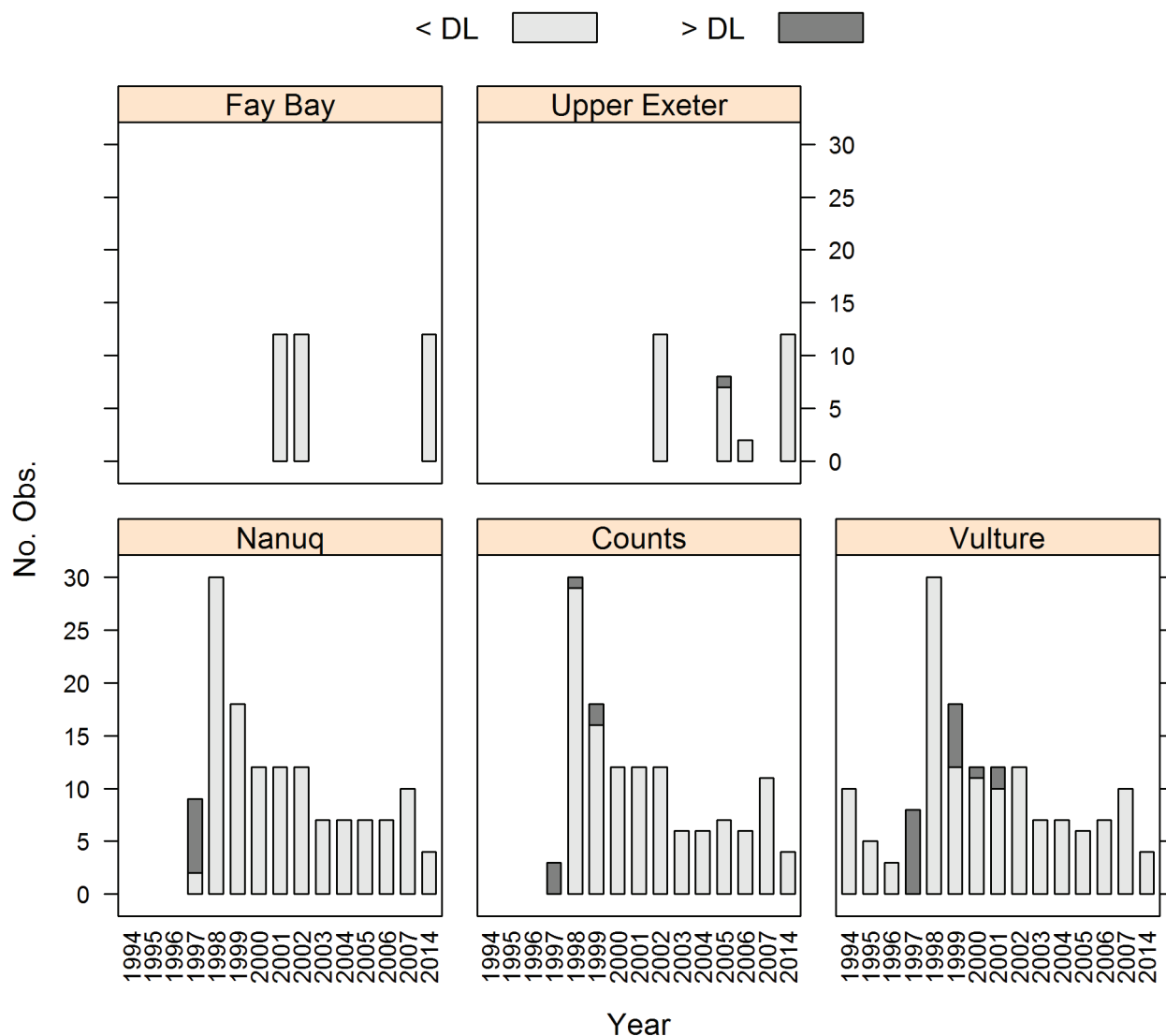


Analysis of Summer Nitrate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2015

1 Censored Data

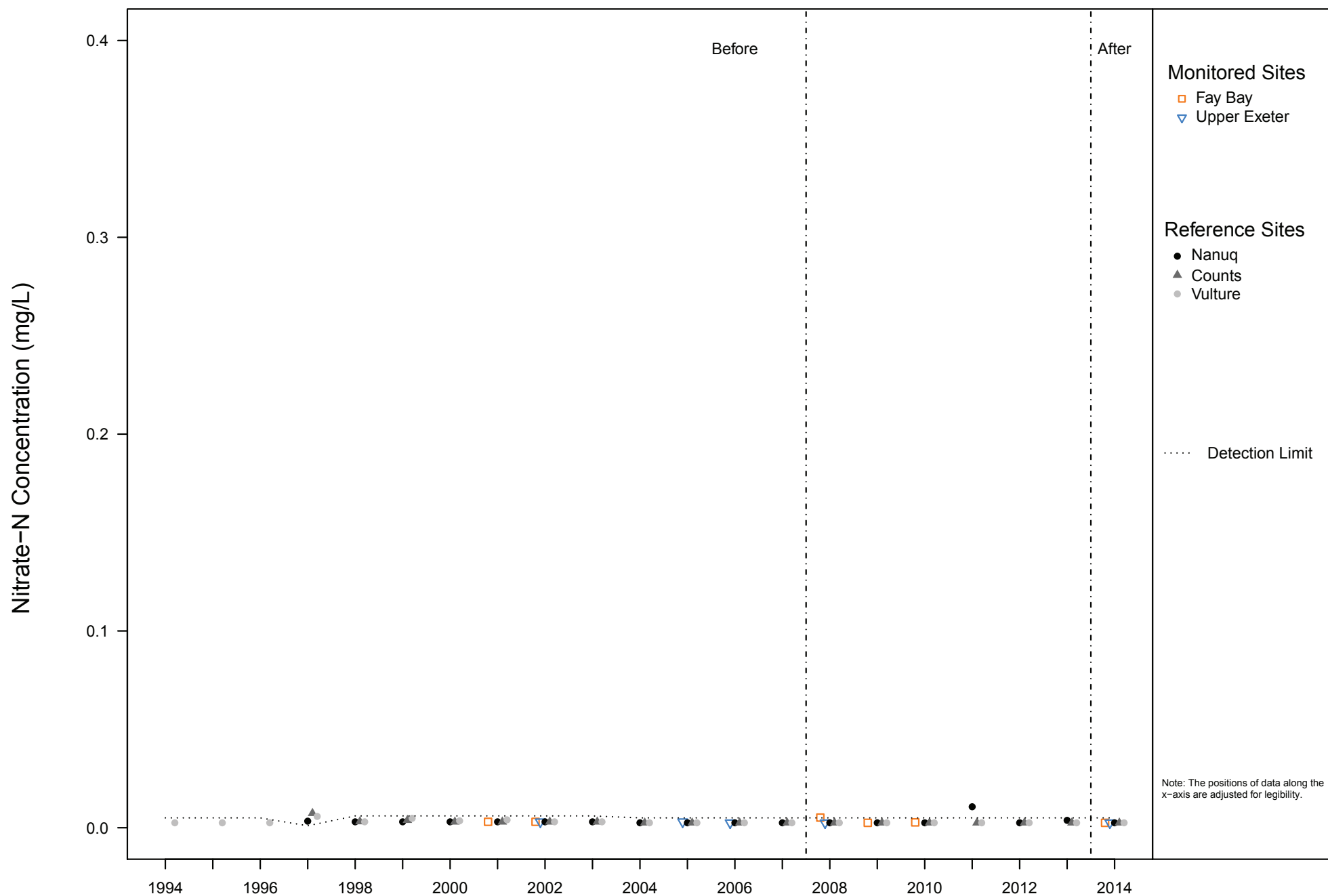
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

NitrateN water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

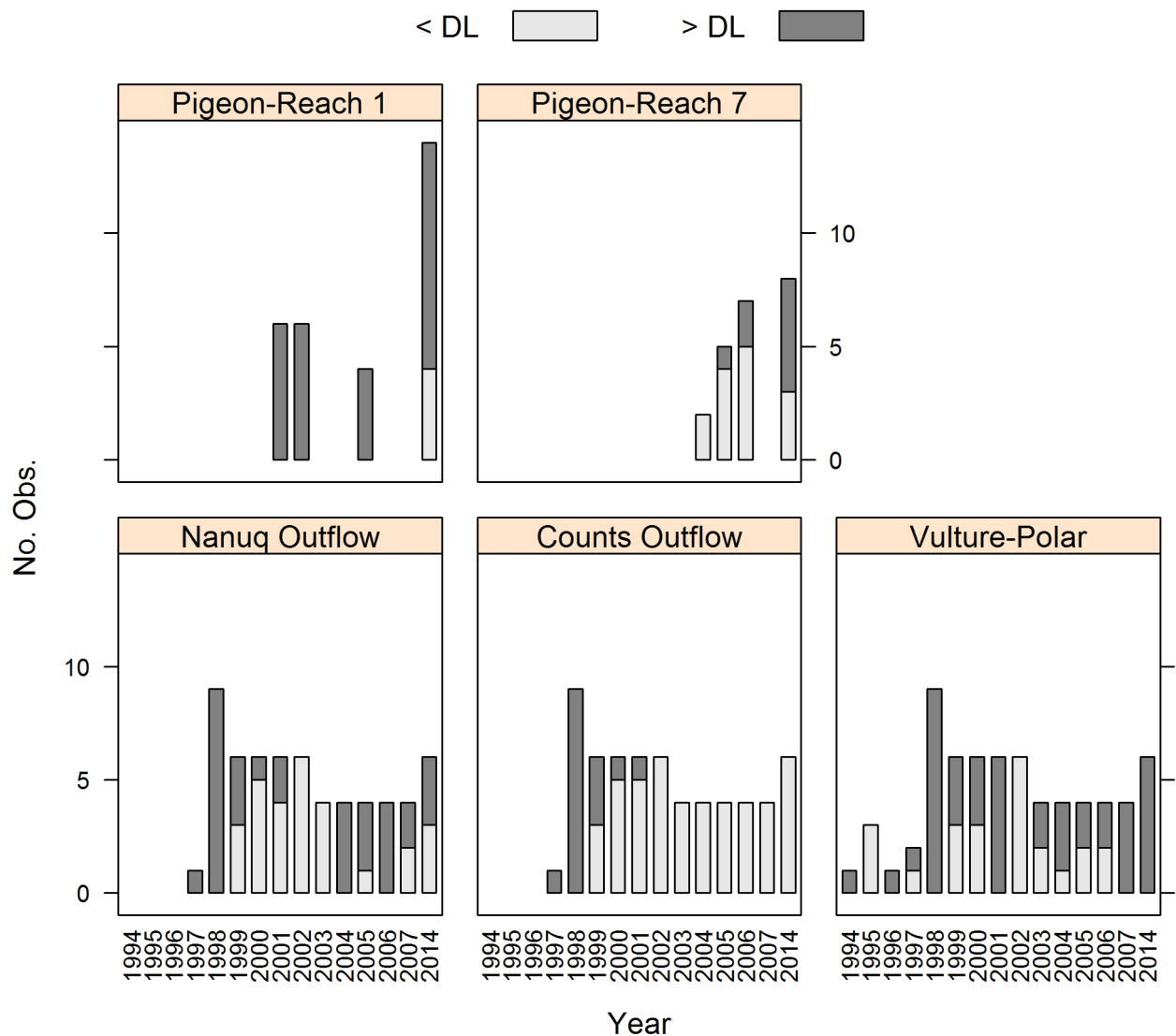


Analysis of Summer Nitrate Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 9244	Vulture-Polar	1994	August	summer
## 9245	Vulture-Polar	1995	July	summer
## 9246	Vulture-Polar	1995	August	summer
## 9247	Vulture-Polar	1995	September	summer
## 9249	Vulture-Polar	1996	August	summer
## 9250	Counts Outflow	1997	September	summer
## 9251	Nanuq Outflow	1997	September	summer
## 9252	Vulture-Polar	1997	July	summer
## 9253	Vulture-Polar	1997	September	summer
## 9258	Counts Outflow	1998	July	summer
## 9259	Counts Outflow	1998	July	summer
## 9260	Counts Outflow	1998	July	summer
## 9261	Counts Outflow	1998	August	summer
## 9262	Counts Outflow	1998	August	summer
## 9263	Counts Outflow	1998	August	summer
## 9264	Counts Outflow	1998	September	summer
## 9265	Counts Outflow	1998	September	summer
## 9266	Counts Outflow	1998	September	summer
## 9271	Nanuq Outflow	1998	July	summer
## 9272	Nanuq Outflow	1998	July	summer
## 9273	Nanuq Outflow	1998	July	summer
## 9274	Nanuq Outflow	1998	August	summer
## 9275	Nanuq Outflow	1998	August	summer
## 9276	Nanuq Outflow	1998	August	summer
## 9277	Nanuq Outflow	1998	September	summer
## 9278	Nanuq Outflow	1998	September	summer
## 9279	Nanuq Outflow	1998	September	summer
## 9284	Vulture-Polar	1998	July	summer
## 9285	Vulture-Polar	1998	July	summer
## 9286	Vulture-Polar	1998	July	summer
## 9287	Vulture-Polar	1998	August	summer
## 9288	Vulture-Polar	1998	August	summer
## 9289	Vulture-Polar	1998	August	summer
## 9290	Vulture-Polar	1998	September	summer
## 9291	Vulture-Polar	1998	September	summer
## 9292	Vulture-Polar	1998	September	summer
## 9296	Counts Outflow	1999	August	summer
## 9297	Counts Outflow	1999	August	summer
## 9298	Counts Outflow	1999	August	summer
## 9299	Counts Outflow	1999	September	summer
## 9300	Counts Outflow	1999	September	summer
## 9301	Counts Outflow	1999	September	summer

## 9305	Nanuq Outflow	1999	August	summer
## 9306	Nanuq Outflow	1999	August	summer
## 9307	Nanuq Outflow	1999	August	summer
## 9308	Nanuq Outflow	1999	September	summer
## 9309	Nanuq Outflow	1999	September	summer
## 9310	Nanuq Outflow	1999	September	summer
## 9314	Vulture-Polar	1999	August	summer
## 9315	Vulture-Polar	1999	August	summer
## 9316	Vulture-Polar	1999	August	summer
## 9317	Vulture-Polar	1999	September	summer
## 9318	Vulture-Polar	1999	September	summer
## 9319	Vulture-Polar	1999	September	summer
## 9323	Counts Outflow	2000	August	summer
## 9324	Counts Outflow	2000	August	summer
## 9325	Counts Outflow	2000	August	summer
## 9326	Counts Outflow	2000	September	summer
## 9327	Counts Outflow	2000	September	summer
## 9328	Counts Outflow	2000	September	summer
## 9332	Nanuq Outflow	2000	August	summer
## 9333	Nanuq Outflow	2000	August	summer
## 9334	Nanuq Outflow	2000	August	summer
## 9335	Nanuq Outflow	2000	September	summer
## 9336	Nanuq Outflow	2000	September	summer
## 9337	Nanuq Outflow	2000	September	summer
## 9341	Vulture-Polar	2000	August	summer
## 9342	Vulture-Polar	2000	August	summer
## 9343	Vulture-Polar	2000	August	summer
## 9344	Vulture-Polar	2000	September	summer
## 9345	Vulture-Polar	2000	September	summer
## 9346	Vulture-Polar	2000	September	summer
## 9349	Counts Outflow	2001	August	summer
## 9350	Counts Outflow	2001	August	summer
## 9351	Counts Outflow	2001	August	summer
## 9352	Counts Outflow	2001	September	summer
## 9353	Counts Outflow	2001	September	summer
## 9354	Counts Outflow	2001	September	summer
## 9358	Nanuq Outflow	2001	August	summer
## 9359	Nanuq Outflow	2001	August	summer
## 9360	Nanuq Outflow	2001	August	summer
## 9361	Nanuq Outflow	2001	September	summer
## 9362	Nanuq Outflow	2001	September	summer
## 9363	Nanuq Outflow	2001	September	summer
## 9367	Pigeon-Reach 1	2001	August	summer
## 9368	Pigeon-Reach 1	2001	August	summer
## 9369	Pigeon-Reach 1	2001	August	summer
## 9370	Pigeon-Reach 1	2001	September	summer
## 9371	Pigeon-Reach 1	2001	September	summer
## 9372	Pigeon-Reach 1	2001	September	summer
## 9376	Vulture-Polar	2001	August	summer
## 9377	Vulture-Polar	2001	August	summer

## 9378	Vulture-Polar	2001	August	summer
## 9379	Vulture-Polar	2001	September	summer
## 9380	Vulture-Polar	2001	September	summer
## 9381	Vulture-Polar	2001	September	summer
## 9385	Counts Outflow	2002	August	summer
## 9386	Counts Outflow	2002	August	summer
## 9387	Counts Outflow	2002	August	summer
## 9388	Counts Outflow	2002	September	summer
## 9389	Counts Outflow	2002	September	summer
## 9390	Counts Outflow	2002	September	summer
## 9394	Nanuq Outflow	2002	August	summer
## 9395	Nanuq Outflow	2002	August	summer
## 9396	Nanuq Outflow	2002	August	summer
## 9397	Nanuq Outflow	2002	September	summer
## 9398	Nanuq Outflow	2002	September	summer
## 9399	Nanuq Outflow	2002	September	summer
## 9412	Vulture-Polar	2002	August	summer
## 9413	Vulture-Polar	2002	August	summer
## 9414	Vulture-Polar	2002	August	summer
## 9415	Vulture-Polar	2002	September	summer
## 9416	Vulture-Polar	2002	September	summer
## 9417	Vulture-Polar	2002	September	summer
## 9420	Counts Outflow	2003	August	summer
## 9421	Counts Outflow	2003	August	summer
## 9422	Counts Outflow	2003	September	summer
## 9423	Counts Outflow	2003	September	summer
## 9426	Nanuq Outflow	2003	August	summer
## 9427	Nanuq Outflow	2003	August	summer
## 9428	Nanuq Outflow	2003	September	summer
## 9429	Nanuq Outflow	2003	September	summer
## 9440	Counts Outflow	2004	August	summer
## 9441	Counts Outflow	2004	August	summer
## 9442	Counts Outflow	2004	September	summer
## 9443	Counts Outflow	2004	September	summer
## 9464	Pigeon-Reach 7	2004	July	summer
## 9466	Pigeon-Reach 7	2004	July	summer
## 9476	Counts Outflow	2005	August	summer
## 9477	Counts Outflow	2005	August	summer
## 9478	Counts Outflow	2005	September	summer
## 9479	Counts Outflow	2005	September	summer
## 9505	Pigeon-Reach 7	2005	August	summer
## 9506	Pigeon-Reach 7	2005	August	summer
## 9507	Pigeon-Reach 7	2005	August	summer
## 9508	Pigeon-Reach 7	2005	September	summer
## 9509	Pigeon-Reach 7	2005	September	summer
## 9518	Counts Outflow	2006	August	summer
## 9519	Counts Outflow	2006	August	summer
## 9520	Counts Outflow	2006	September	summer
## 9521	Counts Outflow	2006	September	summer
## 9542	Pigeon-Reach 7	2006	July	summer


```

## 9543 Pigeon-Reach 7 2006      July summer
## 9544 Pigeon-Reach 7 2006      July summer
## 9545 Pigeon-Reach 7 2006      July summer
## 9546 Pigeon-Reach 7 2006      August summer
## 9547 Pigeon-Reach 7 2006      August summer
## 9548 Pigeon-Reach 7 2006      September summer
## 9556 Counts Outflow 2007      August summer
## 9557 Counts Outflow 2007      August summer
## 9558 Counts Outflow 2007      September summer
## 9559 Counts Outflow 2007      September summer
## 9809 Counts Outflow 2014      July summer
## 9810 Counts Outflow 2014      July summer
## 9811 Counts Outflow 2014      August summer
## 9812 Counts Outflow 2014      August summer
## 9813 Counts Outflow 2014      September summer
## 9814 Counts Outflow 2014      September summer
## 9841 Pigeon-Reach 7 2014      July summer
## 9842 Pigeon-Reach 7 2014      July summer
## 9843 Pigeon-Reach 7 2014      August summer
## 9844 Pigeon-Reach 7 2014      August summer
## 9845 Pigeon-Reach 7 2014      September summer
## 9846 Pigeon-Reach 7 2014      September summer
## 9847 Pigeon-Reach 7 2014      October summer
## 9848 Pigeon-Reach 7 2014      October summer

```

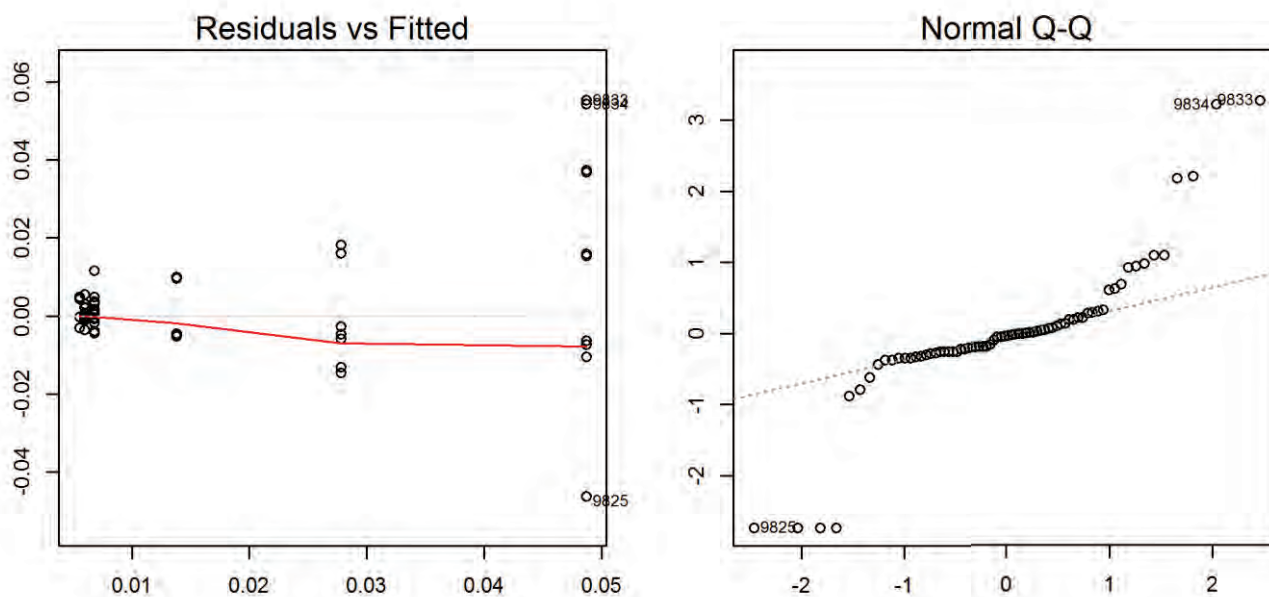
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

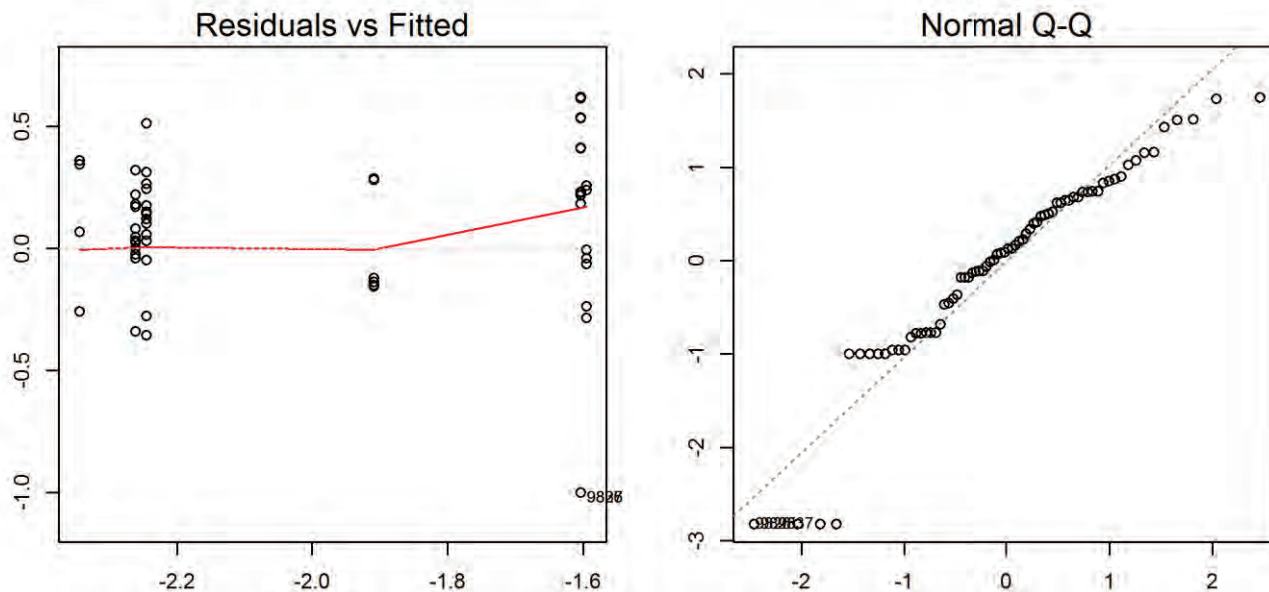
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.02	0.5	0.46
Log-10	0.37	0.44	0.39

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

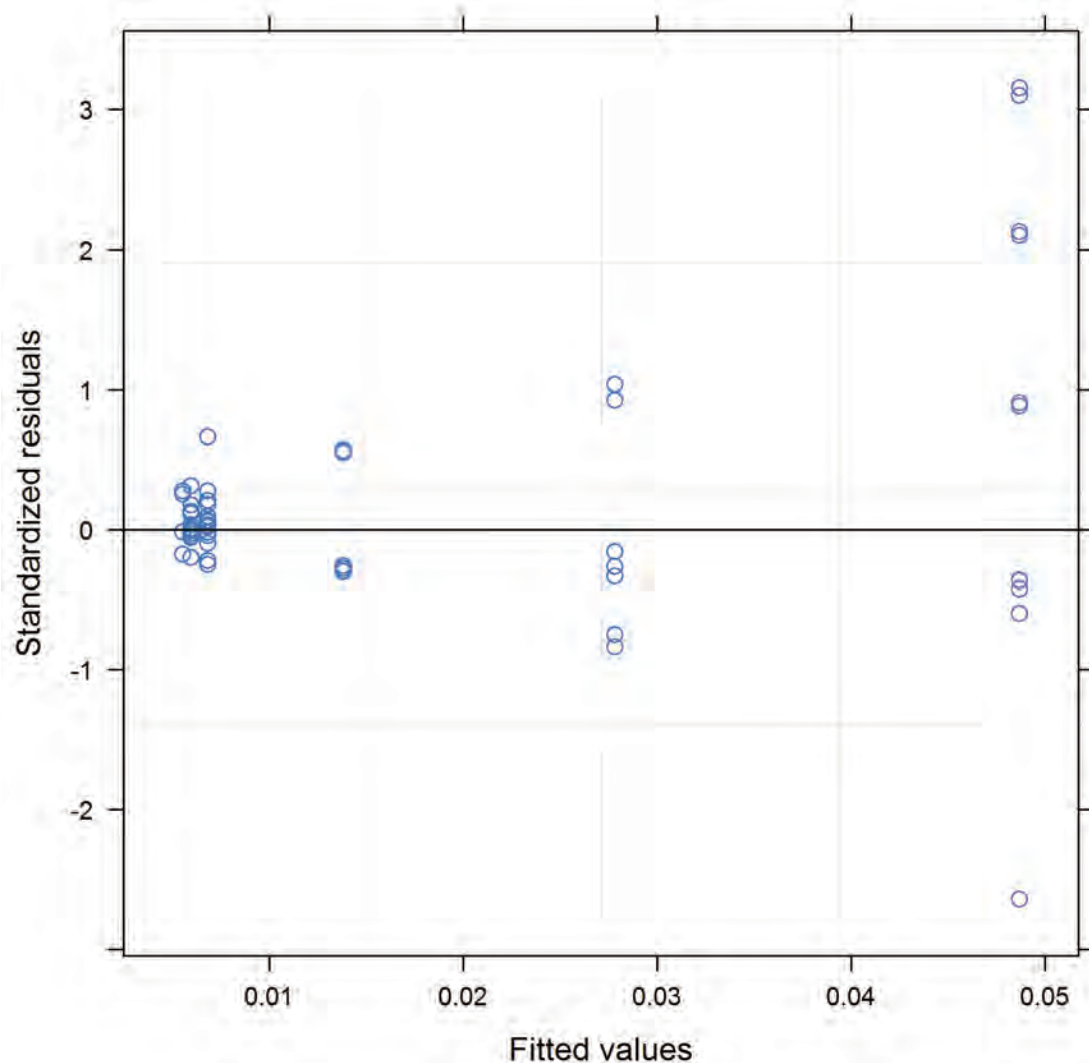
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	7	-318.3	166.15		
LME	8	-316.3	166.15	2.57×10^{-8}	1

Conclusion:

The most appropriate model for nitrate-N at the Pigeon-Reach 1 monitoring site was the simpler GLS model without a year term ($p = 1$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 66
##          numDF F-value p-value
## (Intercept)    1     77 <.0001
## site           2     28 <.0001
## period         1      5  0.028
## site:period     2      2  0.148
```

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.02	-0.04	8.28×10^{-4}	not sig.
Counts Outflow	NA	NA	NA	NA
Vulture-Polar	-0.01	-0.04	0.01	not sig.
Pigeon-Reach 7	NA	NA	NA	NA

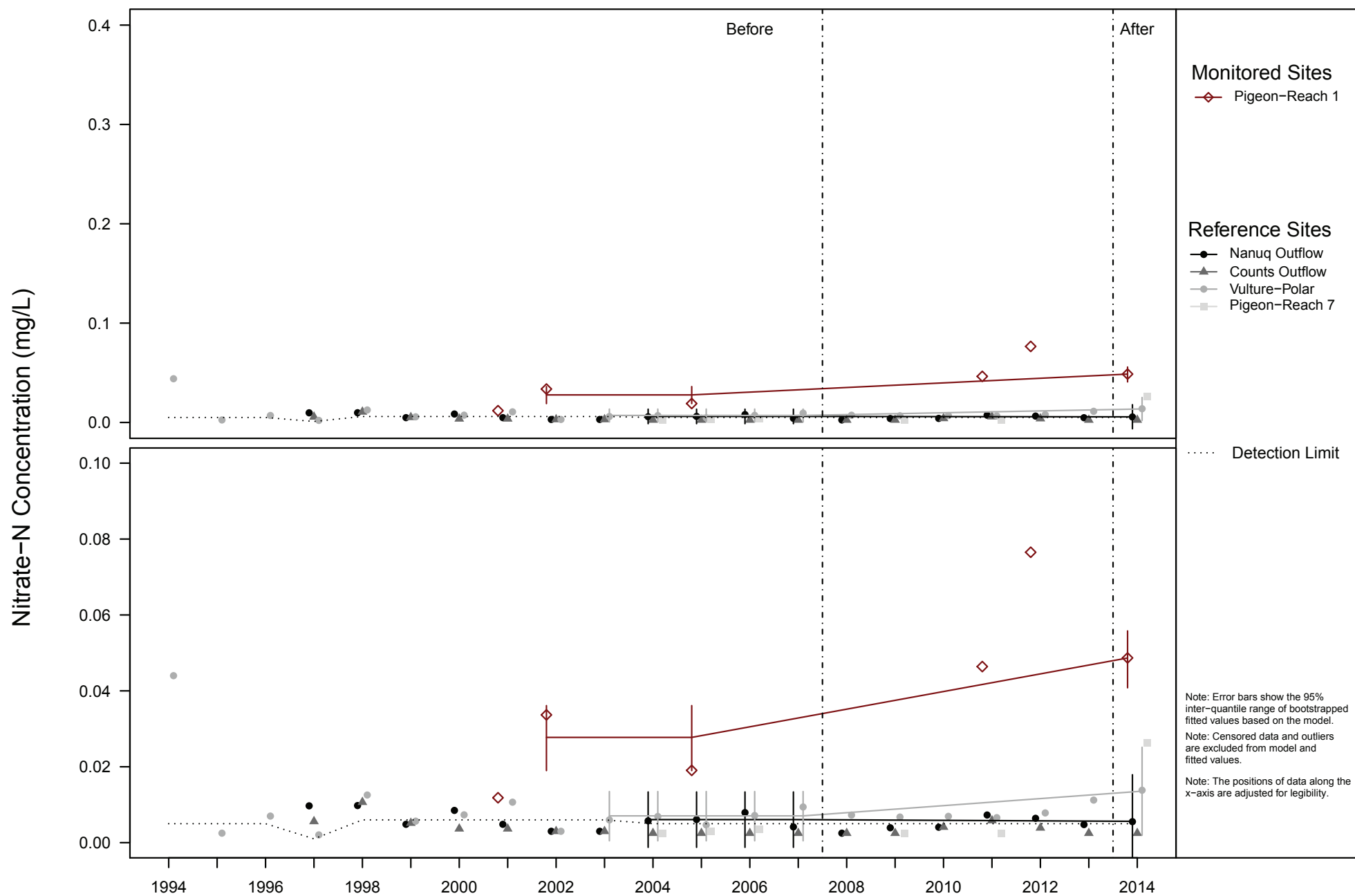
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Nitrate-N concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.148$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

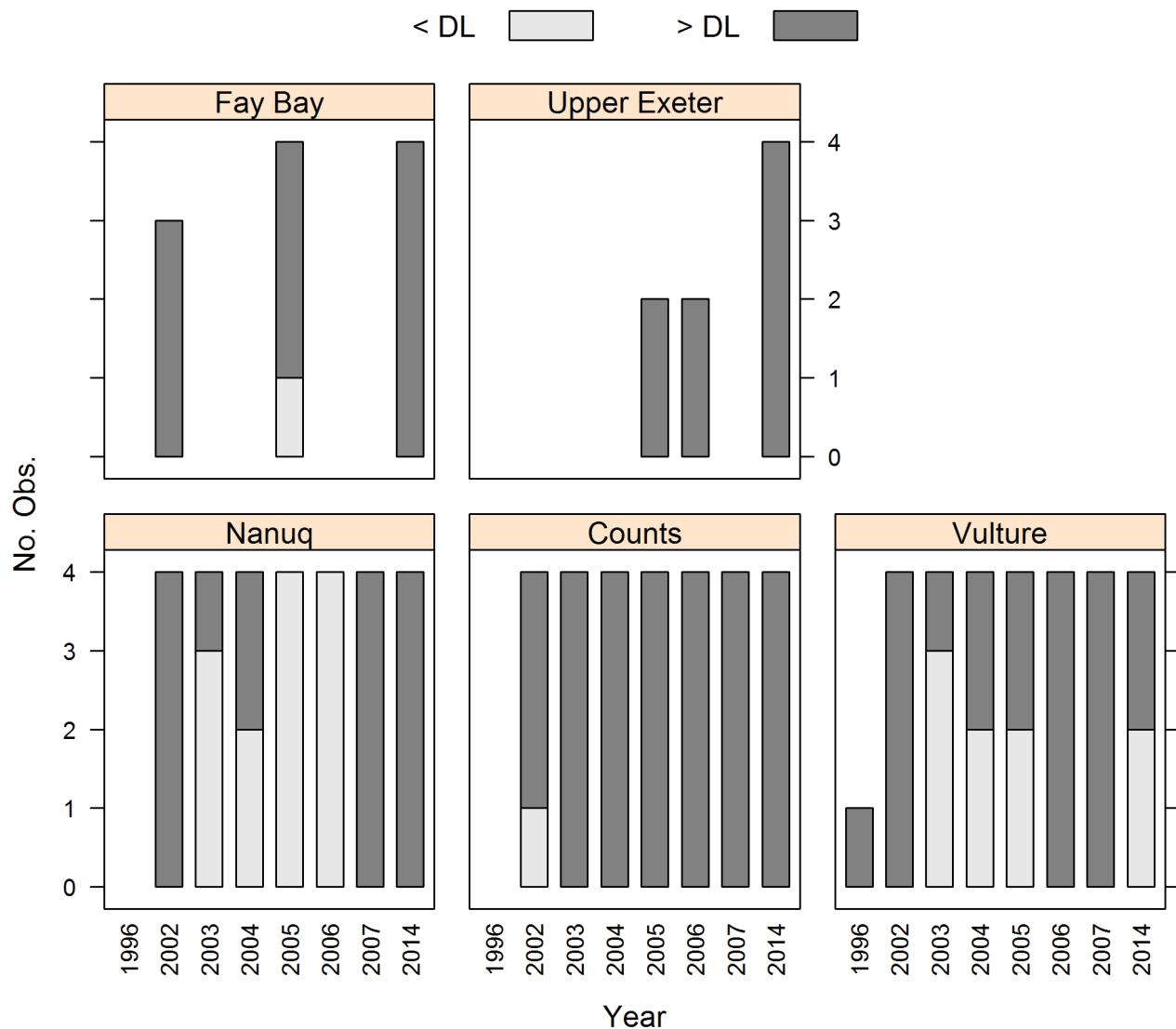


Analysis of Winter Total Phosphate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year month season
## 16194  Nanuq 2003 April winter
## 16195  Nanuq 2003 April winter
## 16196  Nanuq 2003 April winter
## 16197  Nanuq 2003 April winter
## 16205 Vulture 2003 April winter
## 16206 Vulture 2003 April winter
## 16207 Vulture 2003 April winter
## 16208 Vulture 2003 April winter
## 16226  Nanuq 2004 April winter
## 16227  Nanuq 2004 April winter
## 16228  Nanuq 2004 April winter
## 16229  Nanuq 2004 April winter
## 16263  Nanuq 2005 April winter
## 16264  Nanuq 2005 April winter
## 16265  Nanuq 2005 April winter
## 16266  Nanuq 2005 April winter
## 16304  Nanuq 2006 April winter
## 16305  Nanuq 2006 April winter
## 16306  Nanuq 2006 April winter
## 16307  Nanuq 2006 April winter
```

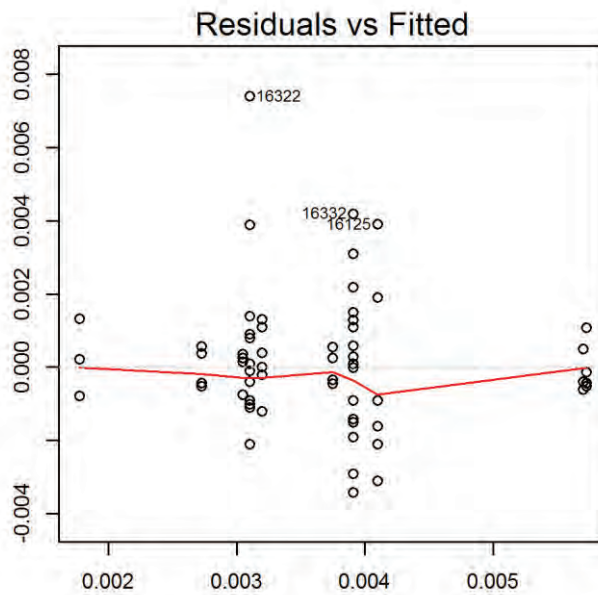
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

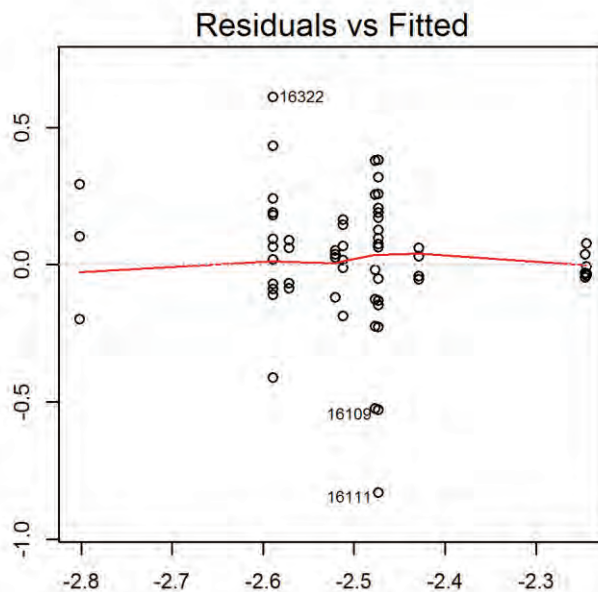
```
## No outliers were identified.
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0	0.21	0.12
Log-10	0.24	0.21	0.12

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

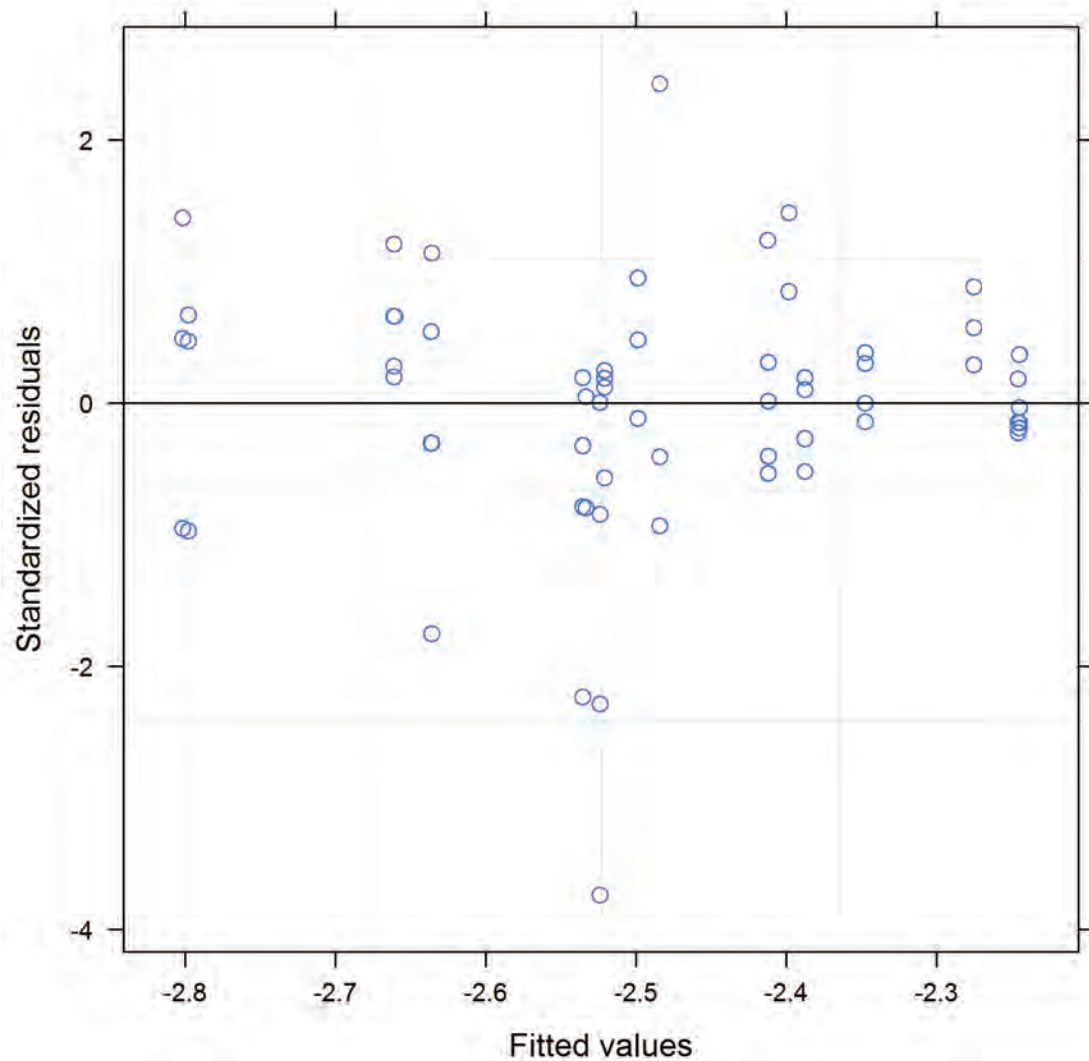
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	35.63	-8.82		
LME	10	25.06	-2.53	12.57	3.92×10 ⁻⁴

Conclusion:

The most appropriate model for total phosphate-P at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	62	1395	<.0001
## site	3	62	7	0.0003
## period	1	6	0	0.9270
## site:period	3	62	2	0.0778

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.04	-0.4	0.34	not sig.
Counts	0.13	-0.22	0.47	not sig.
Vulture	-0.29	-0.63	0.05	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphate-P concentrations at the Fay Bay site were not significantly ($p = 0.078$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

4.2 Upper Exeter Monitoring Location

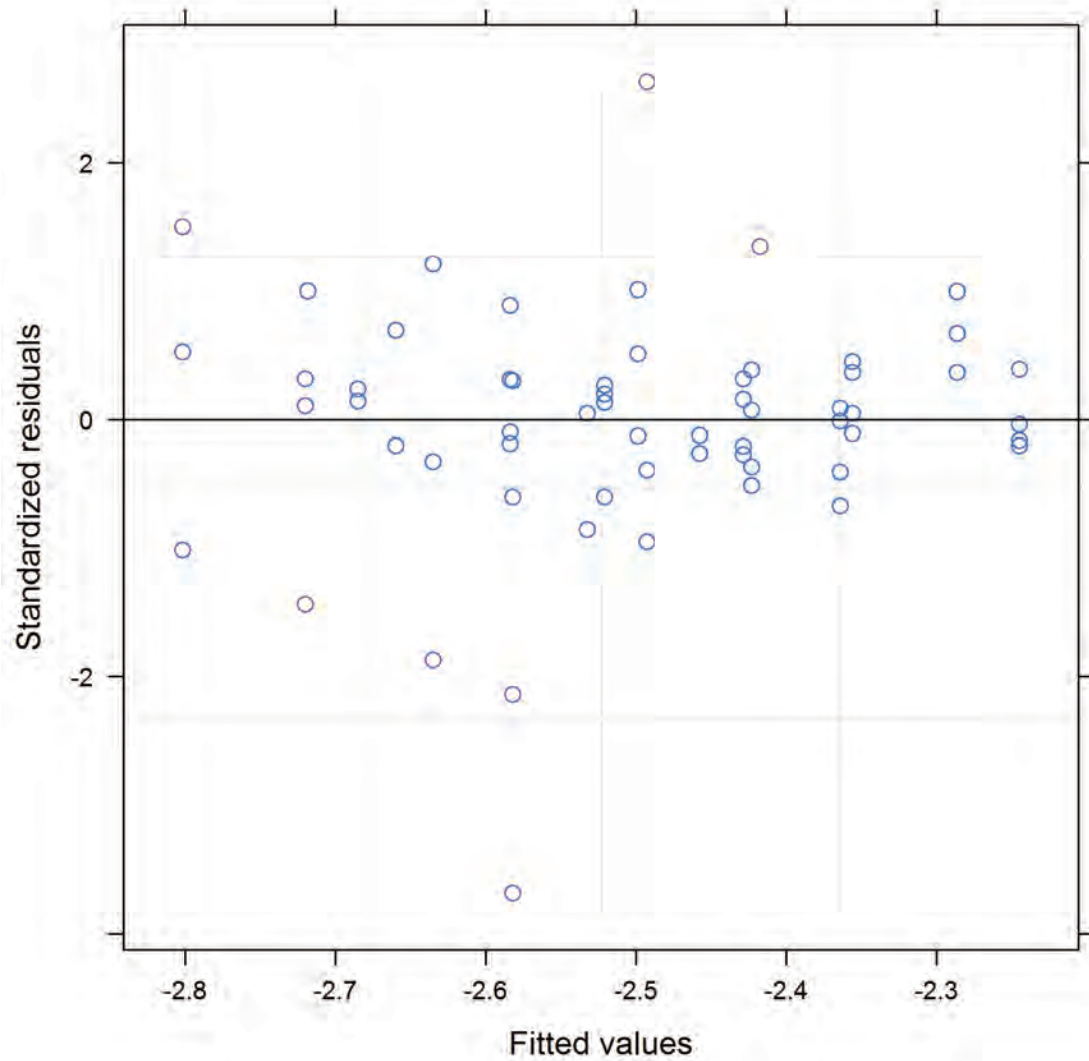
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	27.87	-4.93		
LME	10	16.82	1.59	13.05	3.04×10^{-4}

Conclusion:

The most appropriate model for total phosphate-P at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	59	1672	<.0001
## site	3	59	5	0.0059
## period	1	6	0	0.9251
## site:period	3	59	3	0.0472

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.12	-0.49	0.27	not sig.
Counts	0.08	-0.26	0.44	not sig.
Vulture	-0.34	-0.68	0.01	not sig.

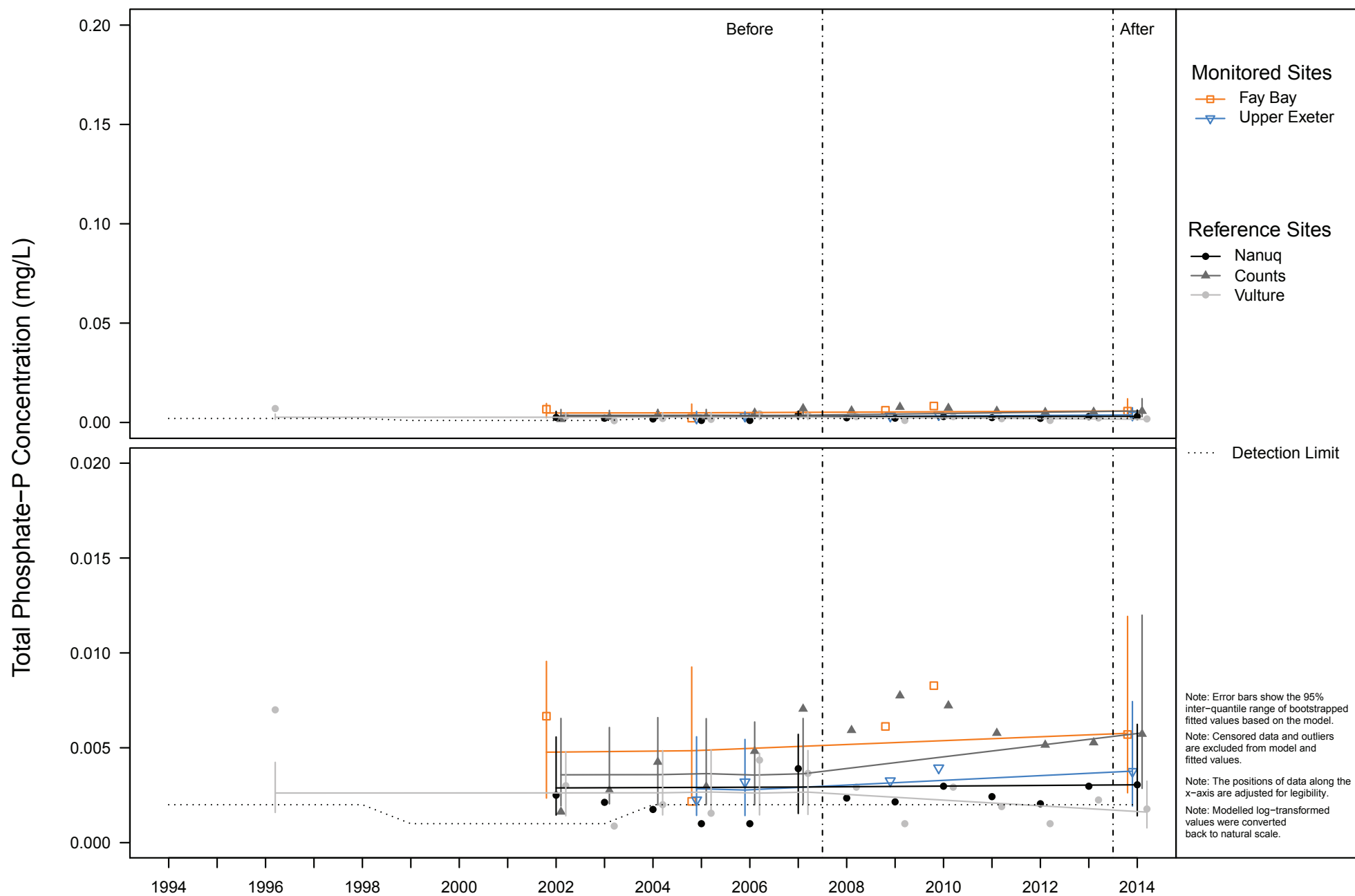
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Phosphate-P concentrations at the Upper Exeter site were significantly ($p = 0.047$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

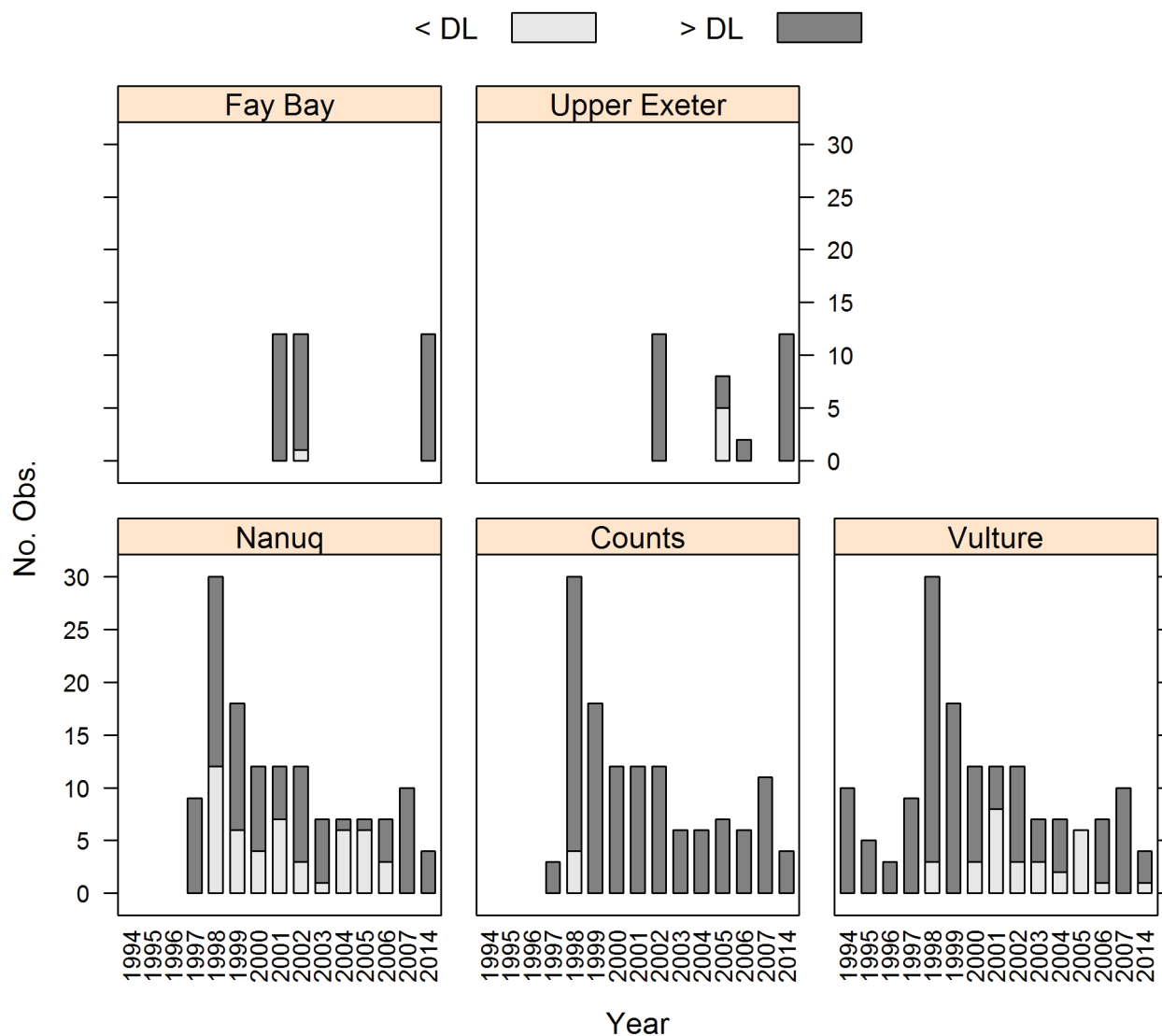


Analysis of Summer Total Phosphate Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 16097	Vulture	2001	July	summer
## 16098	Vulture	2001	July	summer
## 16099	Vulture	2001	July	summer
## 16100	Vulture	2001	July	summer
## 16101	Vulture	2001	August	summer
## 16102	Vulture	2001	August	summer
## 16103	Vulture	2001	August	summer
## 16104	Vulture	2001	August	summer
## 16105	Vulture	2001	September	summer
## 16106	Vulture	2001	September	summer
## 16107	Vulture	2001	September	summer
## 16108	Vulture	2001	September	summer
## 16230	Nanuq	2004	July	summer
## 16231	Nanuq	2004	July	summer
## 16232	Nanuq	2004	August	summer
## 16233	Nanuq	2004	August	summer
## 16234	Nanuq	2004	August	summer
## 16235	Nanuq	2004	September	summer
## 16236	Nanuq	2004	September	summer
## 16267	Nanuq	2005	July	summer
## 16268	Nanuq	2005	July	summer
## 16269	Nanuq	2005	August	summer
## 16270	Nanuq	2005	August	summer
## 16271	Nanuq	2005	September	summer
## 16272	Nanuq	2005	September	summer
## 16273	Nanuq	2005	September	summer
## 16276	Upper Exeter	2005	July	summer
## 16277	Upper Exeter	2005	July	summer
## 16278	Upper Exeter	2005	July	summer
## 16279	Upper Exeter	2005	August	summer
## 16280	Upper Exeter	2005	August	summer
## 16281	Upper Exeter	2005	August	summer
## 16282	Upper Exeter	2005	September	summer
## 16283	Upper Exeter	2005	September	summer
## 16288	Vulture	2005	July	summer
## 16289	Vulture	2005	July	summer
## 16290	Vulture	2005	August	summer
## 16291	Vulture	2005	August	summer
## 16292	Vulture	2005	September	summer
## 16293	Vulture	2005	September	summer

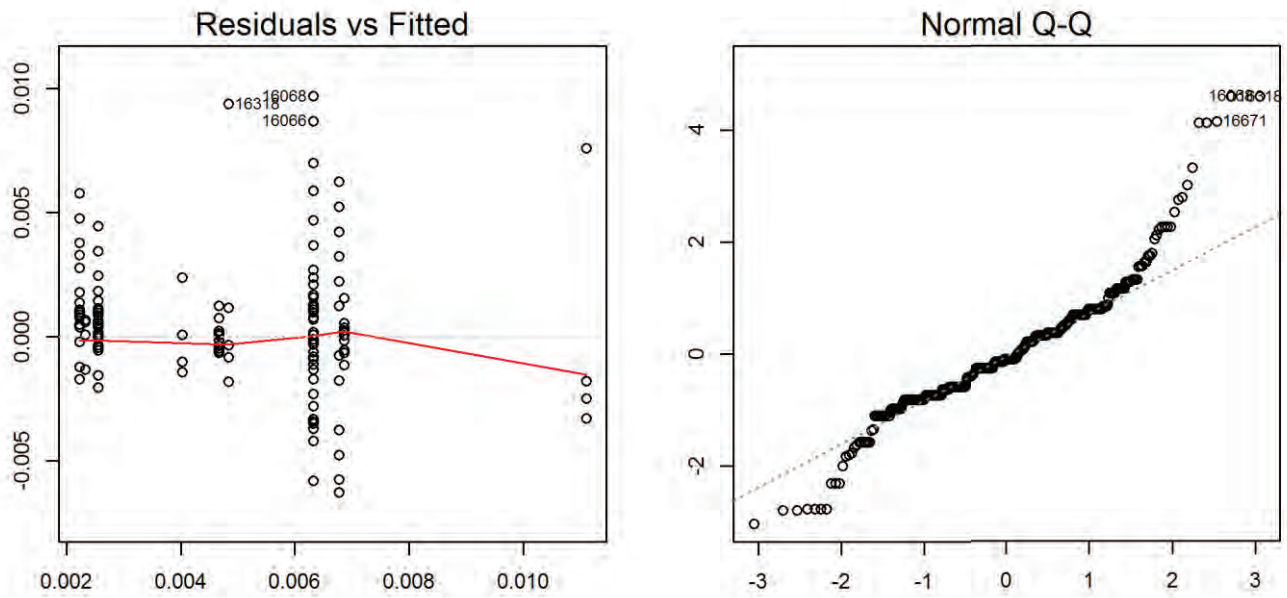
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

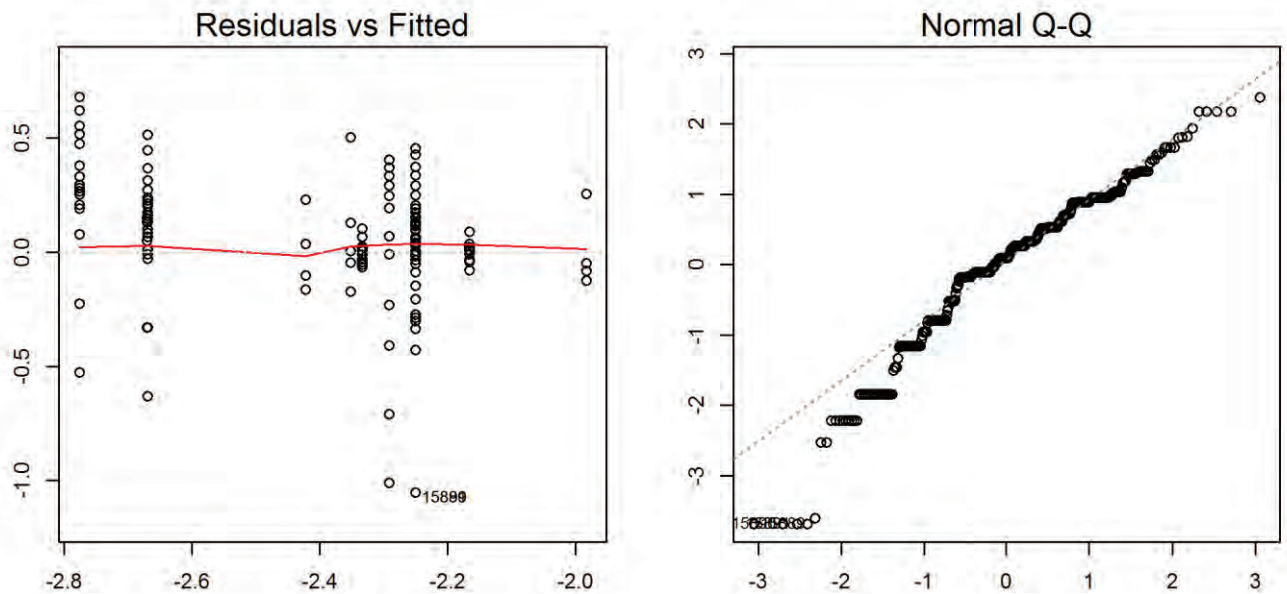
##	site	year	month	season
## 15951	Vulture	1998	July	summer

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0	0.48	0.47
Log-10	0.29	0.41	0.39

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

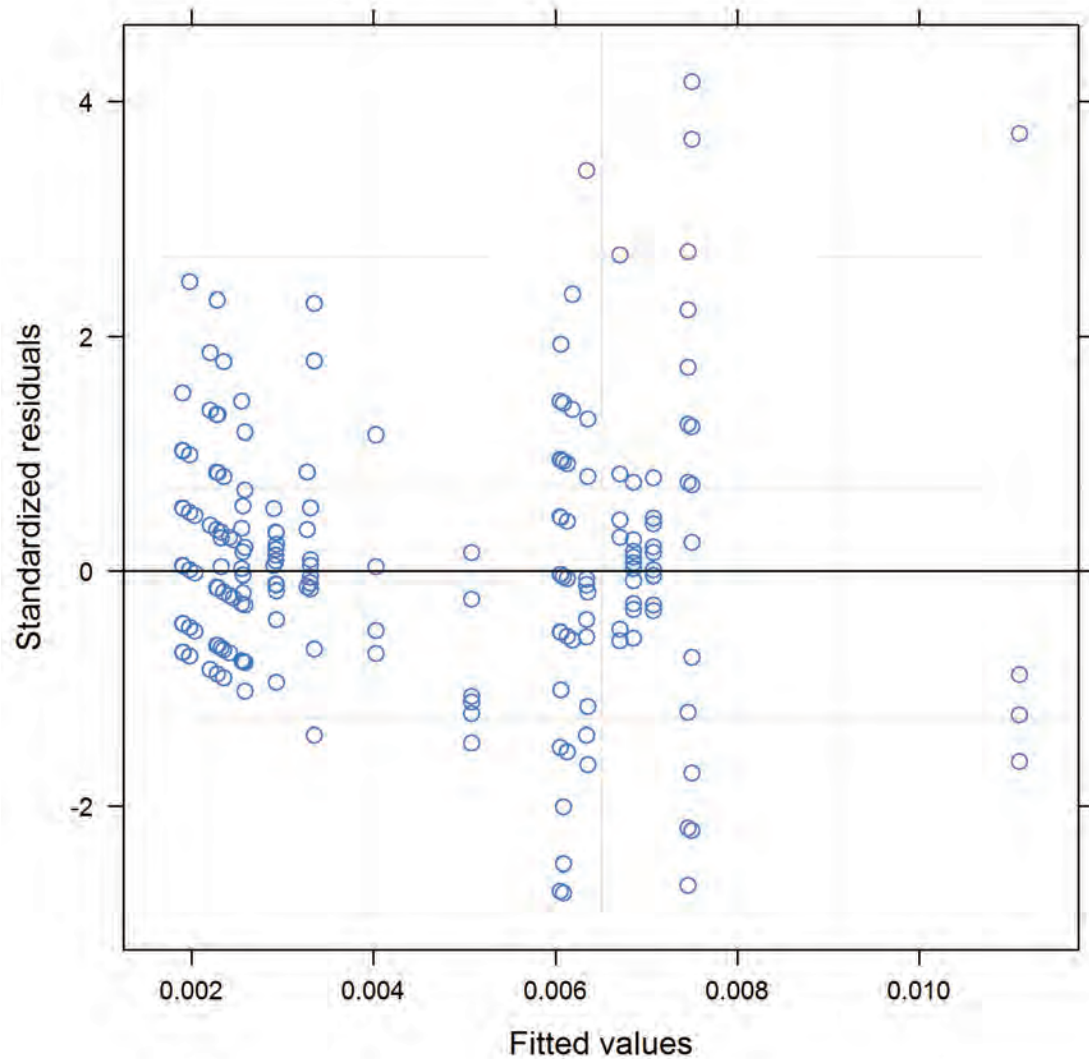
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-3834.34	1926.17		
LME	10	-3846.12	1933.06	13.79	2.05×10 ⁻⁴

Conclusion:

The most appropriate model for total phosphate-P at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	396	326	<.0001
## site	3	396	119	<.0001
## period	1	13	3	0.1243
## site:period	3	396	5	0.0027

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0	0	0	not sig.
Counts	0	0	0.01	sig.
Vulture	-8.04×10^{-4}	0	0	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphate-P concentrations at the Fay Bay site were significantly ($p = 0.003$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

4.2 Upper Exeter Monitoring Location

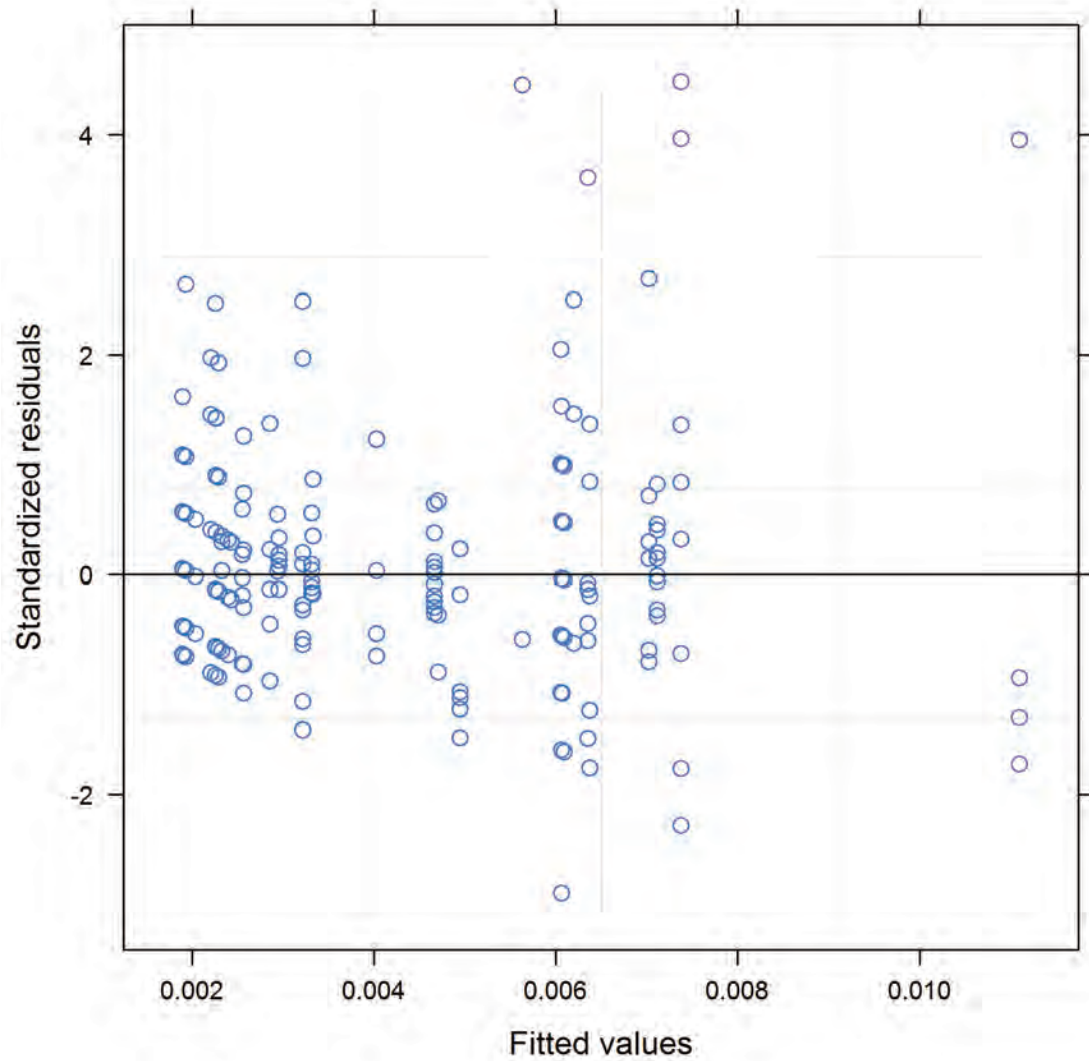
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-3784.88	1901.44		
LME	10	-3797.13	1908.56	14.25	1.6×10^{-4}

Conclusion:

The most appropriate model for total phosphate-P at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	386	291	<.0001
## site	3	386	124	<.0001
## period	1	13	2	0.1923
## site:period	3	386	6	0.0003

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0	-3.64×10^{-4}	0	not sig.
Counts	0.01	0	0.01	sig.
Vulture	7.2710^{-5}	0	0	not sig.

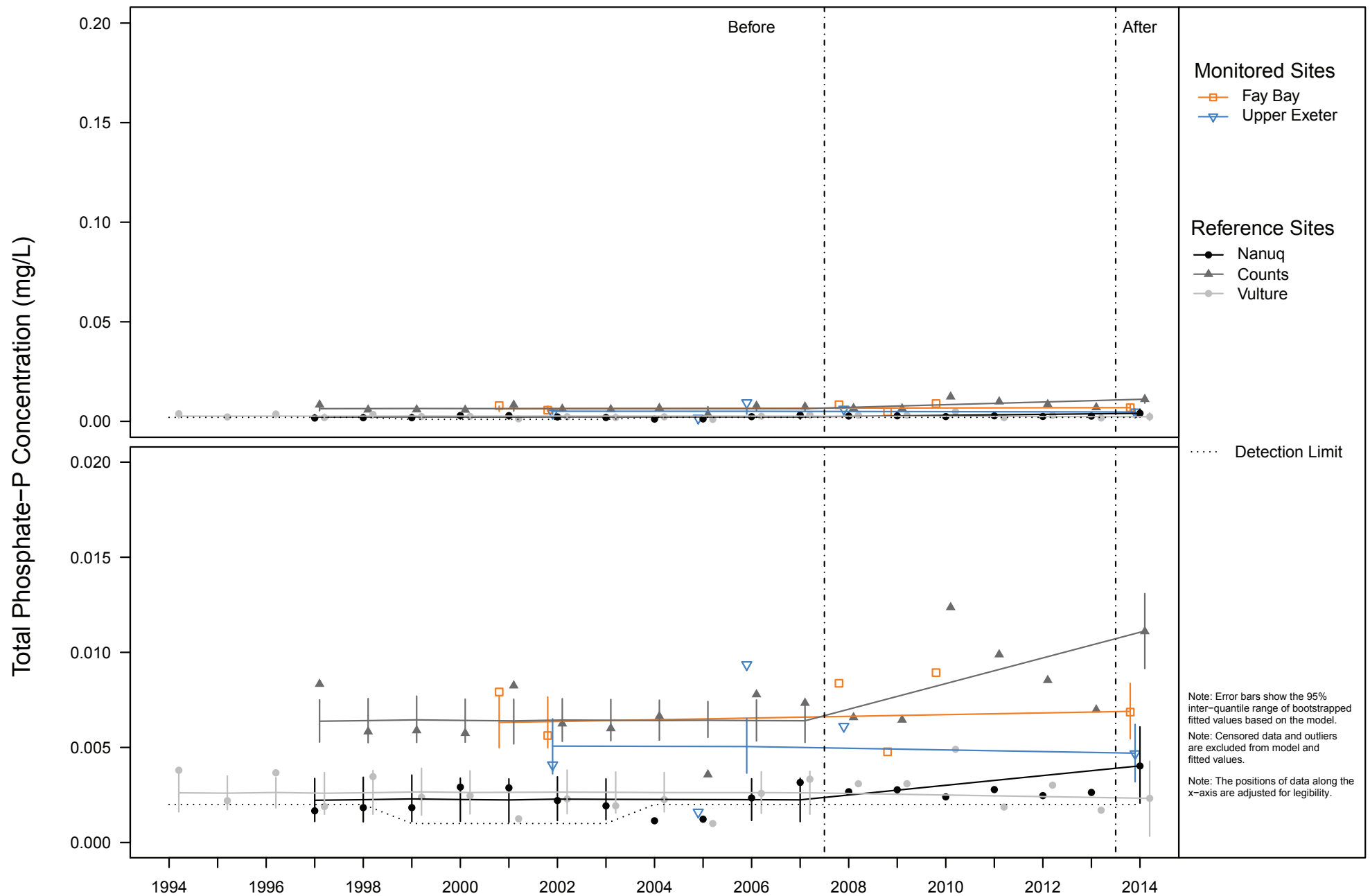
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphate-P concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

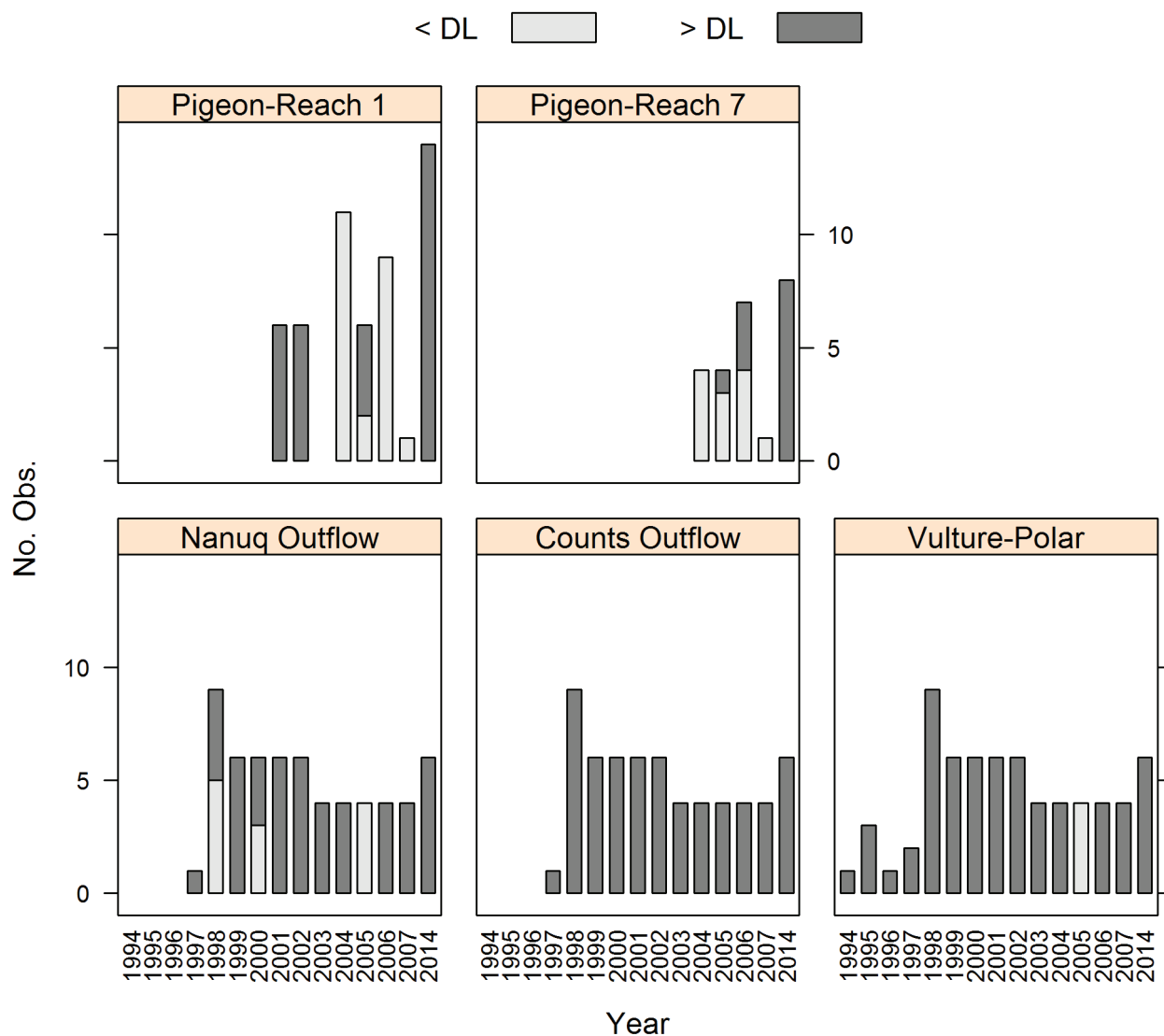


Analysis of Summer Total Phosphate Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 11301	Pigeon-Reach 1	2004	July	summer
## 11302	Pigeon-Reach 1	2004	July	summer
## 11303	Pigeon-Reach 1	2004	July	summer
## 11304	Pigeon-Reach 1	2004	July	summer
## 11305	Pigeon-Reach 1	2004	August	summer
## 11306	Pigeon-Reach 1	2004	August	summer
## 11307	Pigeon-Reach 1	2004	August	summer
## 11308	Pigeon-Reach 1	2004	August	summer
## 11309	Pigeon-Reach 1	2004	September	summer
## 11310	Pigeon-Reach 1	2004	September	summer
## 11311	Pigeon-Reach 1	2004	September	summer
## 11312	Pigeon-Reach 7	2004	July	summer
## 11313	Pigeon-Reach 7	2004	July	summer
## 11314	Pigeon-Reach 7	2004	July	summer
## 11315	Pigeon-Reach 7	2004	July	summer
## 11330	Nanuq Outflow	2005	August	summer
## 11331	Nanuq Outflow	2005	August	summer
## 11332	Nanuq Outflow	2005	September	summer
## 11333	Nanuq Outflow	2005	September	summer
## 11353	Pigeon-Reach 7	2005	August	summer
## 11354	Pigeon-Reach 7	2005	August	summer
## 11356	Pigeon-Reach 7	2005	September	summer
## 11357	Pigeon-Reach 7	2005	September	summer
## 11360	Vulture-Polar	2005	August	summer
## 11361	Vulture-Polar	2005	August	summer
## 11362	Vulture-Polar	2005	September	summer
## 11363	Vulture-Polar	2005	September	summer
## 11379	Pigeon-Reach 1	2006	July	summer
## 11380	Pigeon-Reach 1	2006	July	summer
## 11381	Pigeon-Reach 1	2006	July	summer
## 11382	Pigeon-Reach 1	2006	August	summer
## 11383	Pigeon-Reach 1	2006	August	summer
## 11384	Pigeon-Reach 1	2006	August	summer
## 11385	Pigeon-Reach 1	2006	September	summer
## 11386	Pigeon-Reach 1	2006	September	summer
## 11387	Pigeon-Reach 1	2006	September	summer
## 11418	Pigeon-Reach 1	2007	July	summer
## 11432	Pigeon-Reach 7	2007	July	summer

2 Outliers

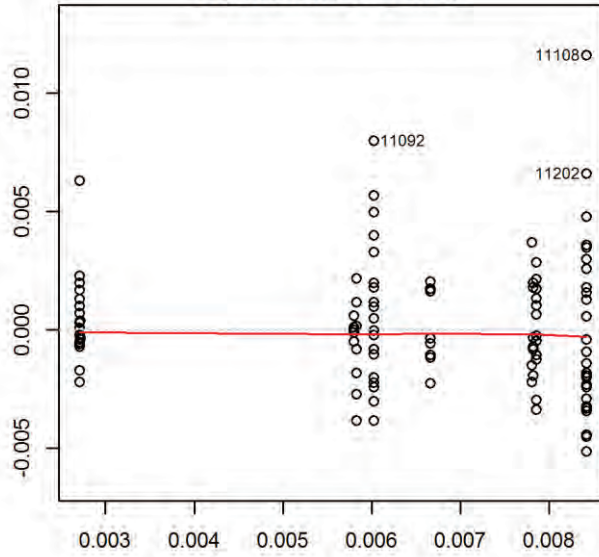
The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

##	site	year	month	season
## 11338	Pigeon-Reach 1	2005	July	summer
## 11350	Pigeon-Reach 1	2005	September	summer
## 11392	Pigeon-Reach 7	2006	July	summer
## 11393	Pigeon-Reach 7	2006	July	summer
## 11394	Pigeon-Reach 7	2006	August	summer
## 11395	Pigeon-Reach 7	2006	August	summer

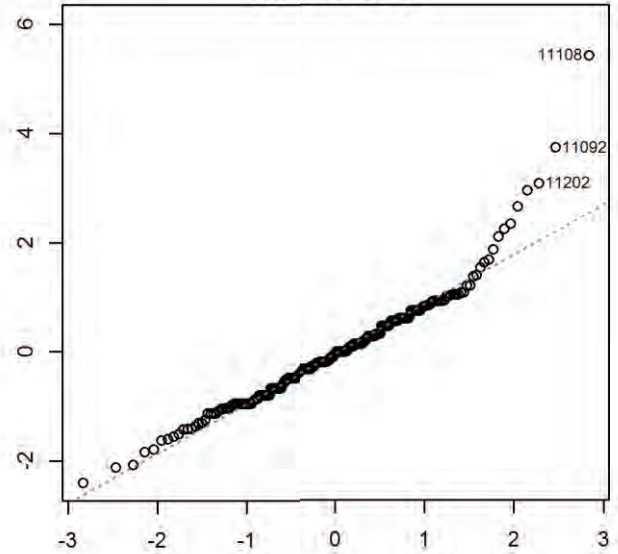
3 Initial Model Fit

Natural Scale Model

Residuals vs Fitted

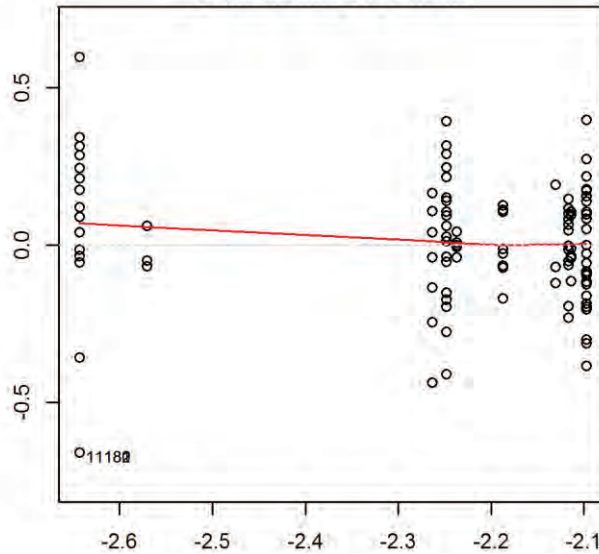


Normal Q-Q

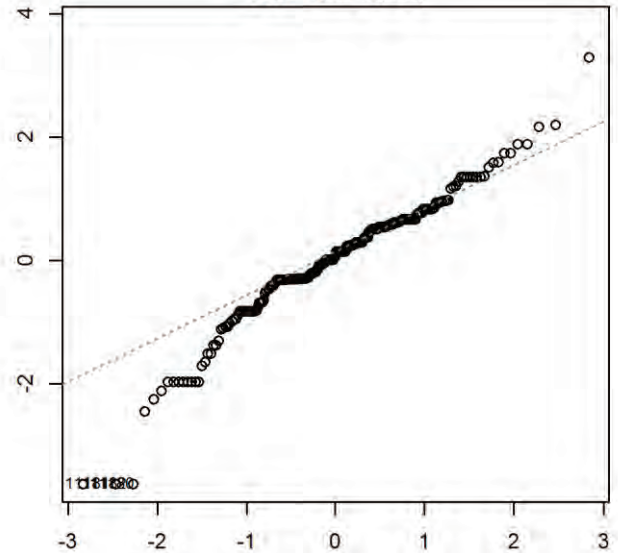


Log-10 Transformed Model

Residuals vs Fitted



Normal Q-Q



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0	0.51	0.49
Log-10	0.18	0.58	0.56

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

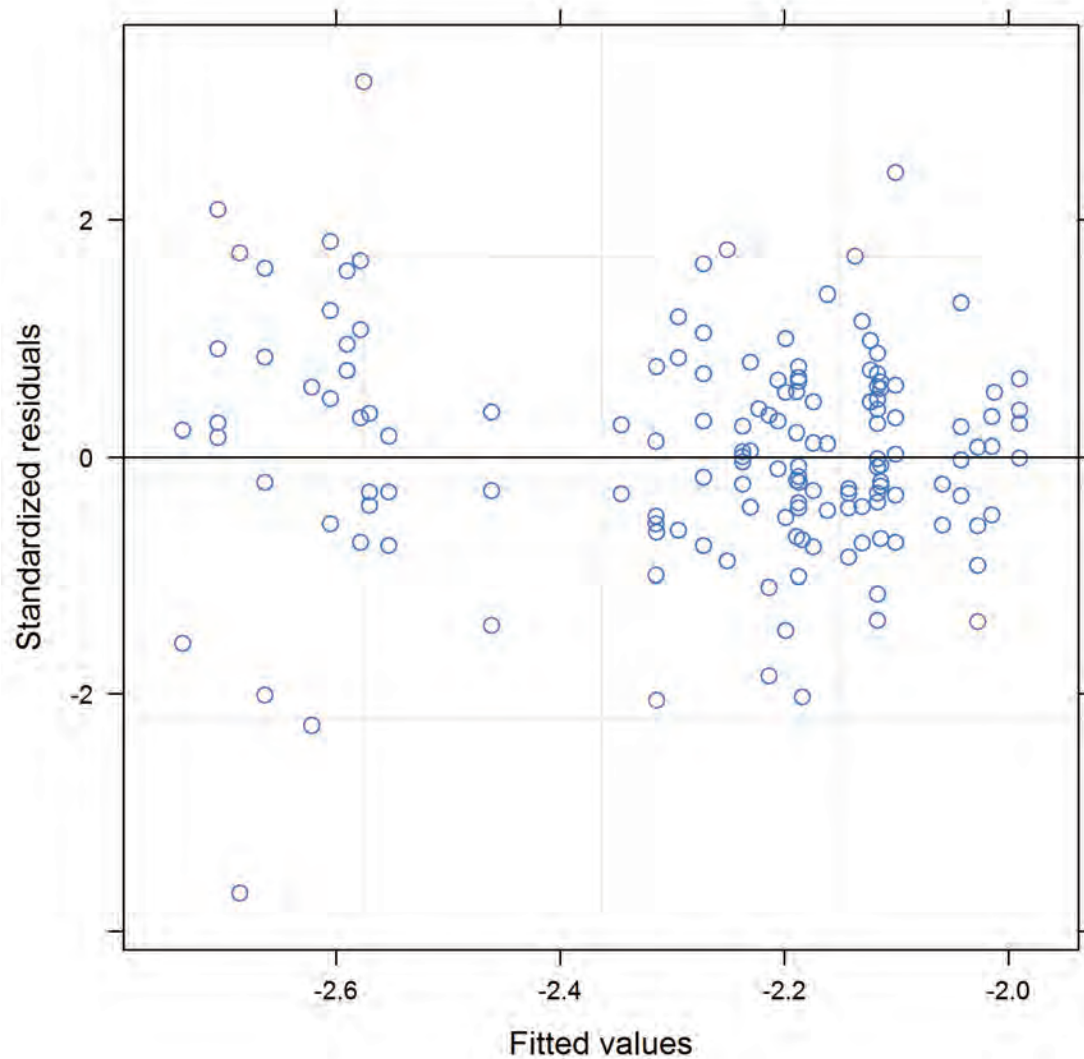
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-68.04	45.02		
LME	12	-84.24	54.12	18.2	1.98×10 ⁻⁵

Conclusion:

The most appropriate model for total phosphate-P at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	196	5263	<.0001
## site	4	196	84	<.0001
## period	1	13	0	0.74
## site:period	4	196	1	0.61

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.04	-0.22	0.15	not sig.
Counts Outflow	-0.14	-0.33	0.04	not sig.
Vulture-Polar	-0.1	-0.29	0.1	not sig.
Pigeon-Reach 7	-0.11	-0.38	0.15	not sig.

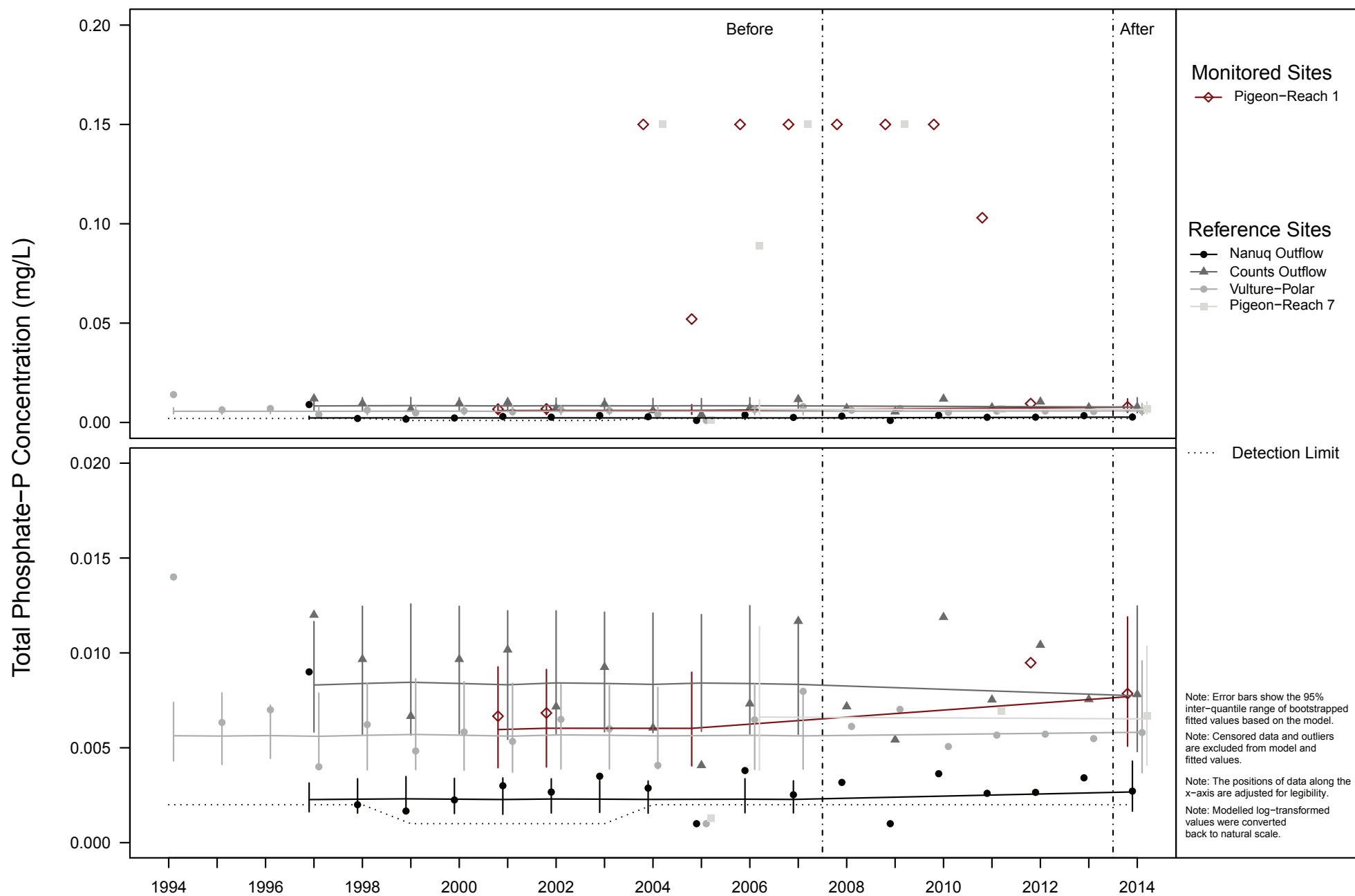
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphate-P concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.615$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

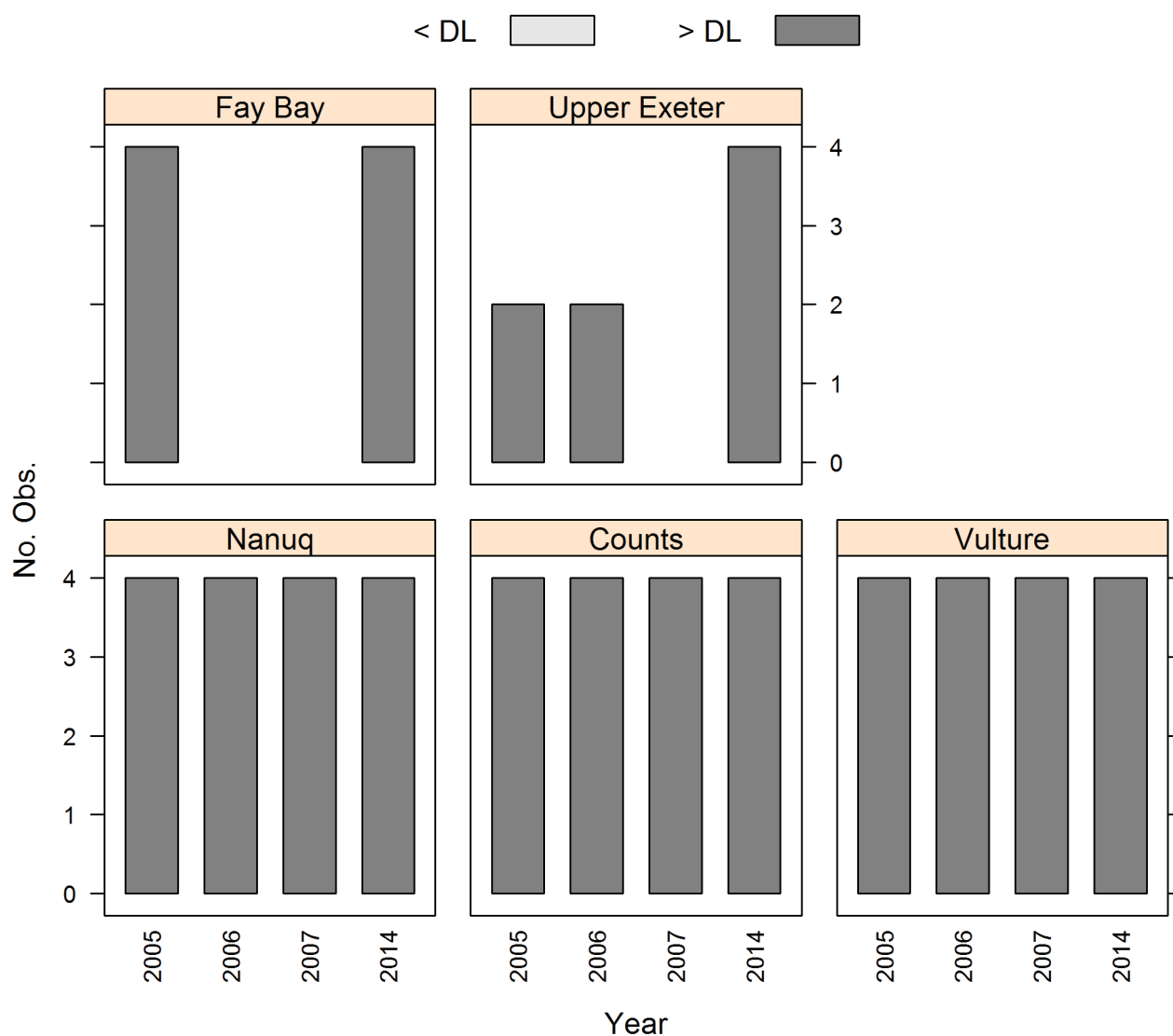


Analysis of Winter Total Organic Carbon Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

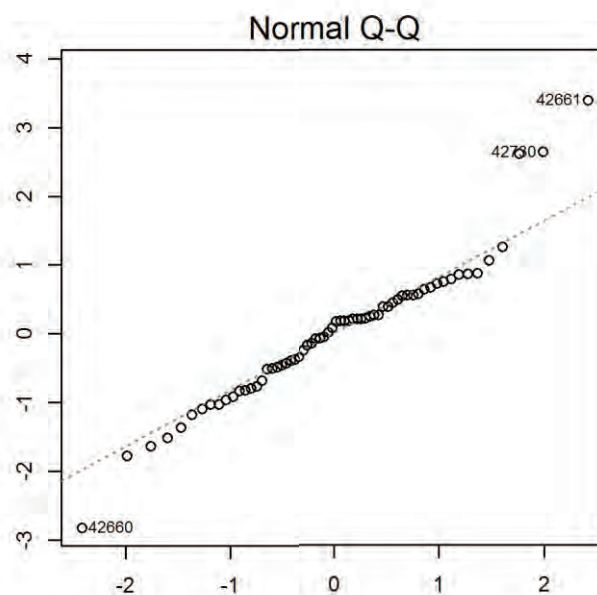
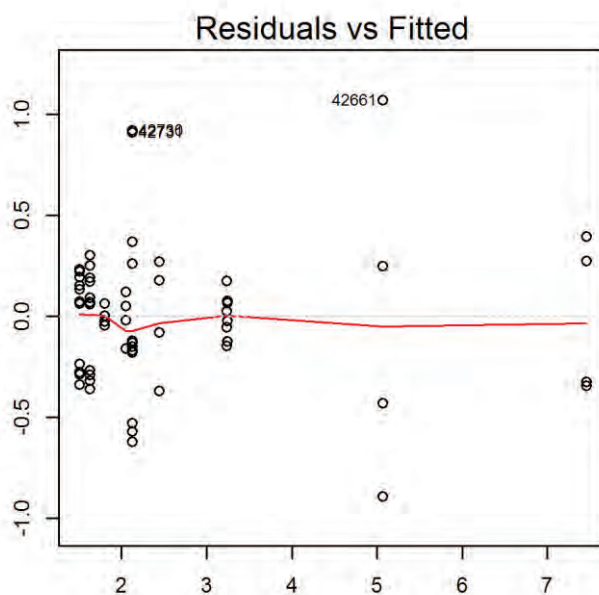
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

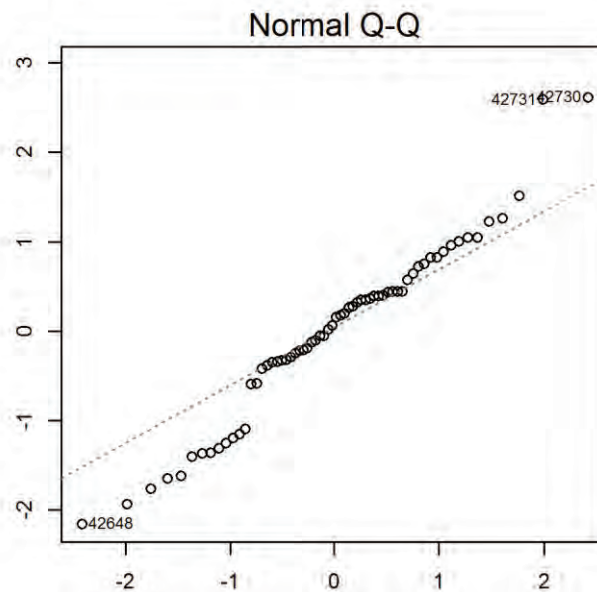
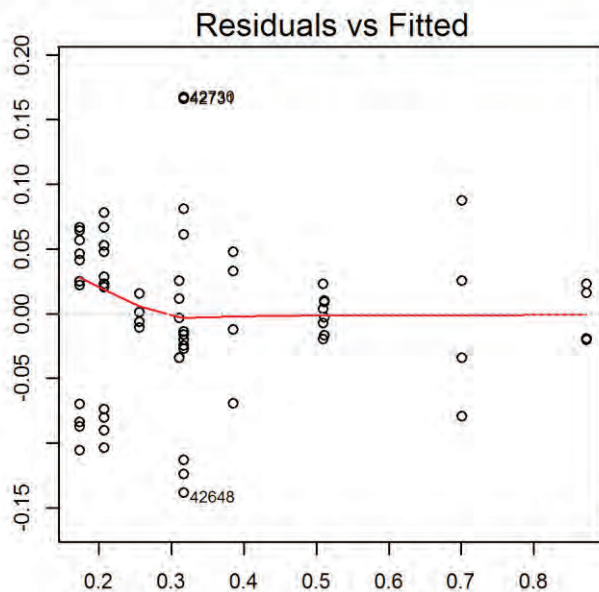
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.36	0.96	0.95
Log-10	0.07	0.91	0.9

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

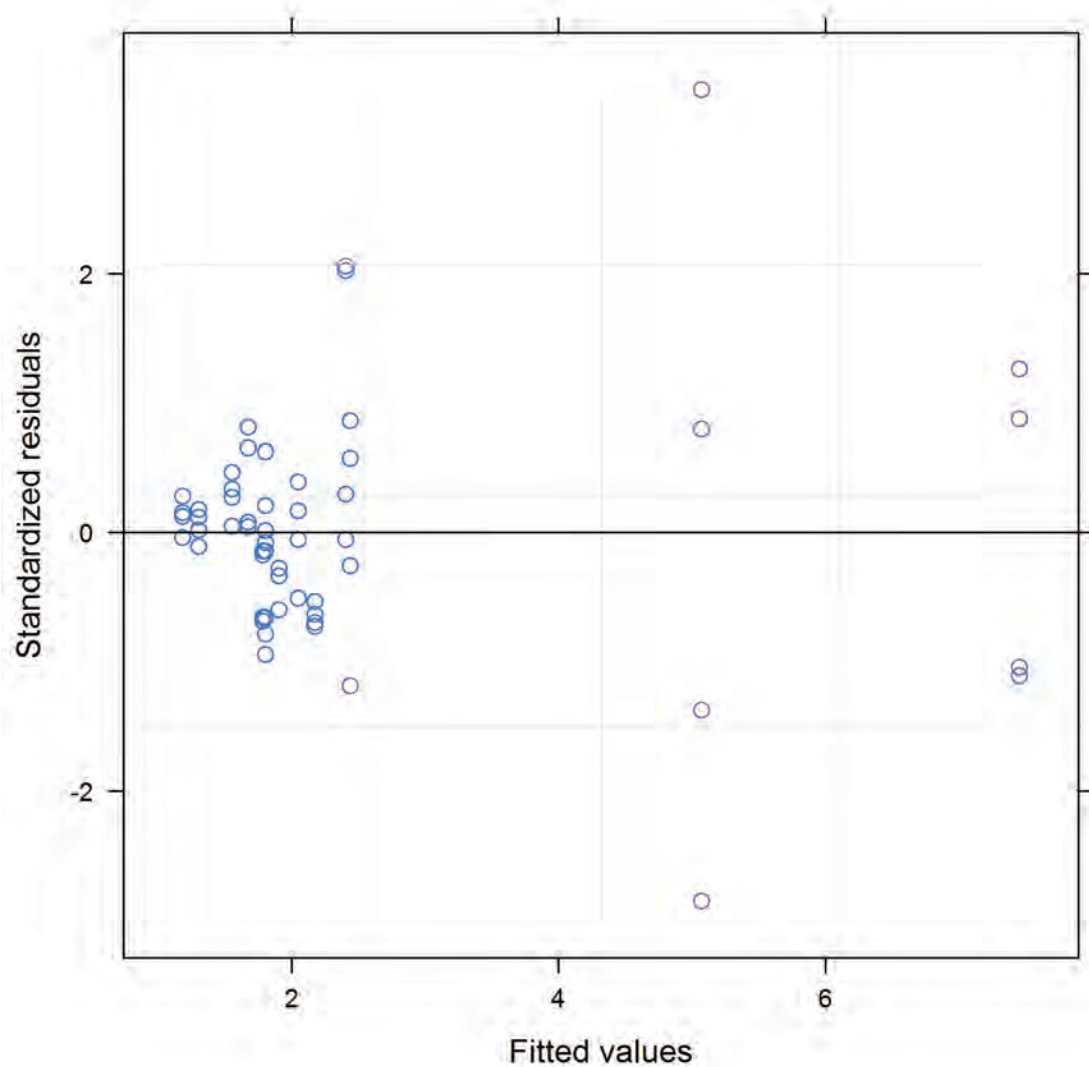
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	76.73	-29.36		
LME	10	64.03	-22.02	14.7	1.26×10 ⁻⁴

Conclusion:

The most appropriate model for total organic carbon at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	46	217	<.0001
## site	3	46	431	<.0001
## period	1	2	3	0.24
## site:period	3	46	16	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-1.52	-2.08	-0.97	sig.
Counts	-1.75	-2.32	-1.19	sig.
Vulture	-1.88	-2.46	-1.32	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

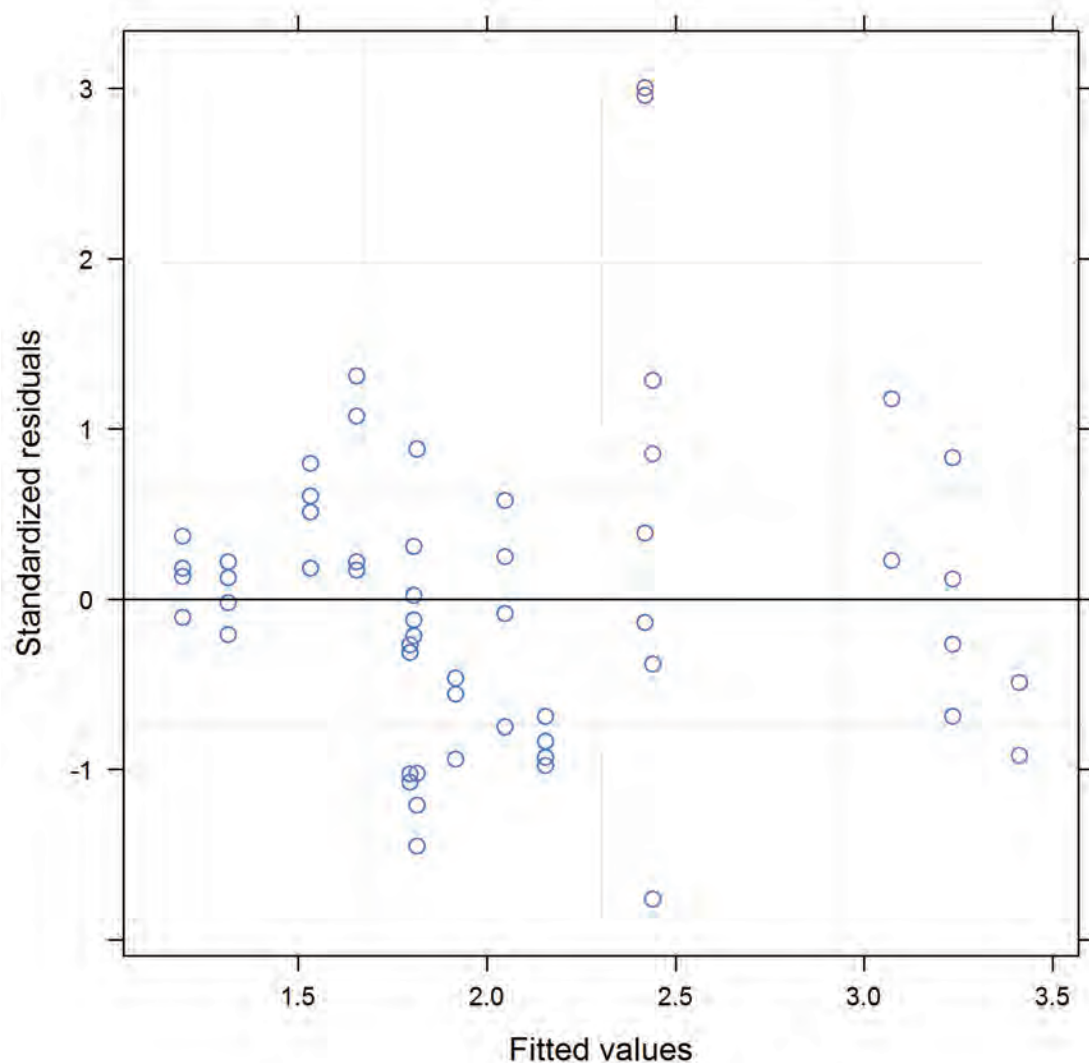
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	55.19	-18.6		
LME	10	27.59	-3.8	29.6	5.31×10^{-8}

Conclusion:

The most appropriate model for total organic carbon at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	46	168	<.0001
## site	3	46	120	<.0001
## period	1	2	0	0.5538
## site:period	3	46	4	0.0076

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.69	0.33	1.06	sig.
Counts	0.46	0.09	0.83	sig.
Vulture	0.33	-0.06	0.72	not sig.

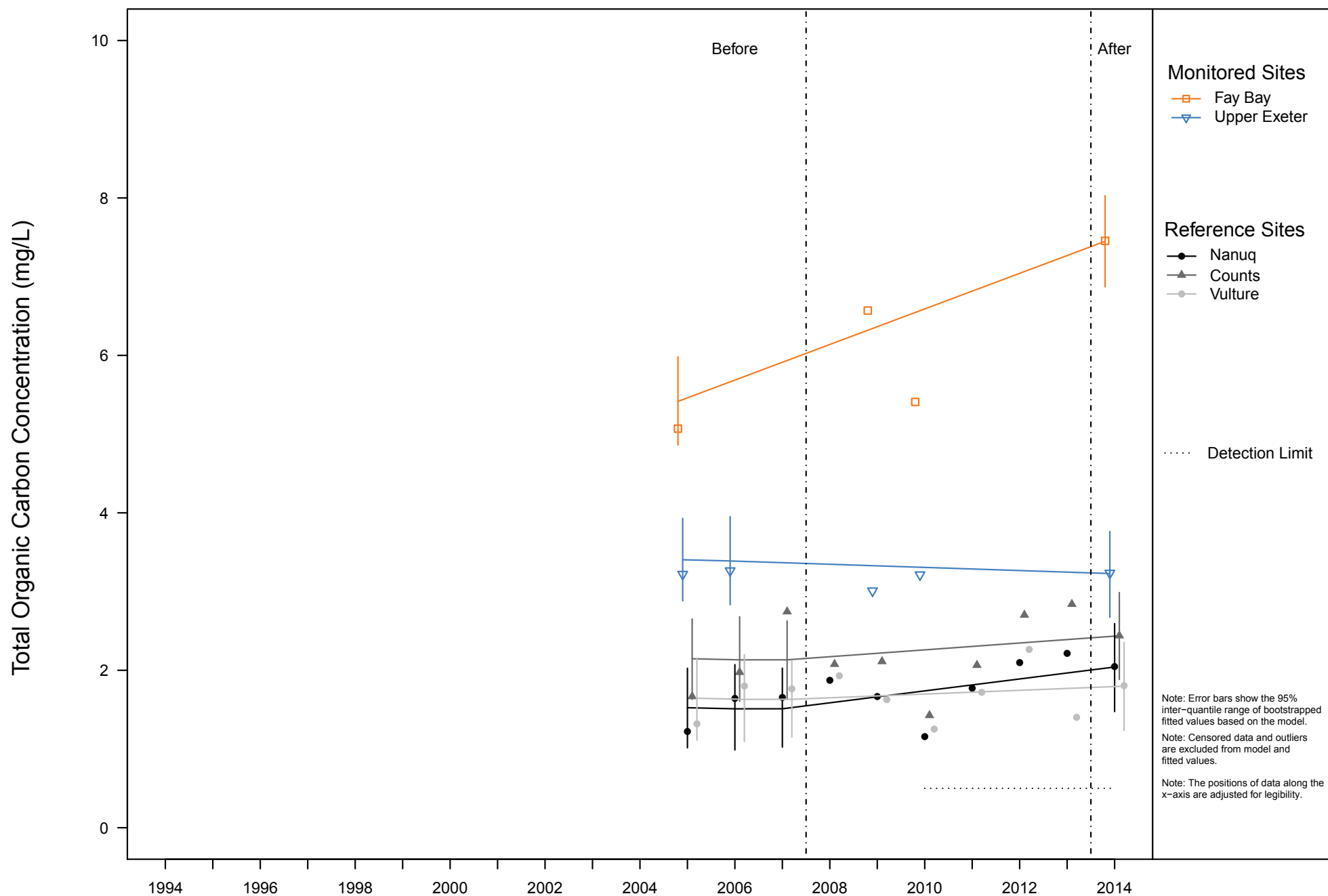
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Upper Exeter site were significantly ($p = 0.008$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

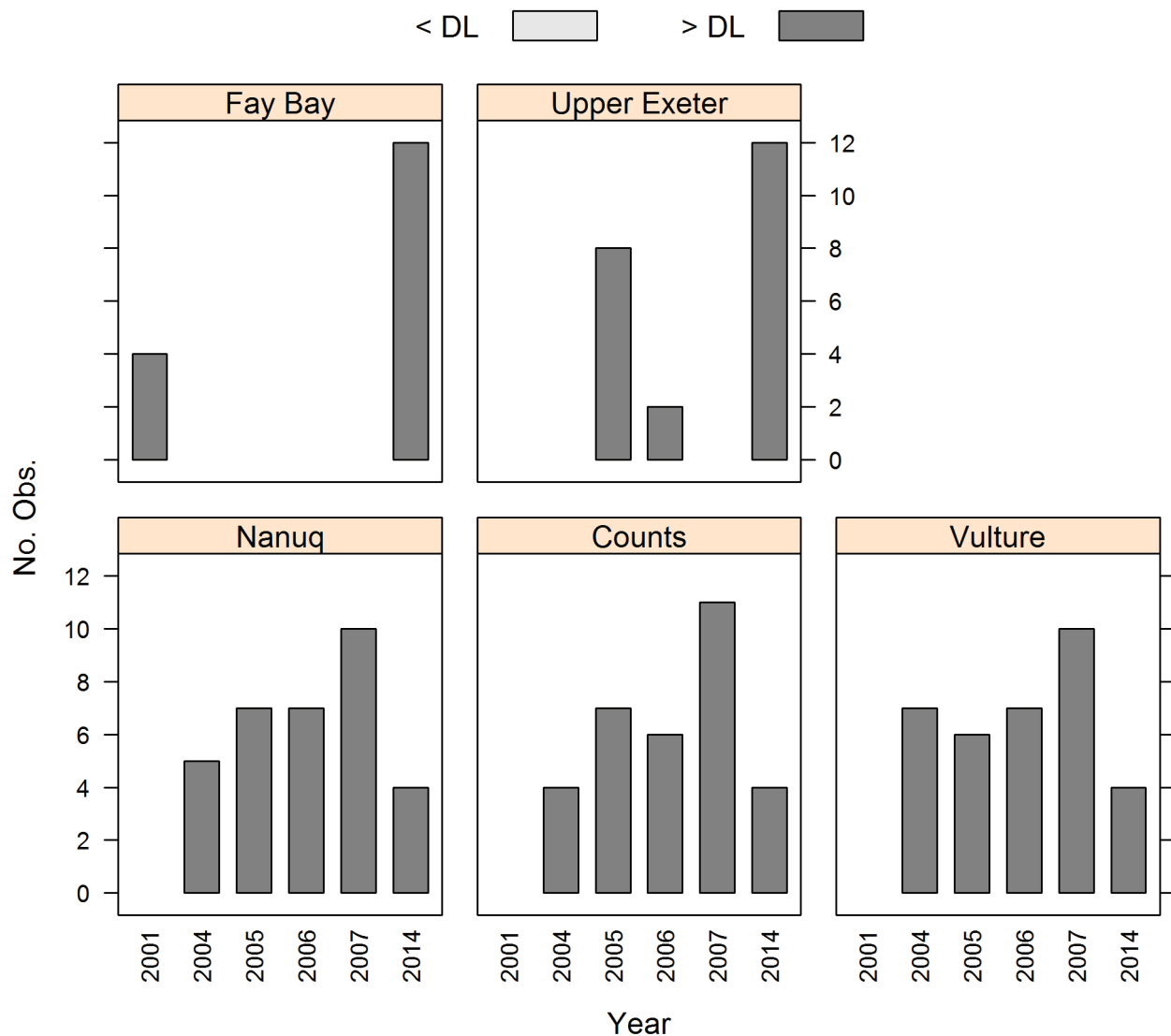


Analysis of Summer Total Organic Carbon Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

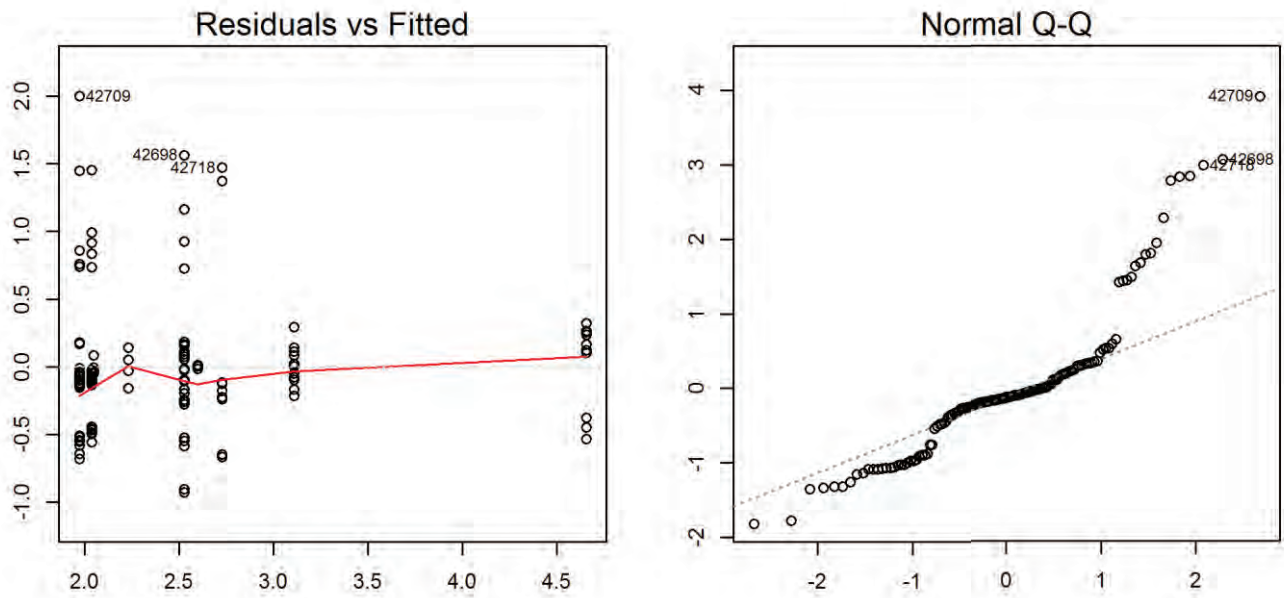
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

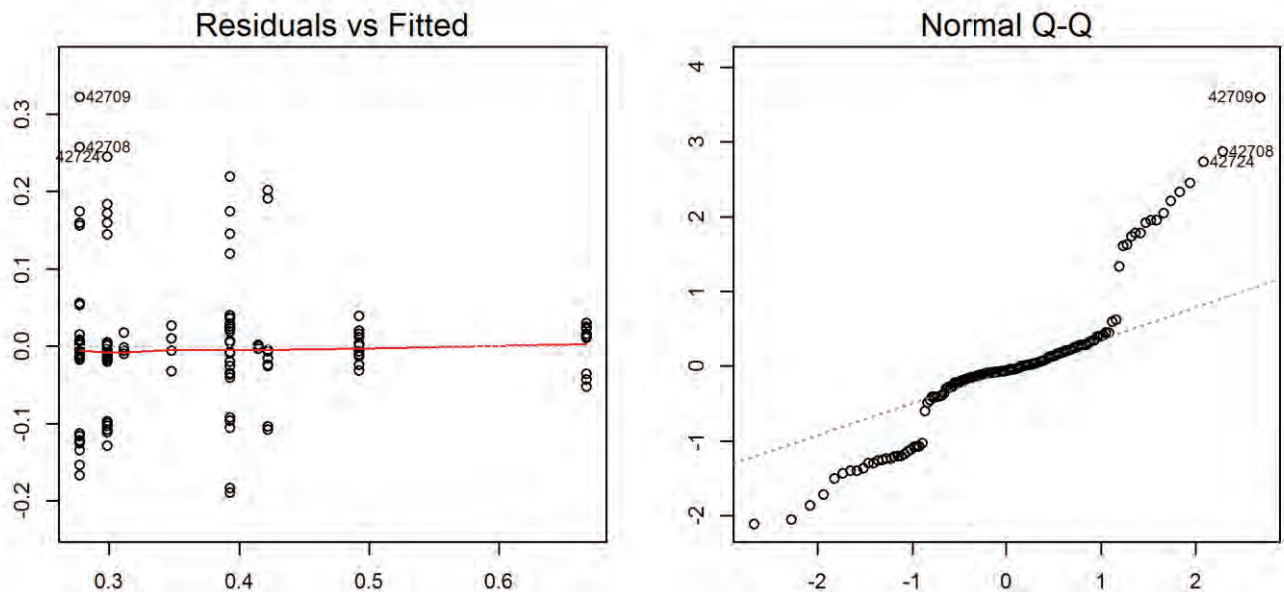
```
##      site year month season
## 42473 Fay Bay 2001  July summer
## 42474 Fay Bay 2001  July summer
## 42475 Fay Bay 2001  July summer
## 42476 Fay Bay 2001  July summer
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.52	0.69	0.68
Log-10	0.09	0.62	0.6

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

The BACI modeling analysis was not conducted on the Fay Bay data because insufficient observations were available for the analysis due to censoring or outliers.

4.2 Upper Exeter Monitoring Location

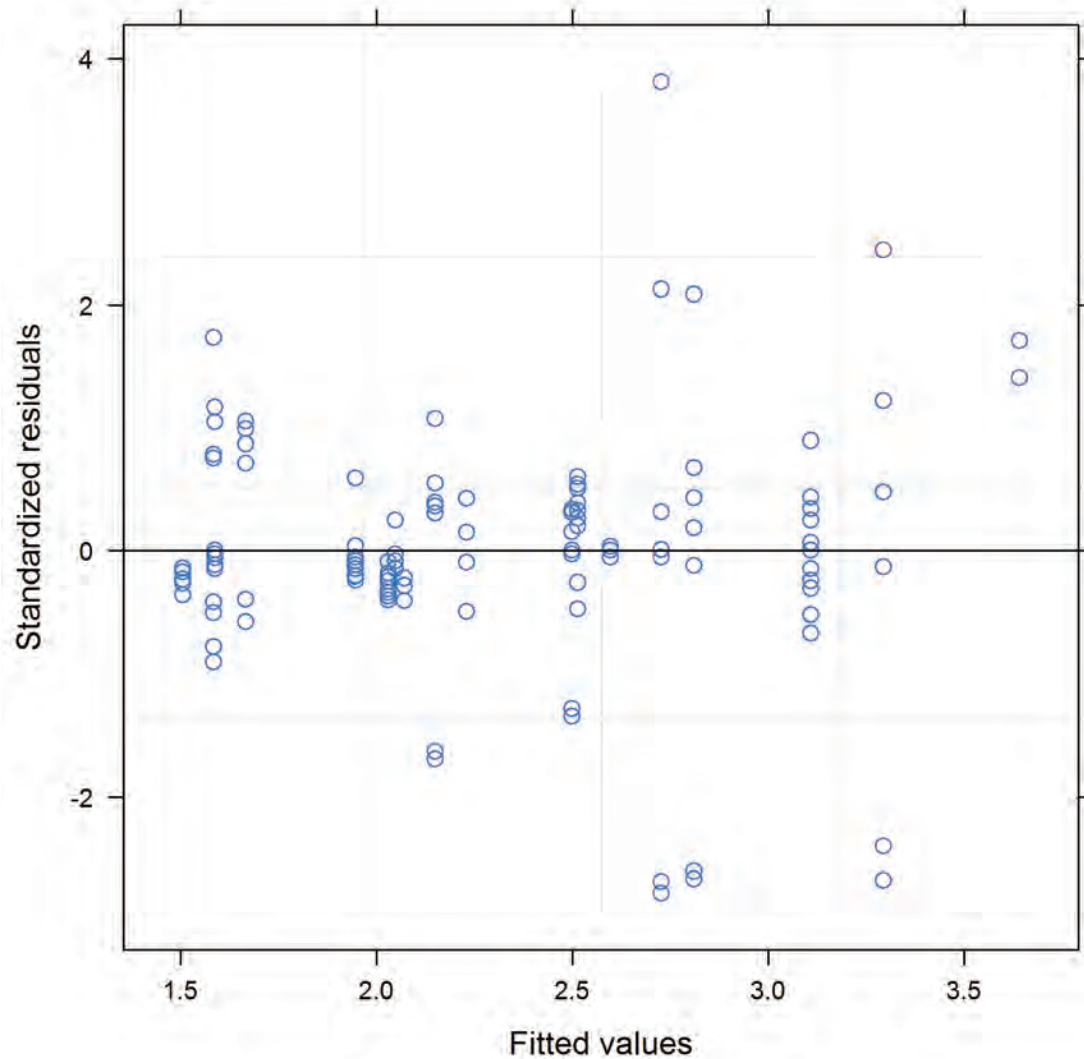
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	216.27	-99.14		
LME	10	119.11	-49.56	99.16	0

Conclusion:

The most appropriate model for total organic carbon at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	110	83	<.0001
## site	3	110	42	<.0001
## period	1	3	0	0.80
## site:period	3	110	1	0.64

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.04	-0.42	0.49	not sig.
Counts	-0.16	-0.6	0.28	not sig.
Vulture	-0.23	-0.66	0.2	not sig.

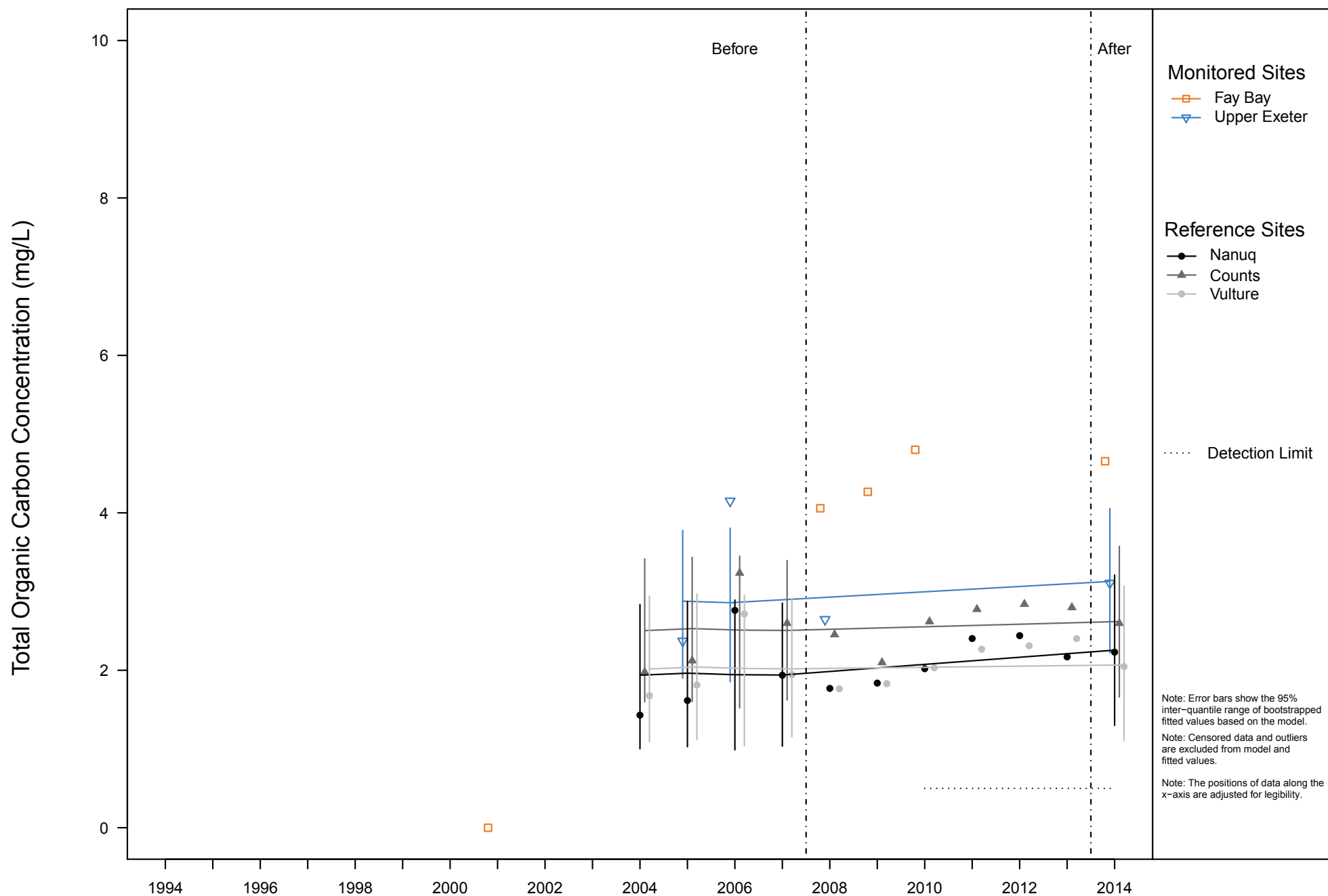
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Upper Exeter site were not significantly ($p = 0.641$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

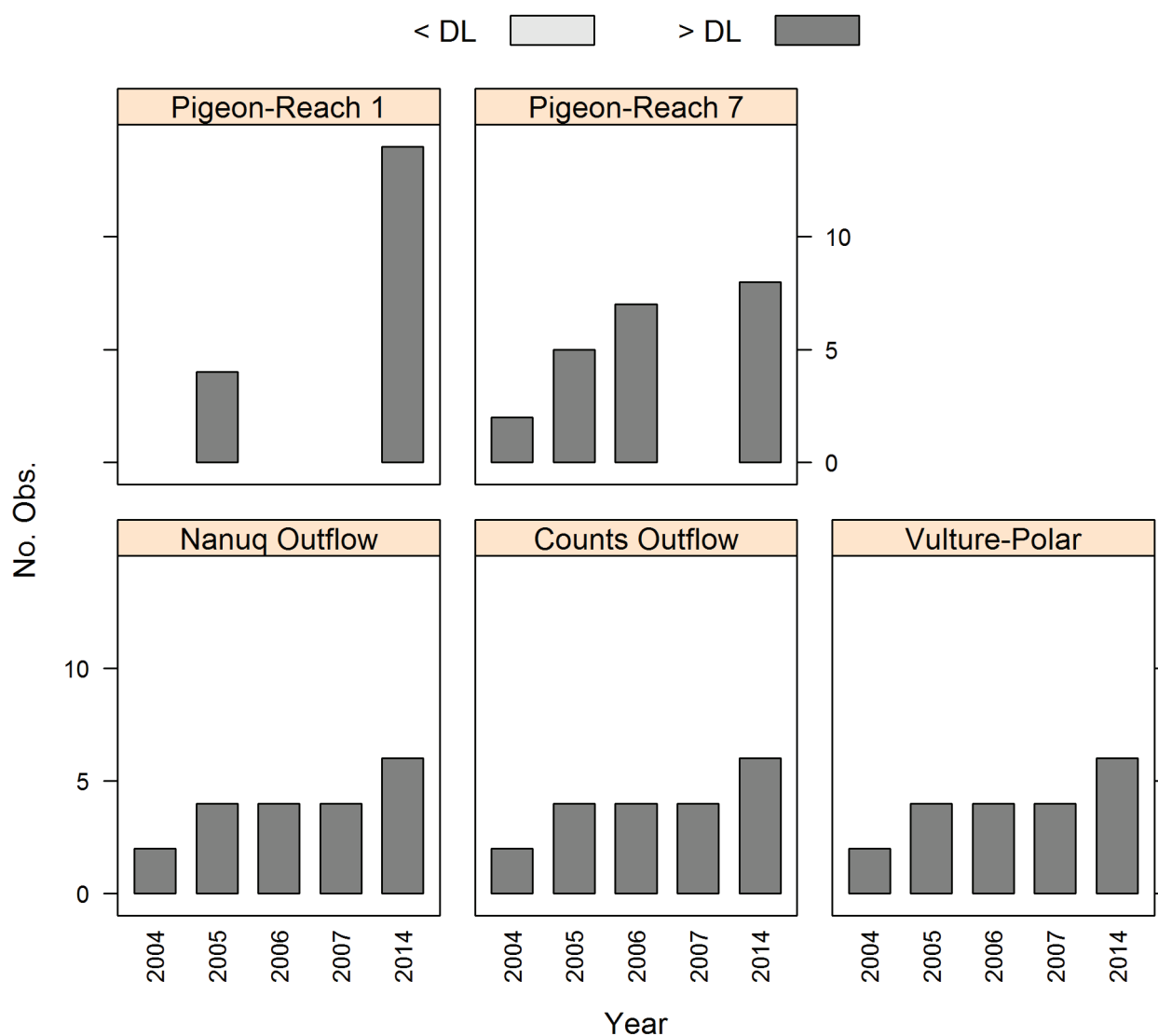


Analysis of Summer Total Organic Carbon Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

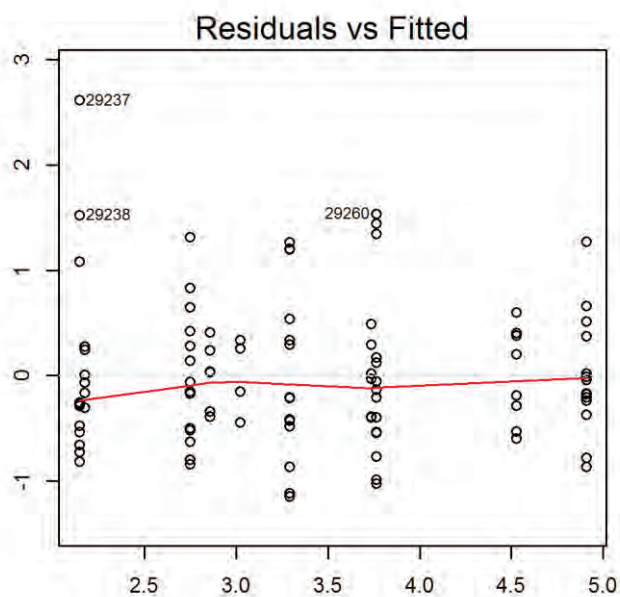
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

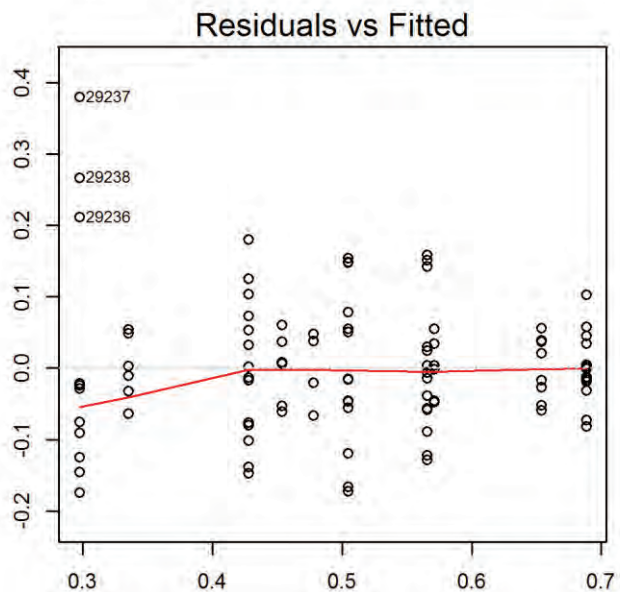
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.7	0.65	0.62
Log-10	0.1	0.65	0.62

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

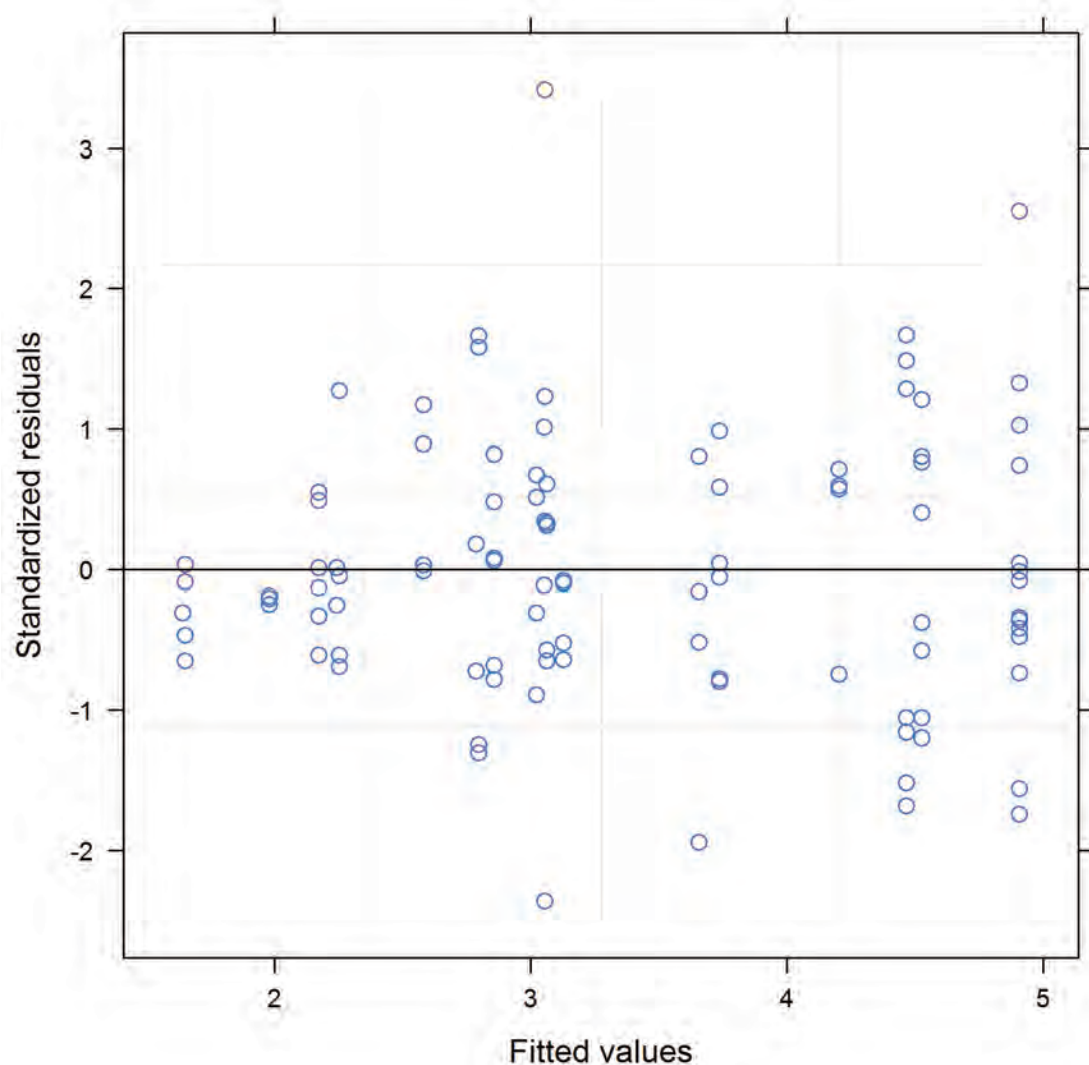
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	236.48	-107.24		
LME	12	185.81	-80.9	52.67	3.94×10 ⁻¹³

Conclusion:

The most appropriate model for total organic carbon at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	87	100	<.0001
## site	4	87	54	<.0001
## period	1	3	1	0.4954
## site:period	4	87	5	0.0016

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-1.36	-2.12	-0.63	sig.
Counts Outflow	-1.28	-2.03	-0.54	sig.
Vulture-Polar	-0.95	-1.71	-0.18	sig.
Pigeon-Reach 7	-0.42	-1.14	0.31	not sig.

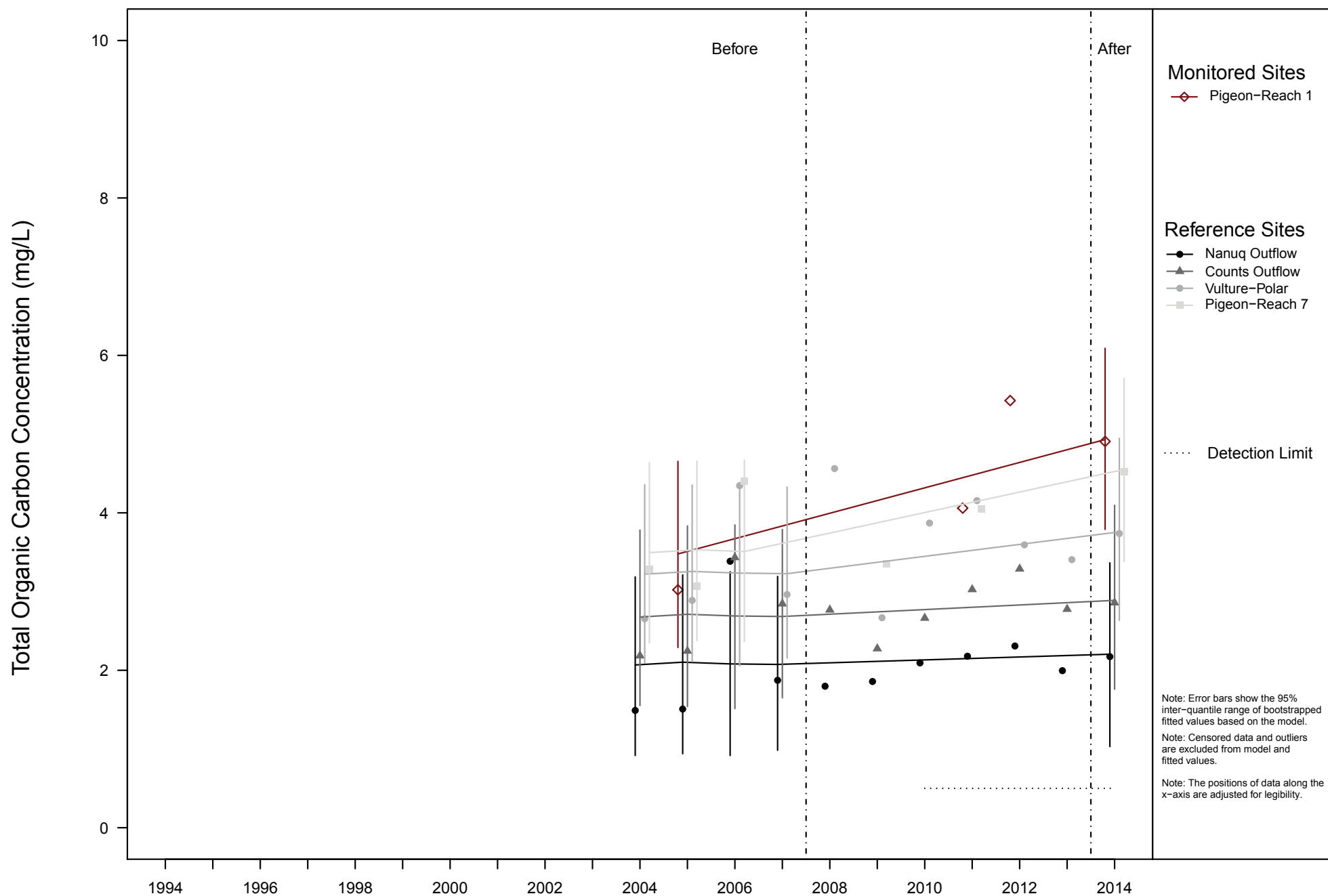
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.002$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

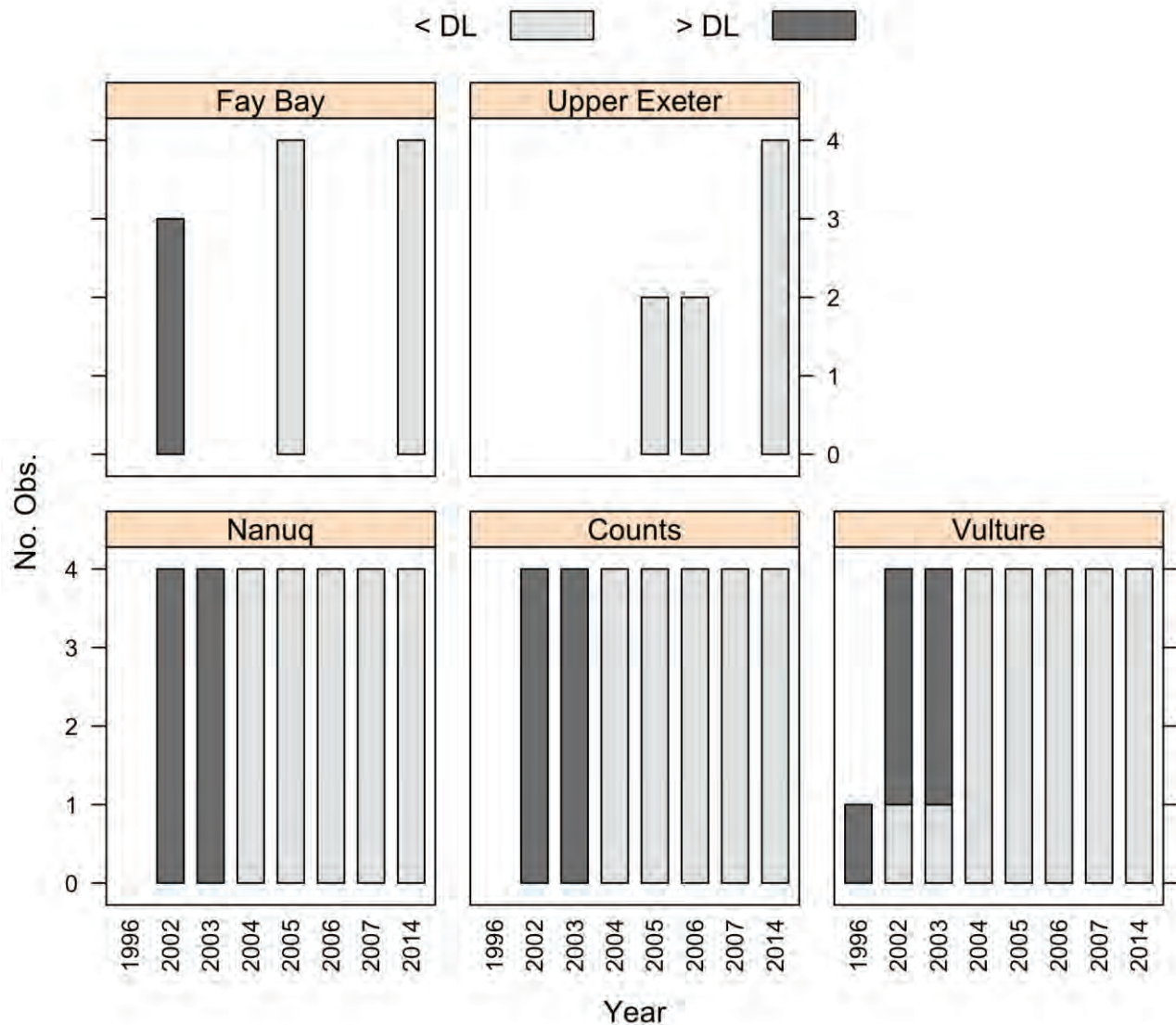


Analysis of Winter Total Antimony Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2015

1 Censored Data

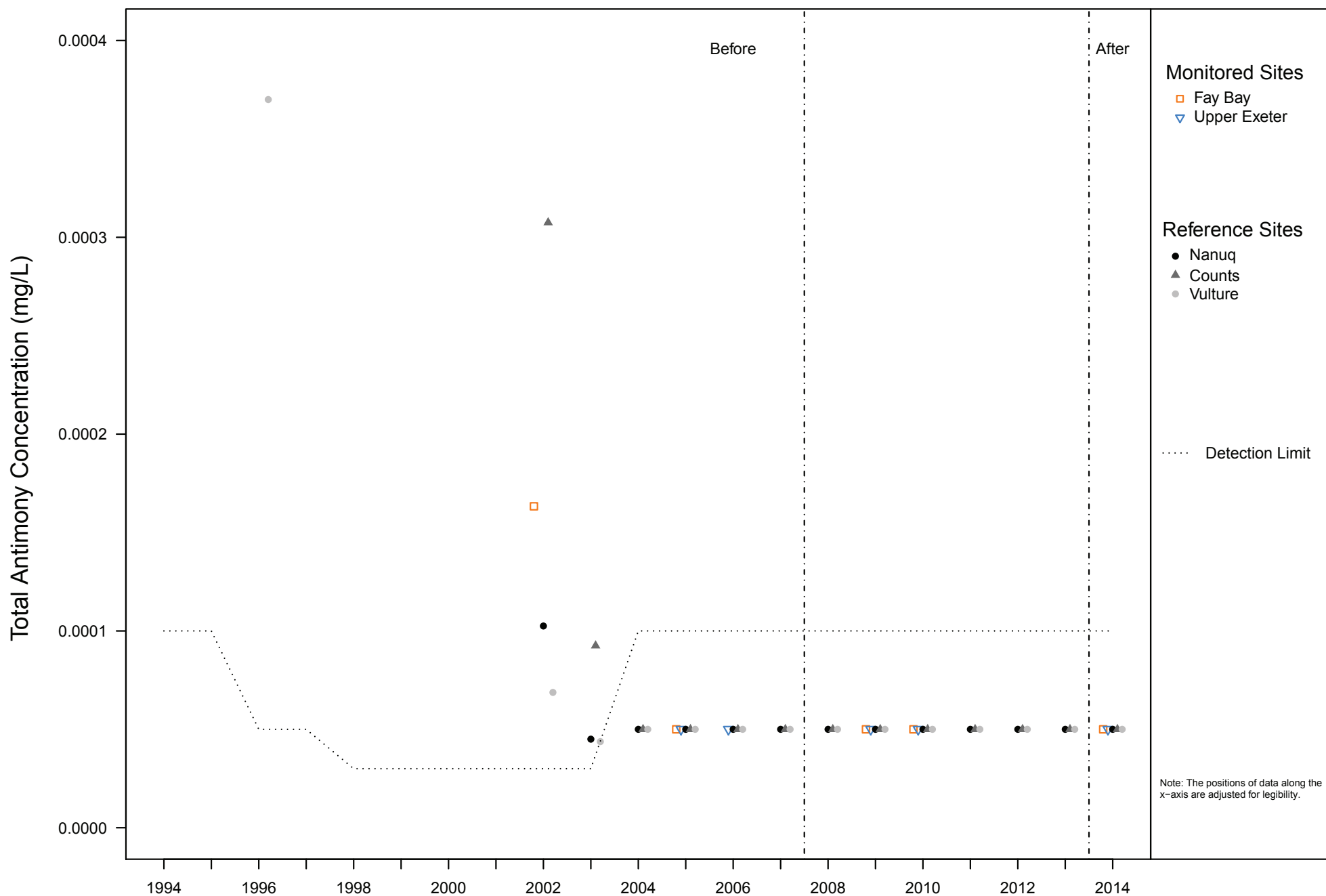
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Antimony water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

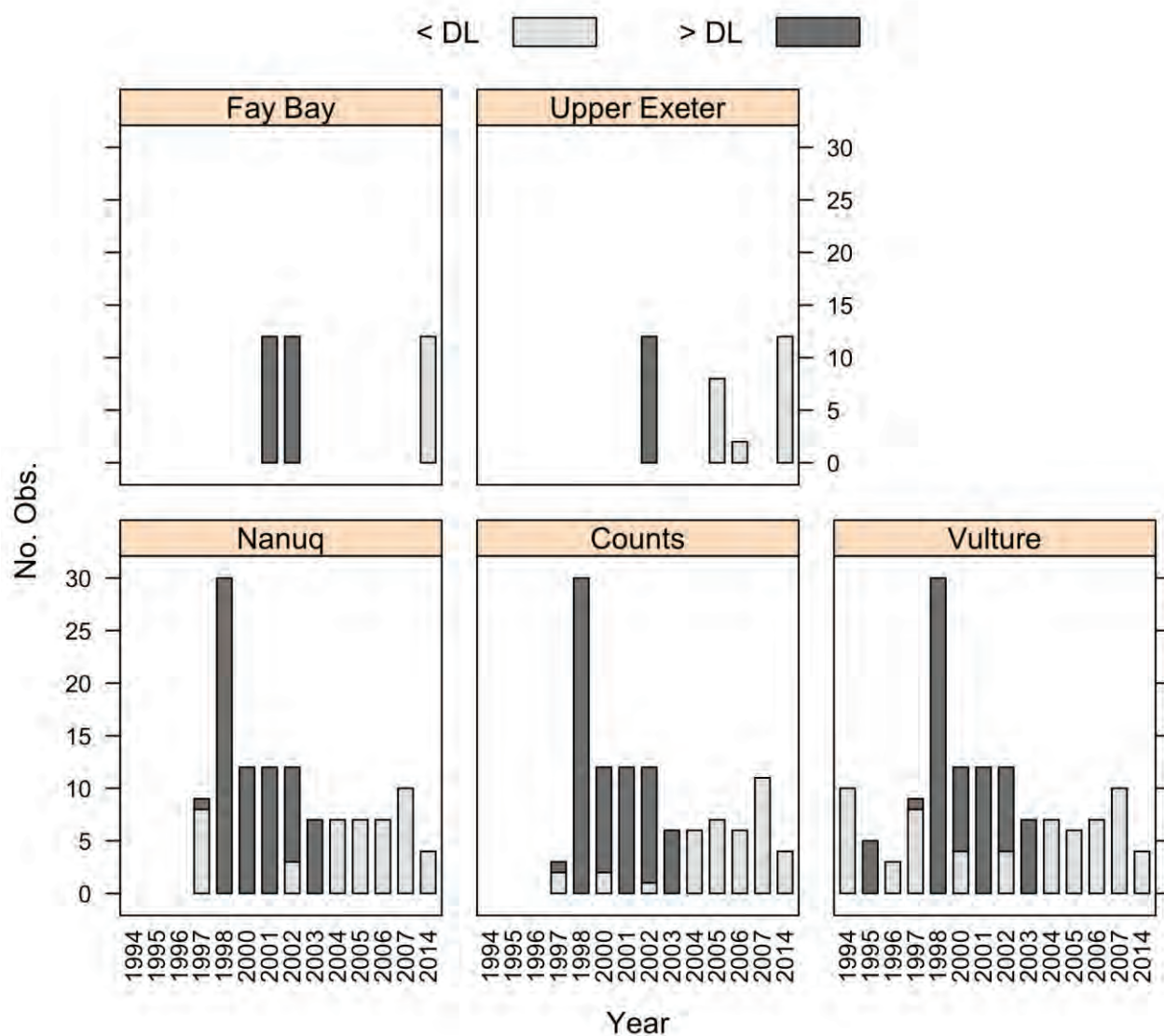


Analysis of Summer Total Antimony Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2015

1 Censored Data

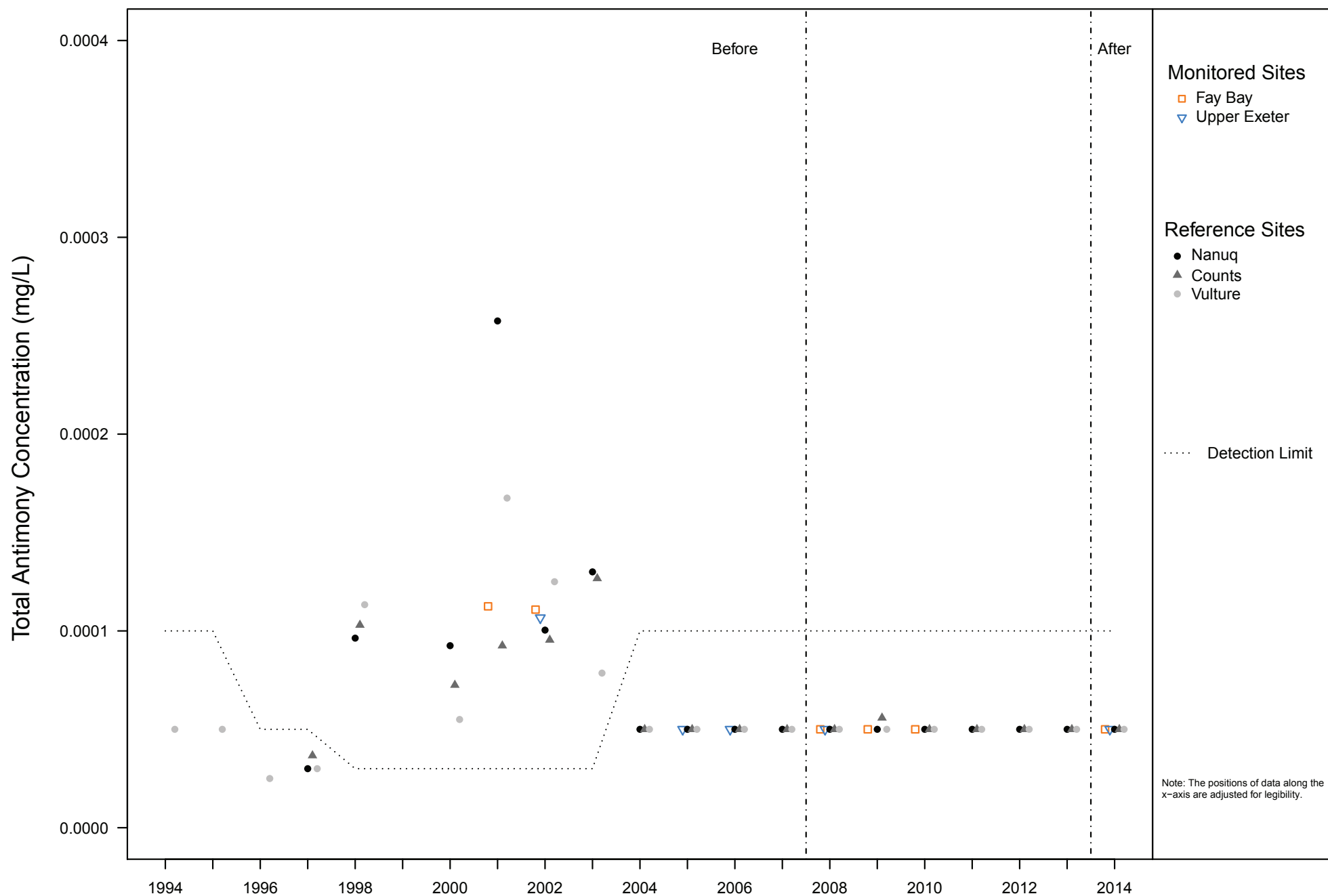
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Antimony water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

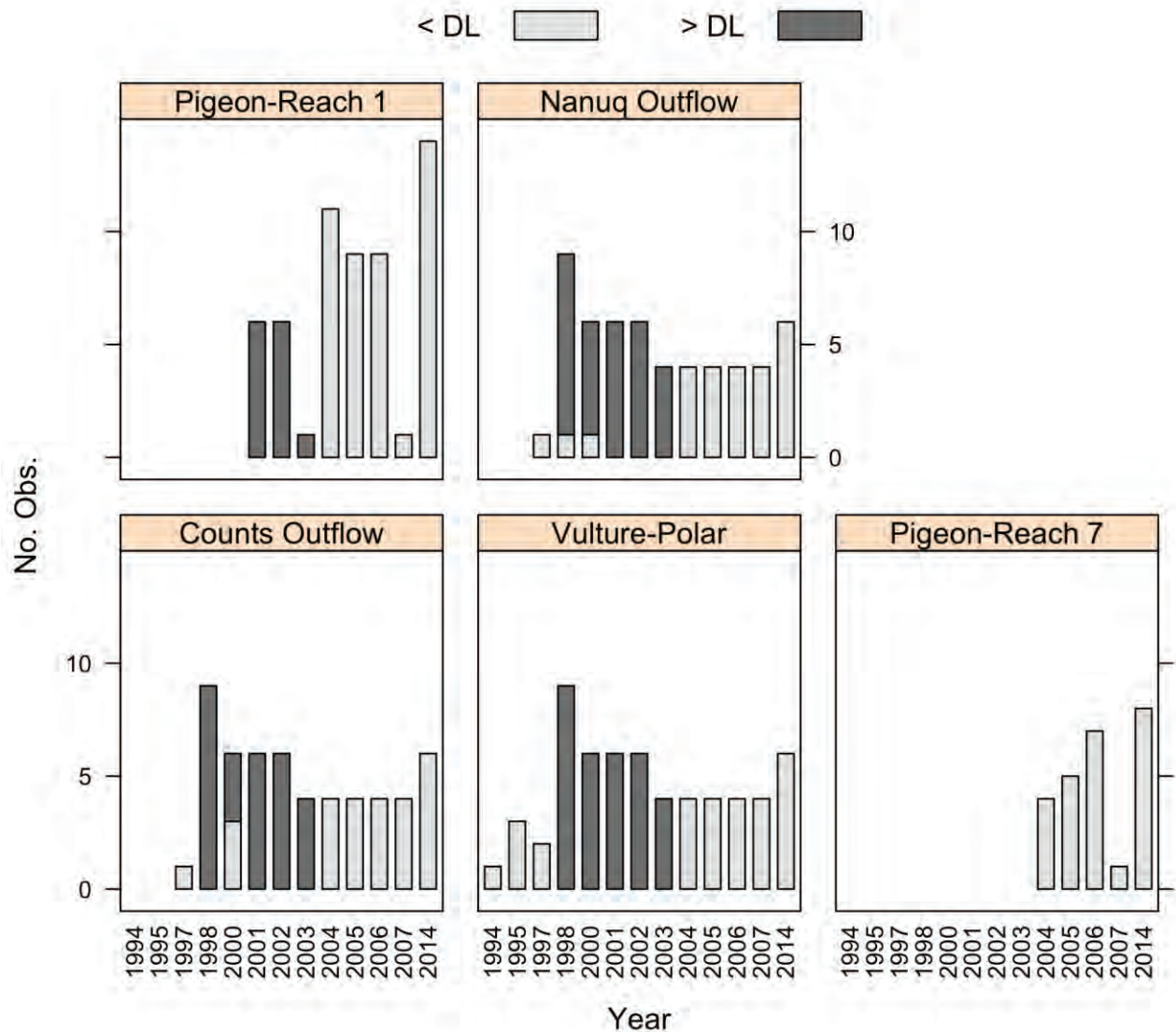


Analysis of Summer Total Antimony Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 23, 2015

1 Censored Data

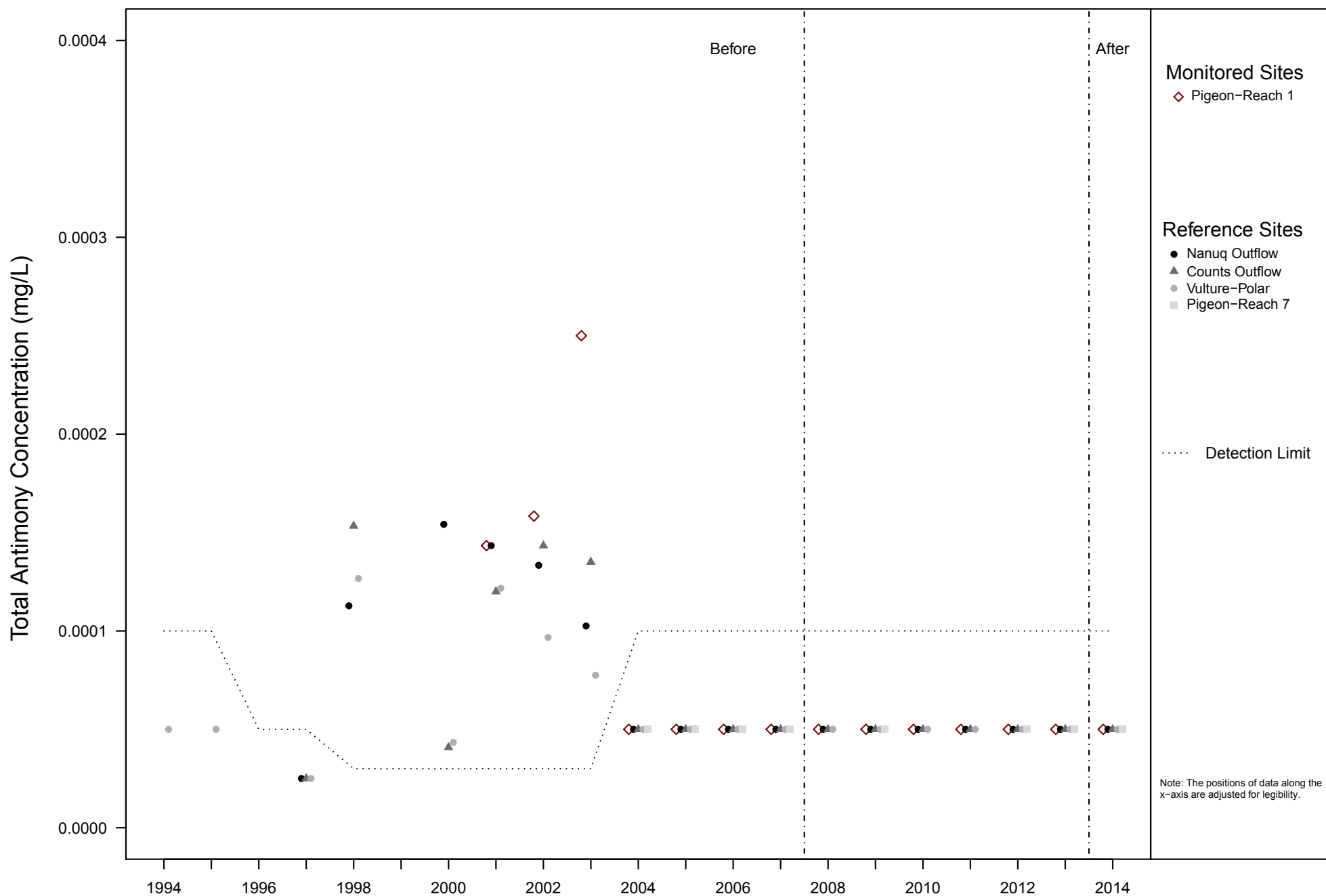
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Antimony water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

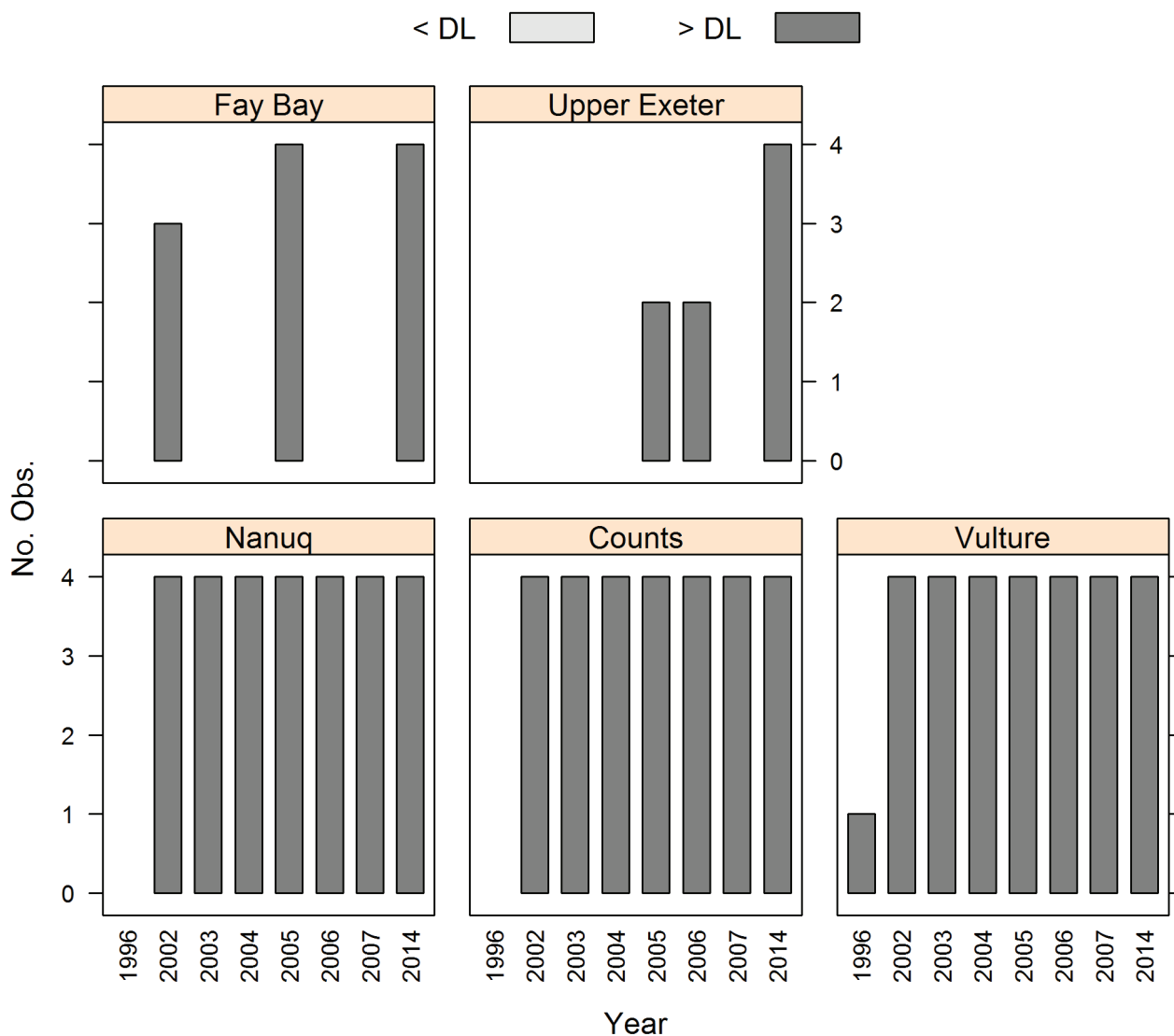


Analysis of Winter Total Arsenic Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 21, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

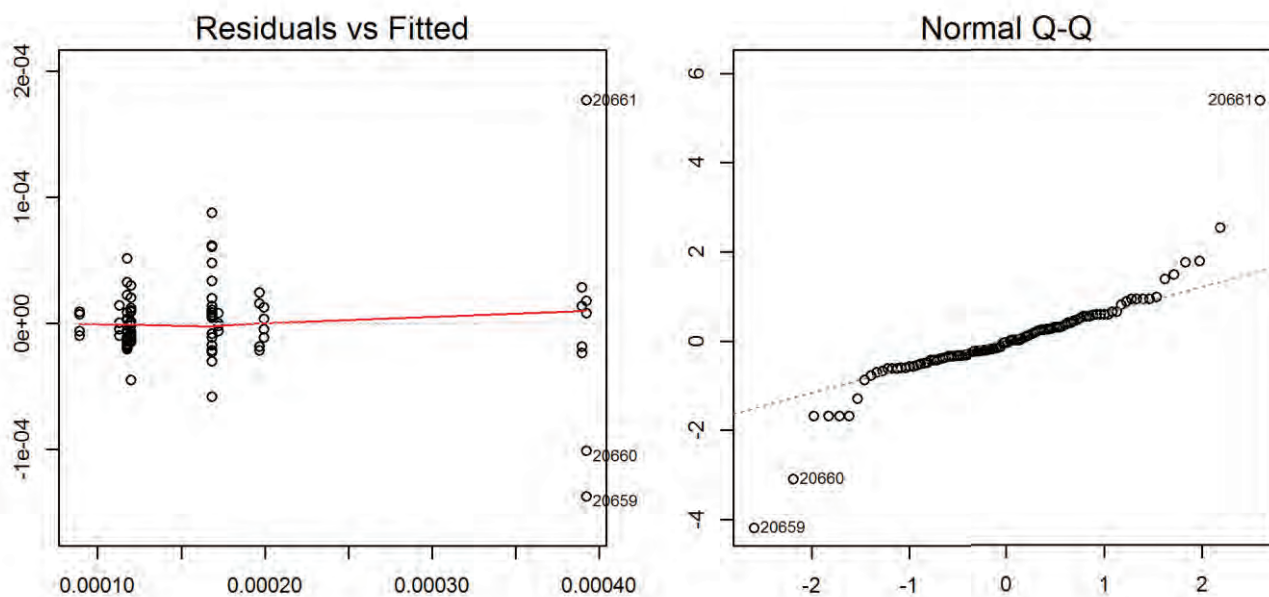
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

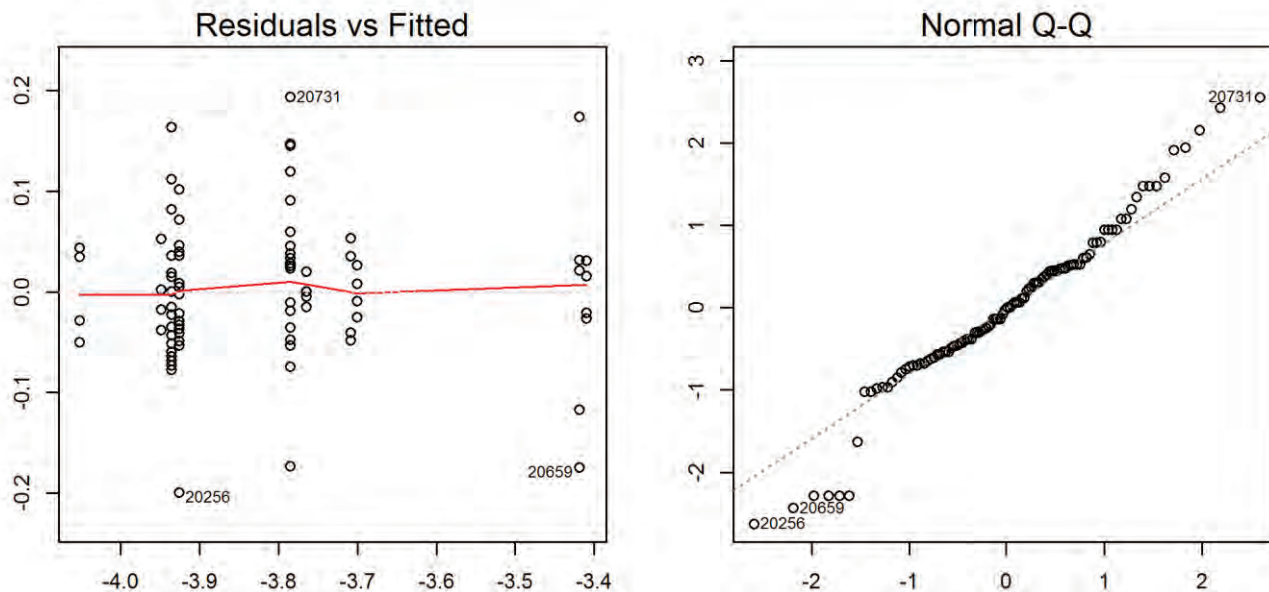
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	3.54×10 ⁻⁵	0.86	0.84
Log-10	0.08	0.83	0.82

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

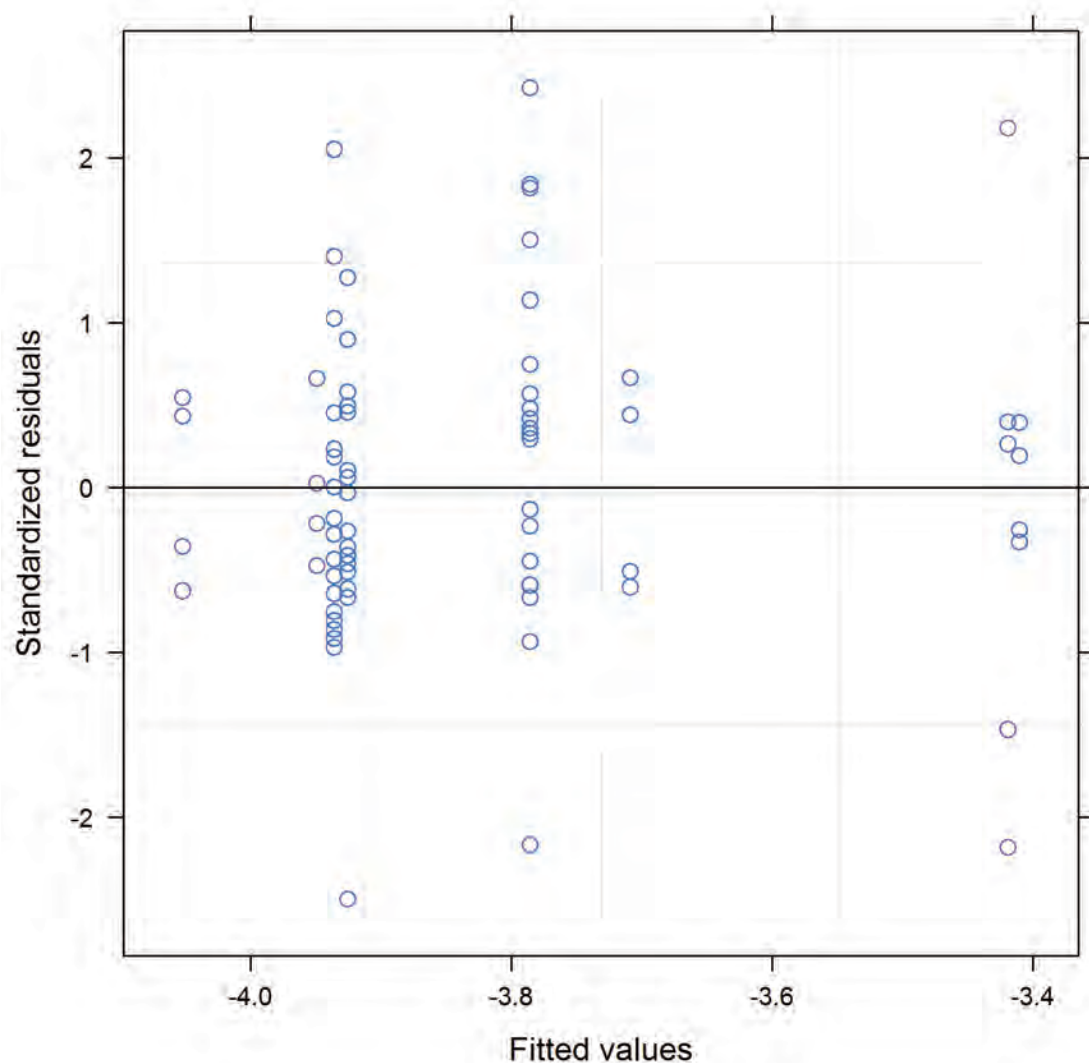
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-159.99	89		
LME	10	-160.23	90.12	2.24	0.13

Conclusion:

The most appropriate model for Total Arsenic at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.134$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 88
##          numDF F-value p-value
## (Intercept)    1  220926  <.0001
## site           3    140  <.0001
## period         1     0    0.50
## site:period    3     3    0.02
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.13	-0.26	0.01	not sig.
Counts	0.07	-0.06	0.2	not sig.
Vulture	-0.03	-0.16	0.1	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Arsenic concentrations at the Fay Bay site were significantly ($p = 0.02$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

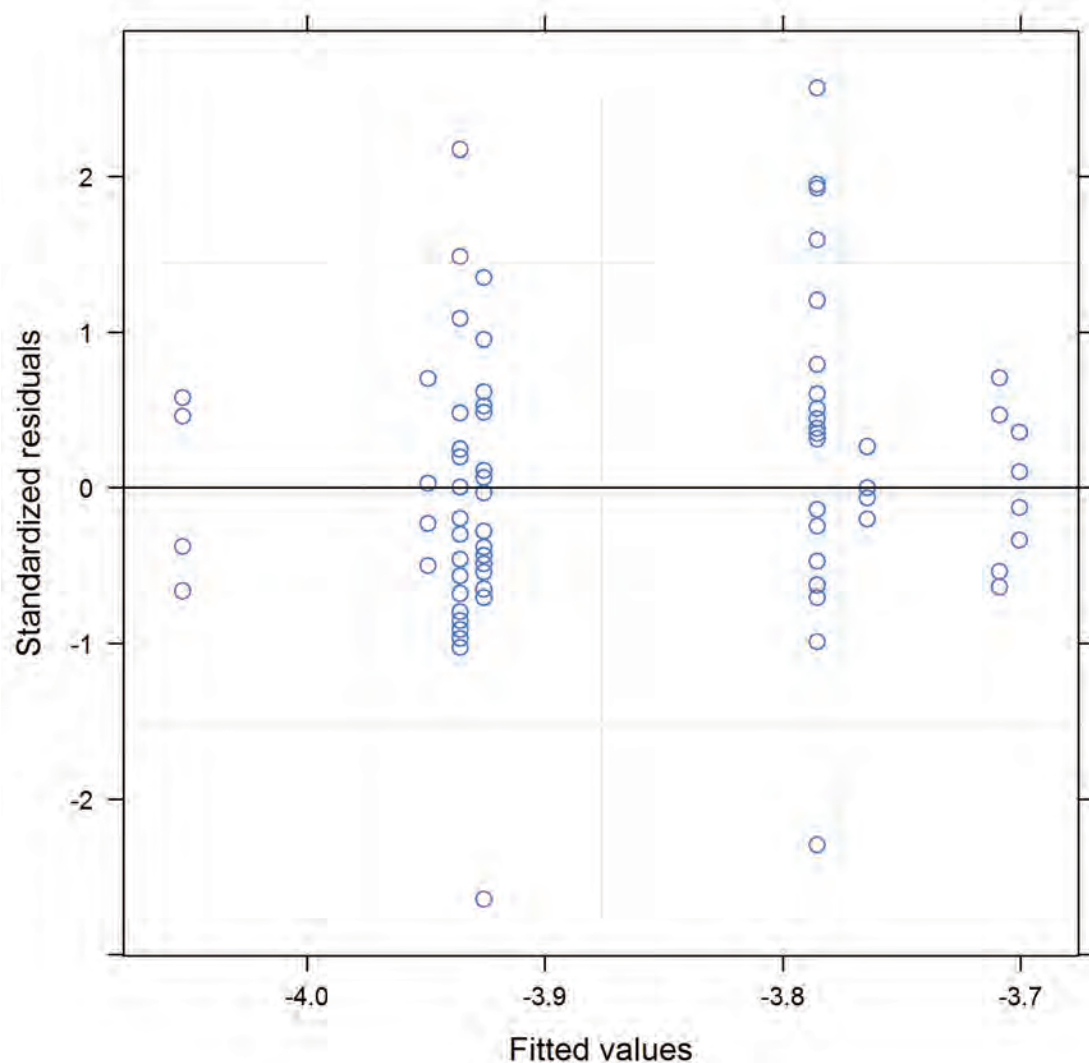
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-163.68	90.84		
LME	10	-164.36	92.18	2.68	0.1

Conclusion:

The most appropriate model for Total Arsenic at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.102$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 85
##          numDF F-value p-value
## (Intercept)    1  245250 <.0001
## site           3     41 <.0001
## period         1      2  0.194
## site:period    3      4  0.011
```


Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.05	-0.19	0.08	not sig.
Counts	0.14	0.01	0.27	sig.
Vulture	0.04	-0.09	0.17	not sig.

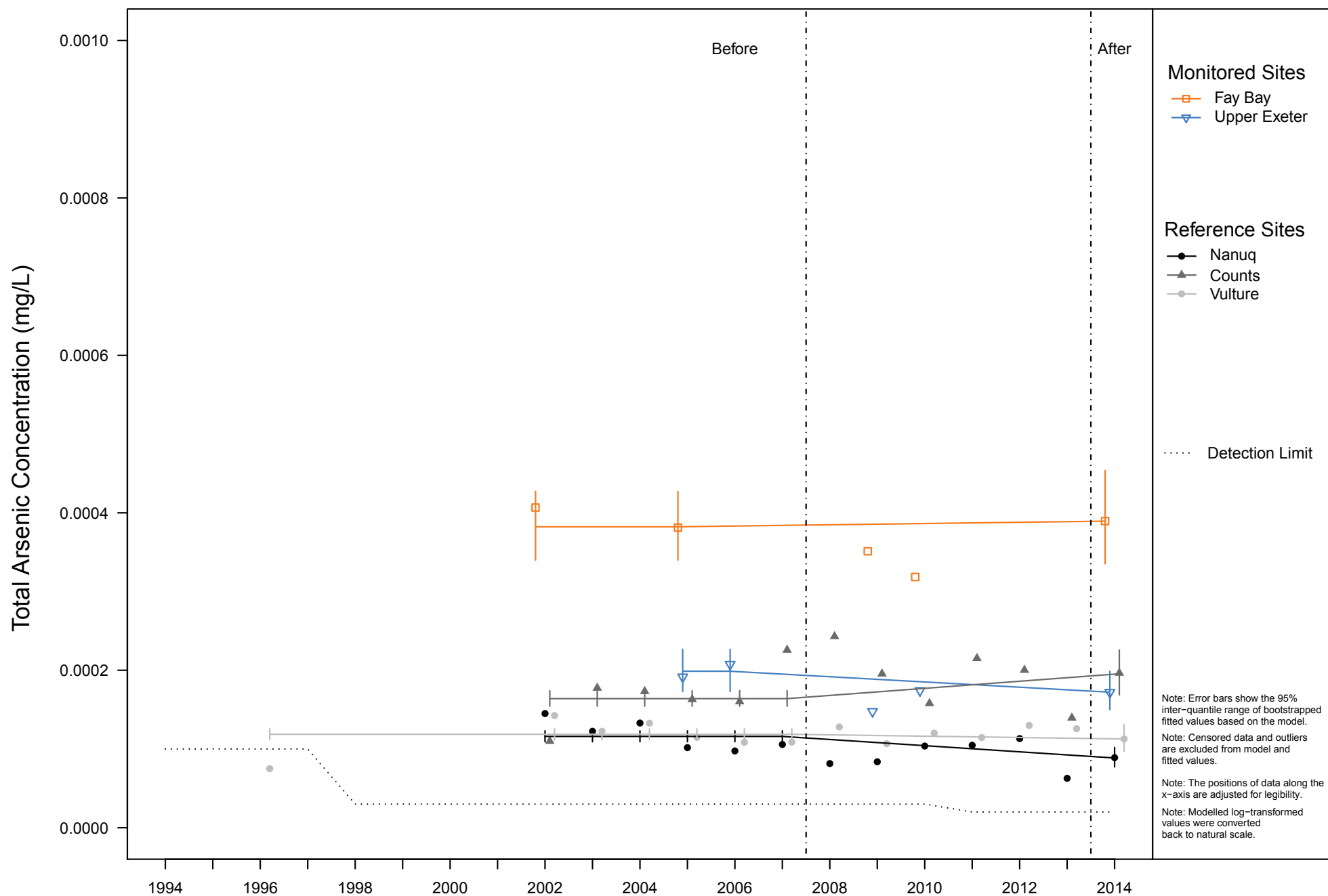
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Arsenic concentrations at the Upper Exeter site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

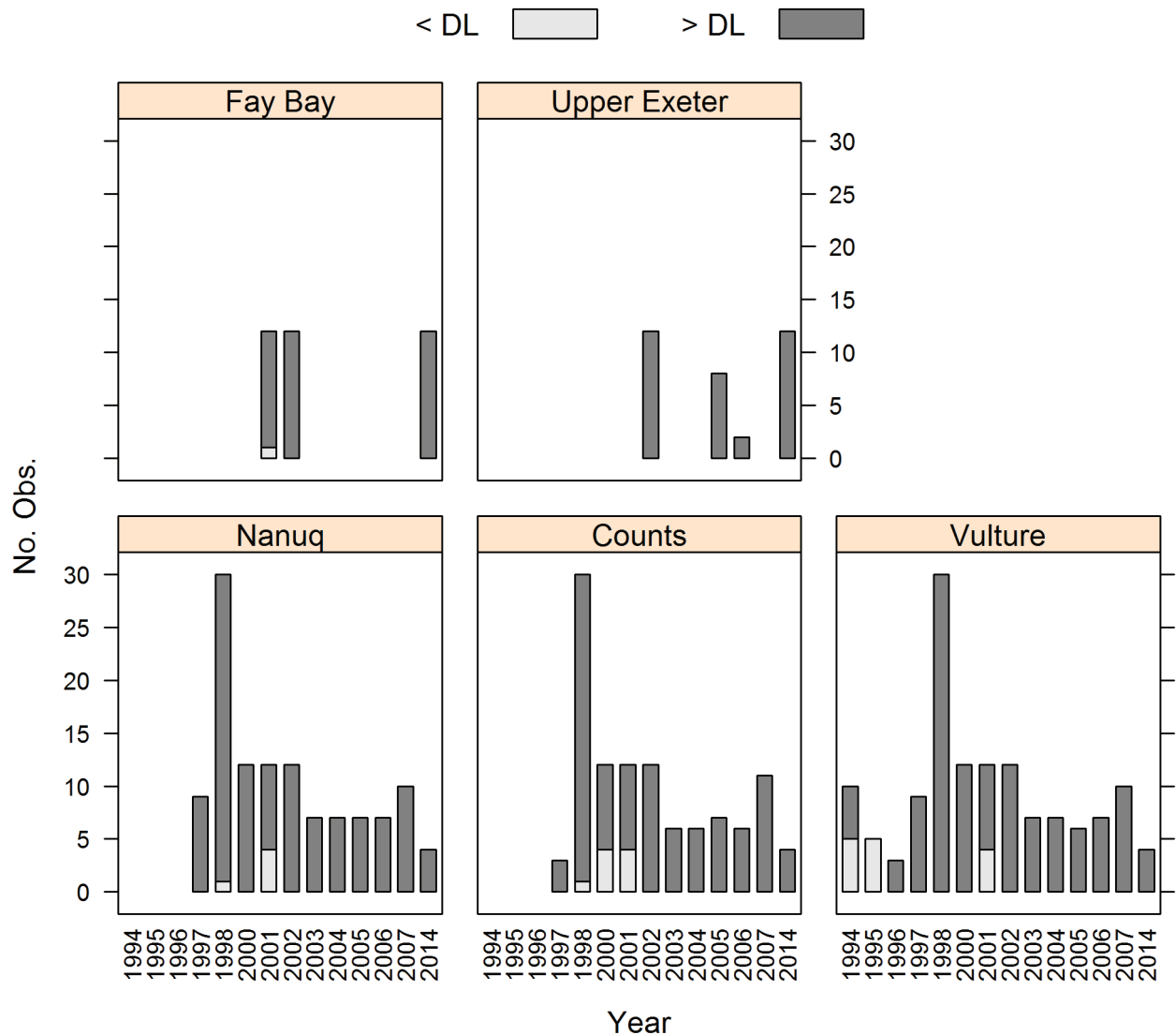


Analysis of Summer Total Arsenic Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 20, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 20251	Vulture	1995	August	summer
## 20252	Vulture	1995	August	summer
## 20253	Vulture	1995	August	summer
## 20254	Vulture	1995	August	summer
## 20255	Vulture	1995	August	summer

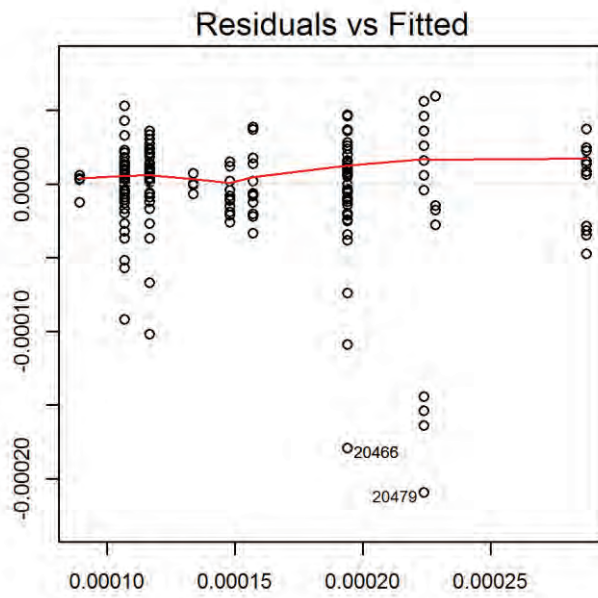
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

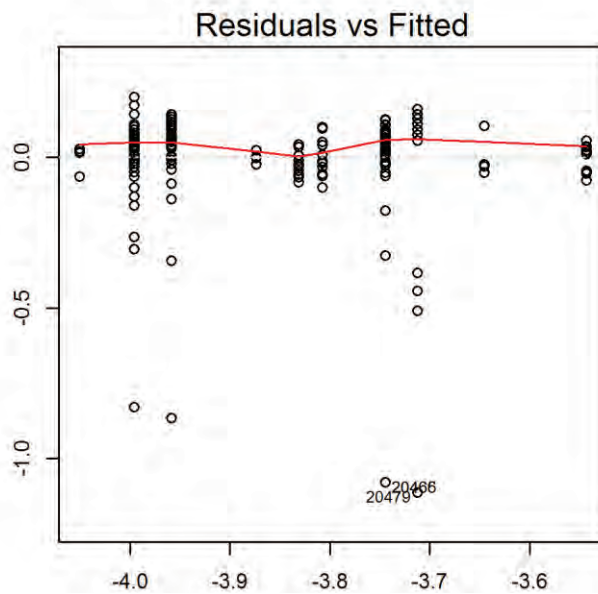
##	site	year	month	season
## 20425	Counts	2000	July	summer
## 20426	Counts	2000	July	summer
## 20427	Counts	2000	July	summer
## 20428	Counts	2000	July	summer

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	3.62×10 ⁻⁵	0.64	0.63
Log-10	0.19	0.3	0.28

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

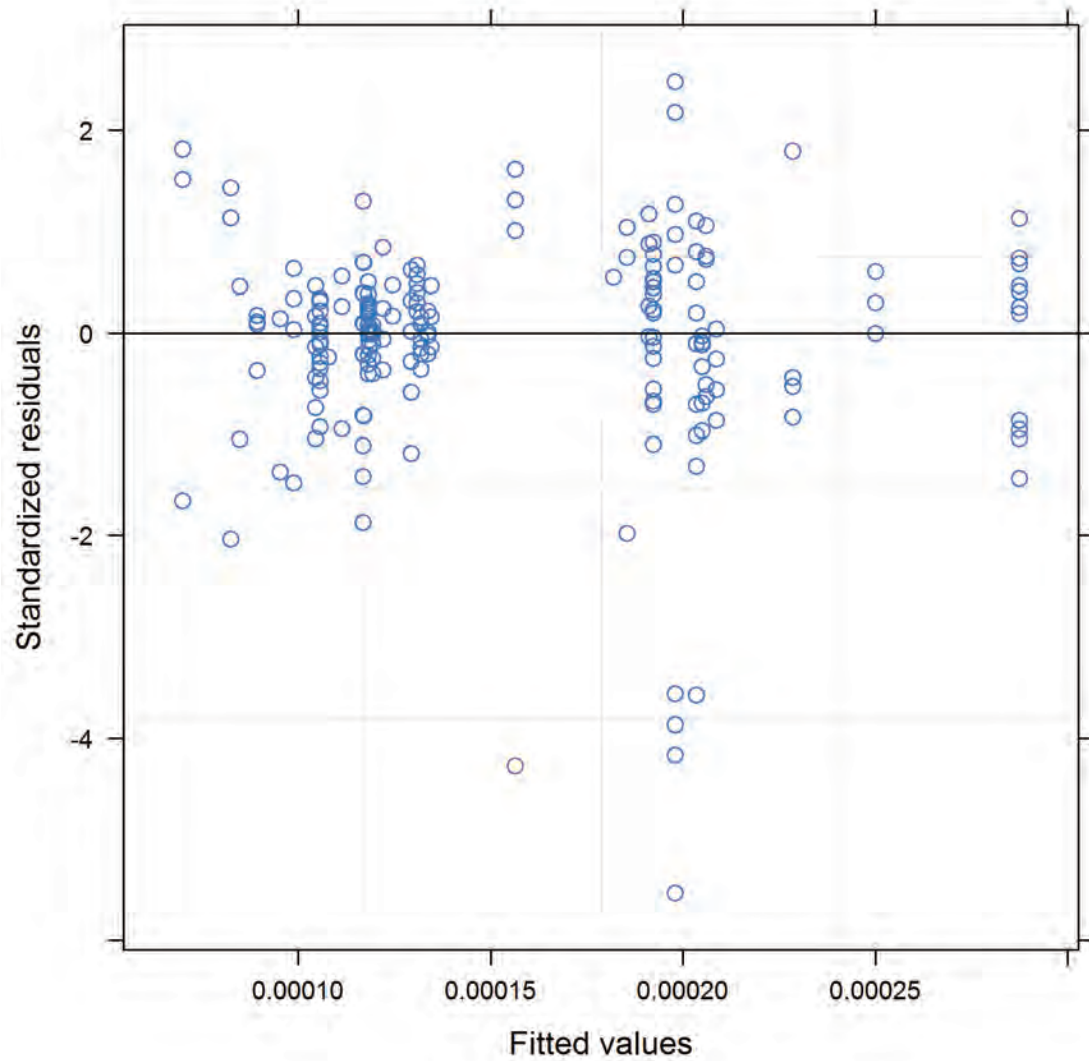
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-6610.31	3314.15		
LME	10	-6677.27	3348.64	68.96	1.11×10 ⁻¹⁶

Conclusion:

The most appropriate model for Total Arsenic at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	368	646	<.0001
## site	3	368	236	<.0001
## period	1	11	2	0.1756
## site:period	3	368	4	0.0071

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-7.02×10^{-5}	-1.12×10^{-4}	-2.92×10^{-5}	sig.
Counts	-1.76×10^{-5}	-5.73×10^{-5}	2.29×10^{-5}	not sig.
Vulture	-3.83×10^{-5}	-8.13×10^{-5}	2.52×10^{-6}	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Arsenic concentrations at the Fay Bay site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

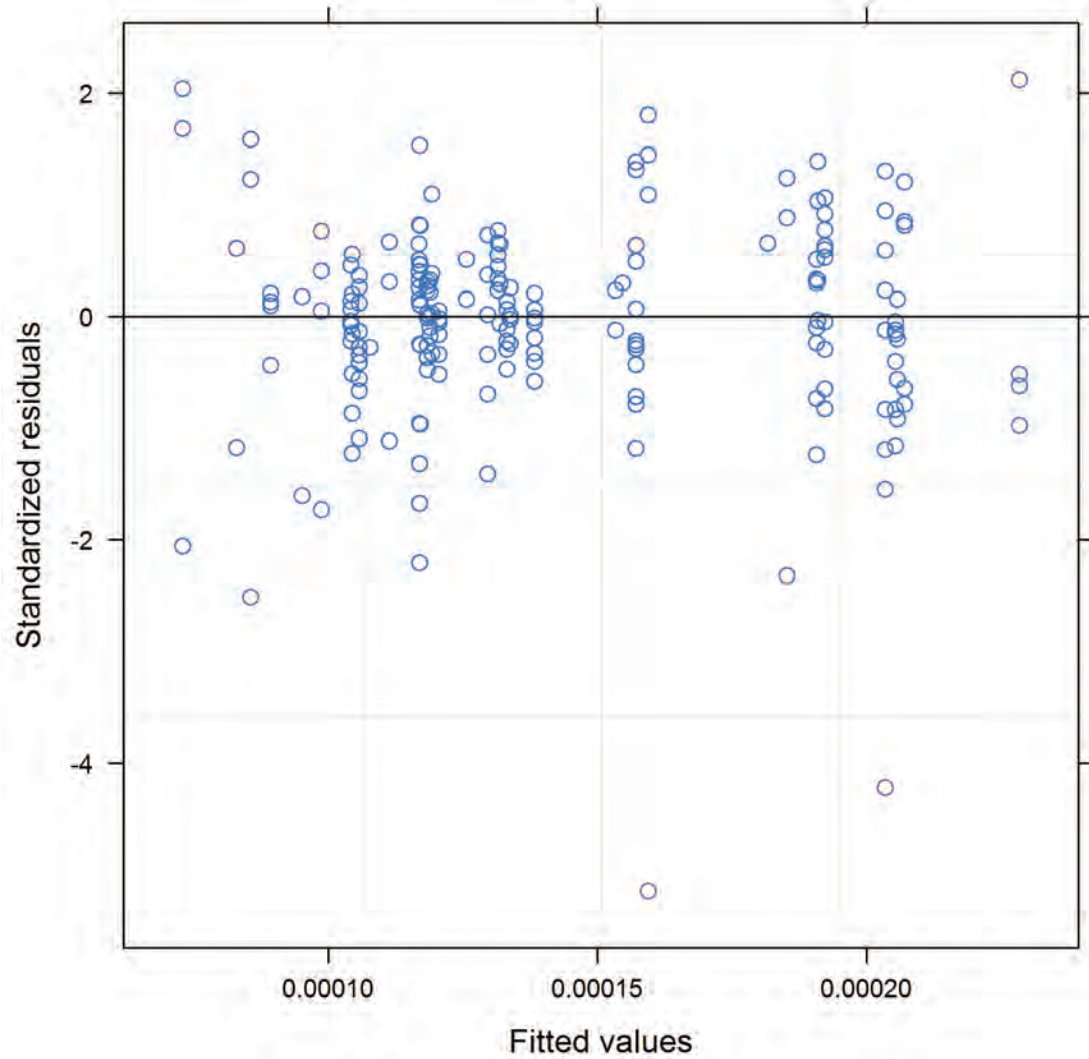
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-6691.87	3354.93		
LME	10	-6762.49	3391.25	72.62	0

Conclusion:

The most appropriate model for Total Arsenic at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	366	619	<.0001
## site	3	366	207	<.0001
## period	1	11	1	0.434
## site:period	3	366	2	0.072

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-3.38×10^{-5}	-6.82×10^{-5}	1.39×10^{-7}	not sig.
Counts	1.89×10^{-5}	-1.48×10^{-5}	5.27×10^{-5}	not sig.
Vulture	-1.92×10^{-6}	-3.61×10^{-5}	3.11×10^{-5}	not sig.

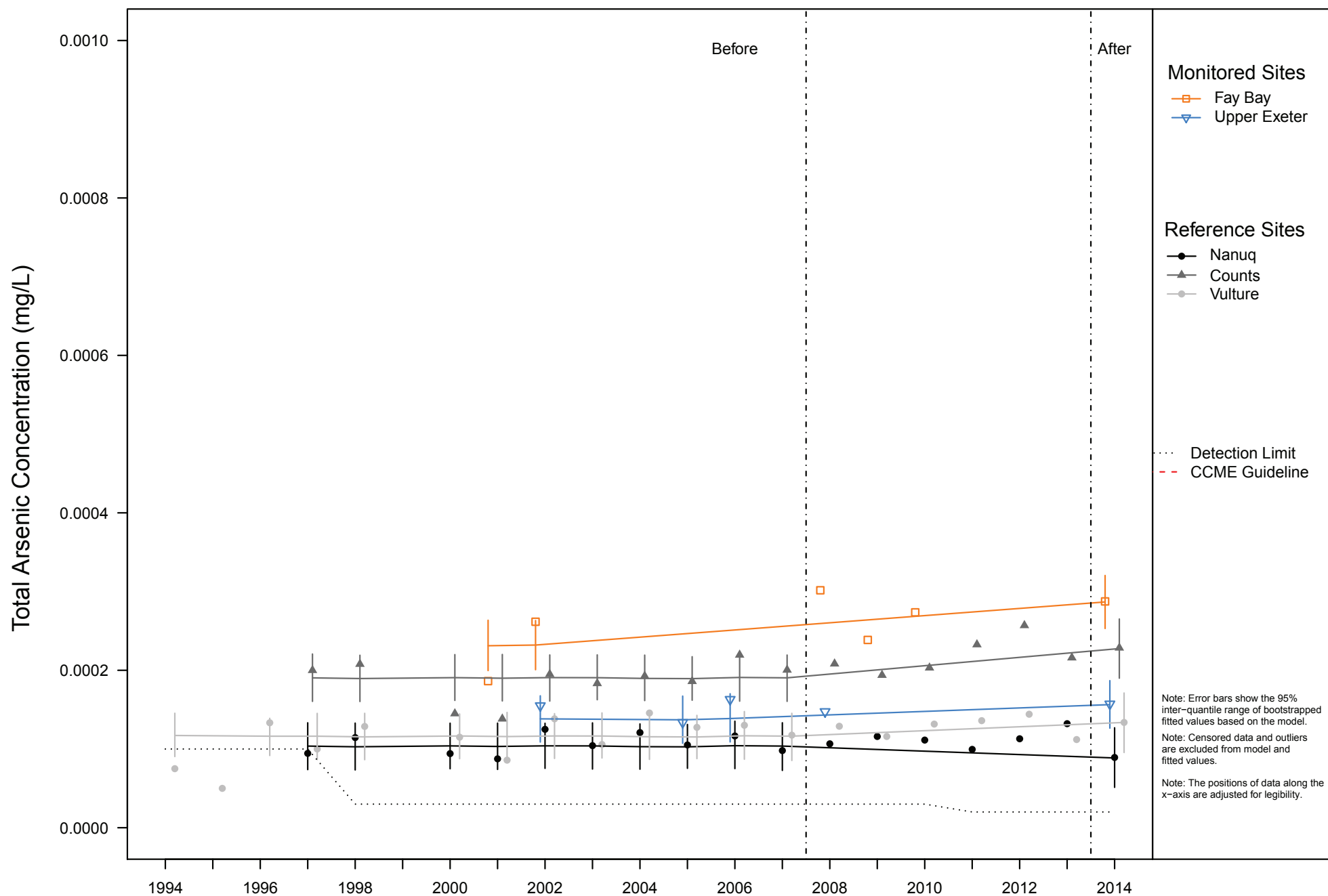
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Arsenic concentrations at the Upper Exeter site were not significantly ($p = 0.07$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

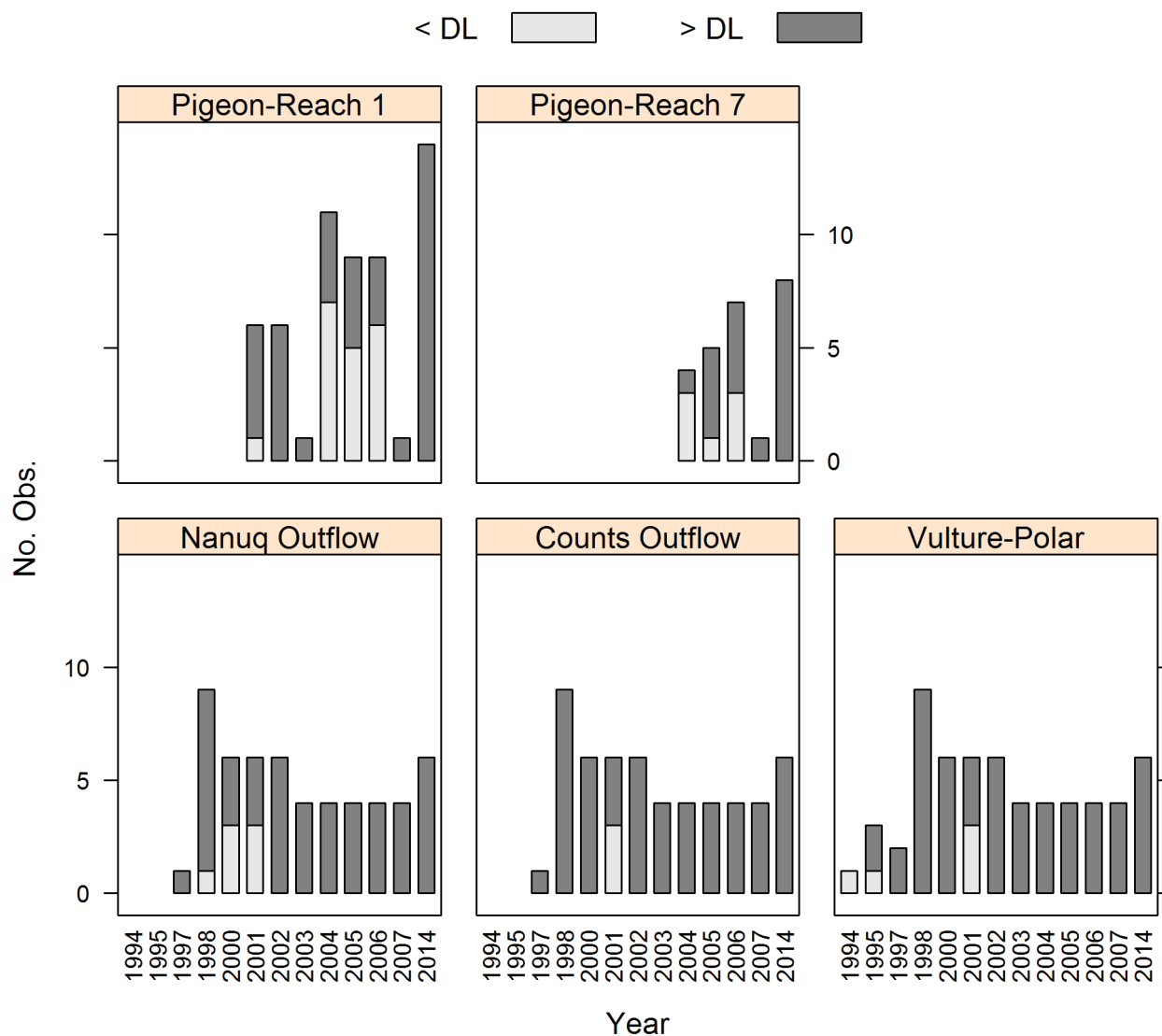


Analysis of Summer Total Arsenic Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 20, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 13556	Vulture-Polar	1994	August	summer
## 13765	Pigeon-Reach 1	2004	July	summer
## 13766	Pigeon-Reach 1	2004	July	summer
## 13767	Pigeon-Reach 1	2004	July	summer
## 13768	Pigeon-Reach 1	2004	July	summer
## 13769	Pigeon-Reach 1	2004	August	summer
## 13770	Pigeon-Reach 1	2004	August	summer
## 13771	Pigeon-Reach 1	2004	August	summer
## 13772	Pigeon-Reach 1	2004	August	summer
## 13773	Pigeon-Reach 1	2004	September	summer
## 13774	Pigeon-Reach 1	2004	September	summer
## 13775	Pigeon-Reach 1	2004	September	summer
## 13776	Pigeon-Reach 7	2004	July	summer
## 13777	Pigeon-Reach 7	2004	July	summer
## 13778	Pigeon-Reach 7	2004	July	summer
## 13779	Pigeon-Reach 7	2004	July	summer
## 13843	Pigeon-Reach 1	2006	July	summer
## 13844	Pigeon-Reach 1	2006	July	summer
## 13845	Pigeon-Reach 1	2006	July	summer
## 13846	Pigeon-Reach 1	2006	August	summer
## 13847	Pigeon-Reach 1	2006	August	summer
## 13848	Pigeon-Reach 1	2006	August	summer
## 13849	Pigeon-Reach 1	2006	September	summer
## 13850	Pigeon-Reach 1	2006	September	summer
## 13851	Pigeon-Reach 1	2006	September	summer

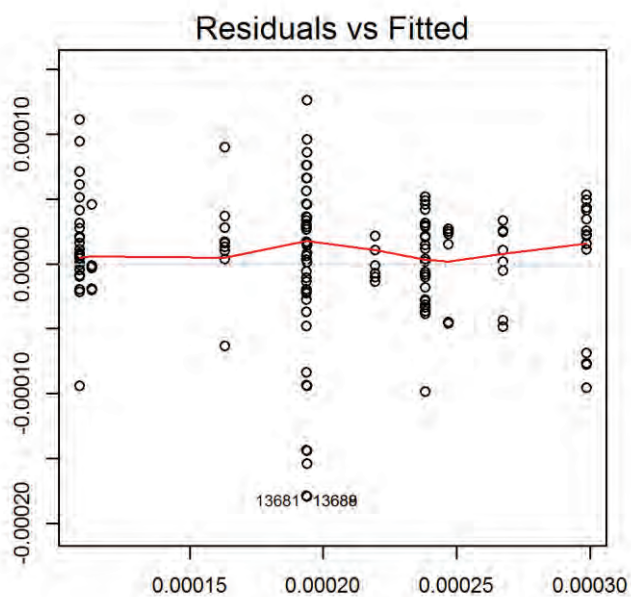
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

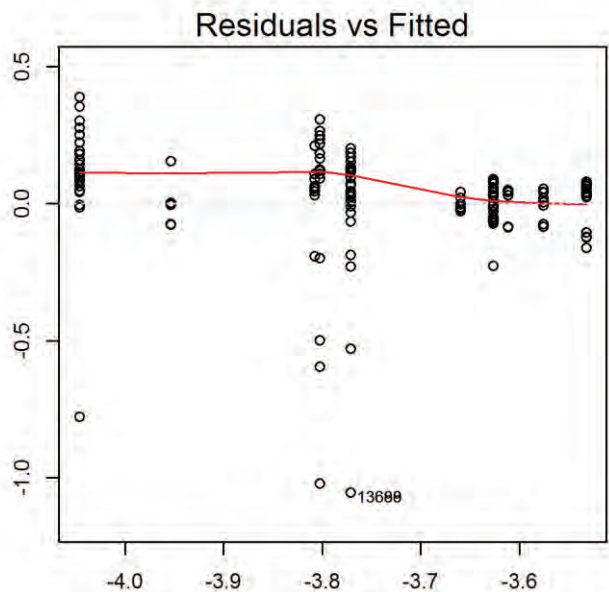
##	site	year	month	season
## 13557	Vulture-Polar	1995	July	summer
## 13661	Counts Outflow	2001	August	summer
## 13662	Counts Outflow	2001	August	summer
## 13663	Counts Outflow	2001	August	summer
## 13868	Counts Outflow	2007	August	summer
## 13869	Counts Outflow	2007	August	summer

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	5.56×10 ⁻⁵	0.52	0.5
Log-10	0.25	0.32	0.29

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

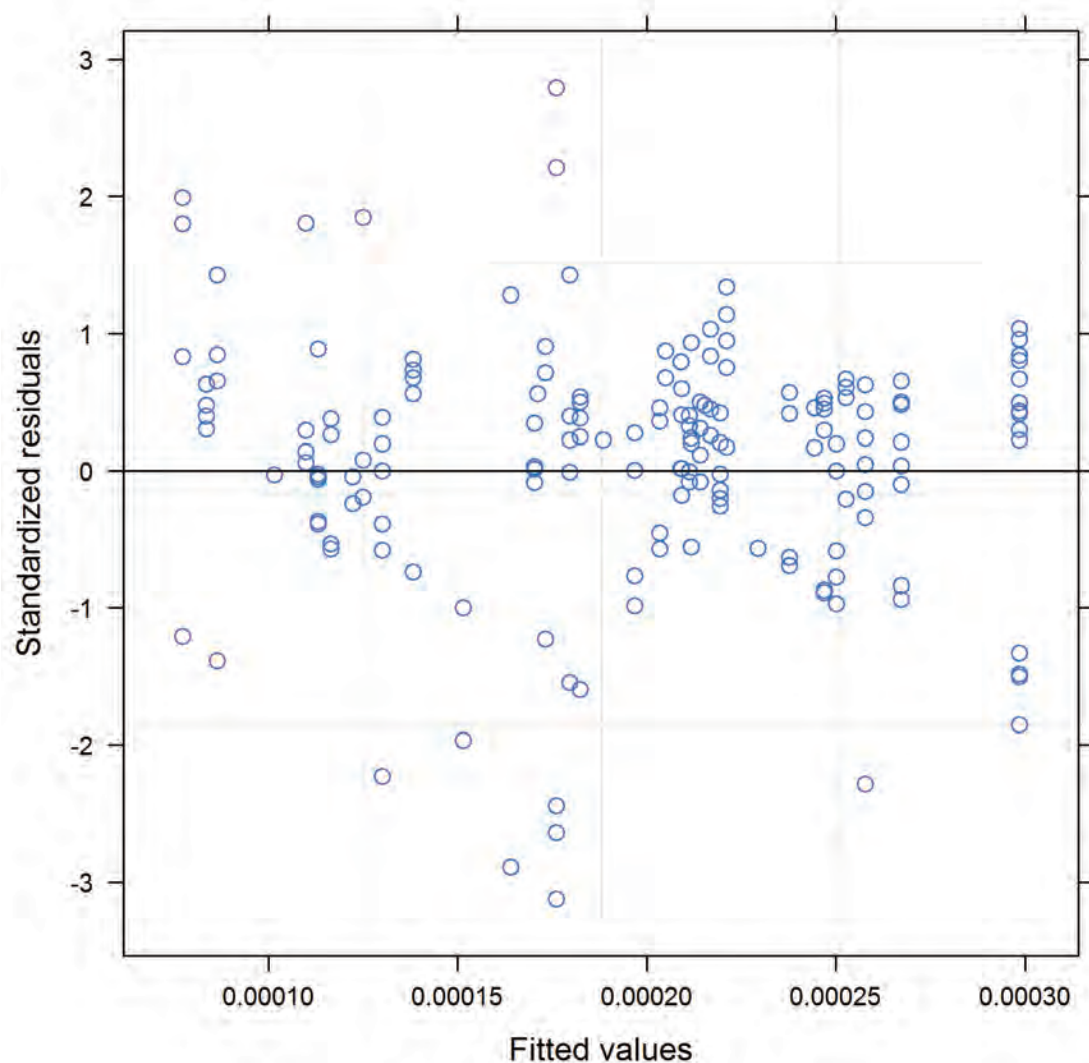
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-3436.14	1729.07		
LME	12	-3450.93	1737.46	16.79	4.18×10 ⁻⁵

Conclusion:

The most appropriate model for Total Arsenic at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	198	451	<.0001
## site	4	198	49	<.0001
## period	1	10	4	0.0899
## site:period	4	198	5	0.0014

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-8.66×10^{-5}	-1.46×10^{-4}	-3.13×10^{-5}	sig.
Counts Outflow	-8.07×10^{-5}	-1.39×10^{-4}	-2.44×10^{-5}	sig.
Vulture-Polar	-6.73×10^{-5}	-1.26×10^{-4}	-1.27×10^{-5}	sig.
Pigeon-Reach 7	1.28×10^{-5}	-4.64×10^{-5}	7.14×10^{-5}	not sig.

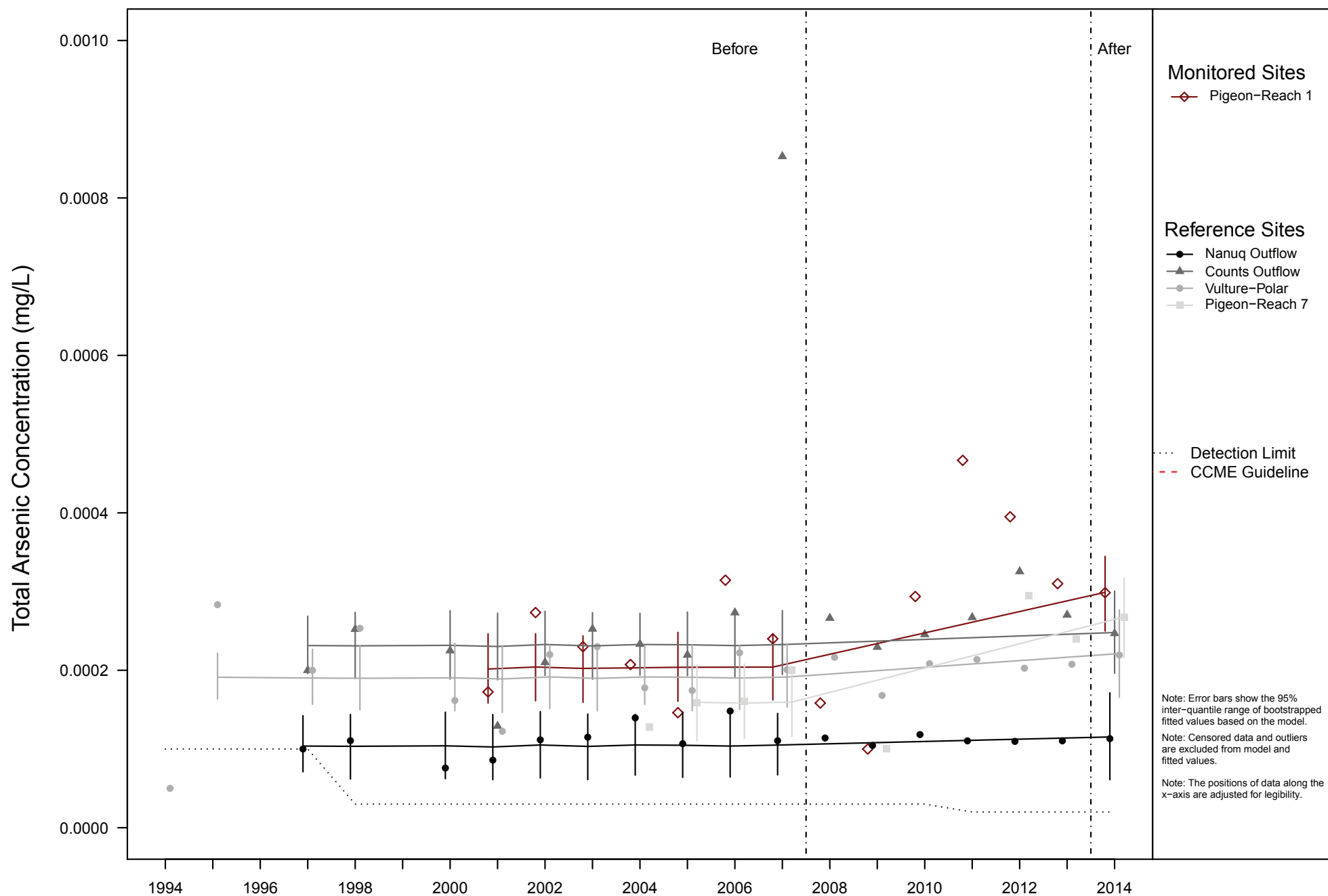
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total Arsenic concentrations at the Pigeon-Reach 1 site were significantly ($p = 0$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

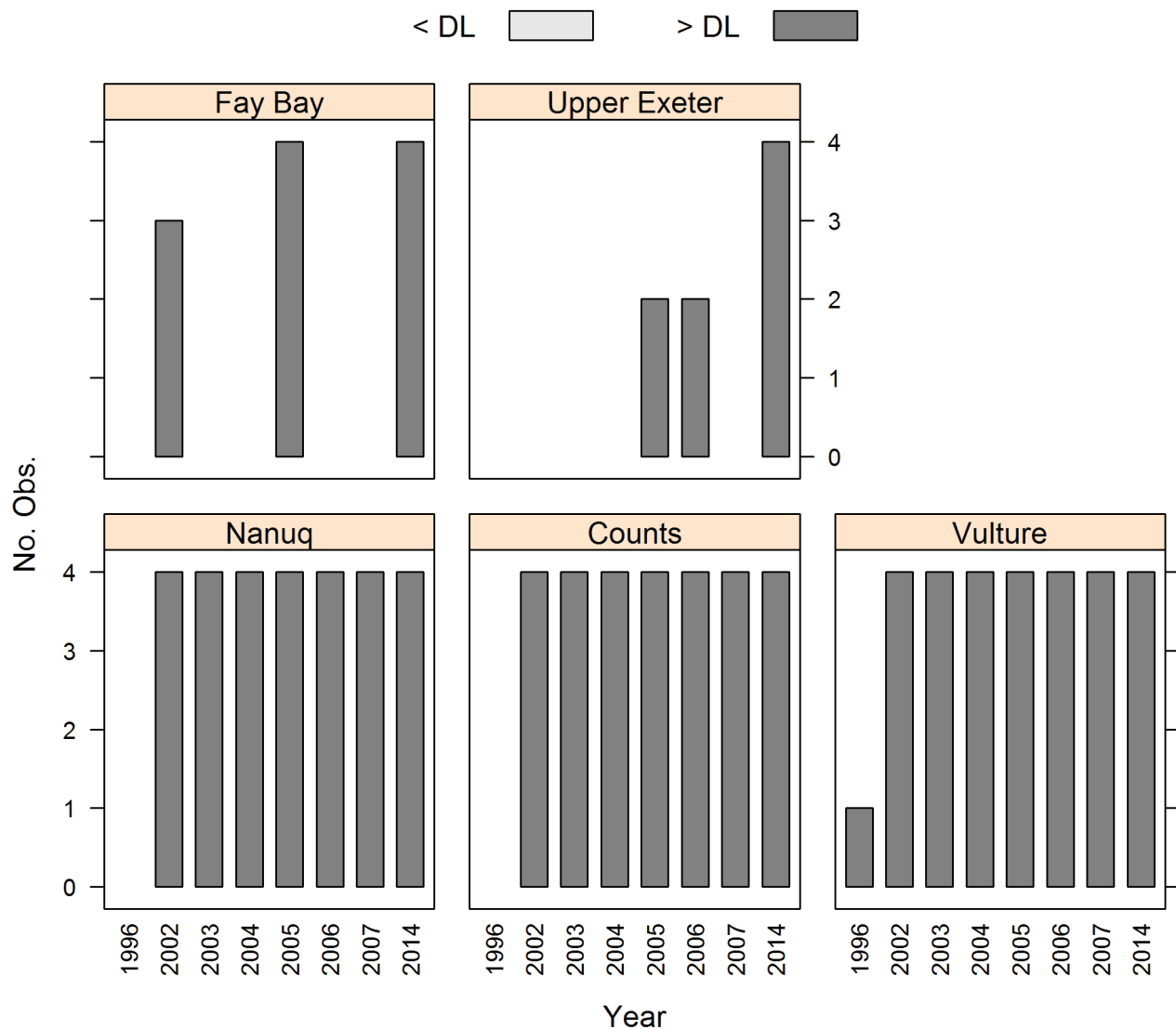


Analysis of Winter Total Barium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

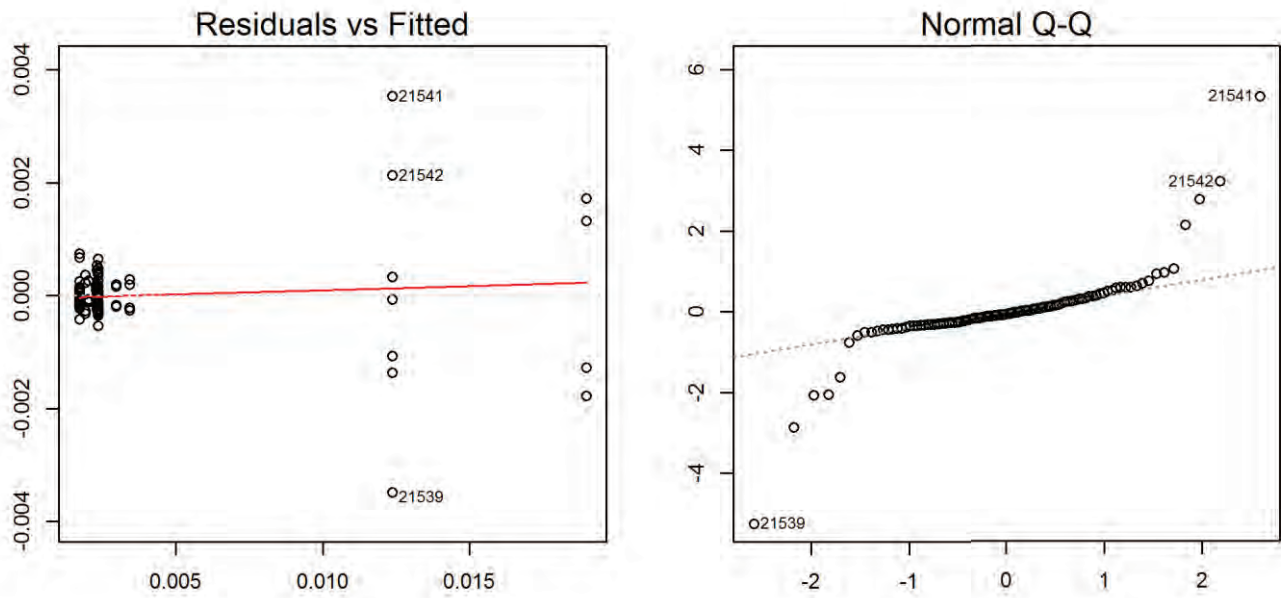
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

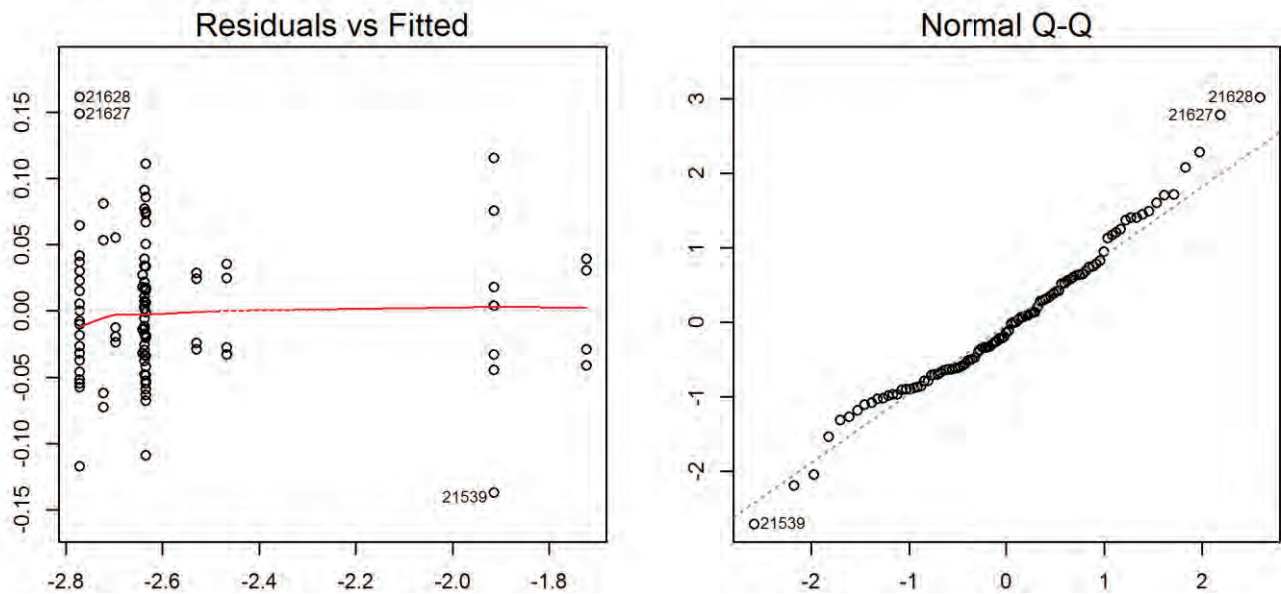
```
##          site year month season
## 21136 Vulture 1996 April  winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	7.1510 ⁻⁴	0.97	0.97
Log-10	0.05	0.96	0.96

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

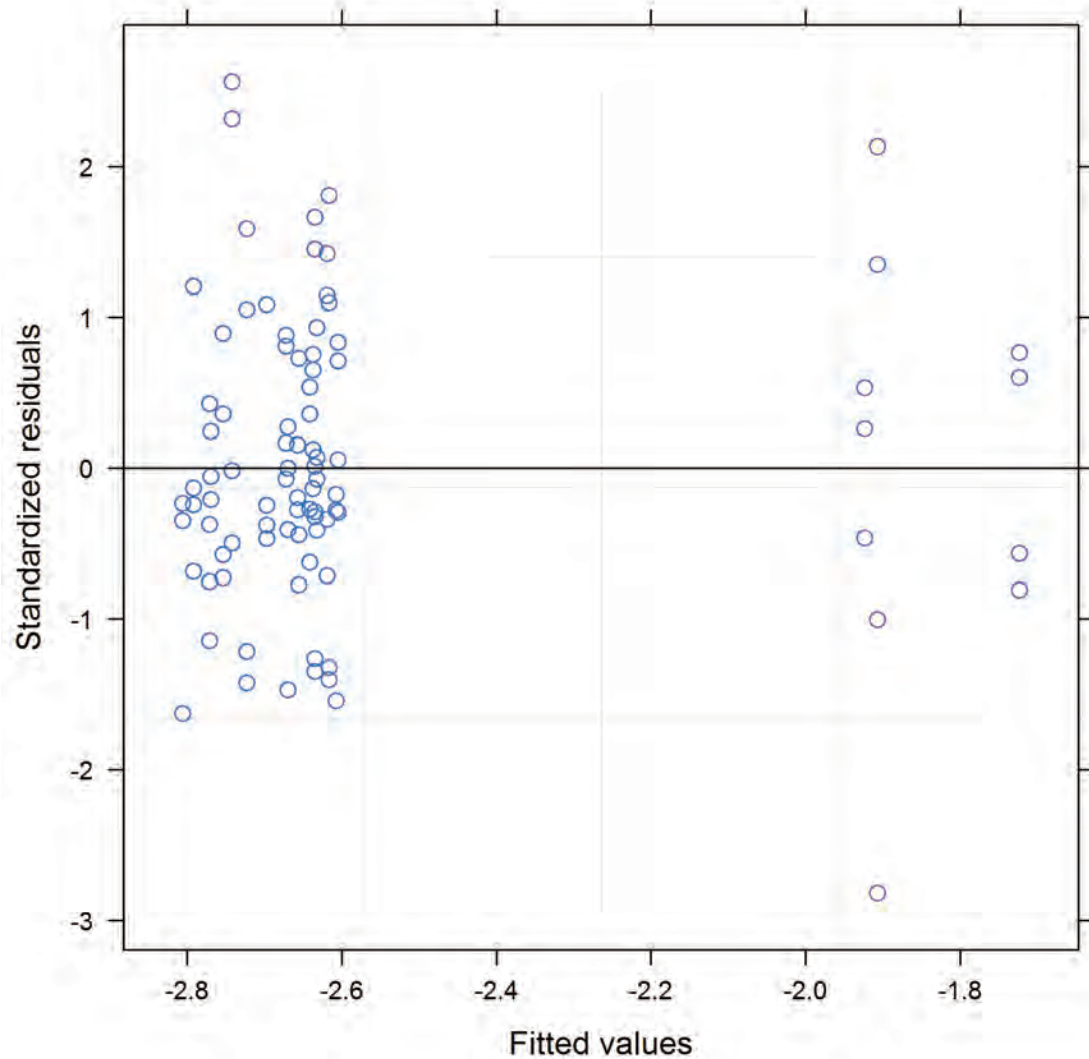
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-220.15	119.08		
LME	10	-226.27	123.13	8.12	0

Conclusion:

The most appropriate model for total barium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p = 0.004$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	82	51033	<.0001
## site	3	82	802	<.0001
## period	1	5	1	0.34
## site:period	3	82	14	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.15	-0.24	-0.07	sig.
Counts	-0.26	-0.35	-0.18	sig.
Vulture	-0.21	-0.29	-0.12	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total barium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

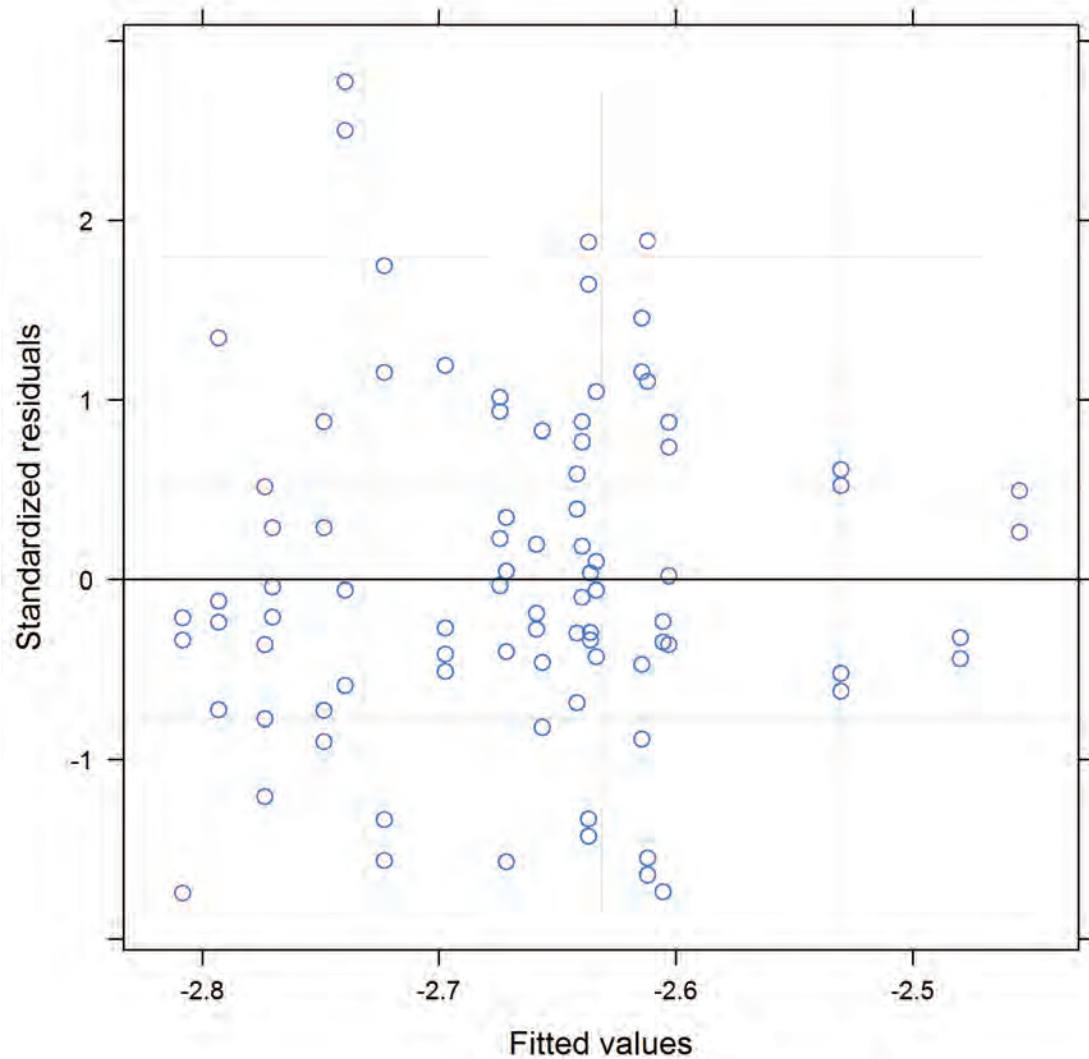
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-222.25	120.12		
LME	10	-231.97	125.99	11.73	6.17×10^{-4}

Conclusion:

The most appropriate model for total barium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	50681	<.0001
## site	3	79	77	<.0001
## period	1	5	0	0.721
## site:period	3	79	4	0.013

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.1	0.02	0.18	sig.
Counts	-0.01	-0.1	0.07	not sig.
Vulture	0.05	-0.03	0.13	not sig.

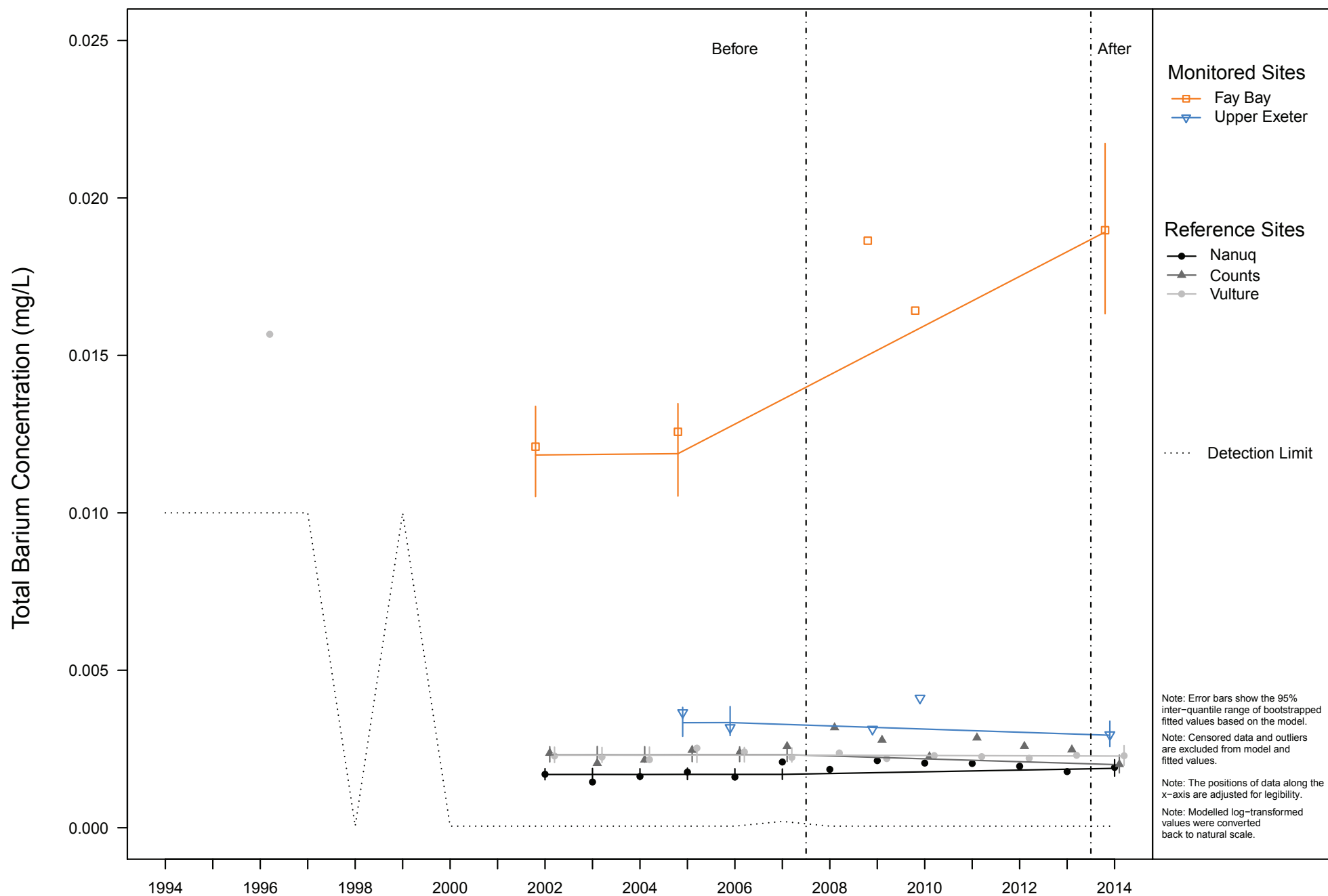
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total barium concentrations at the Upper Exeter site were significantly ($p = 0.013$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

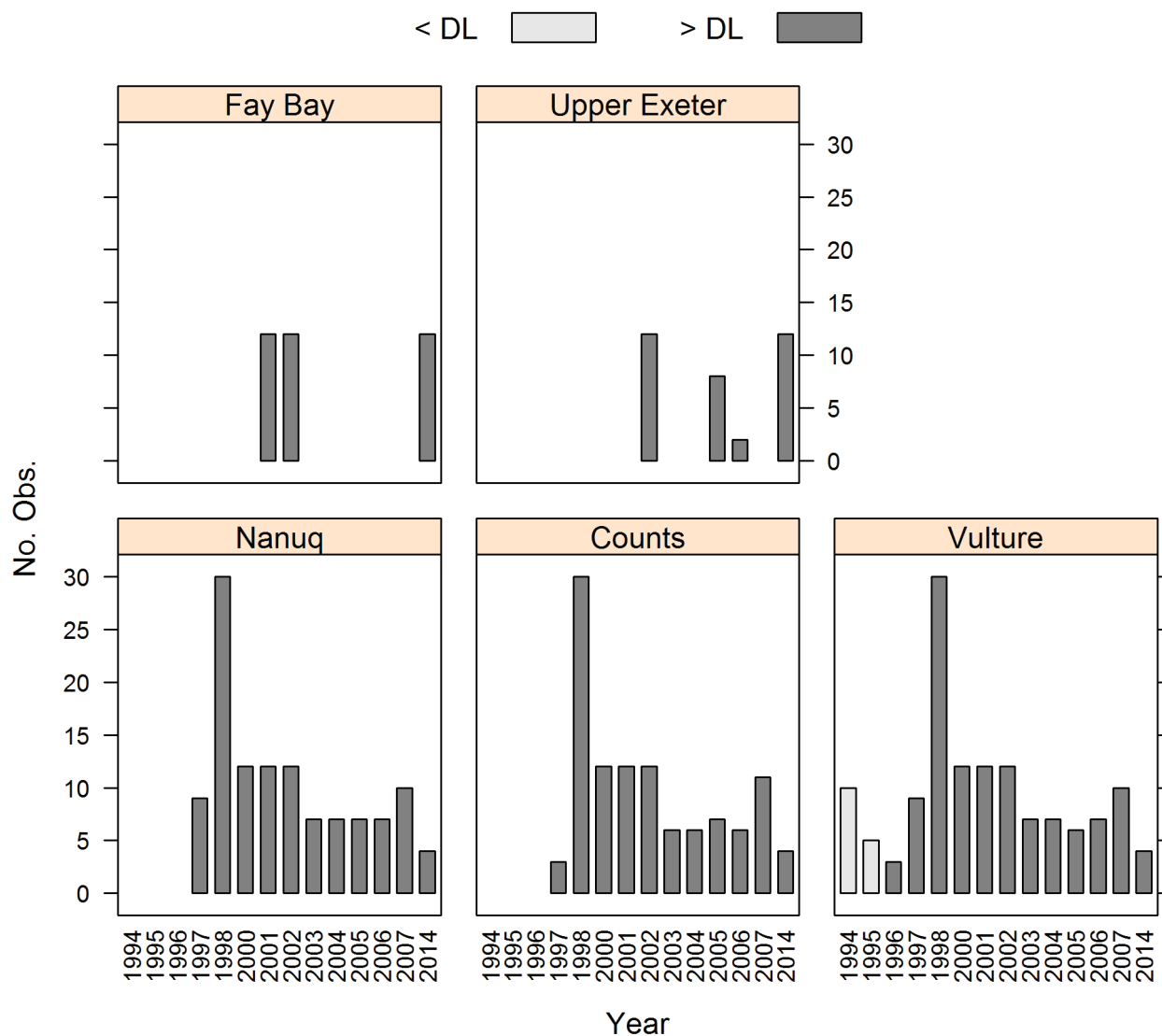


Analysis of Summer Total Barium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year  month season
## 21121 Vulture 1994   July  summer
## 21122 Vulture 1994   July  summer
## 21123 Vulture 1994   July  summer
## 21124 Vulture 1994   July  summer
## 21125 Vulture 1994   July  summer
## 21126 Vulture 1994 August  summer
## 21127 Vulture 1994 August  summer
## 21128 Vulture 1994 August  summer
## 21129 Vulture 1994 August  summer
## 21130 Vulture 1994 August  summer
## 21131 Vulture 1995 August  summer
## 21132 Vulture 1995 August  summer
## 21133 Vulture 1995 August  summer
## 21134 Vulture 1995 August  summer
## 21135 Vulture 1995 August  summer
```

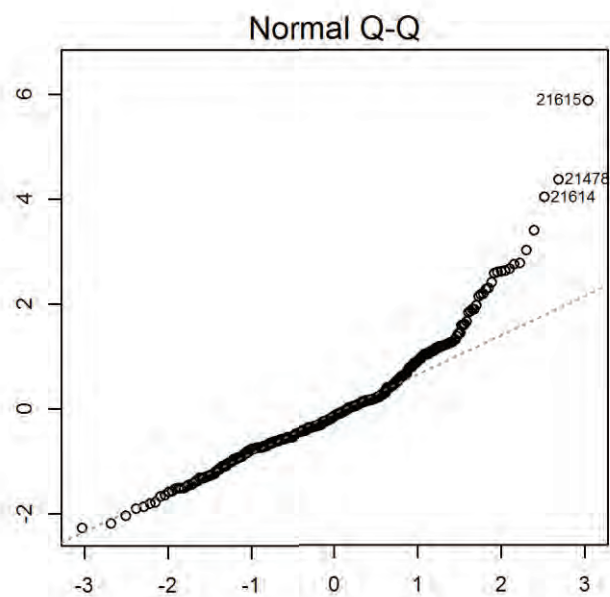
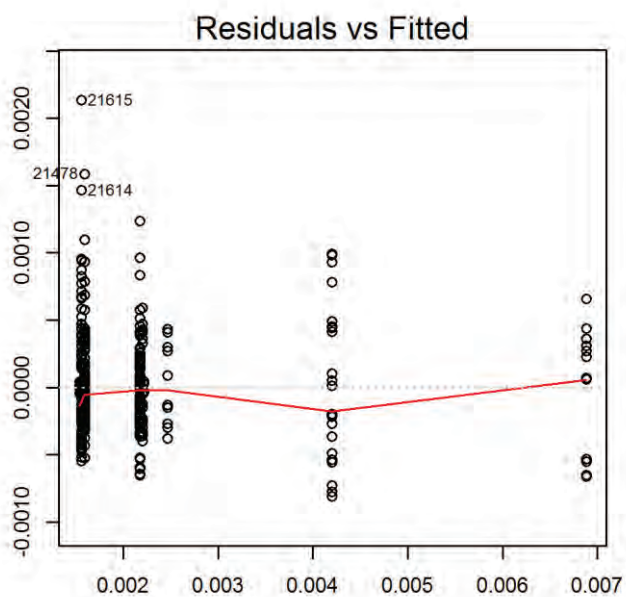
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

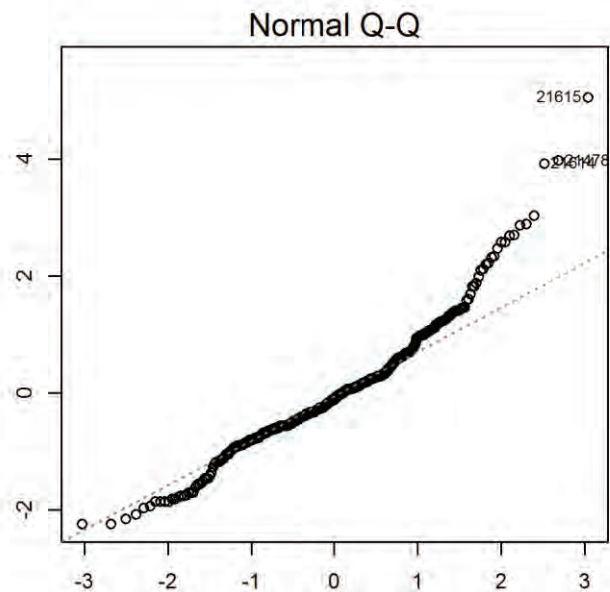
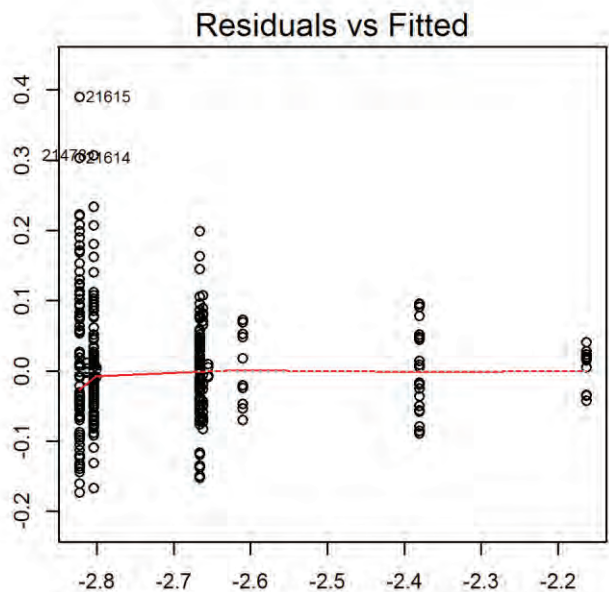
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	3.64×10 ⁻⁴	0.89	0.89
Log-10	0.08	0.79	0.78

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

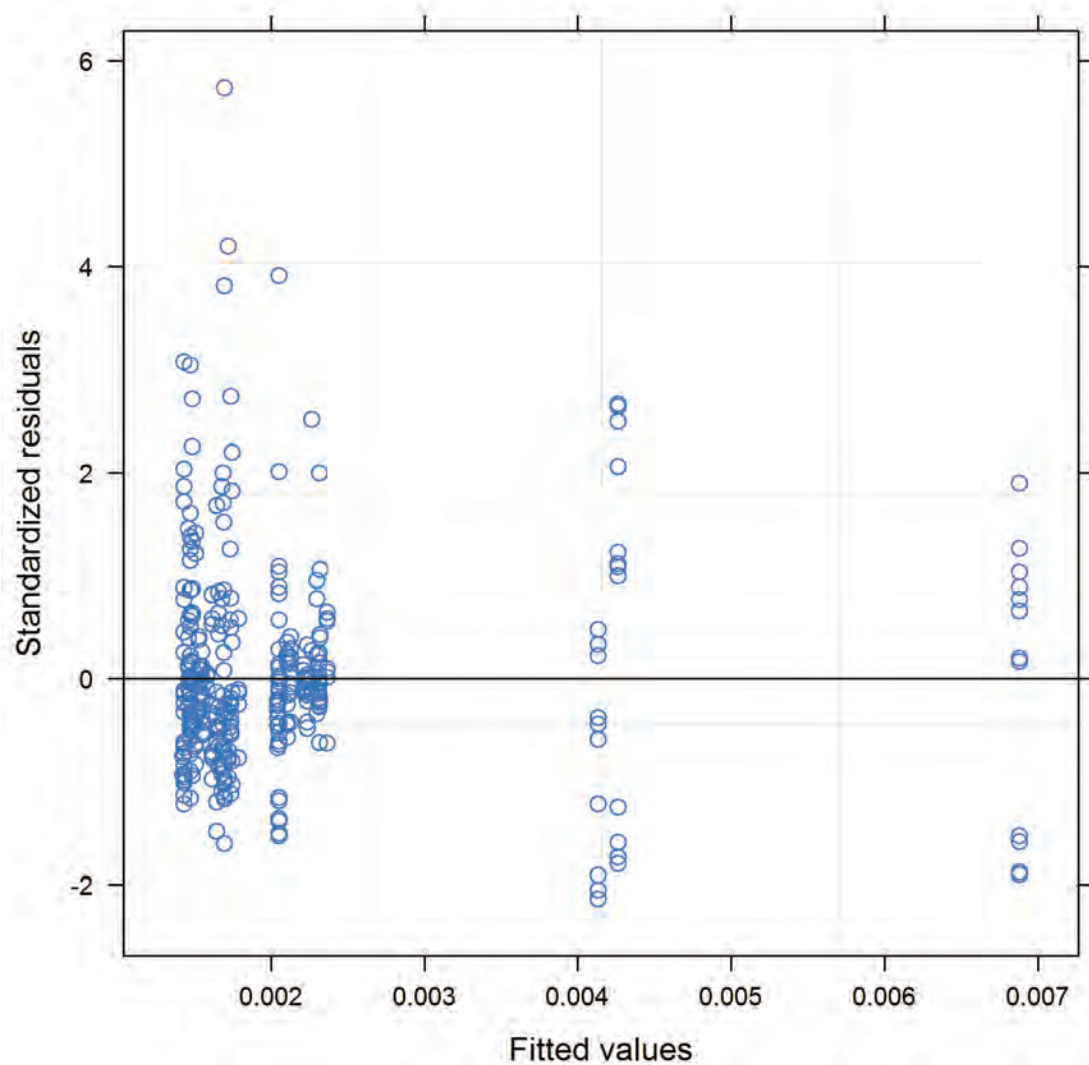
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-4799.26	2408.63		
LME	10	-4823.7	2421.85	26.44	2.72×10 ⁻⁷

Conclusion:

The most appropriate model for total barium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	363	2375	<.0001
## site	3	363	780	<.0001
## period	1	10	38	1e-04
## site:period	3	363	90	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.0027	-0.0031	-0.0023	sig.
Counts	-0.0027	-0.0031	-0.0023	sig.
Vulture	-0.0026	-0.0031	-0.0022	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total barium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

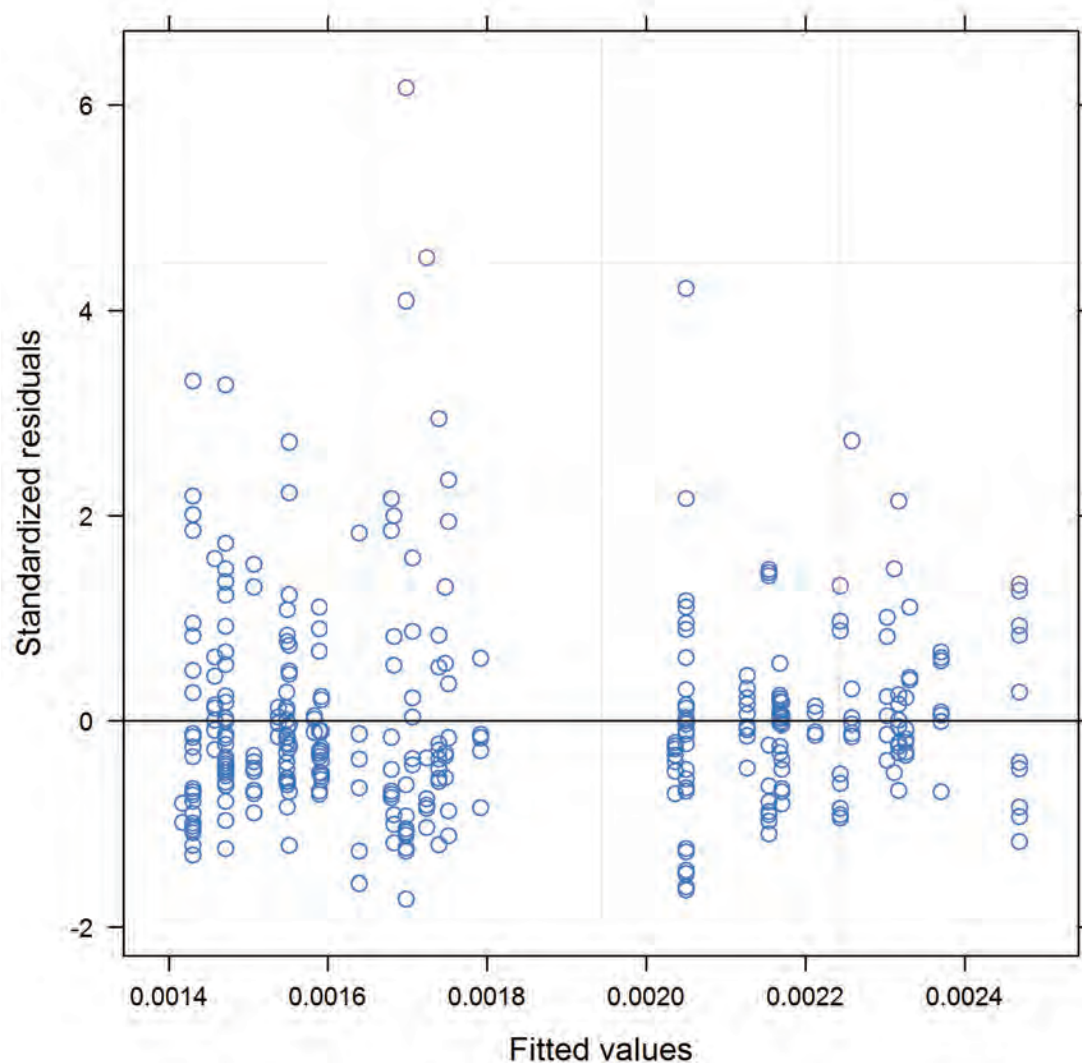
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-4822.86	2420.43		
LME	10	-4850.46	2435.23	29.6	5.31×10^{-8}

Conclusion:

The most appropriate model for total barium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	361	1893	<.0001
## site	3	361	106	<.0001
## period	1	10	0	0.66
## site:period	3	361	1	0.26

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-3.23×10^{-4}	-7.44×10^{-4}	8.78×10^{-5}	not sig.
Counts	-3.27×10^{-4}	-7.16×10^{-4}	7×10^{-5}	not sig.
Vulture	-2.71×10^{-4}	-6.71×10^{-4}	1.58×10^{-4}	not sig.

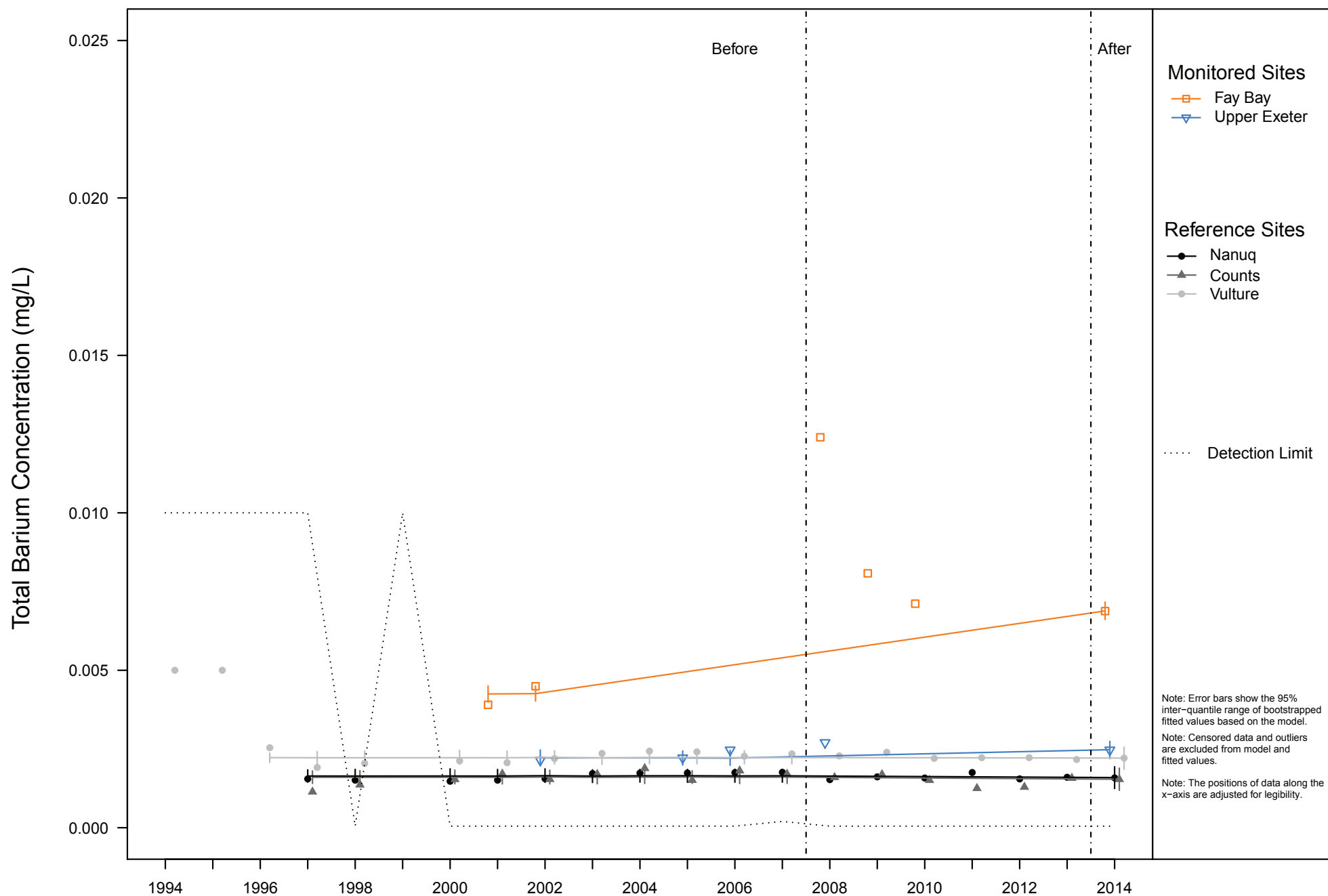
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total barium concentrations at the Upper Exeter site were not significantly ($p = 0.255$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

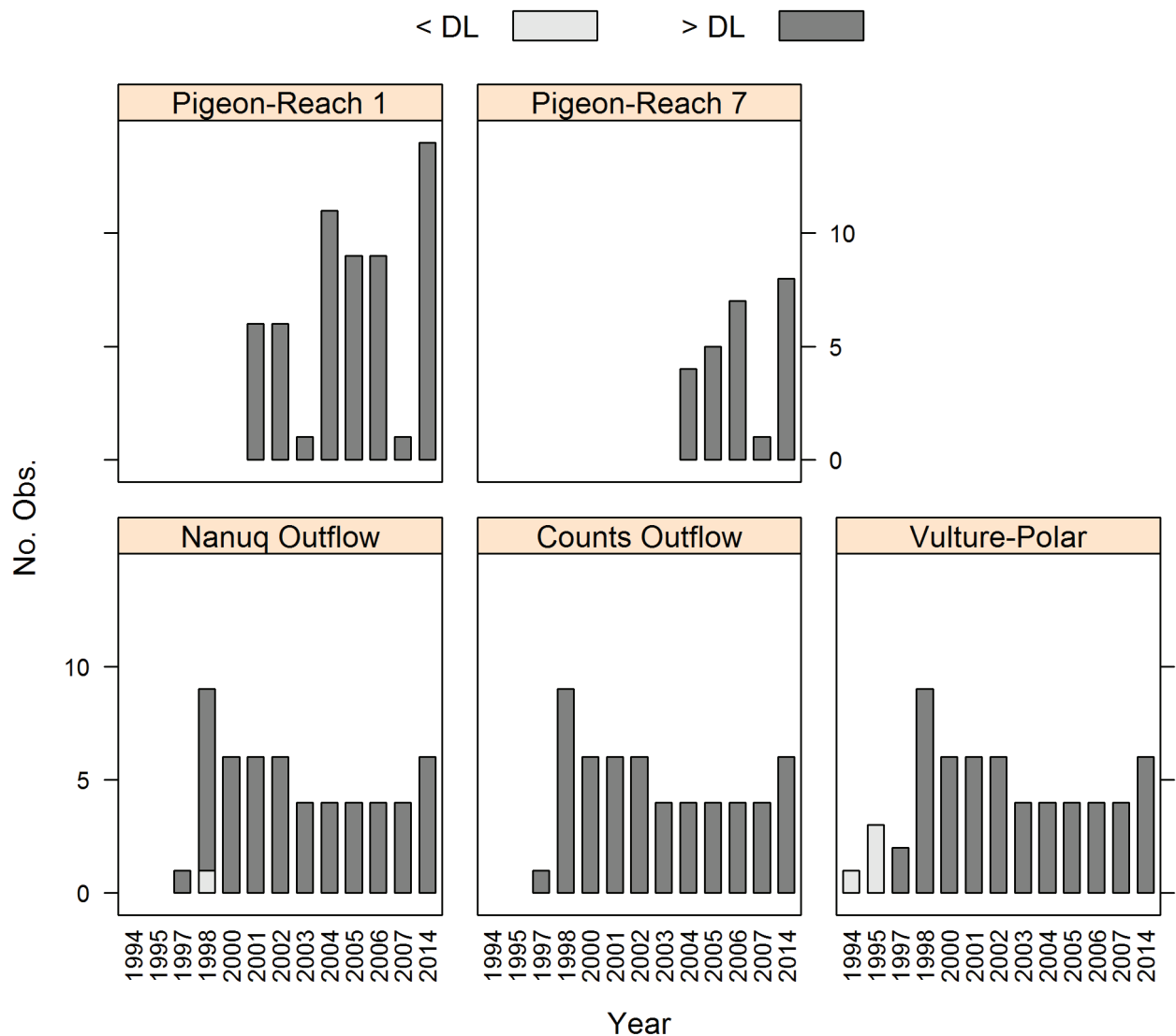


Analysis of Summer Total Barium Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 14172	Vulture-Polar	1994	August	summer
## 14173	Vulture-Polar	1995	July	summer
## 14174	Vulture-Polar	1995	August	summer
## 14175	Vulture-Polar	1995	September	summer

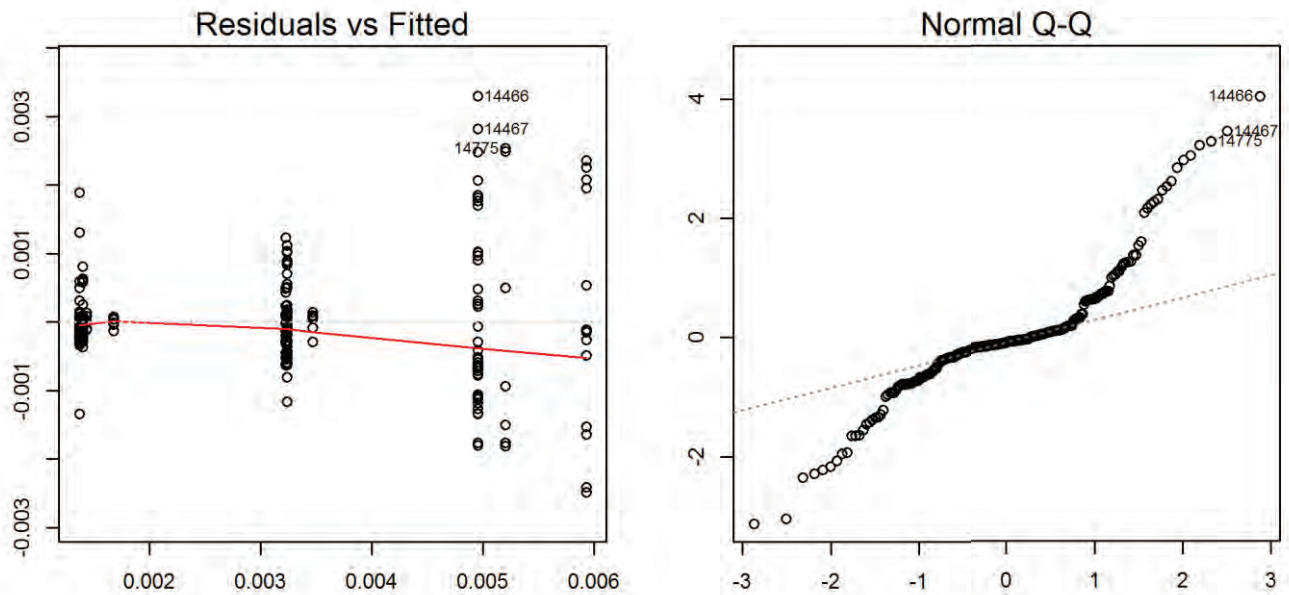
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

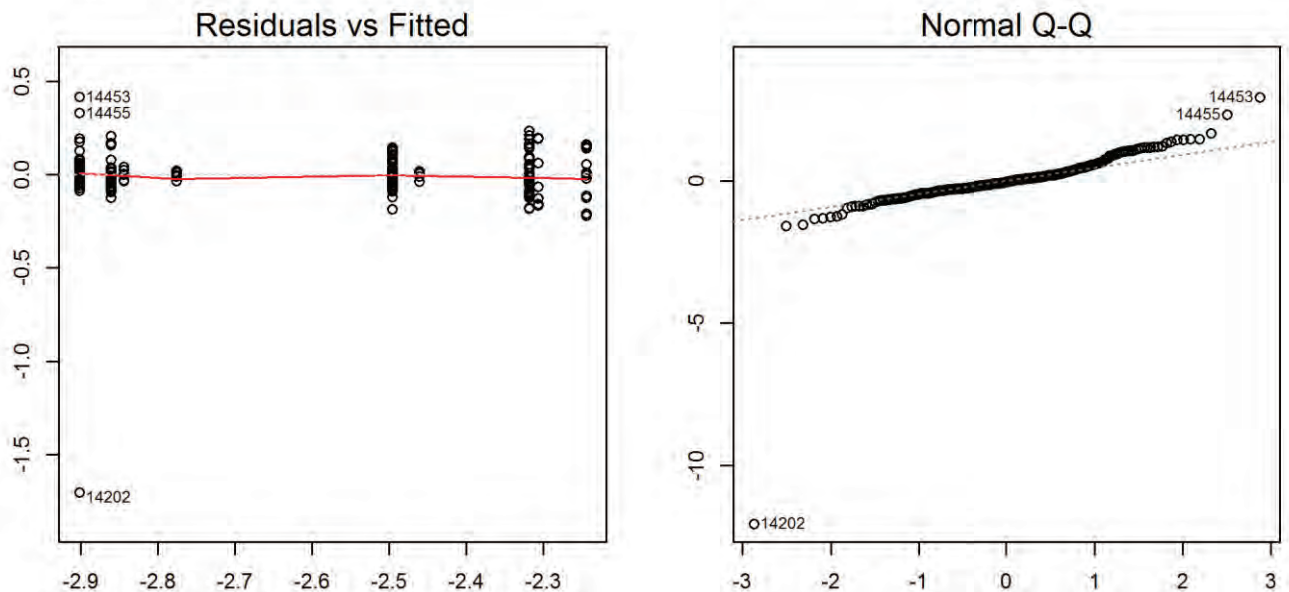
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	8.24×10 ⁻⁴	0.79	0.78
Log-10	0.14	0.76	0.75

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

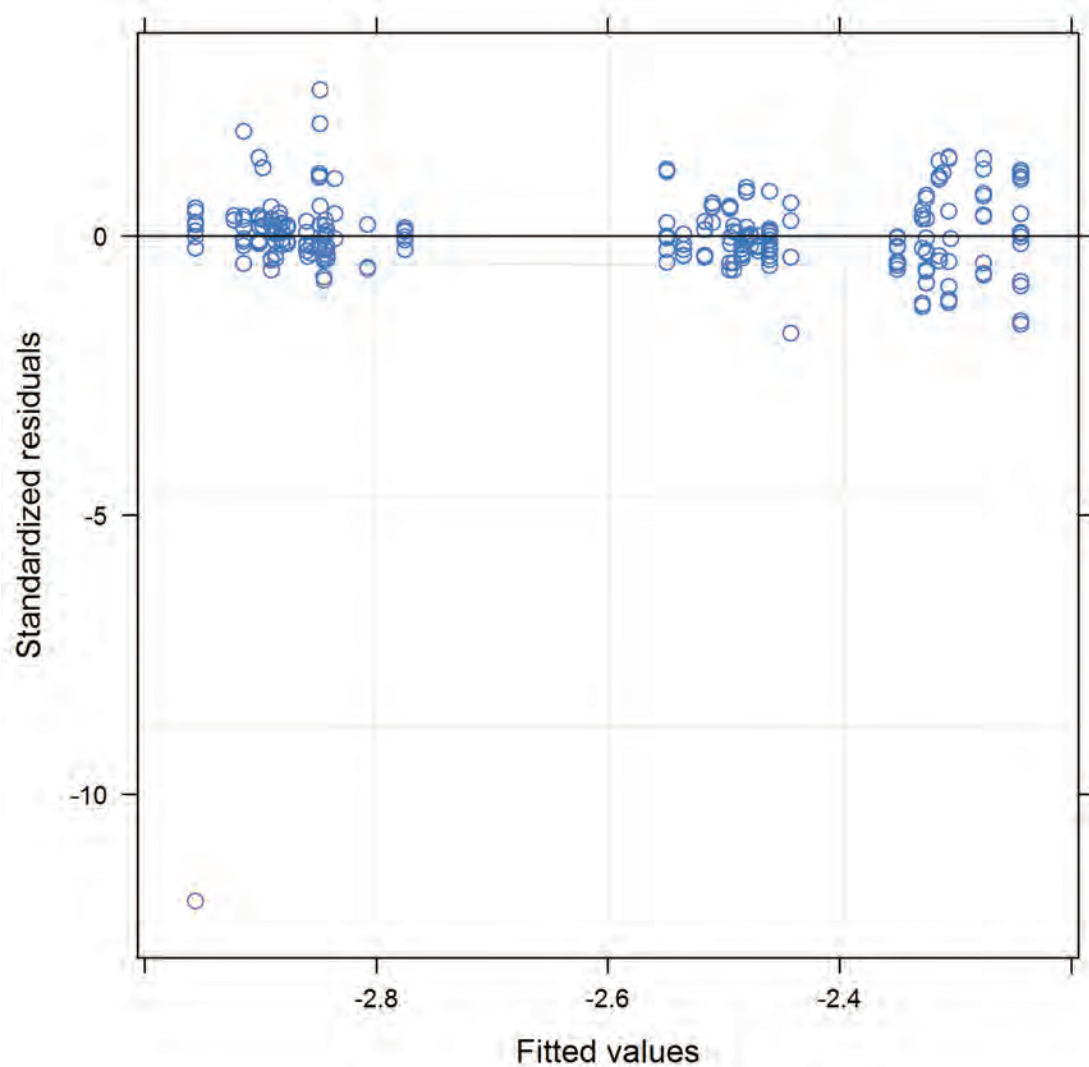
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-198.74	110.37		
LME	12	-203.01	113.51	6.27	0.01

Conclusion:

The most appropriate model for total barium at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p = 0.012$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	226	31455	<.0001
## site	4	226	166	<.0001
## period	1	9	3	0.097
## site:period	4	226	1	0.296

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.03	-0.18	0.11	not sig.
Counts Outflow	-2.4410^{-4}	-0.15	0.14	not sig.
Vulture-Polar	-0.05	-0.2	0.09	not sig.
Pigeon-Reach 7	0.12	-0.02	0.26	not sig.

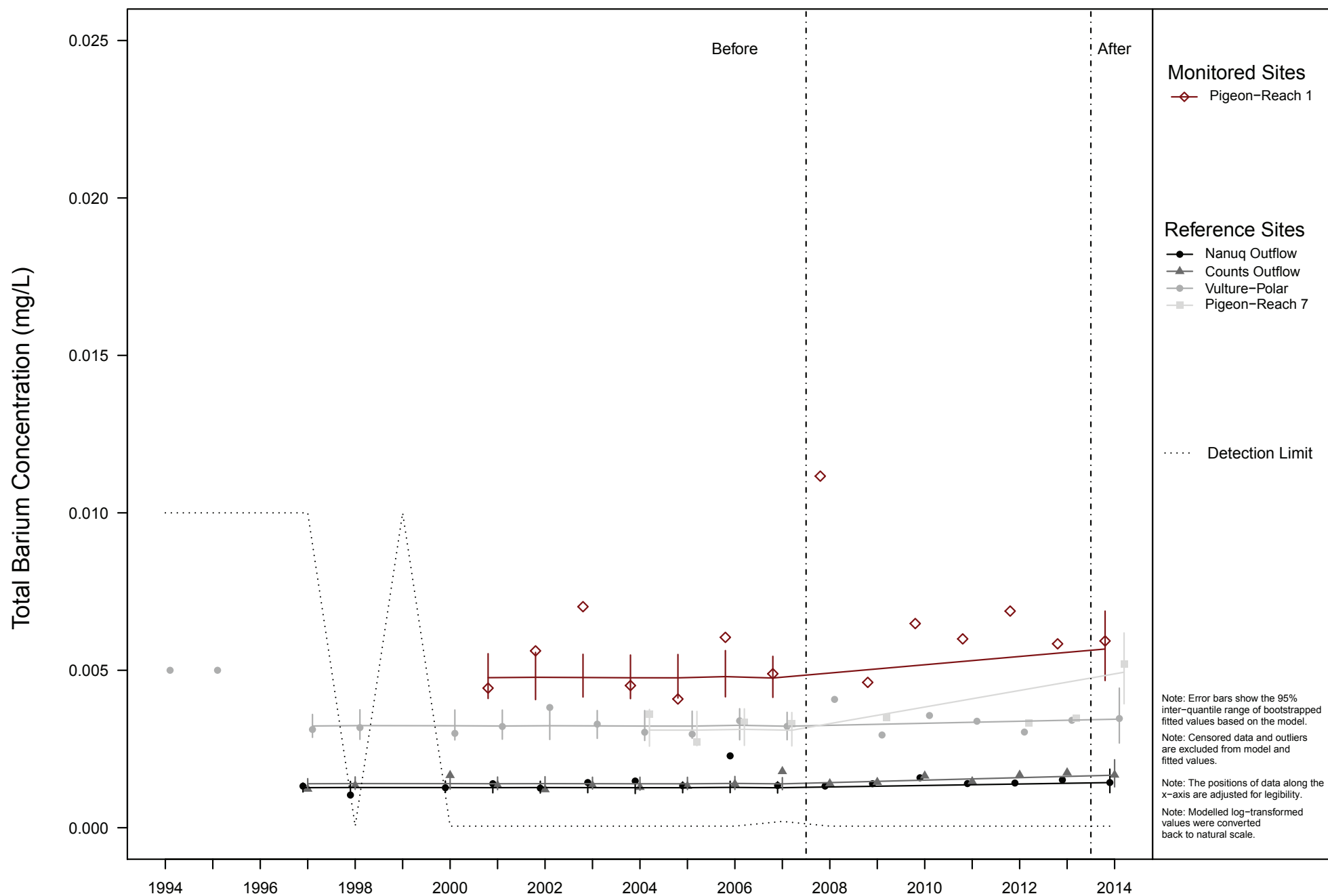
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total barium concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.296$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

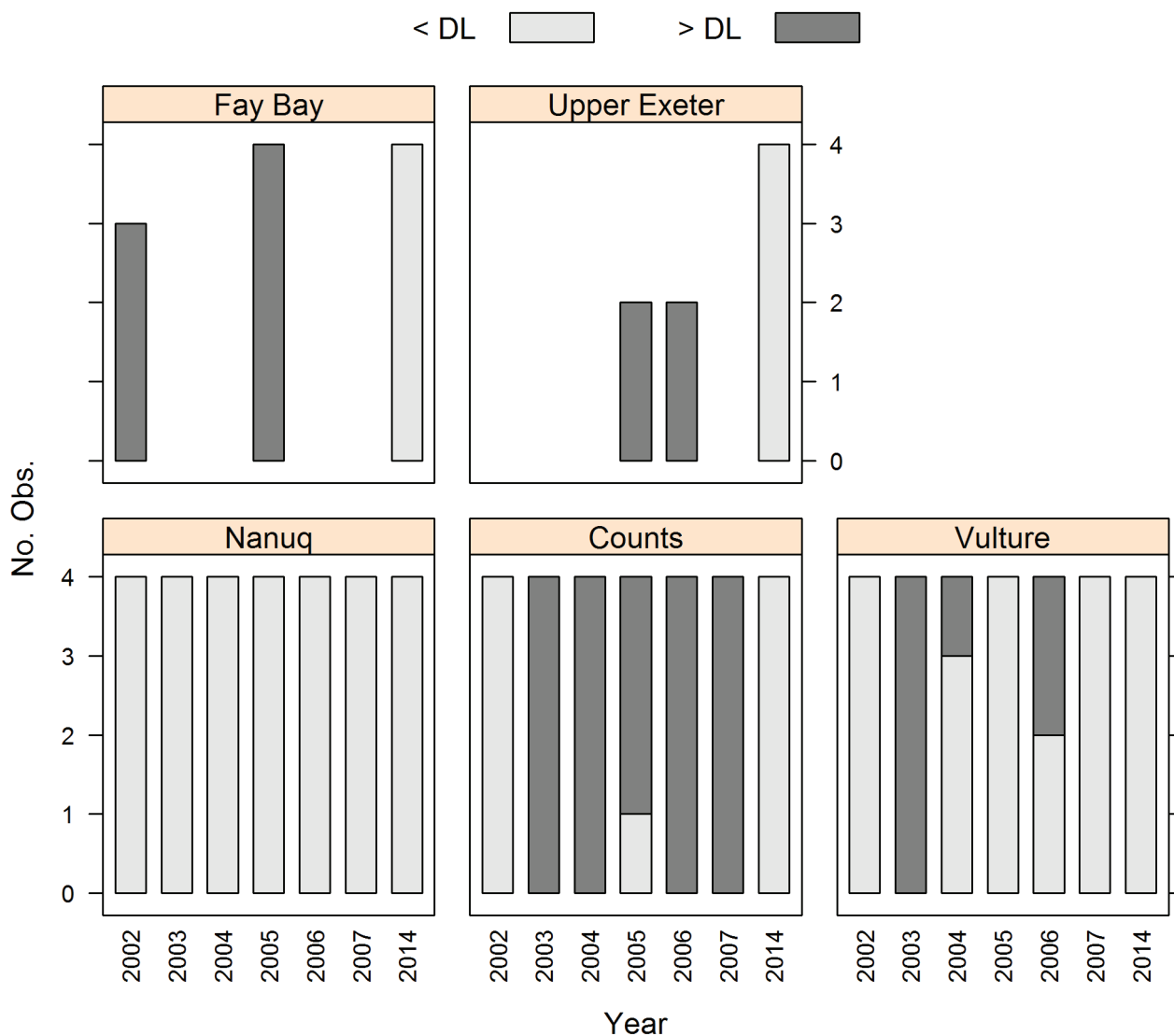


Analysis of Winter Total Boron Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

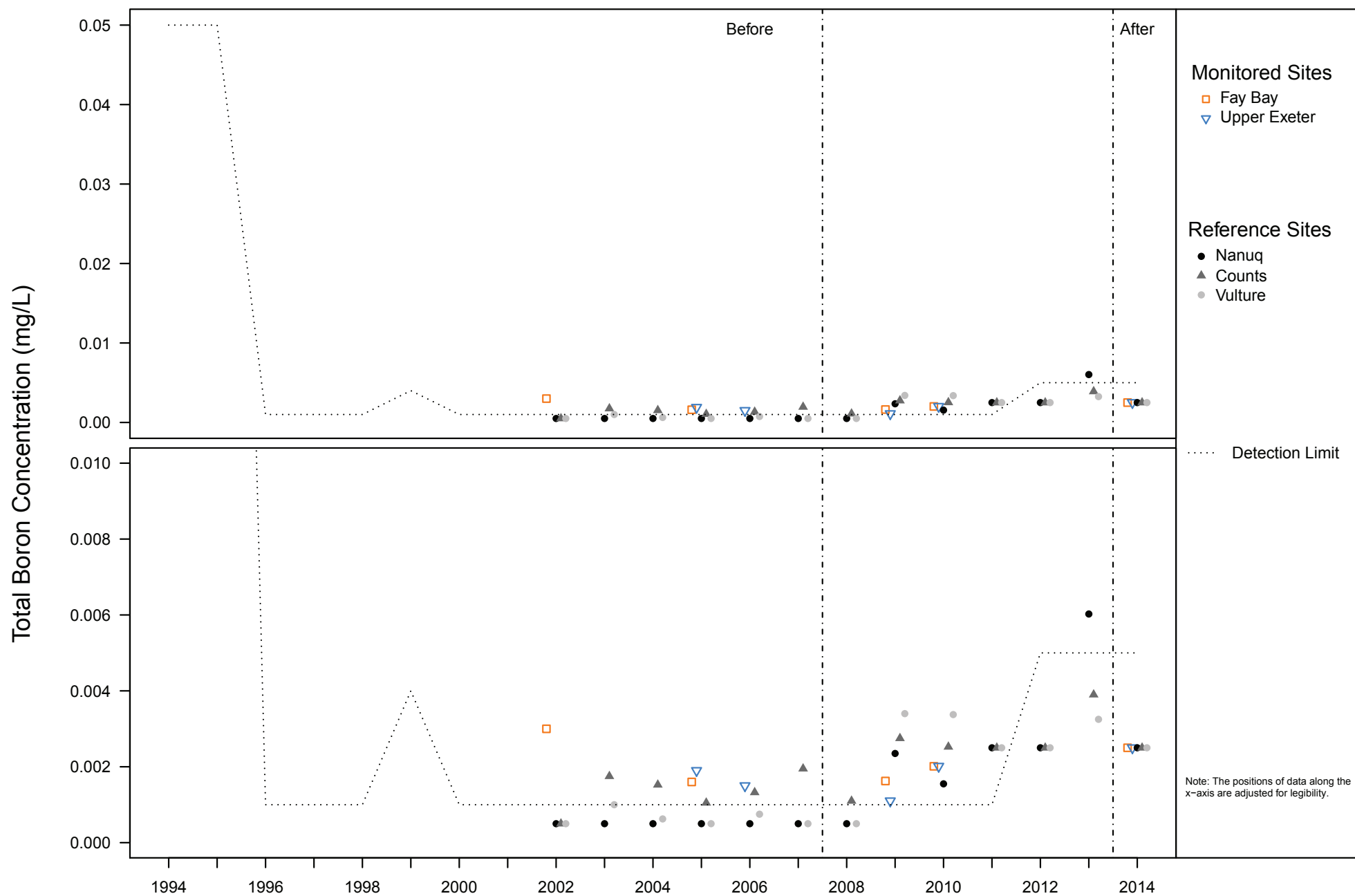
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Boron water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

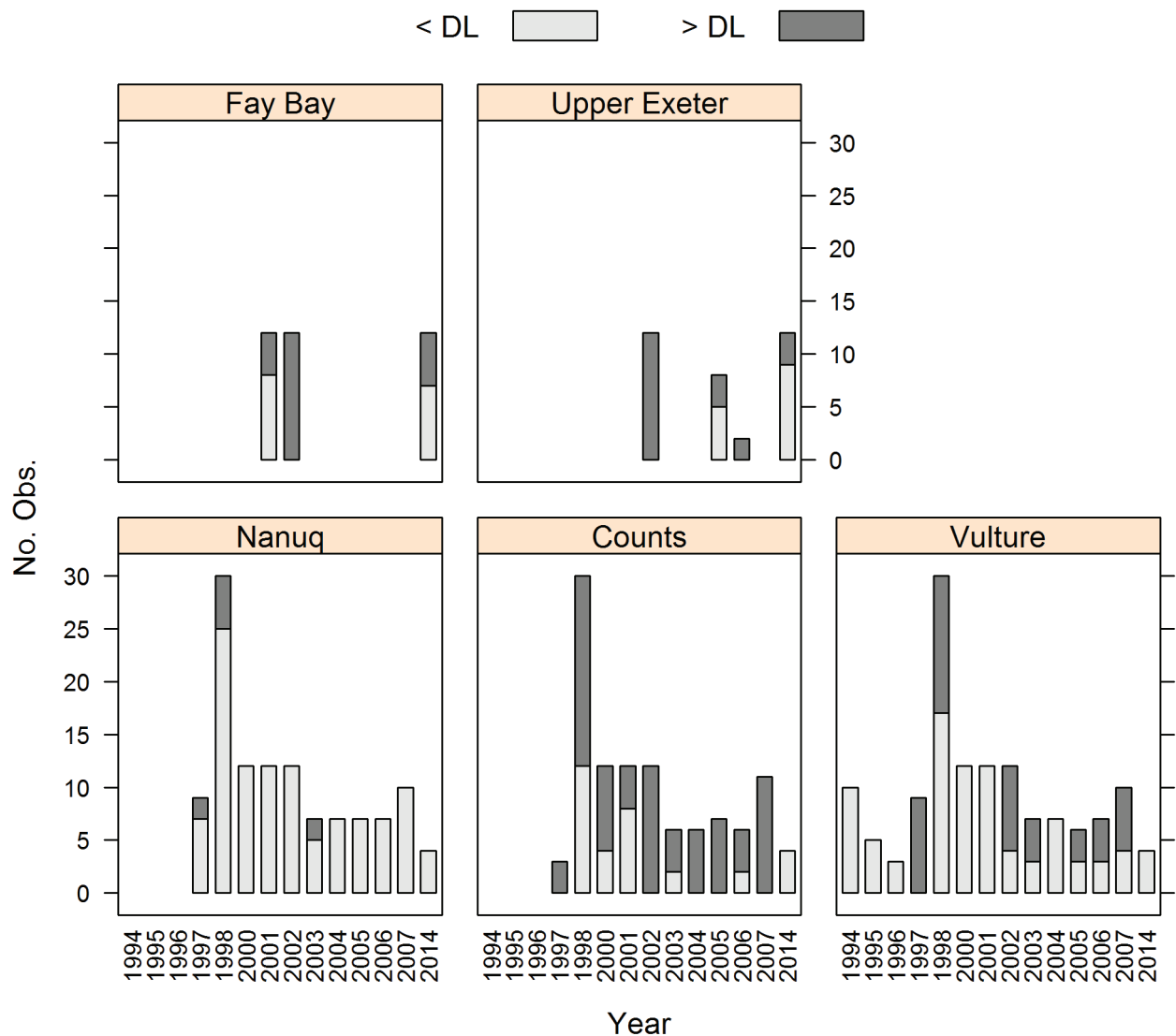


Analysis of Summer Total Boron Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

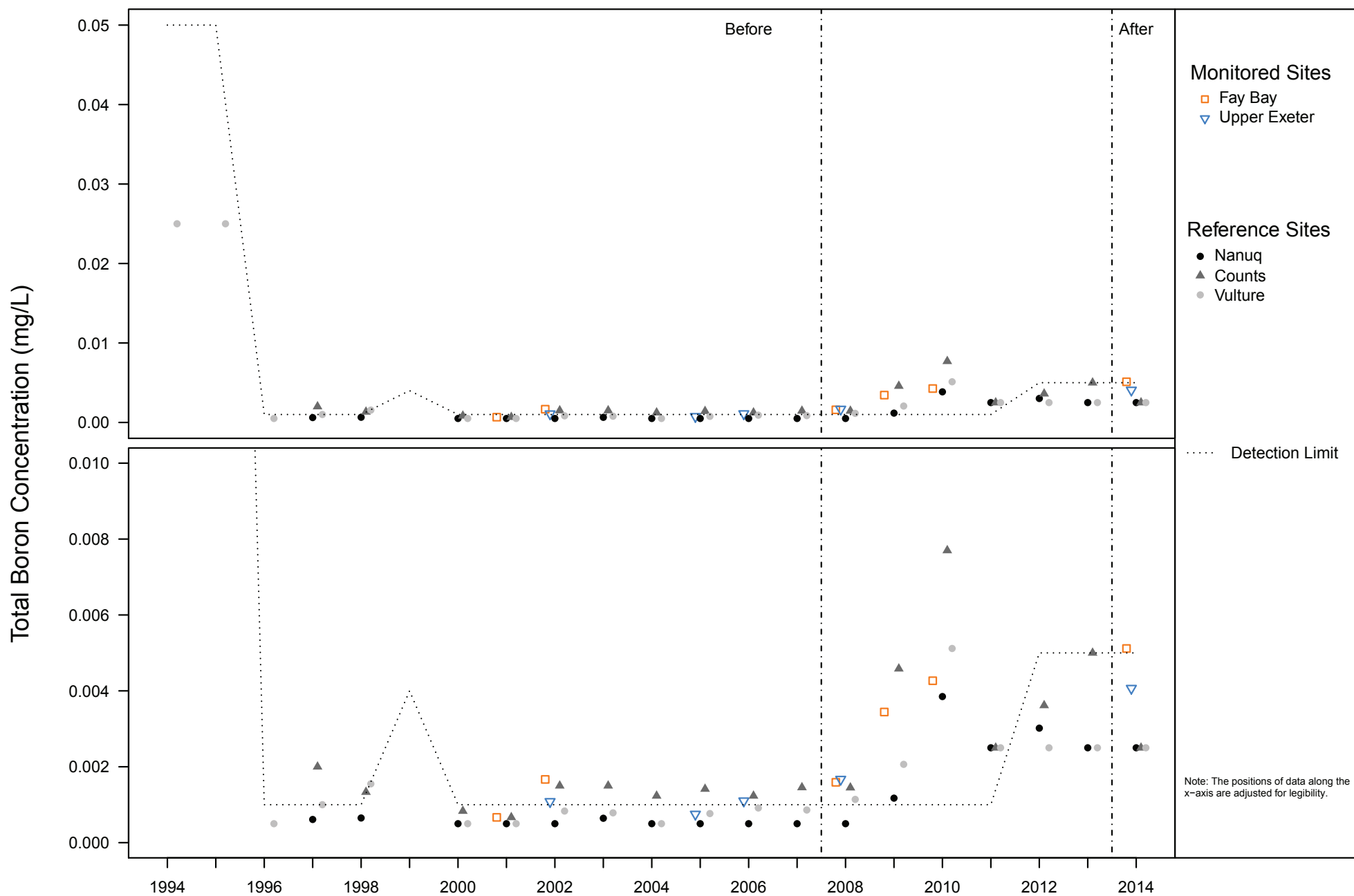
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Boron water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

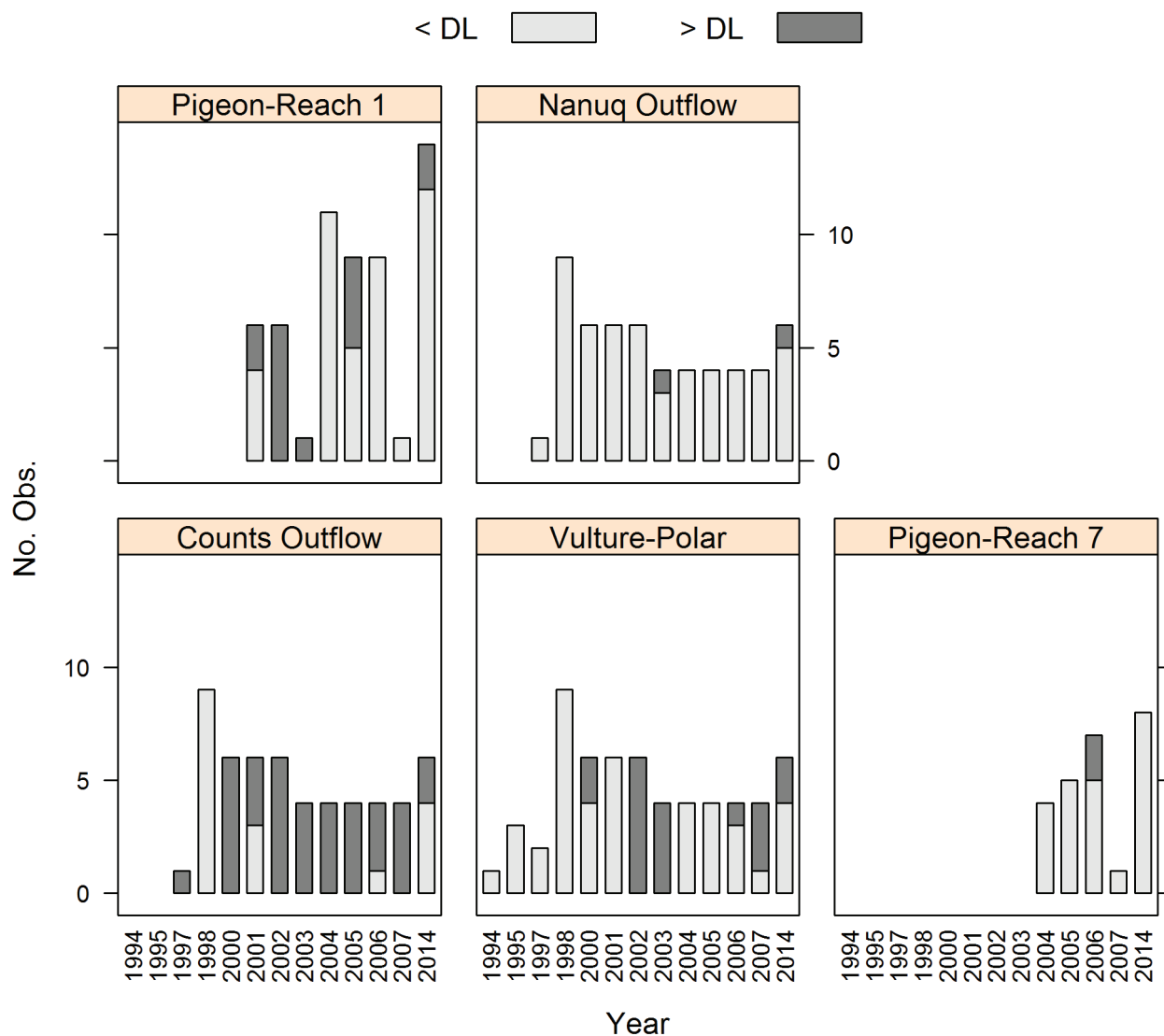


Analysis of Summer Total Boron Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

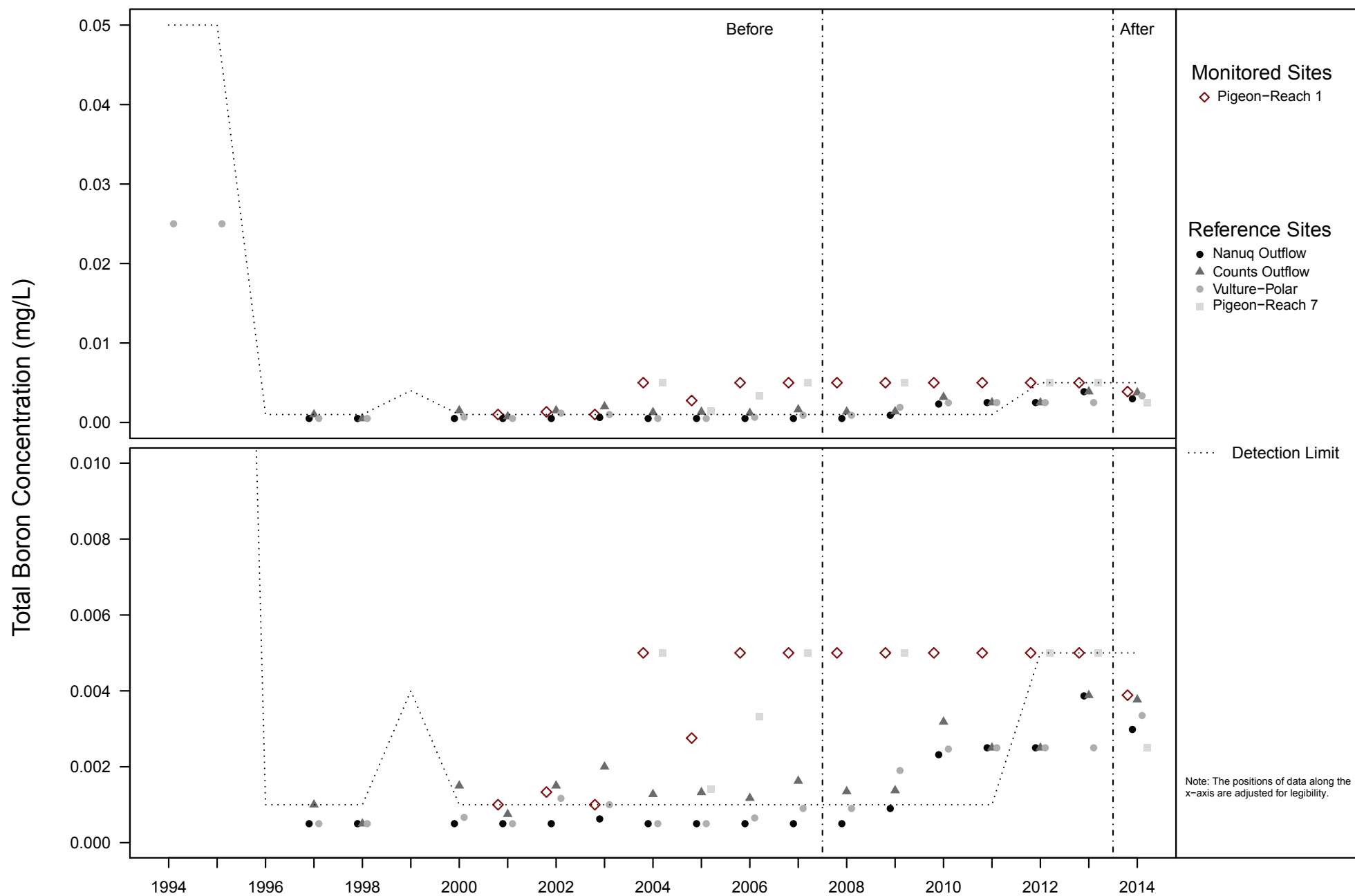
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Boron water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

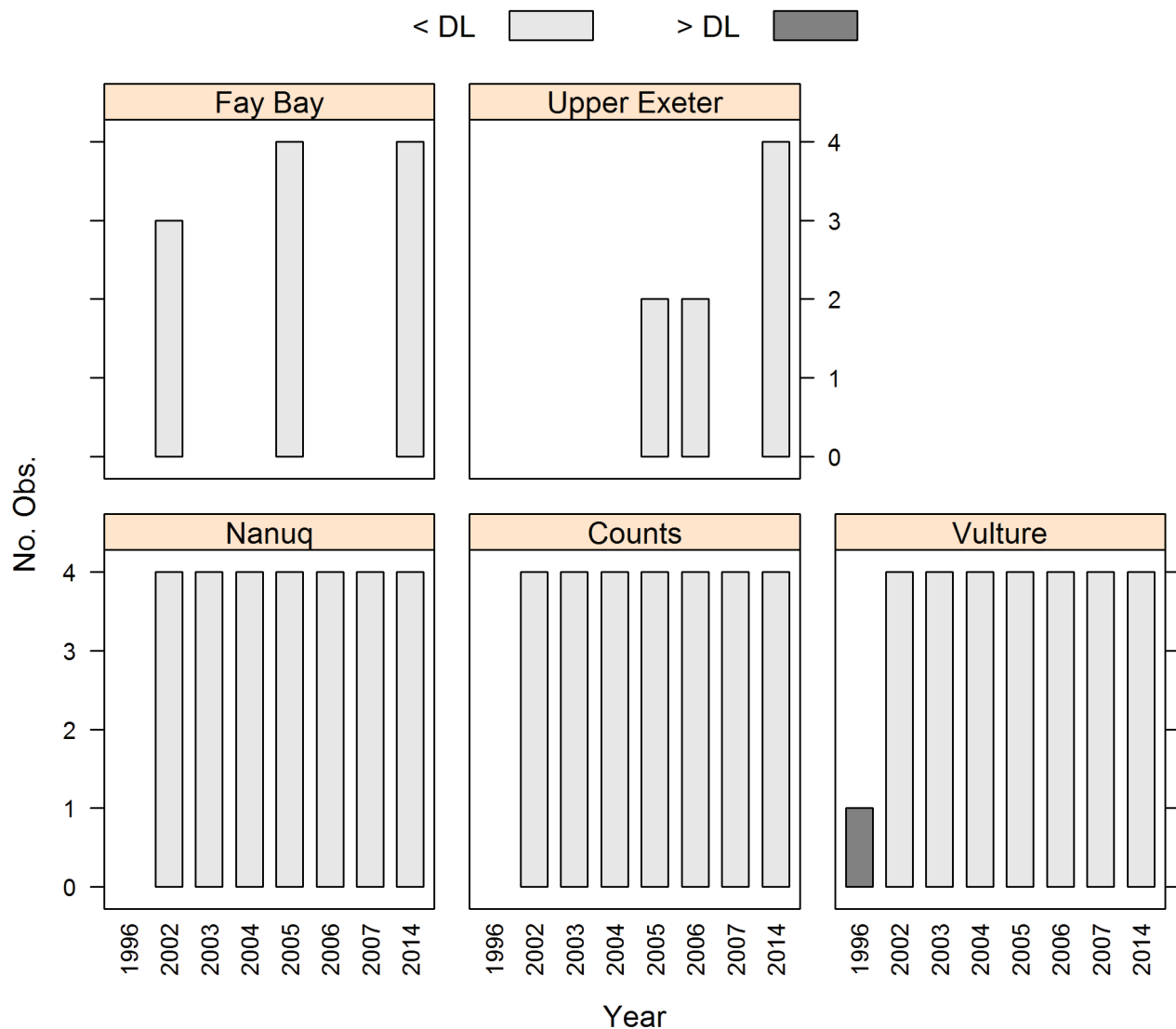


Analysis of Winter Total Cadmium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

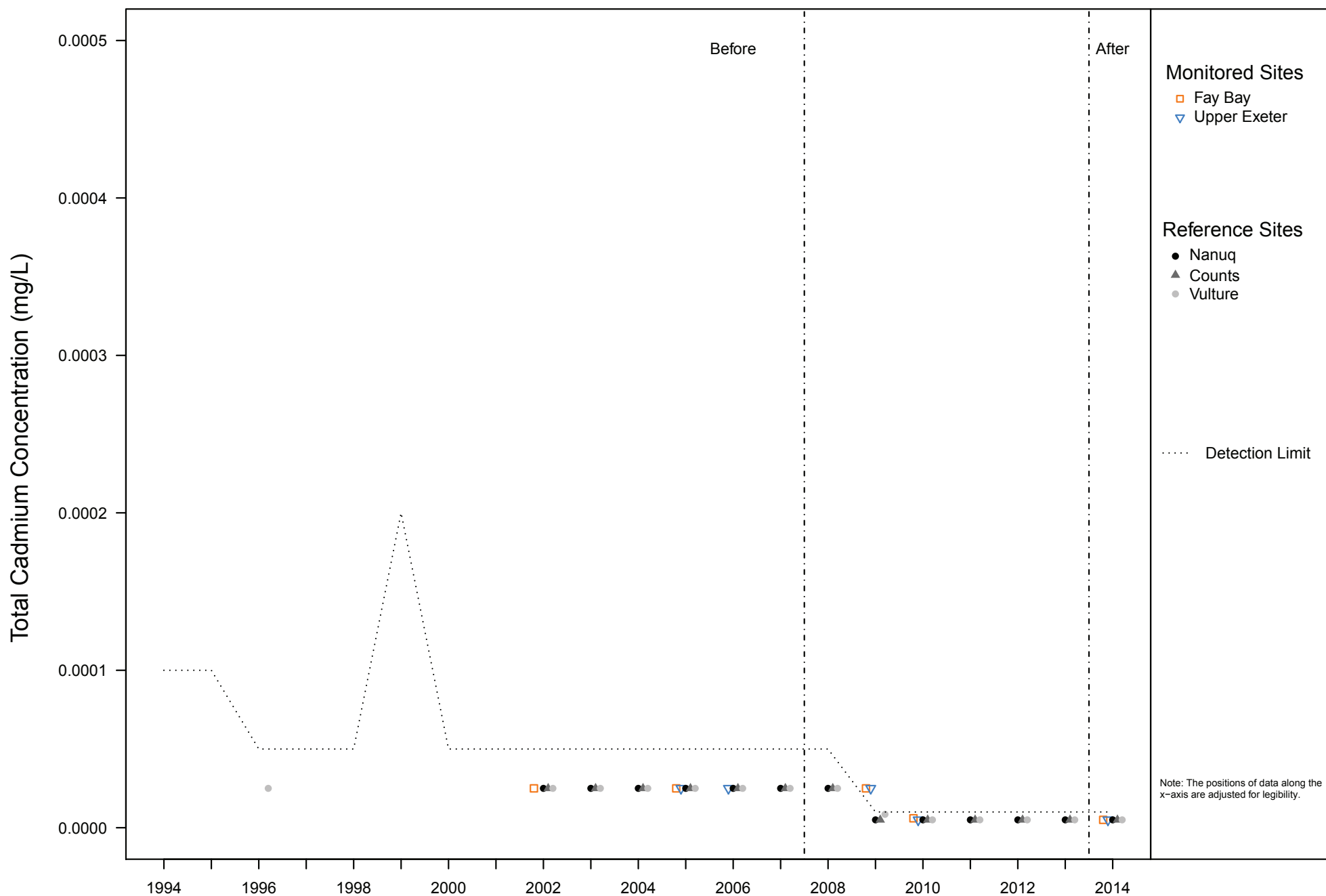
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Cadmium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

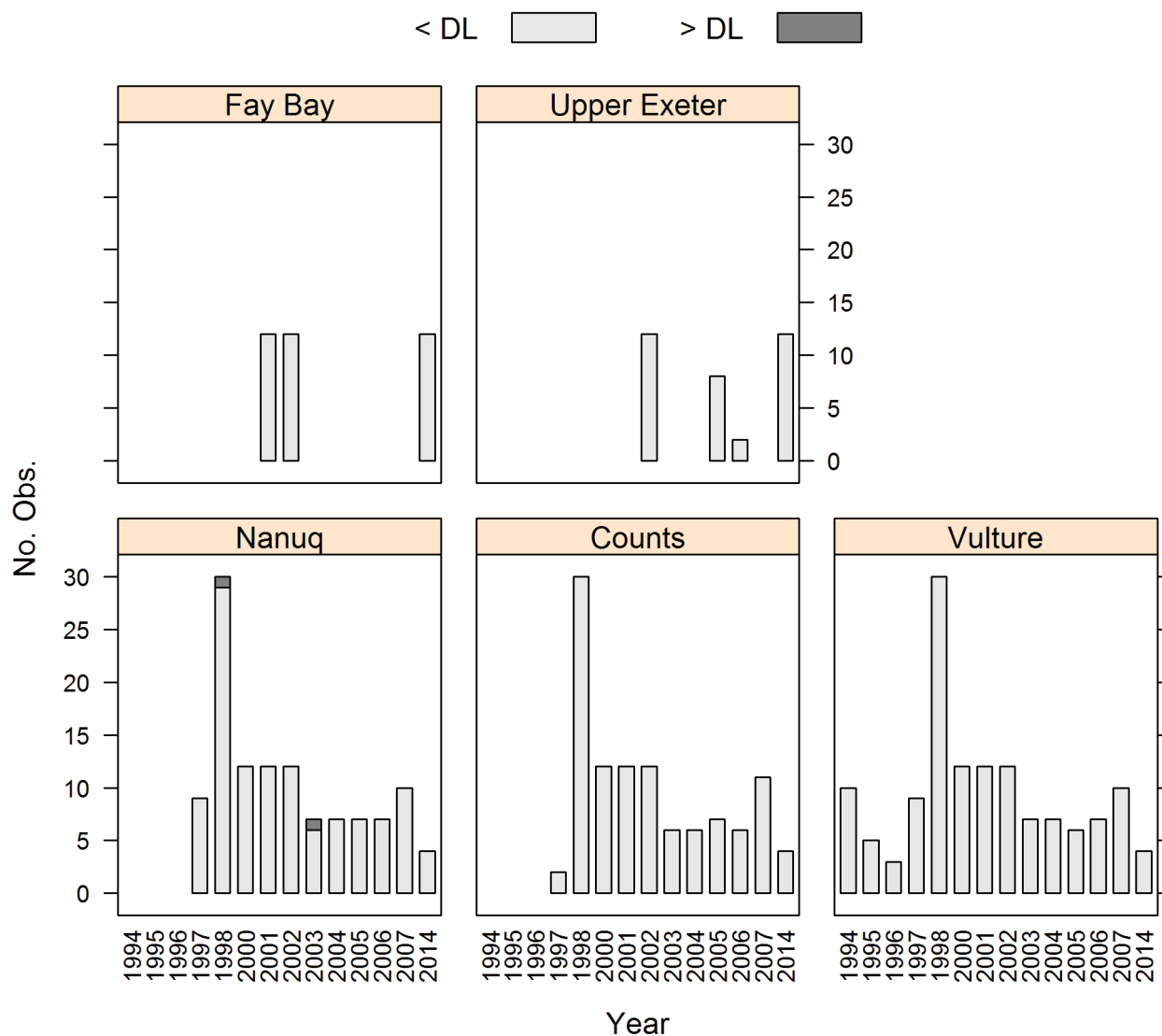


Analysis of Summer Total Cadmium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

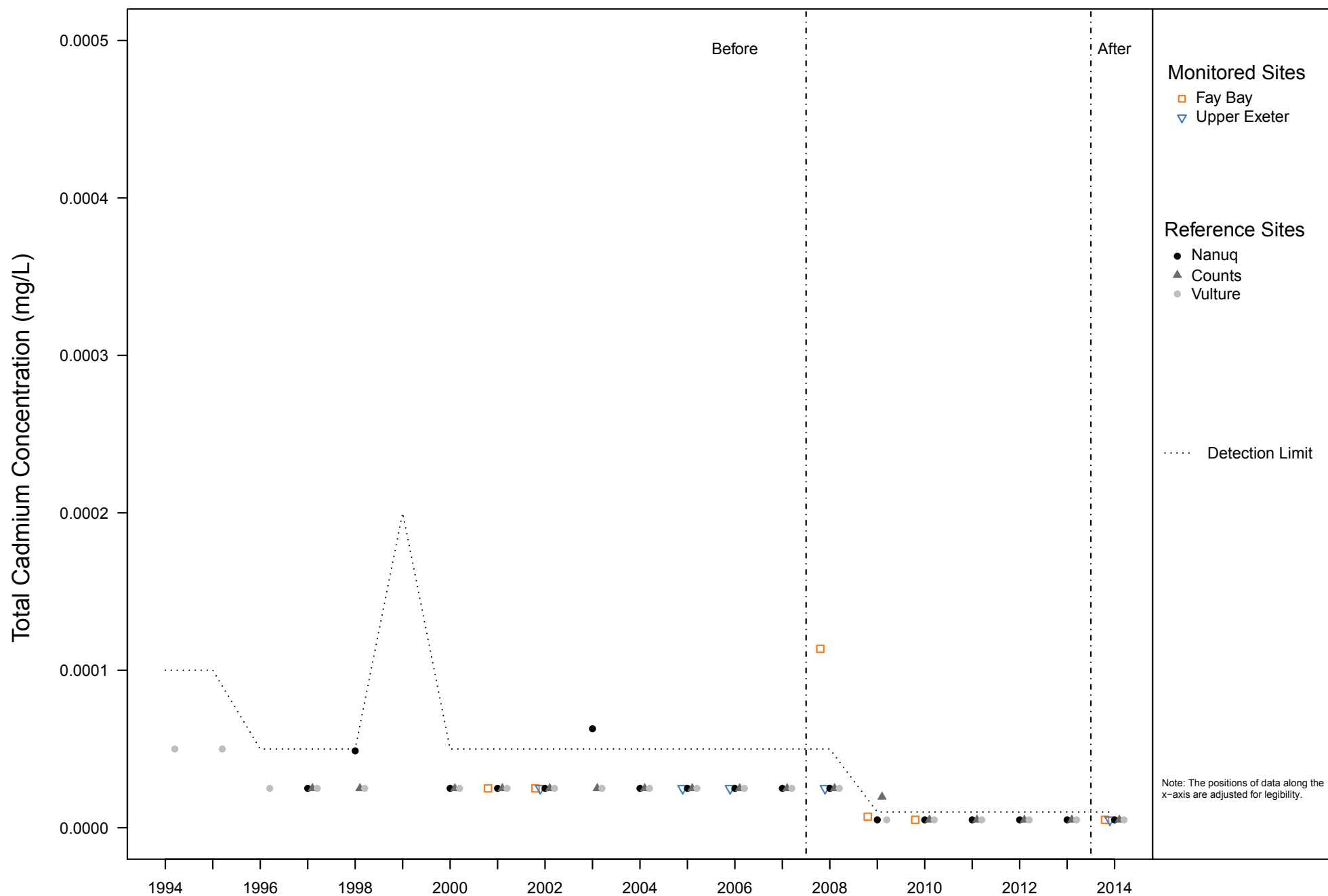
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Cadmium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

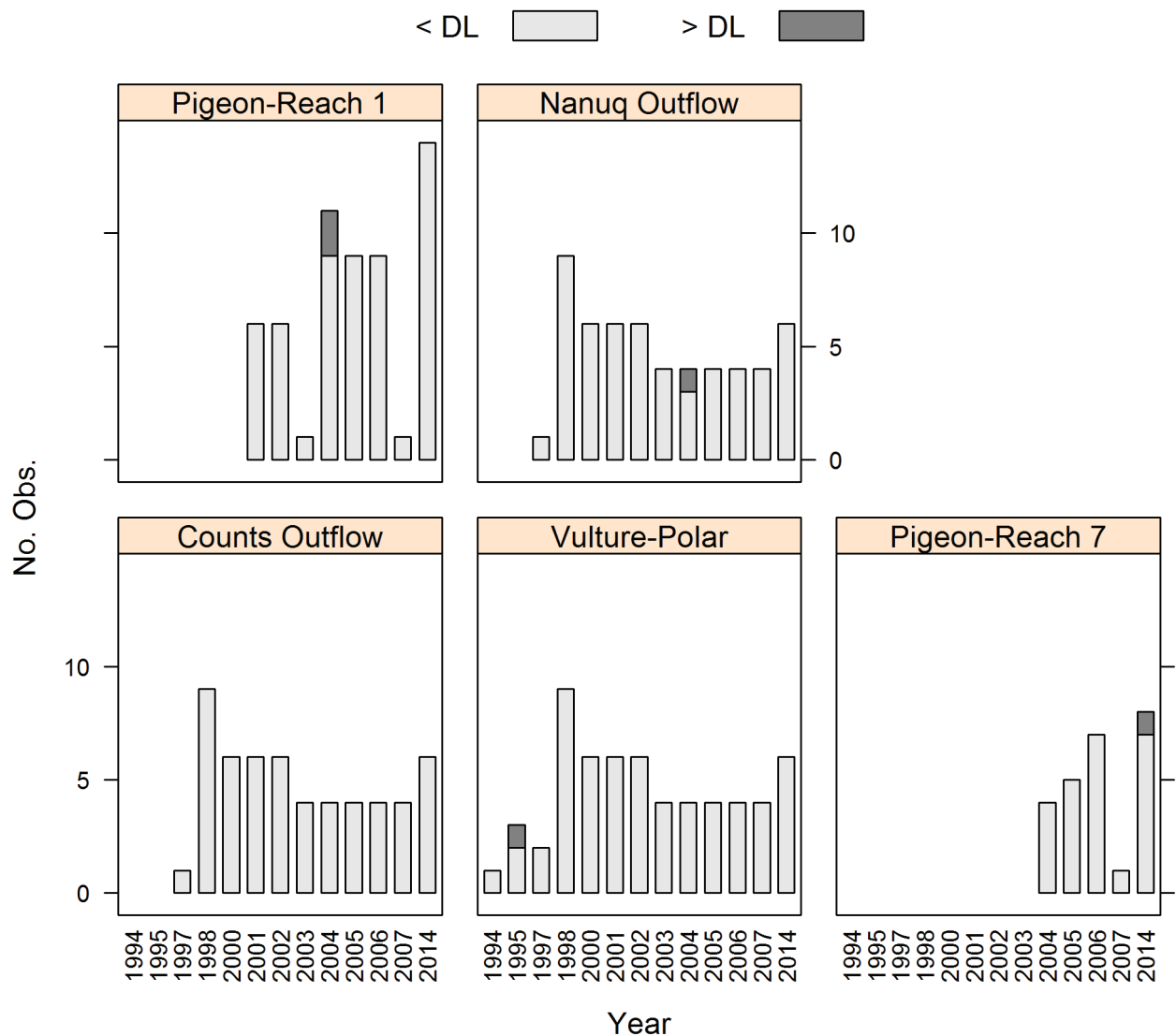


Analysis of Summer Total Cadmium Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

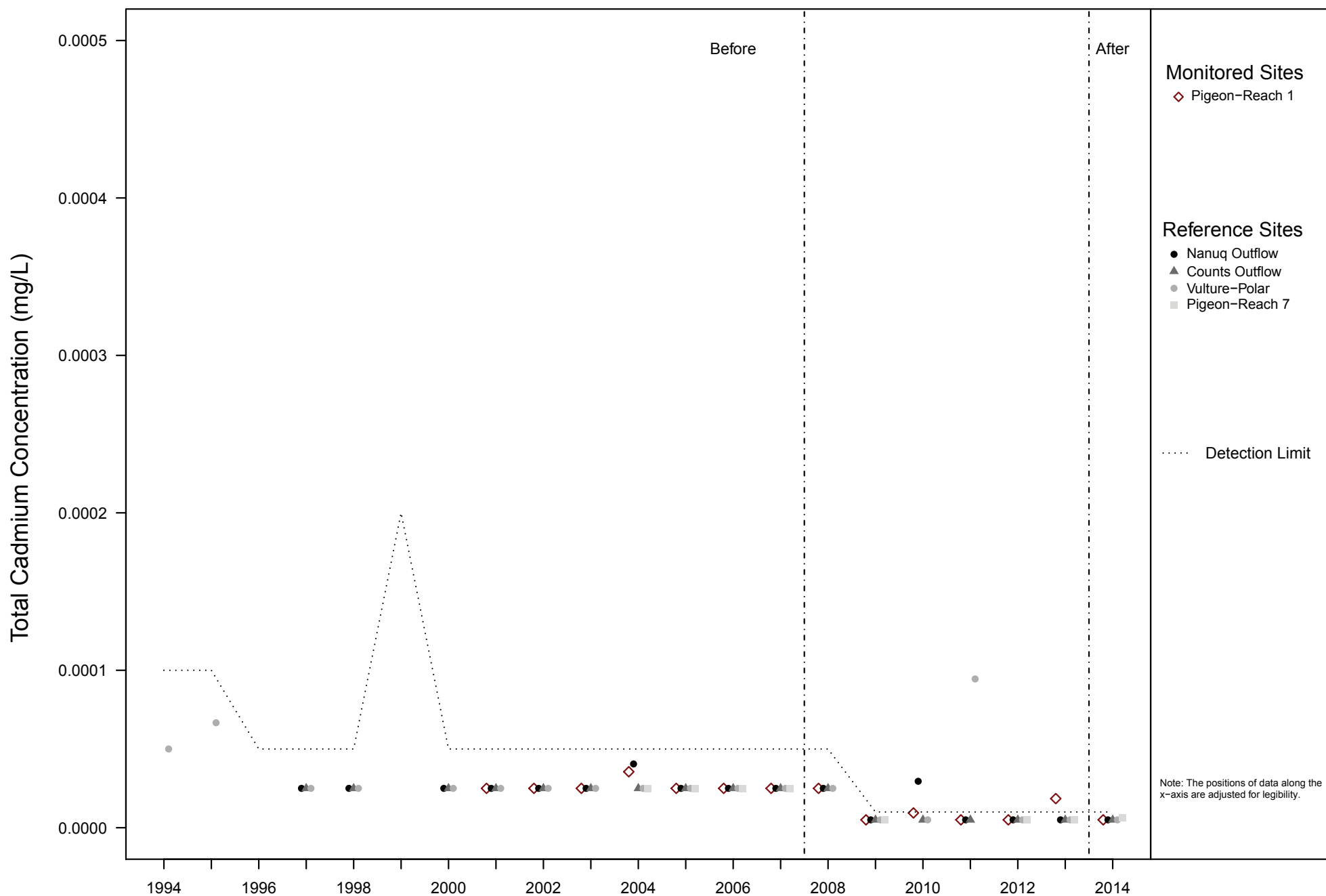
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Cadmium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

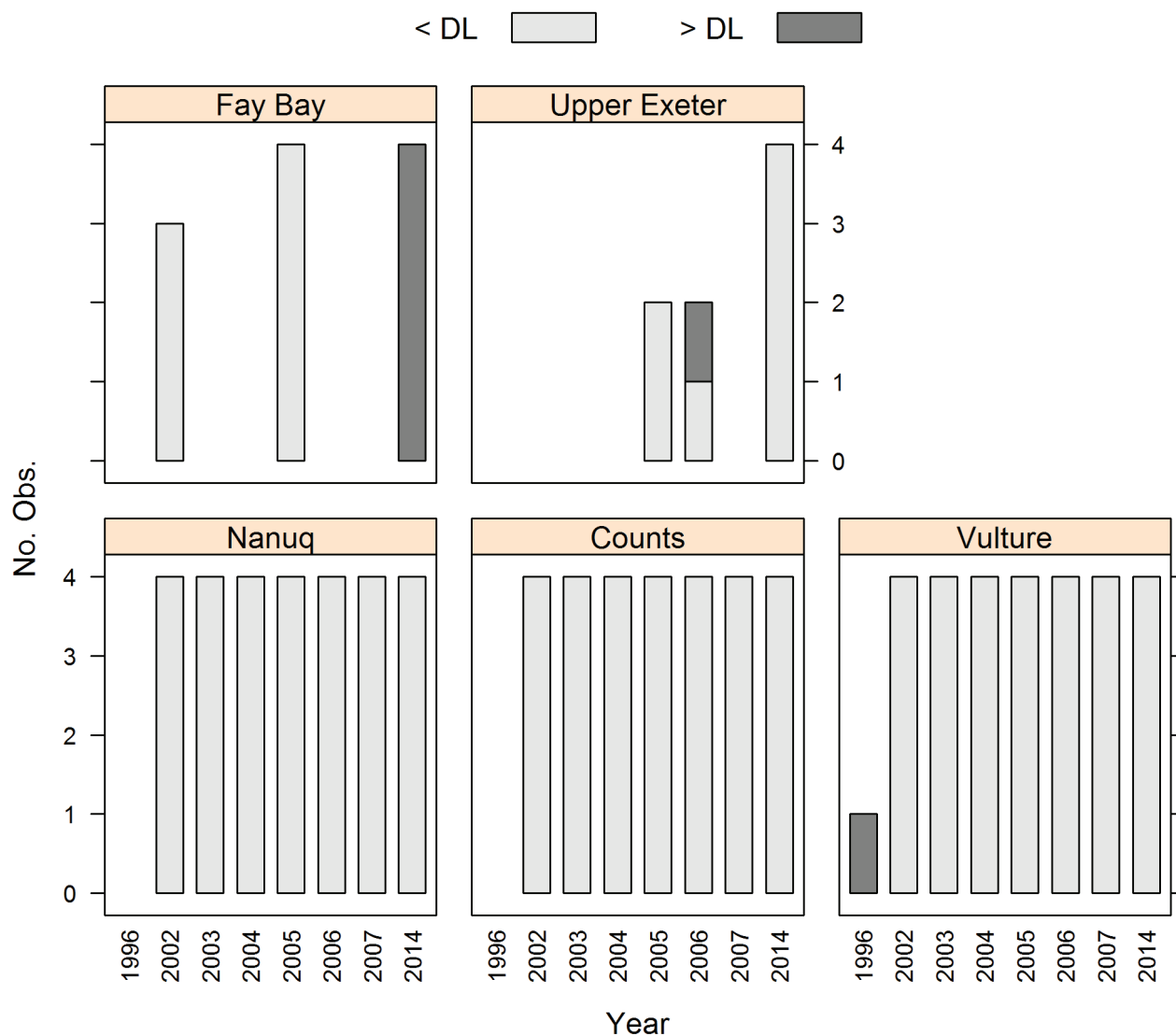


Analysis of Winter Total Molybdenum Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

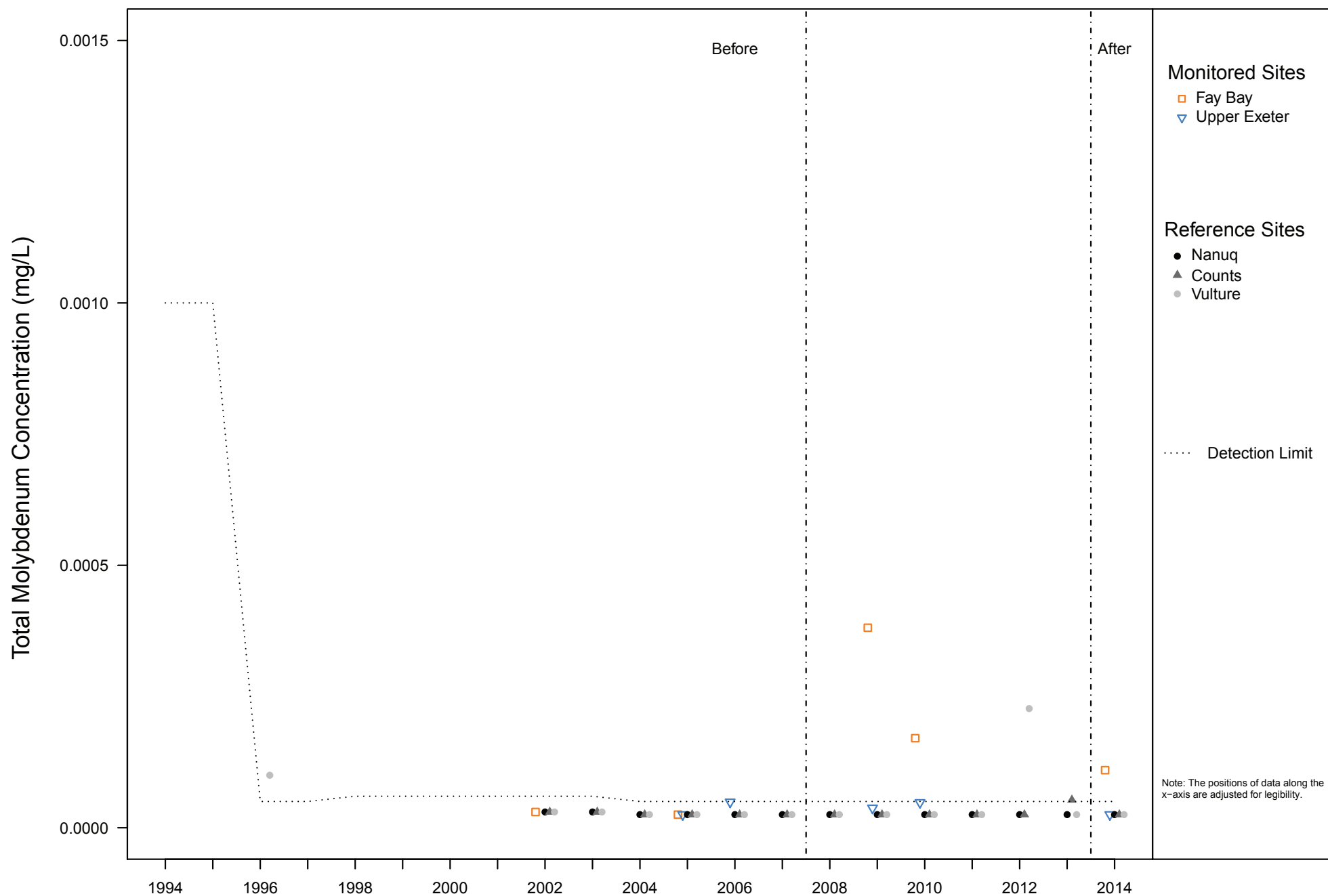
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Molybdenum water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

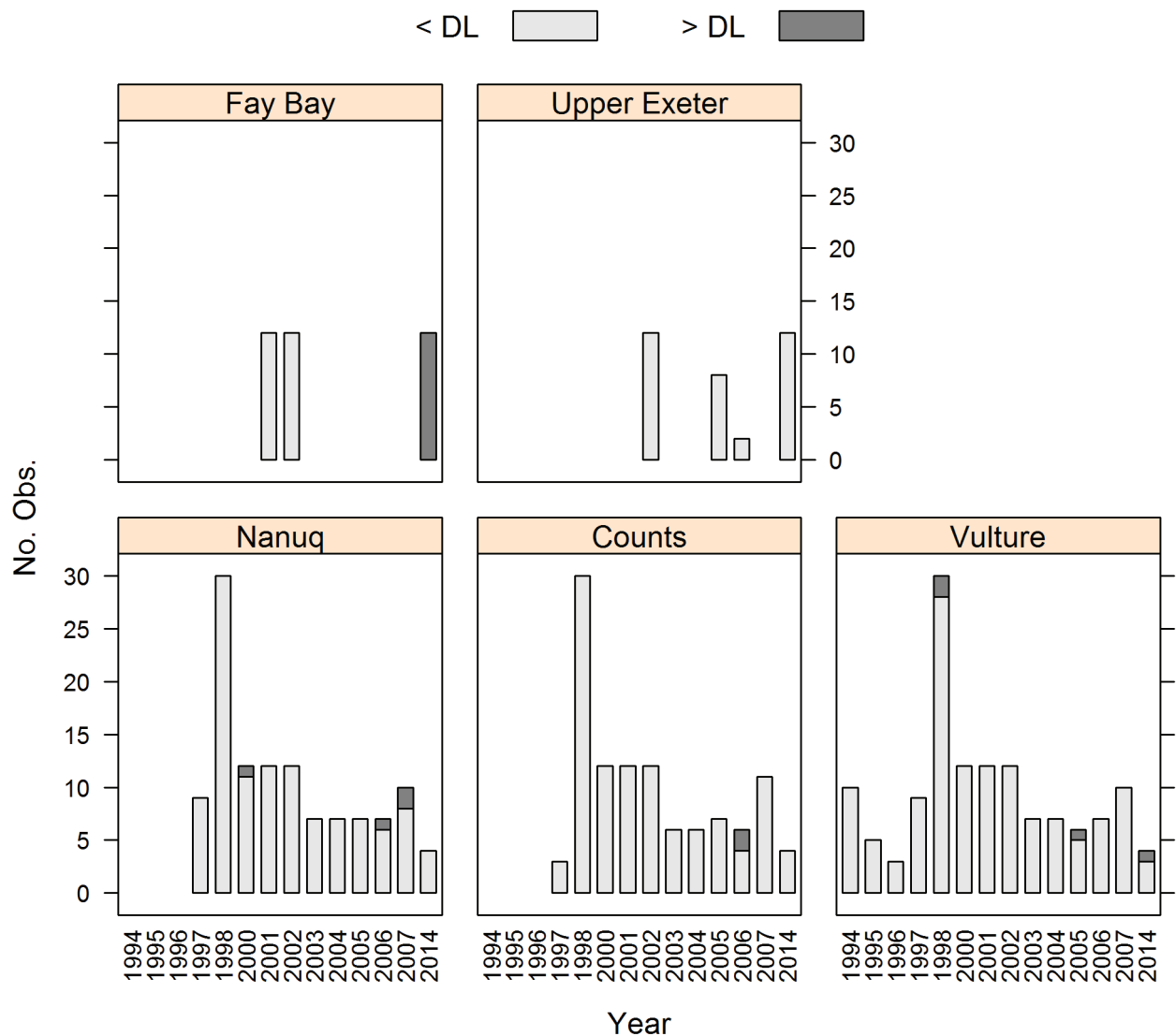


Analysis of Summer Total Molybdenum Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

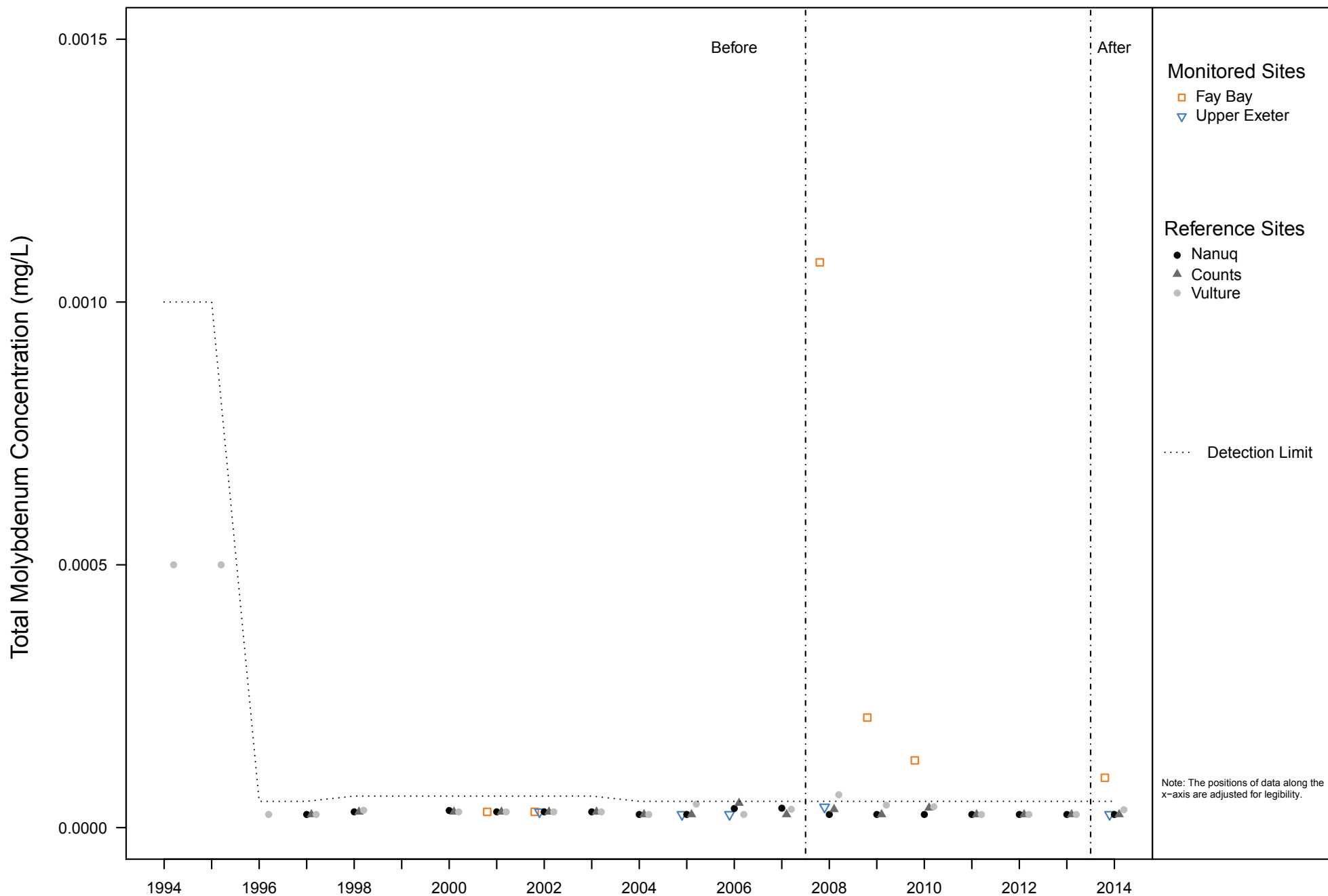
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Molybdenum water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

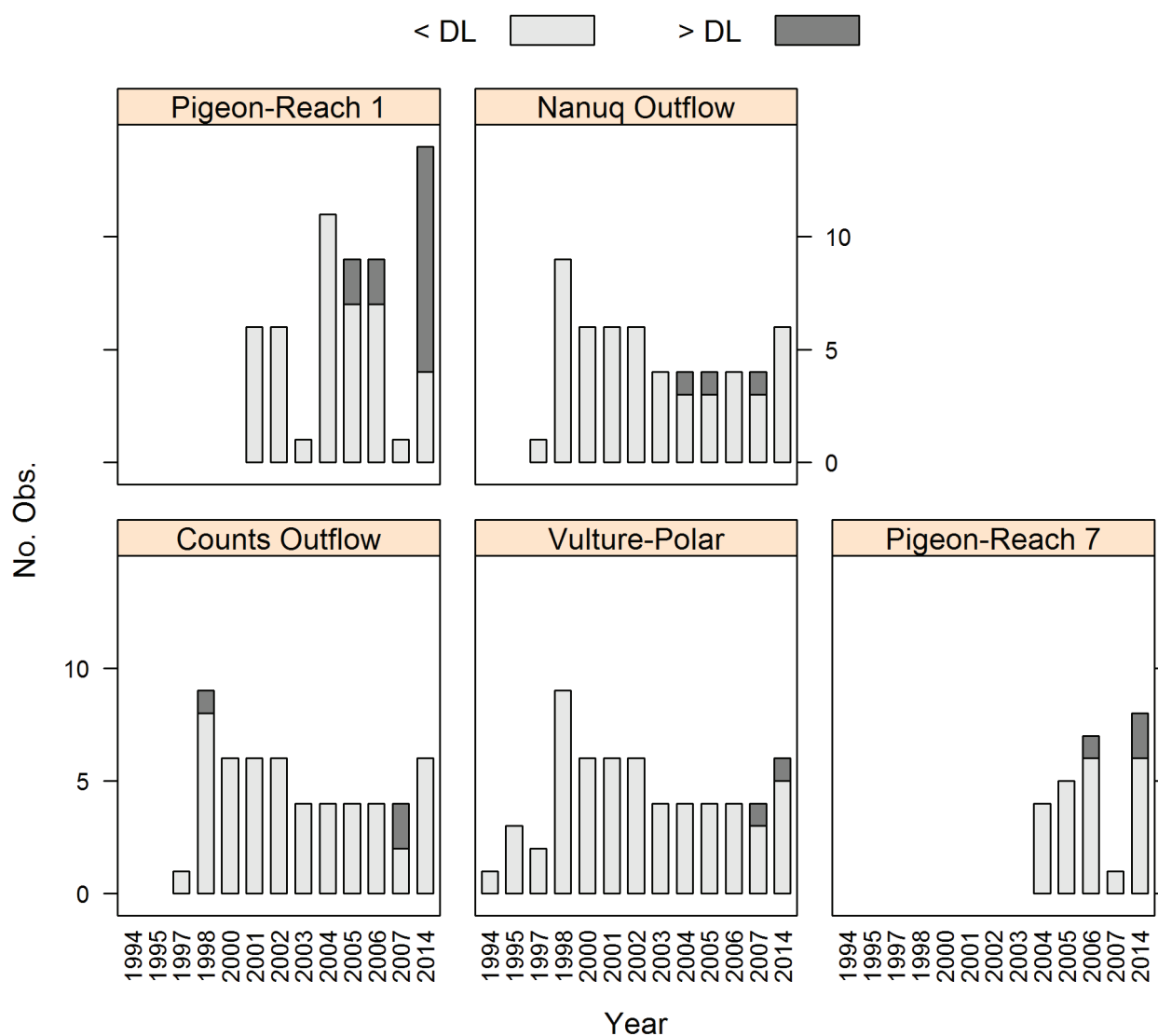


Analysis of Summer Total Molybdenum Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

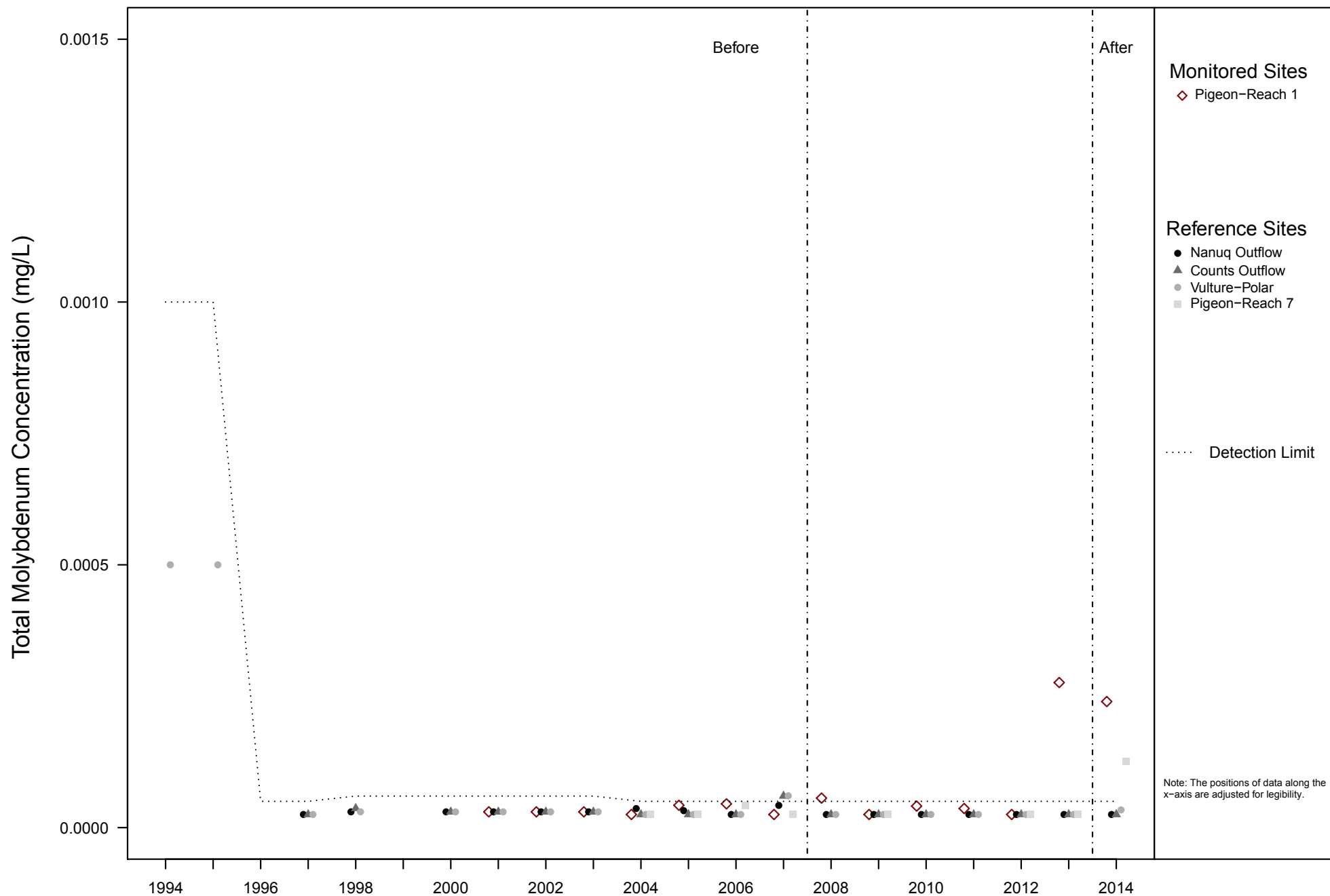
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Molybdenum water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

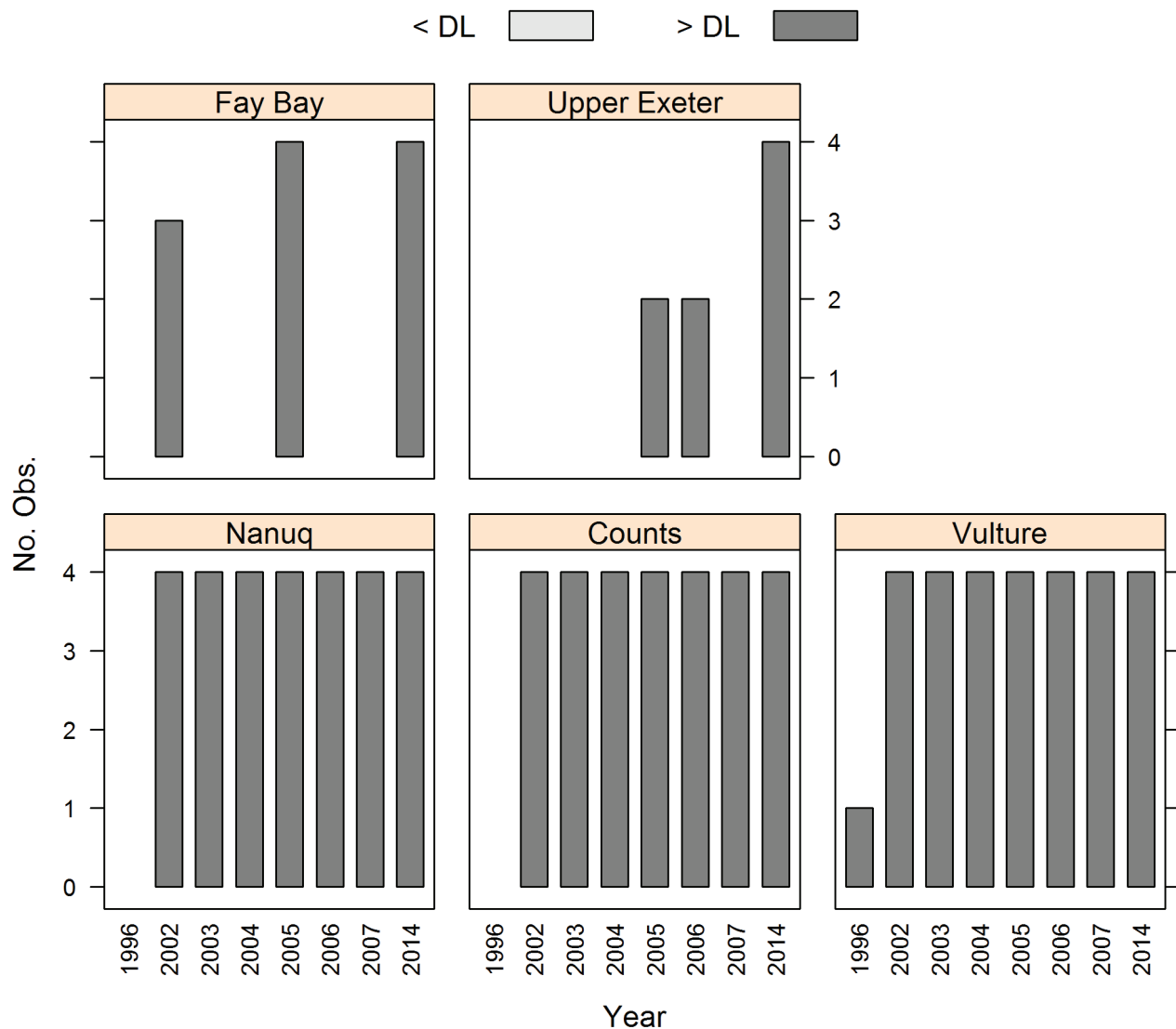


Analysis of Winter Total Nickel Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

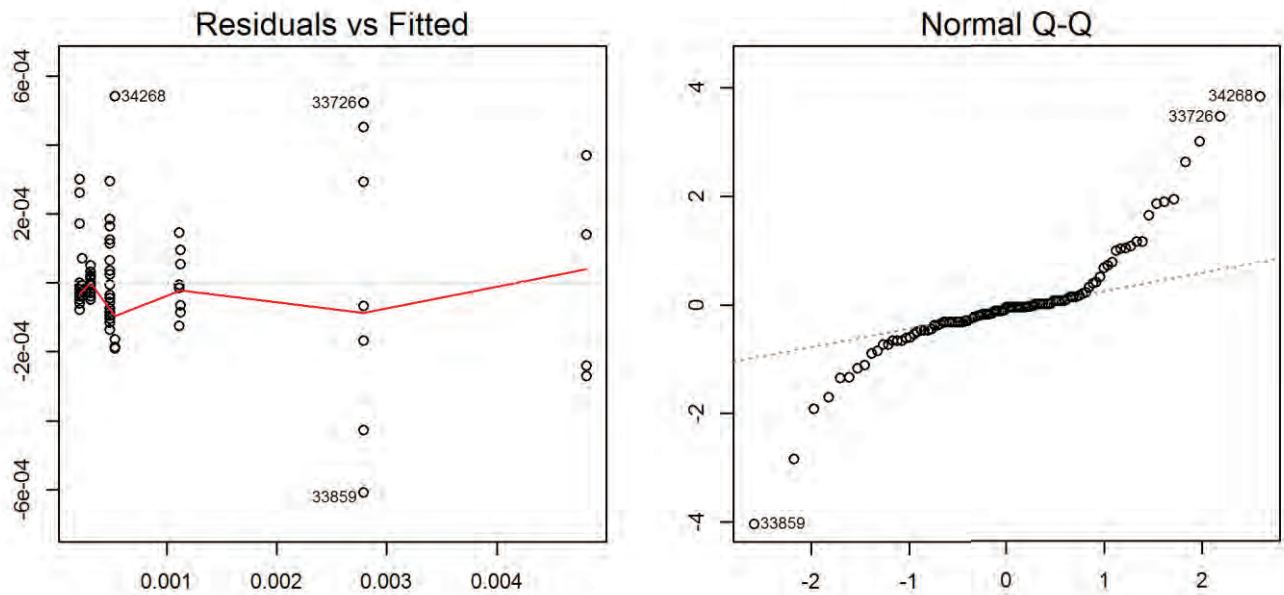
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

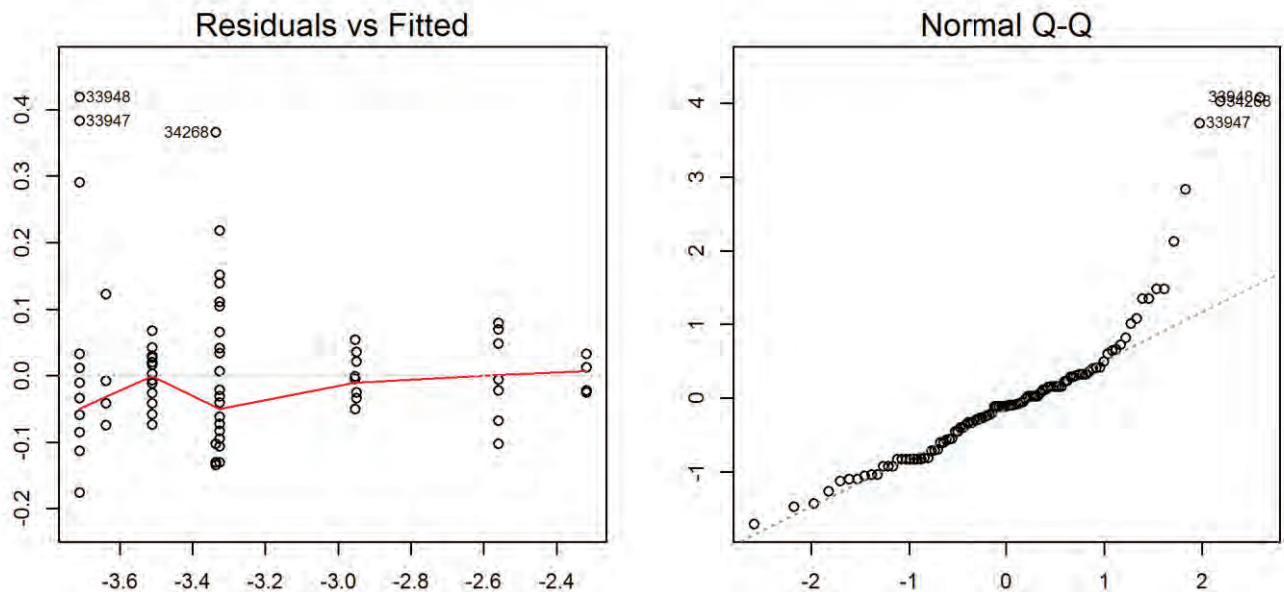
```
##          site year month season
## 33456 Vulture 1996 April  winter
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.63×10 ⁻⁴	0.98	0.98
Log-10	0.1	0.93	0.93

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

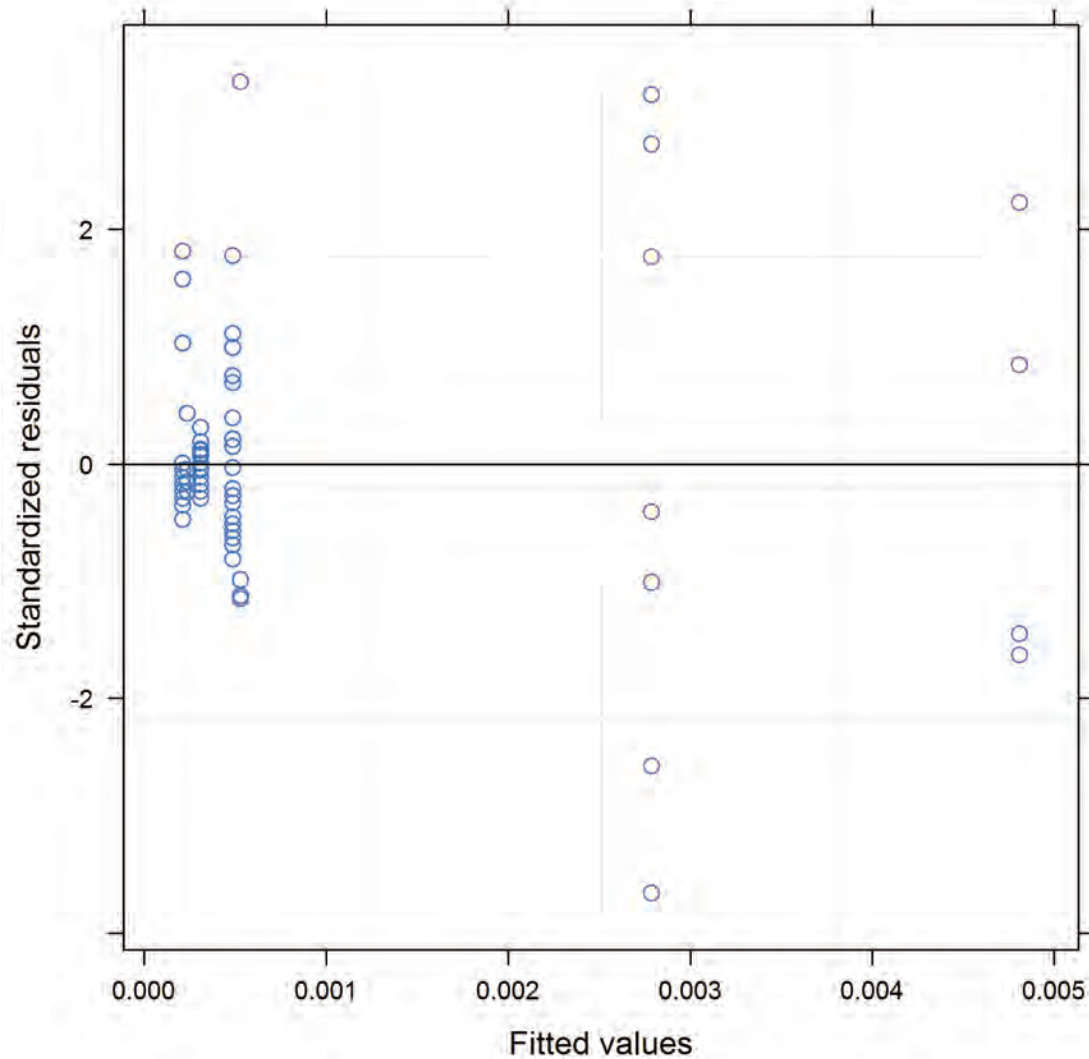
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-1232.42	625.21		
LME	10	-1232.72	626.36	2.3	0.13

Conclusion:

The most appropriate model for total nickel at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.129$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 87
##          numDF F-value p-value
## (Intercept)    1   1718 <.0001
## site           3   1206 <.0001
## period         1    82  <.0001
## site:period     3    99  <.0001
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.0020	-0.0023	-0.0017	sig.
Counts	-0.0020	-0.0023	-0.0017	sig.
Vulture	-0.0020	-0.0023	-0.0018	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

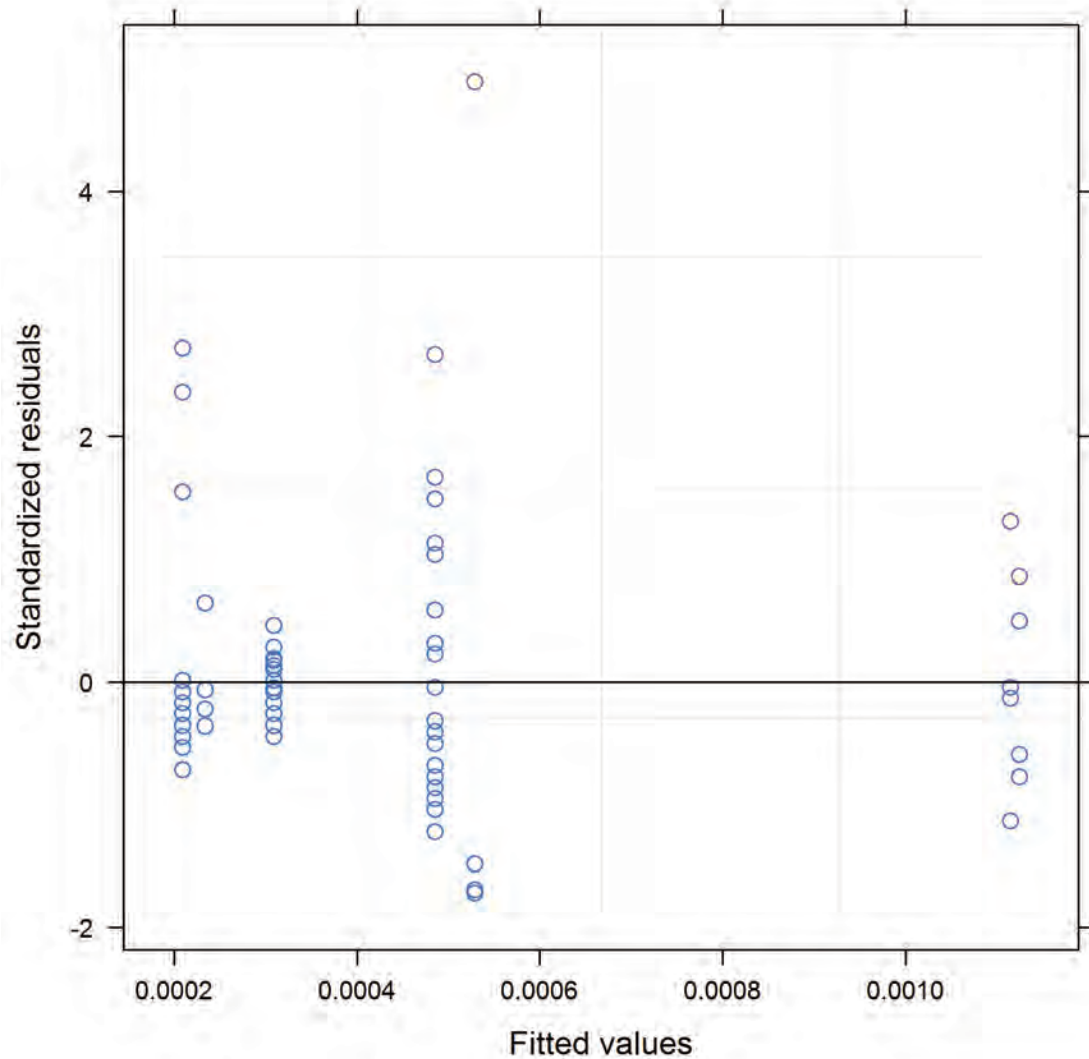
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-1257.78	637.89		
LME	10	-1255.87	637.94	0.09	0.76

Conclusion:

The most appropriate model for total nickel at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.758$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 84
##          numDF F-value p-value
## (Intercept)    1   1240 <.0001
## site           3    153 <.0001
## period         1      0  0.58
## site:period    3      0  0.93
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	3.48×10^{-5}	-1.61×10^{-4}	2.3×10^{-4}	not sig.
Counts	5.4×10^{-5}	-1.41×10^{-4}	2.49×10^{-4}	not sig.
Vulture	9.75×10^{-6}	-1.86×10^{-4}	2.05×10^{-4}	not sig.

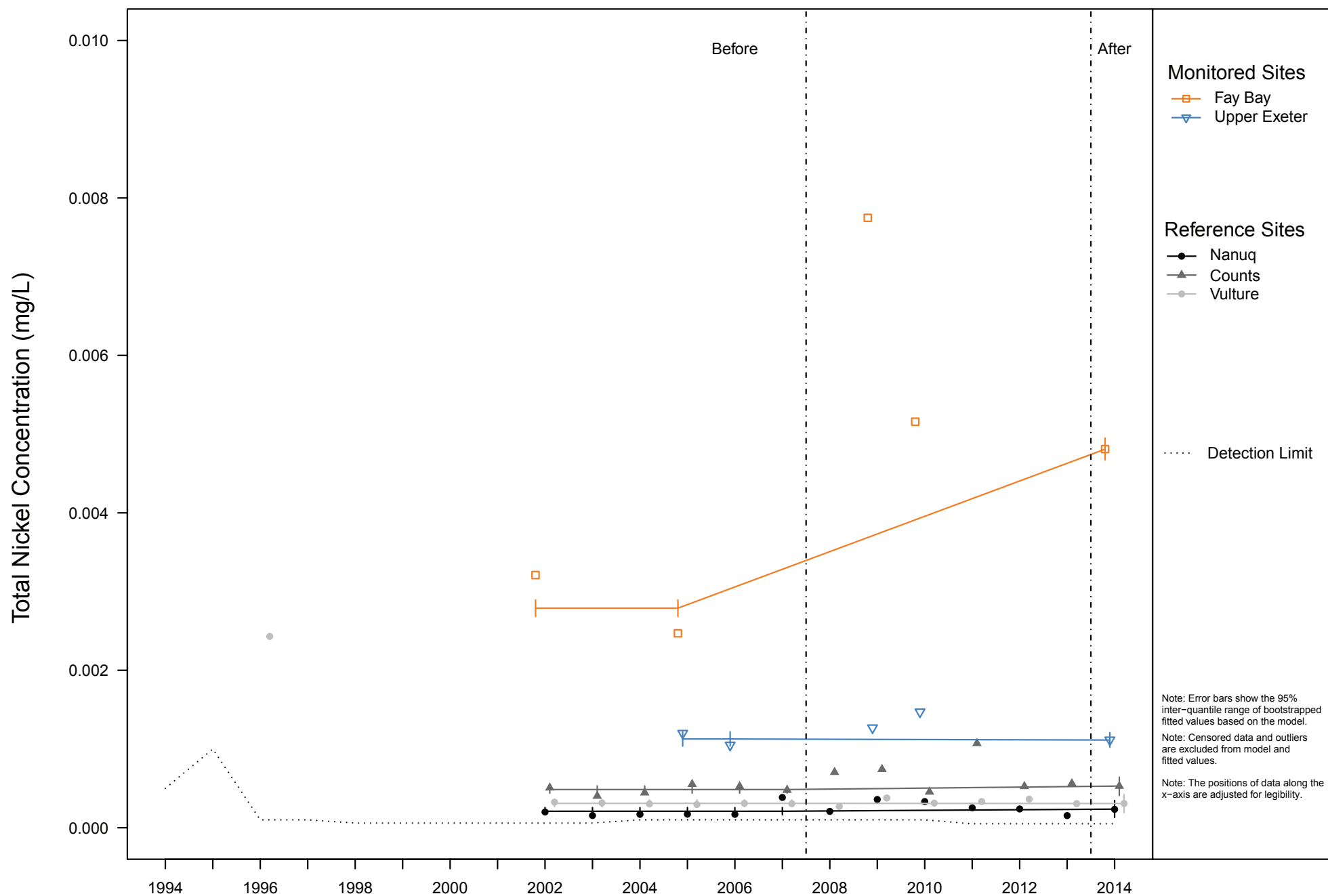
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Upper Exeter site were not significantly ($p = 0.935$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

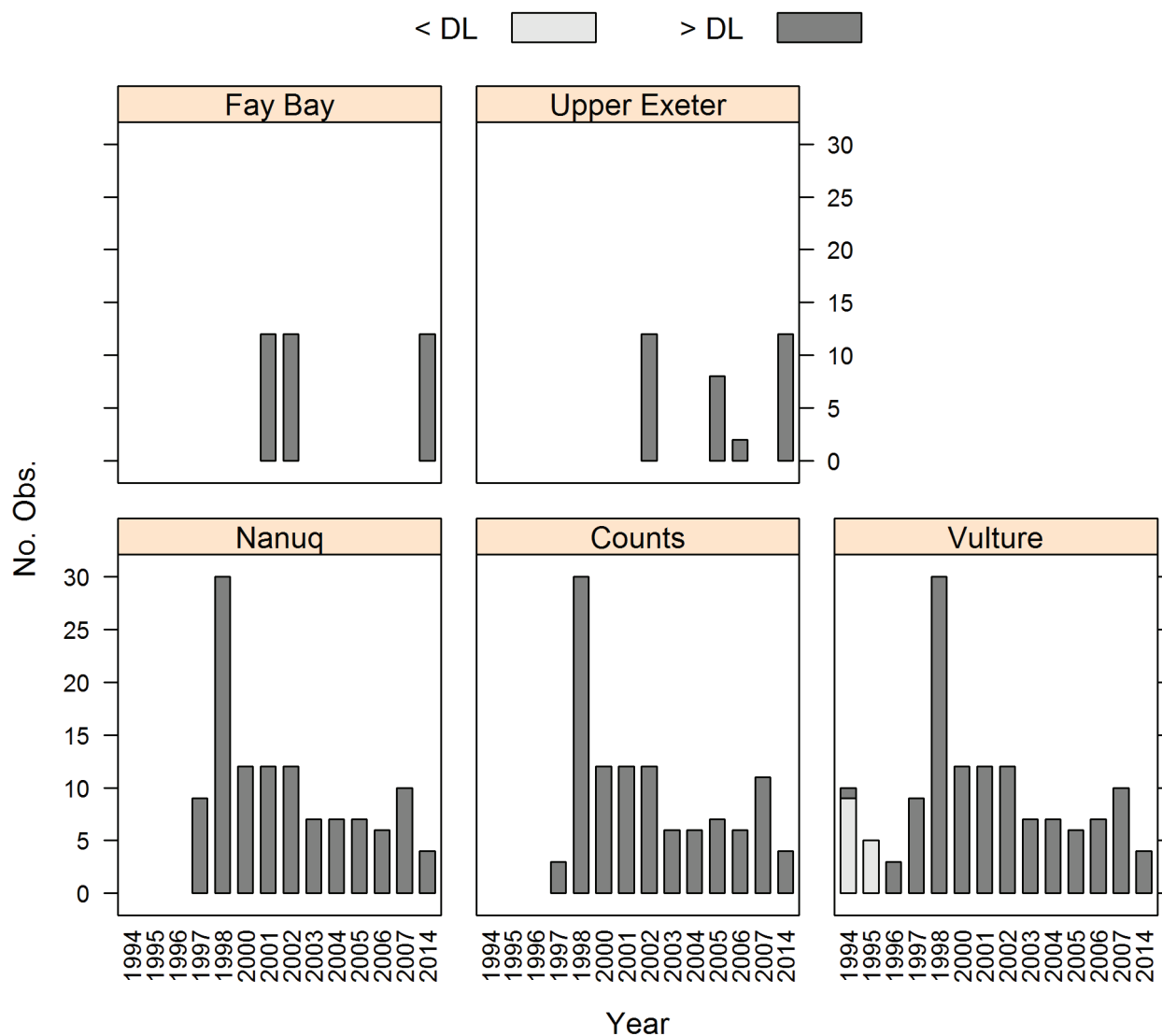


Analysis of Summer Total Nickel Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
##      site year month season
## 33441 Vulture 1994  July summer
## 33442 Vulture 1994  July summer
## 33443 Vulture 1994  July summer
## 33444 Vulture 1994  July summer
## 33445 Vulture 1994  July summer
## 33446 Vulture 1994 August summer
## 33447 Vulture 1994 August summer
## 33448 Vulture 1994 August summer
## 33449 Vulture 1994 August summer
## 33450 Vulture 1994 August summer
## 33451 Vulture 1995 August summer
## 33452 Vulture 1995 August summer
## 33453 Vulture 1995 August summer
## 33454 Vulture 1995 August summer
## 33455 Vulture 1995 August summer
```

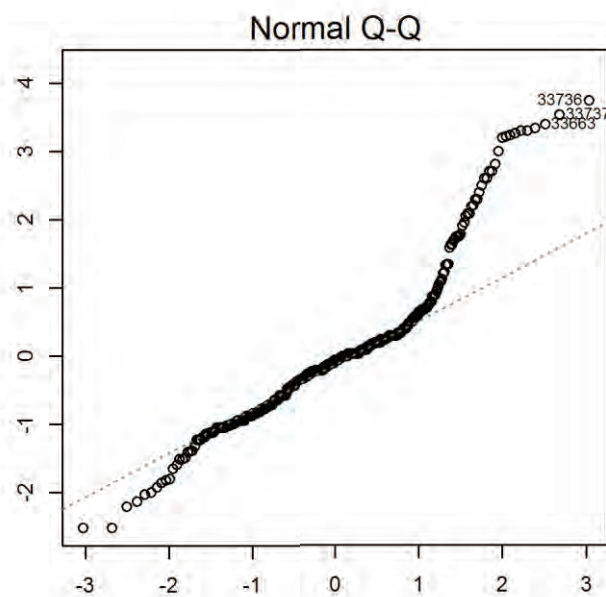
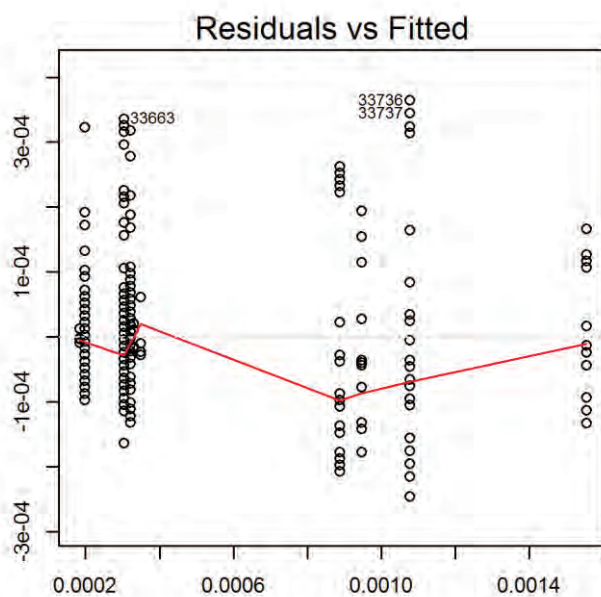
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

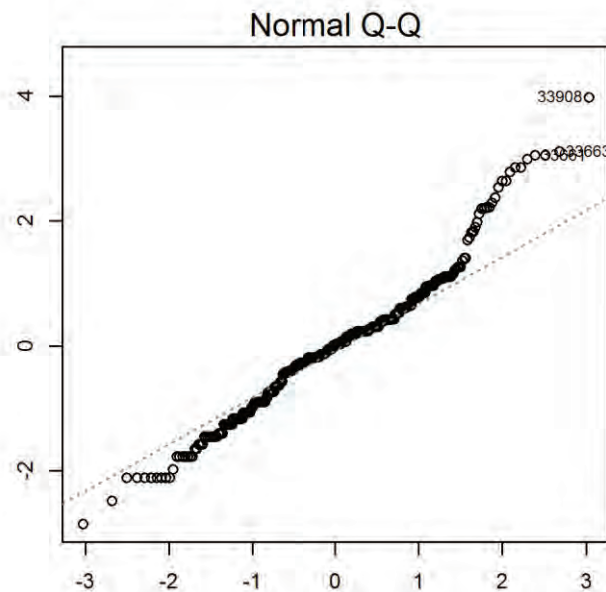
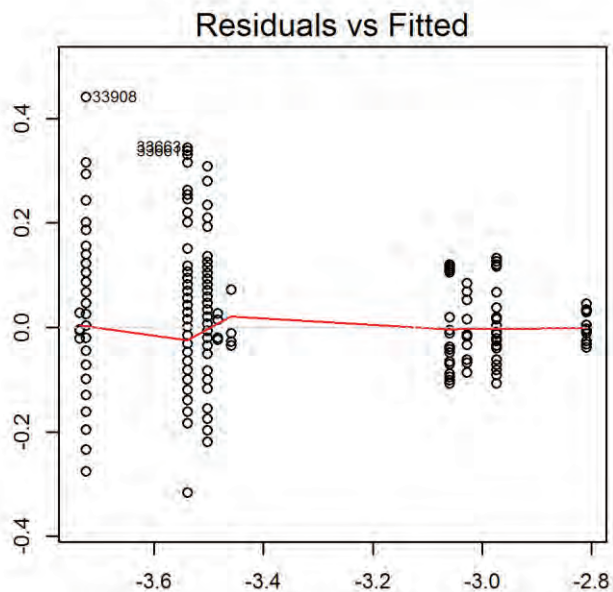
```
##      site year month season
## 33788 Counts 2003  July summer
## 33888 Vulture 2005  July summer
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	9.95×10 ⁻⁵	0.91	0.91
Log-10	0.11	0.84	0.83

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

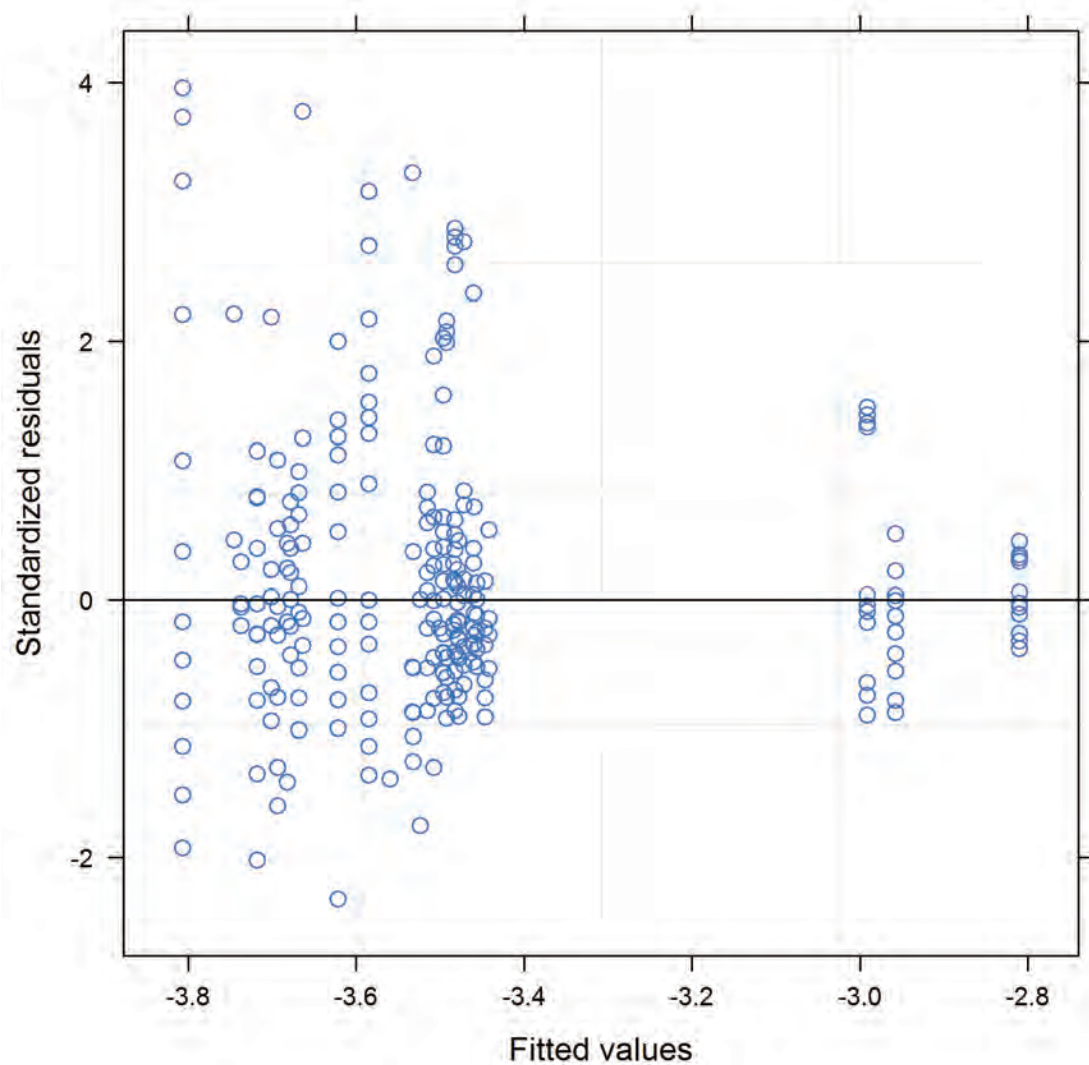
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-516.48	267.24		
LME	10	-588.6	304.3	74.13	0

Conclusion:

The most appropriate model for total nickel at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	360	57038	<.0001
## site	3	360	432	<.0001
## period	1	10	2	0.1579
## site:period	3	360	5	0.0016

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.22	-0.34	-0.1	sig.
Counts	-0.13	-0.25	-0.01	sig.
Vulture	-0.19	-0.31	-0.06	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Fay Bay site were significantly ($p = 0.002$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

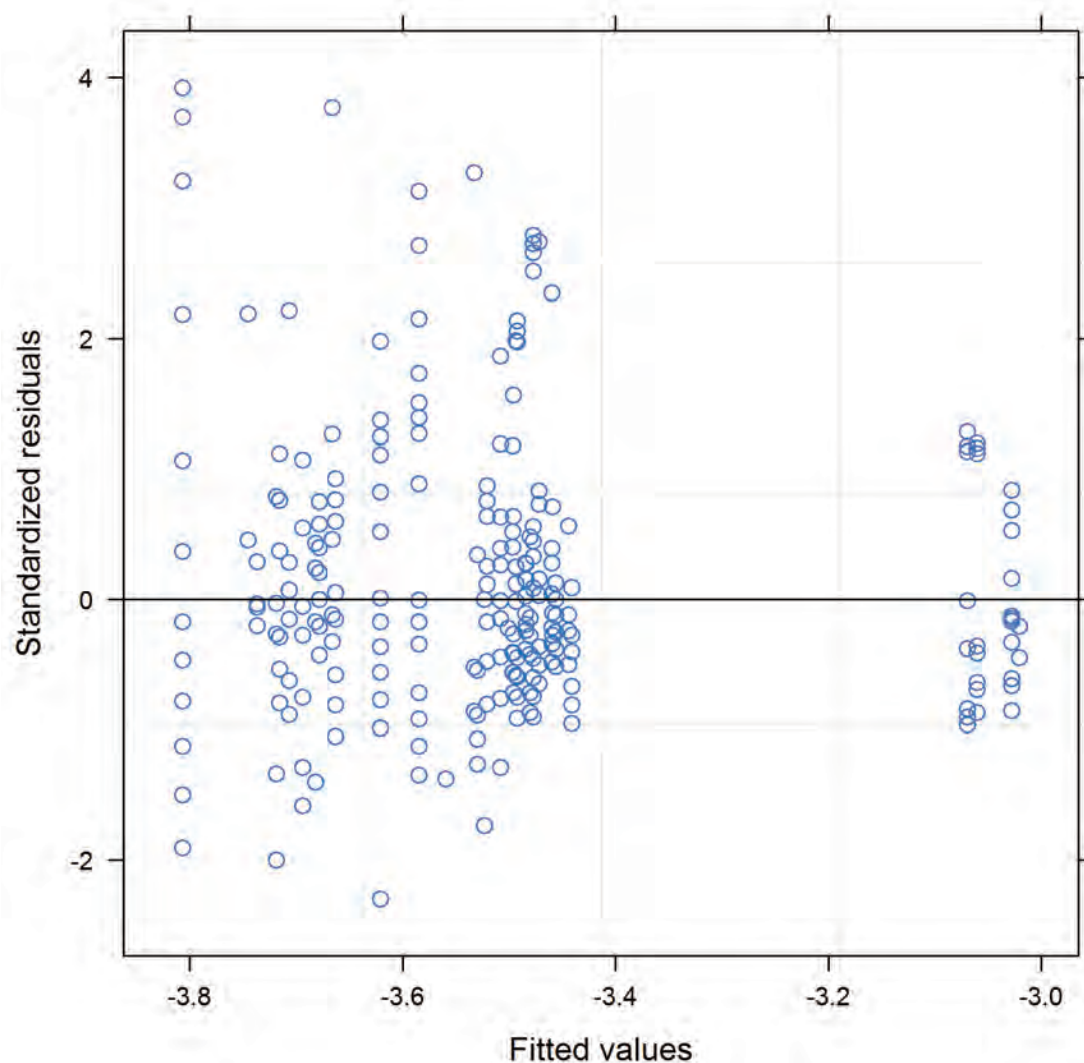
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-506.87	262.44		
LME	10	-577.79	298.9	72.92	0

Conclusion:

The most appropriate model for total nickel at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	358	57155	<.0001
## site	3	358	314	<.0001
## period	1	10	0	0.70
## site:period	3	358	1	0.61

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.06	-0.19	0.06	not sig.
Counts	0.03	-0.1	0.16	not sig.
Vulture	-0.03	-0.16	0.09	not sig.

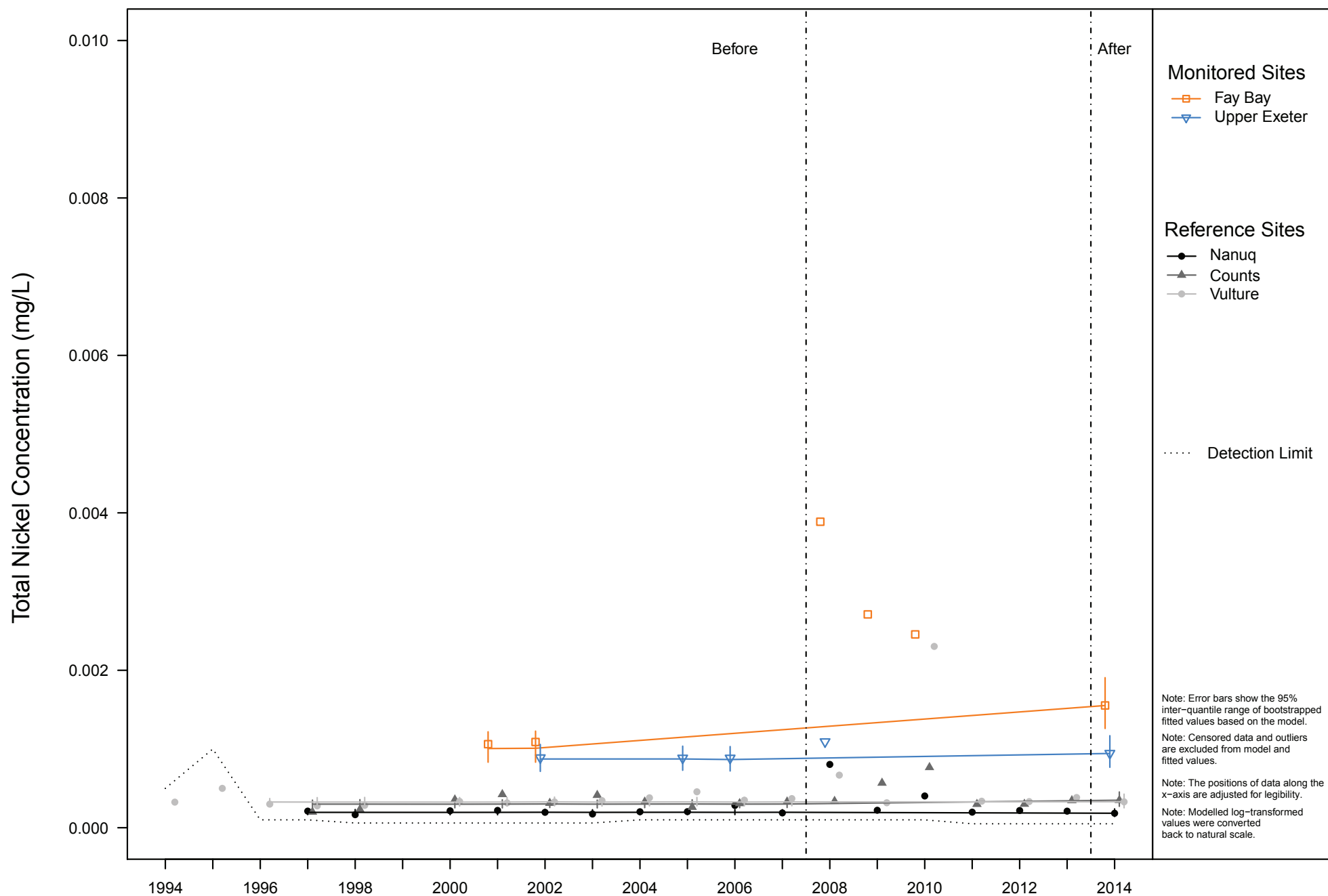
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Upper Exeter site were not significantly ($p = 0.607$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

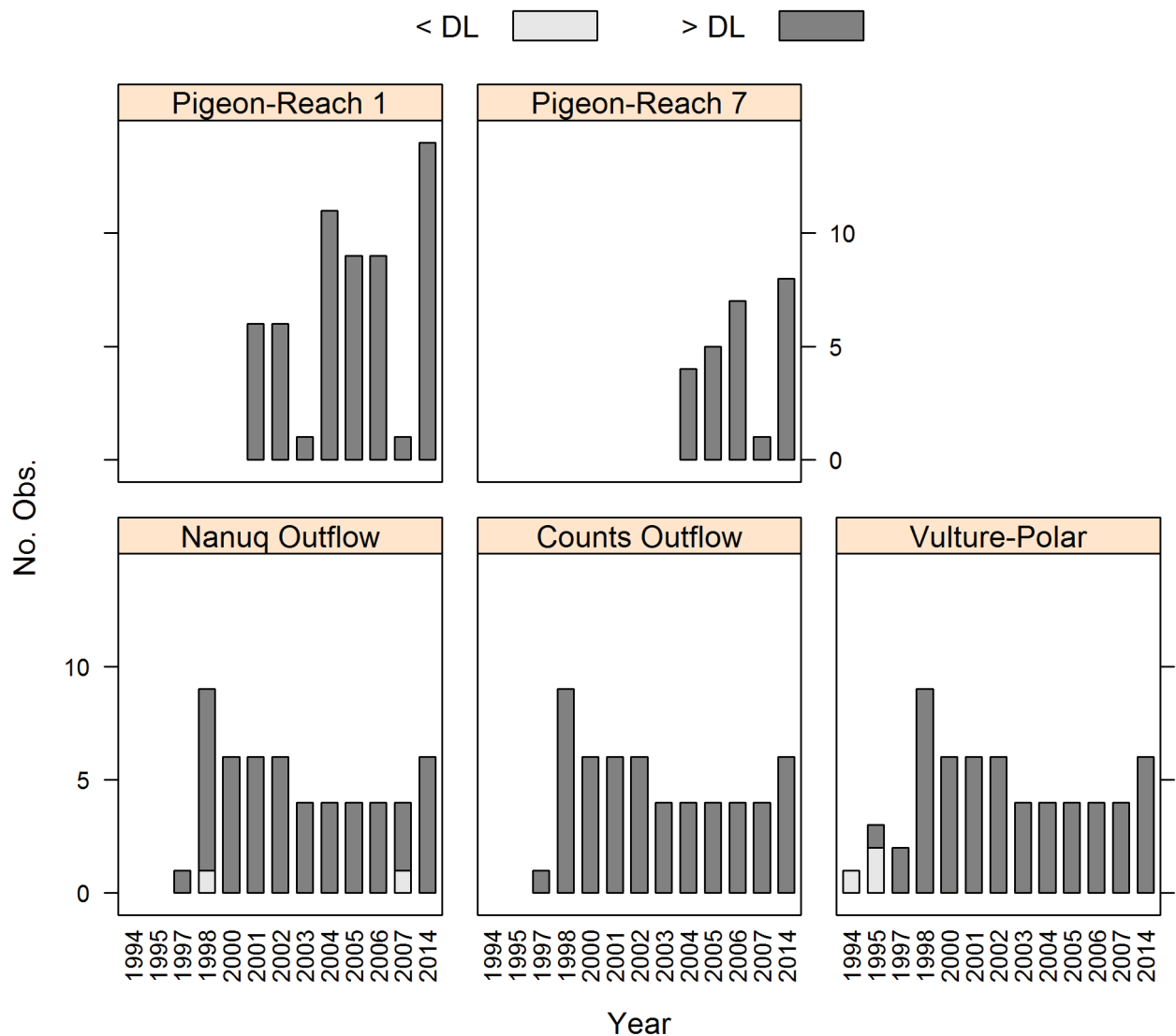


Analysis of Summer Total Nickel Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 22796	Vulture-Polar	1994	August	summer
## 22797	Vulture-Polar	1995	July	summer
## 22798	Vulture-Polar	1995	August	summer
## 22799	Vulture-Polar	1995	September	summer

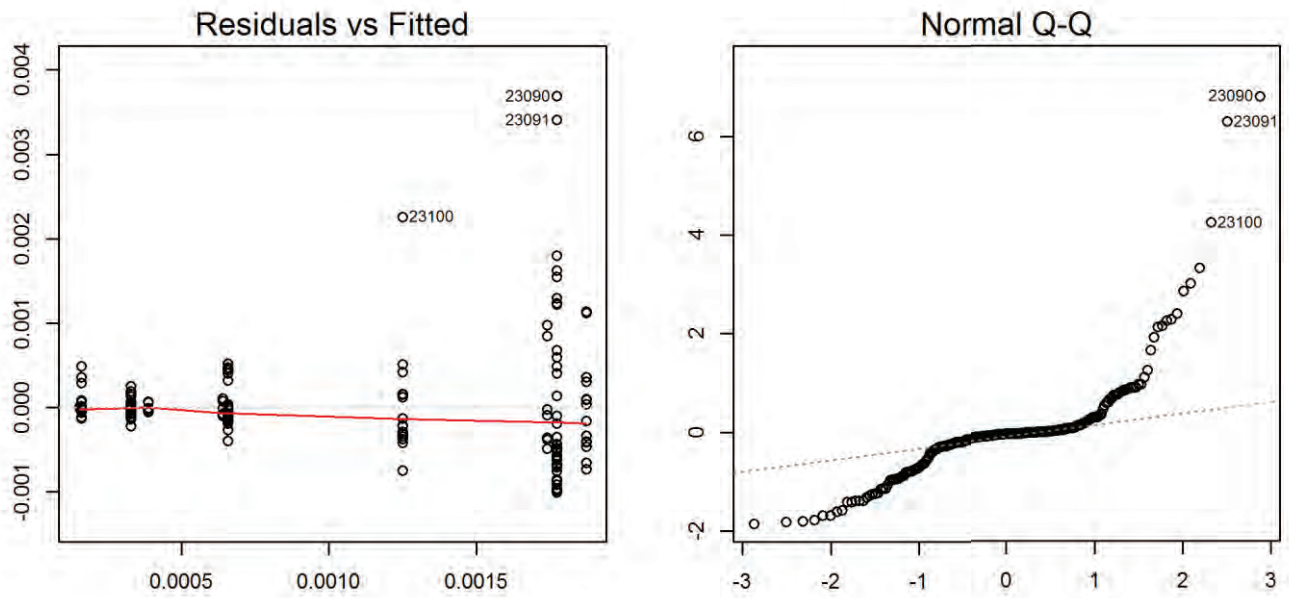
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

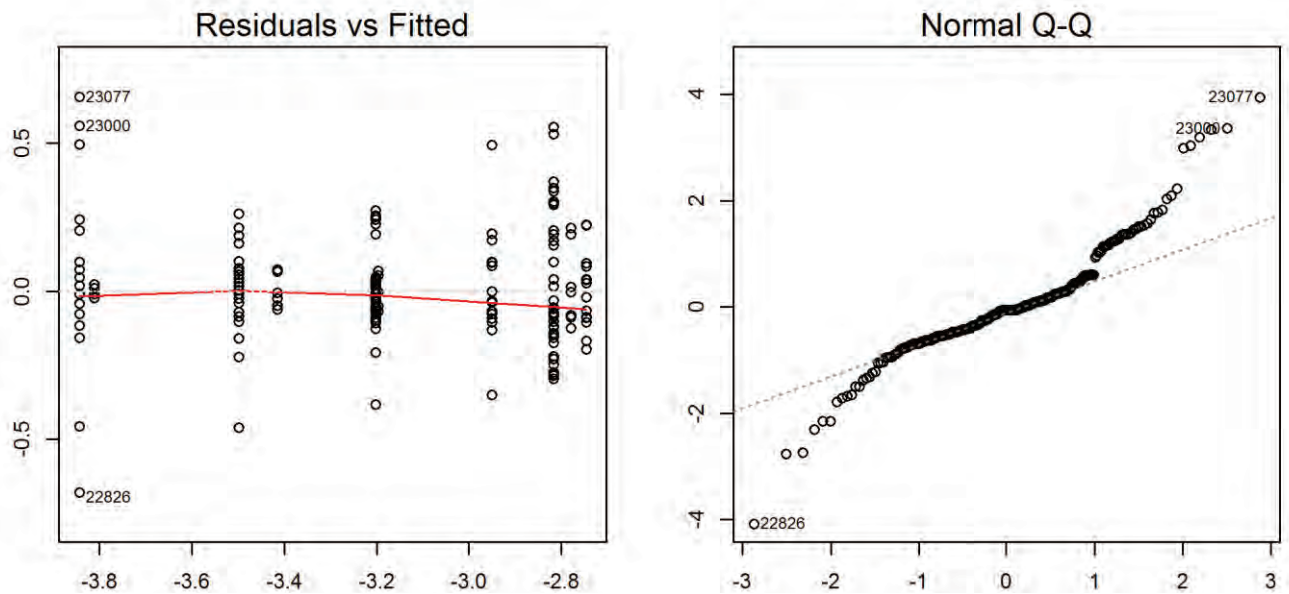
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	5.48×10 ⁻⁴	0.59	0.58
Log-10	0.17	0.85	0.84

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

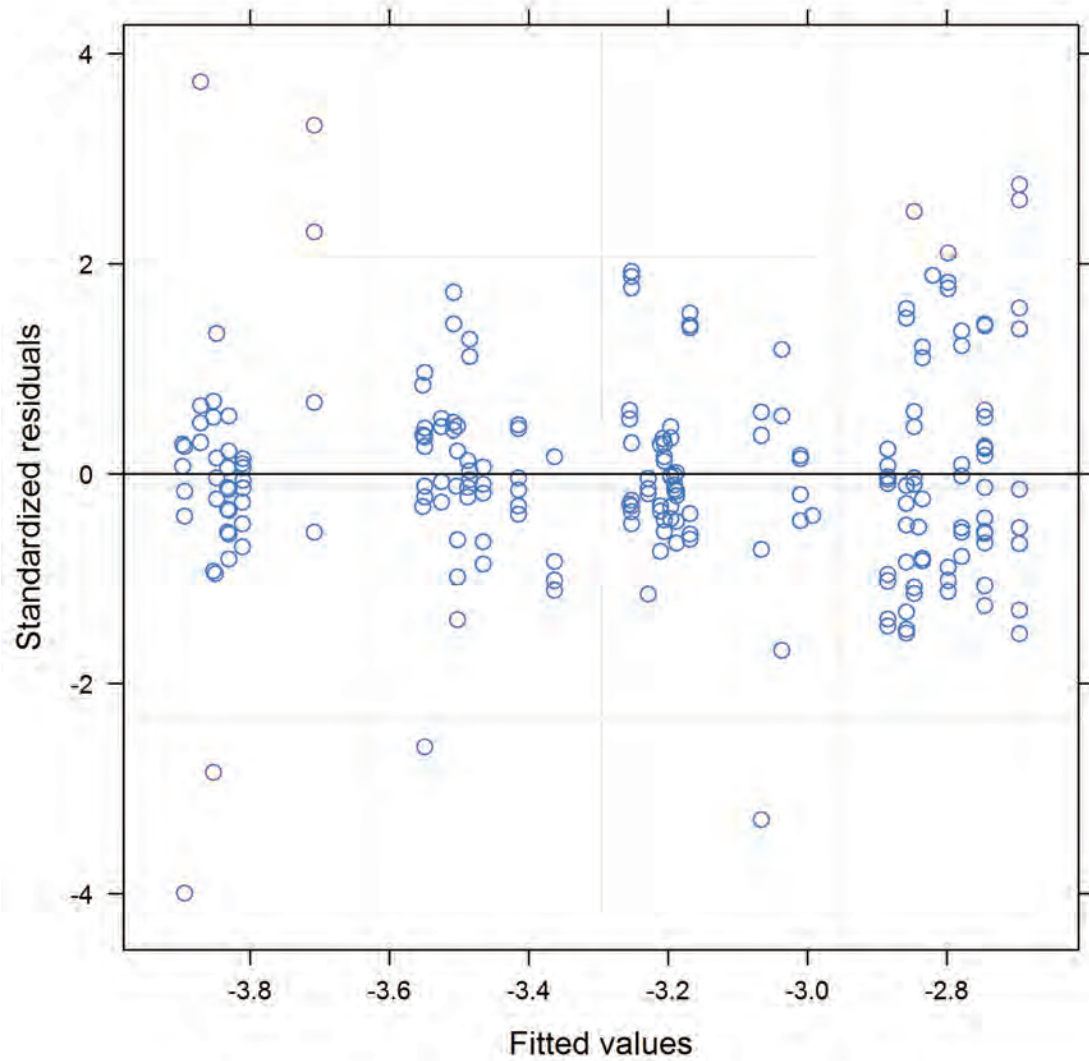
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-120.53	71.26		
LME	12	-138.22	81.11	19.69	9.11×10 ⁻⁶

Conclusion:

The most appropriate model for total nickel at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	226	22679	<.0001
## site	4	226	311	<.0001
## period	1	9	1	0.31
## site:period	4	226	1	0.30

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.05	-0.22	0.11	not sig.
Counts Outflow	0	-0.17	0.16	not sig.
Vulture-Polar	-0.08	-0.25	0.08	not sig.
Pigeon-Reach 7	0.12	-0.05	0.28	not sig.

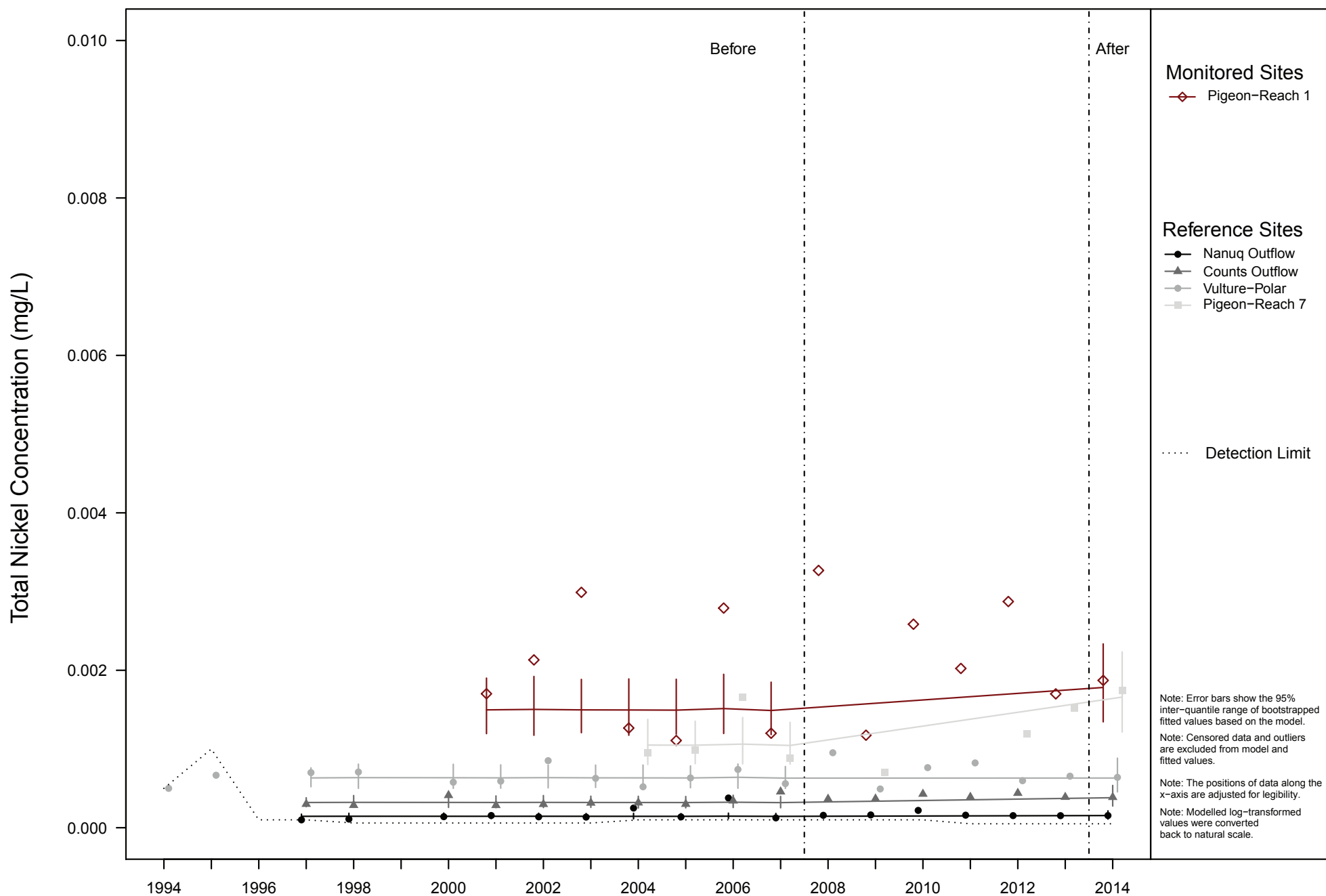
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.301$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

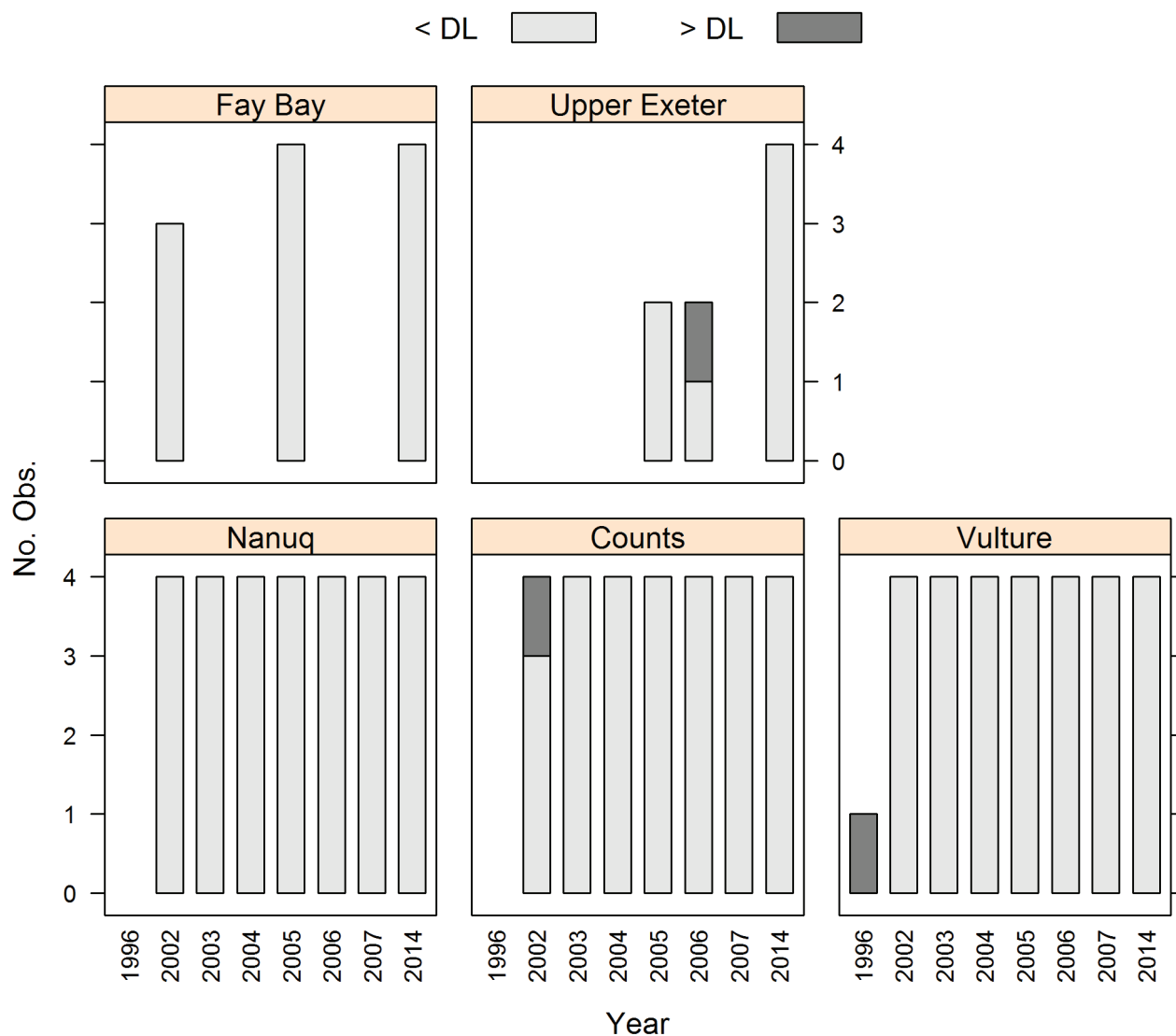


Analysis of Winter Total Selenium Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

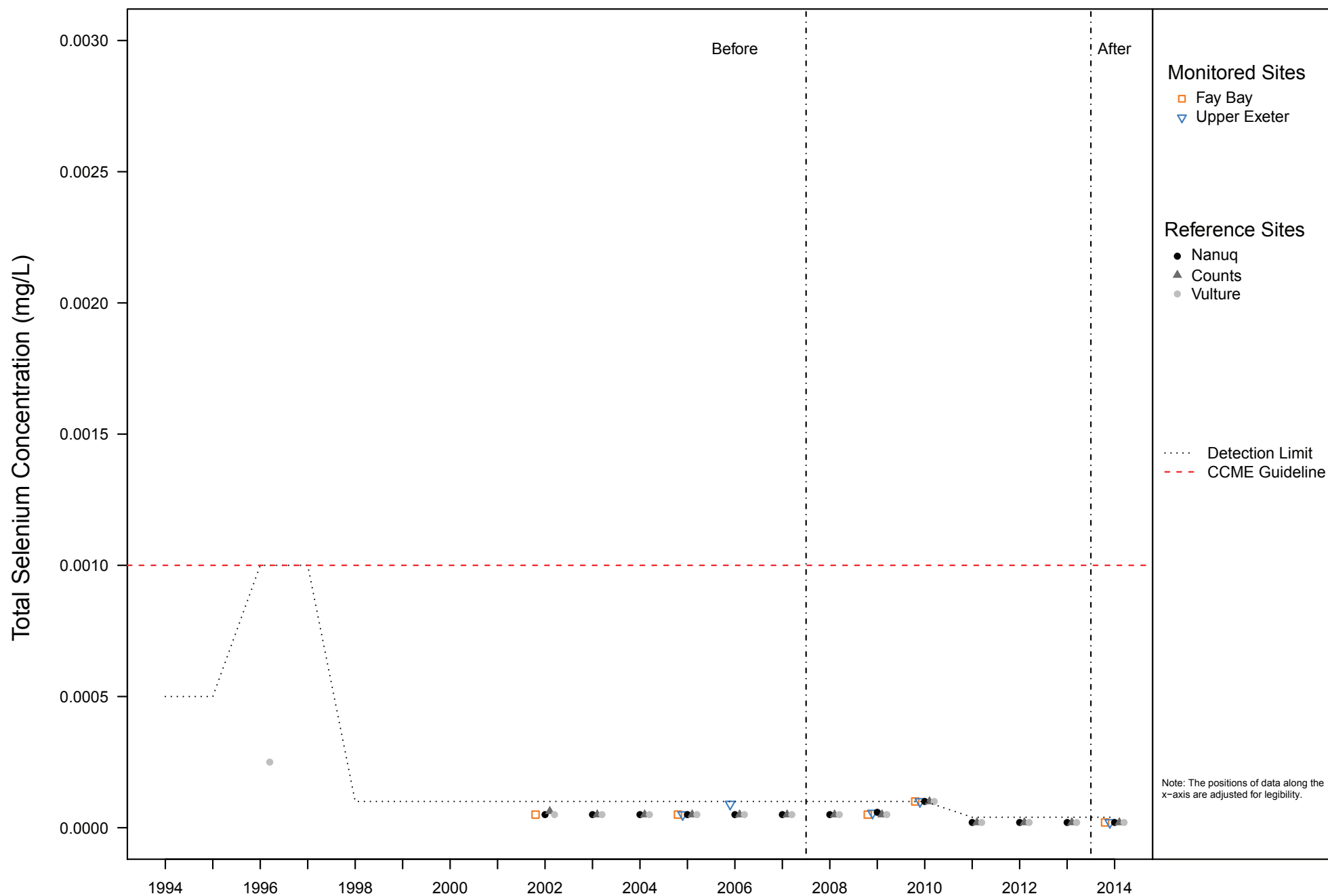
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Selenium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

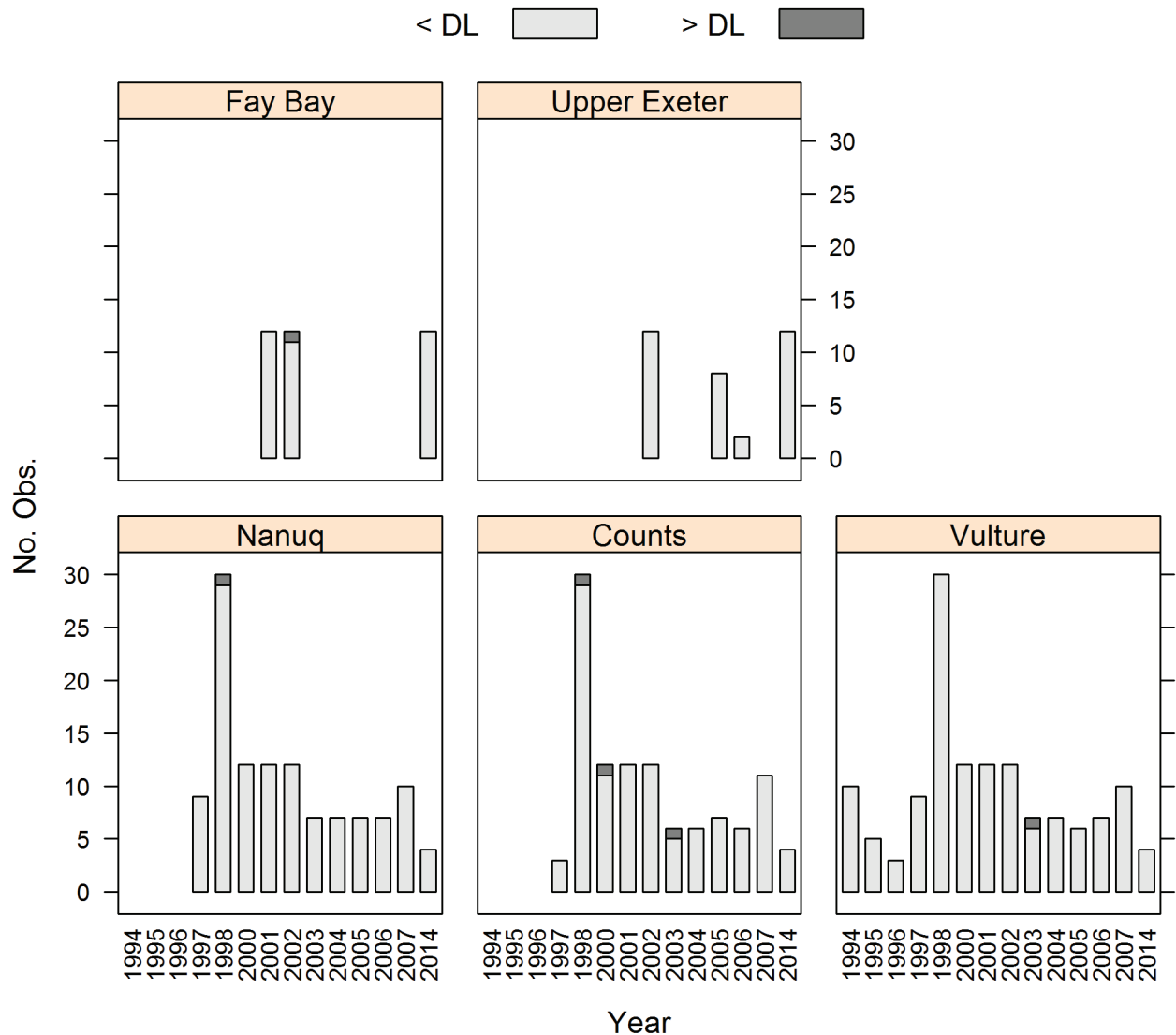


Analysis of Summer Total Selenium Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

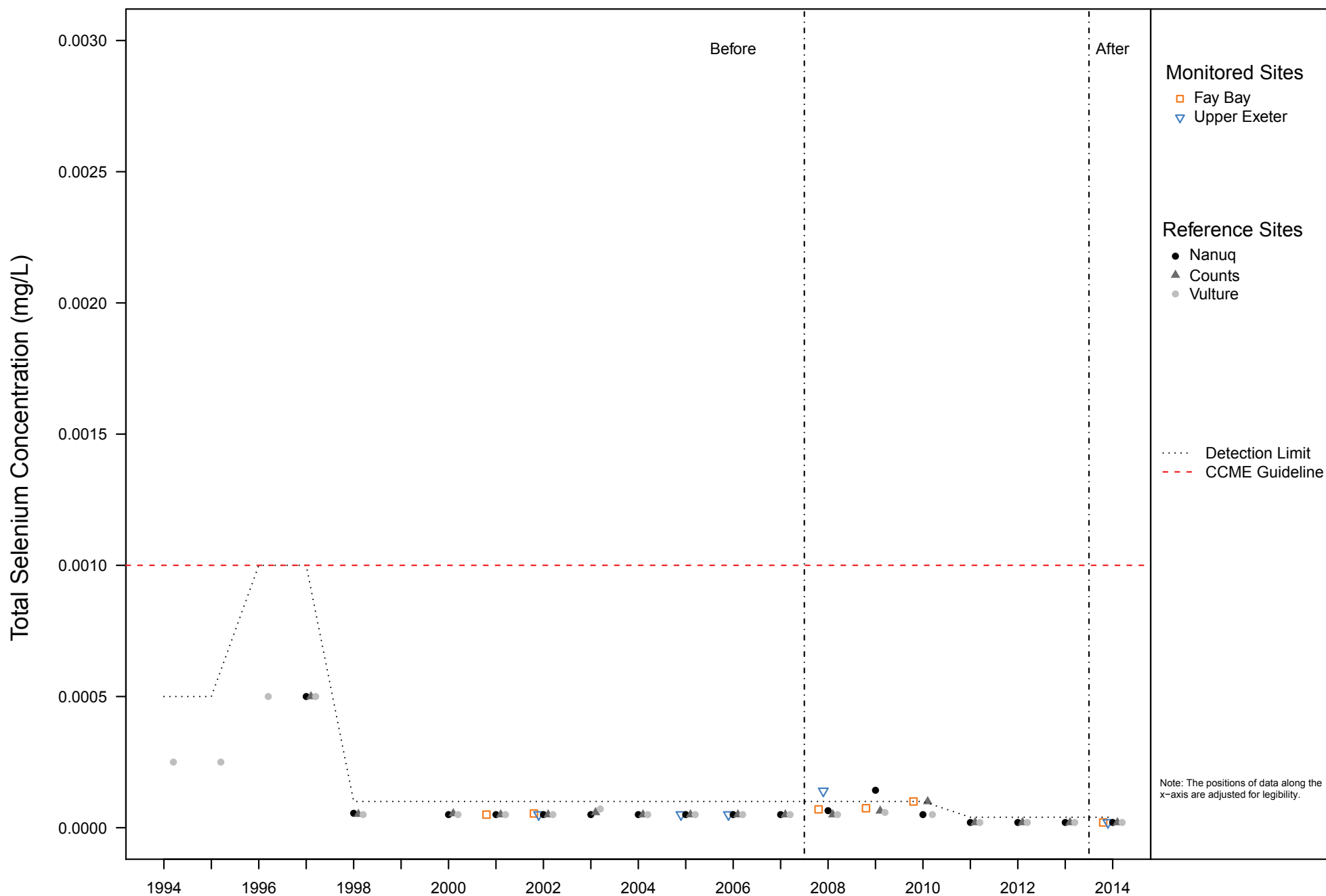
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Selenium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

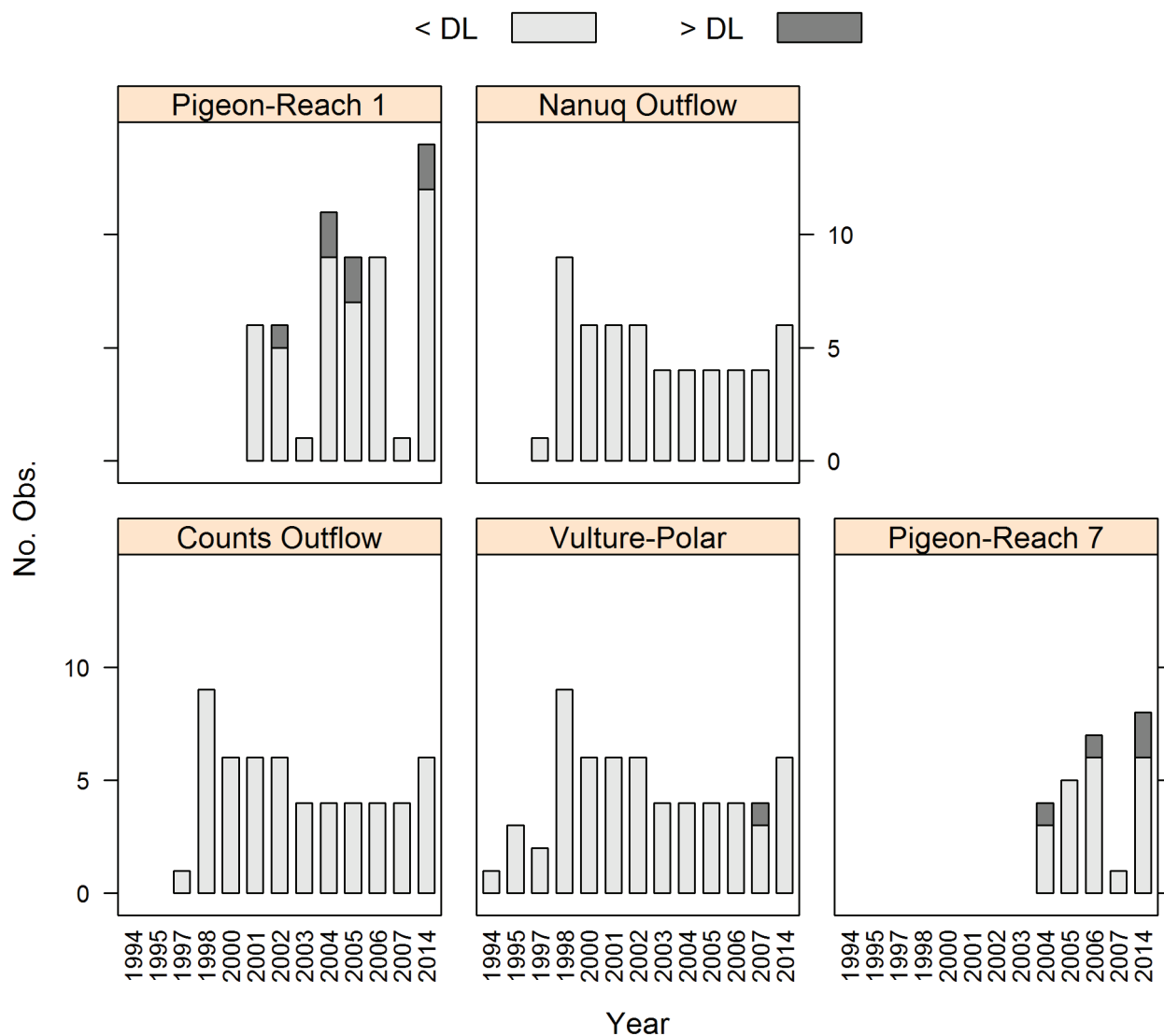


Analysis of Summer Total Selenium Water Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

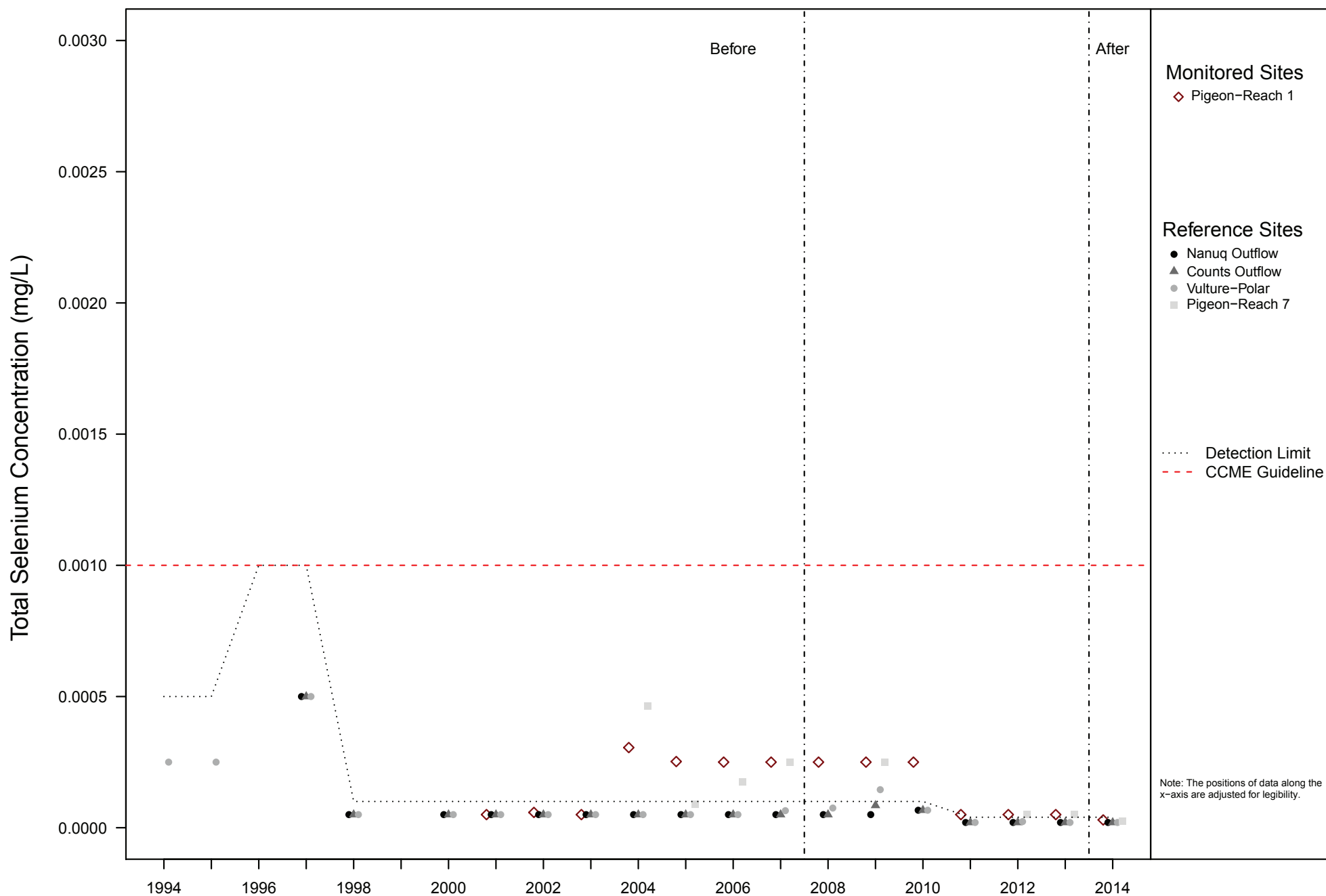
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Selenium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

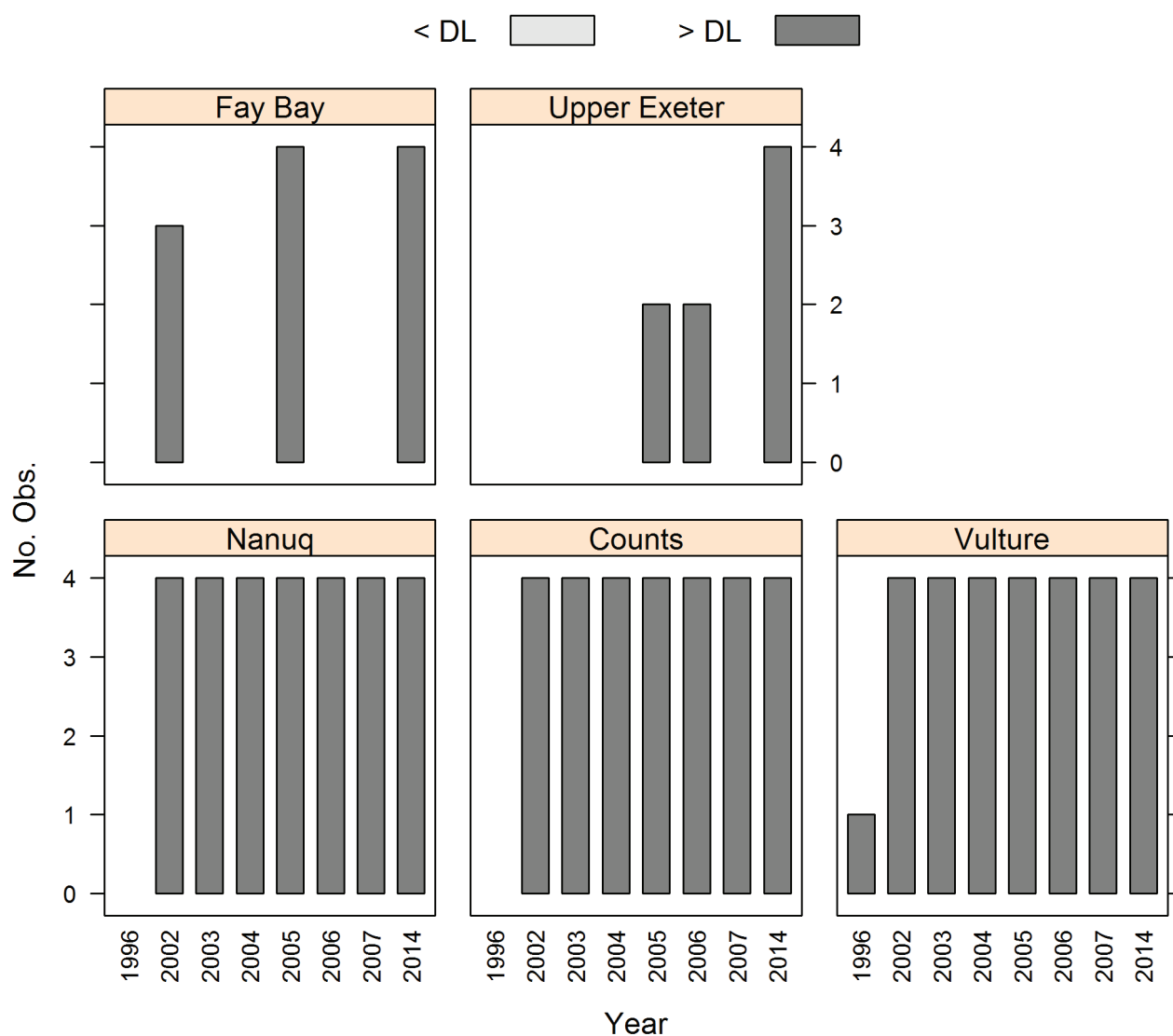


Analysis of Winter Total Strontium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

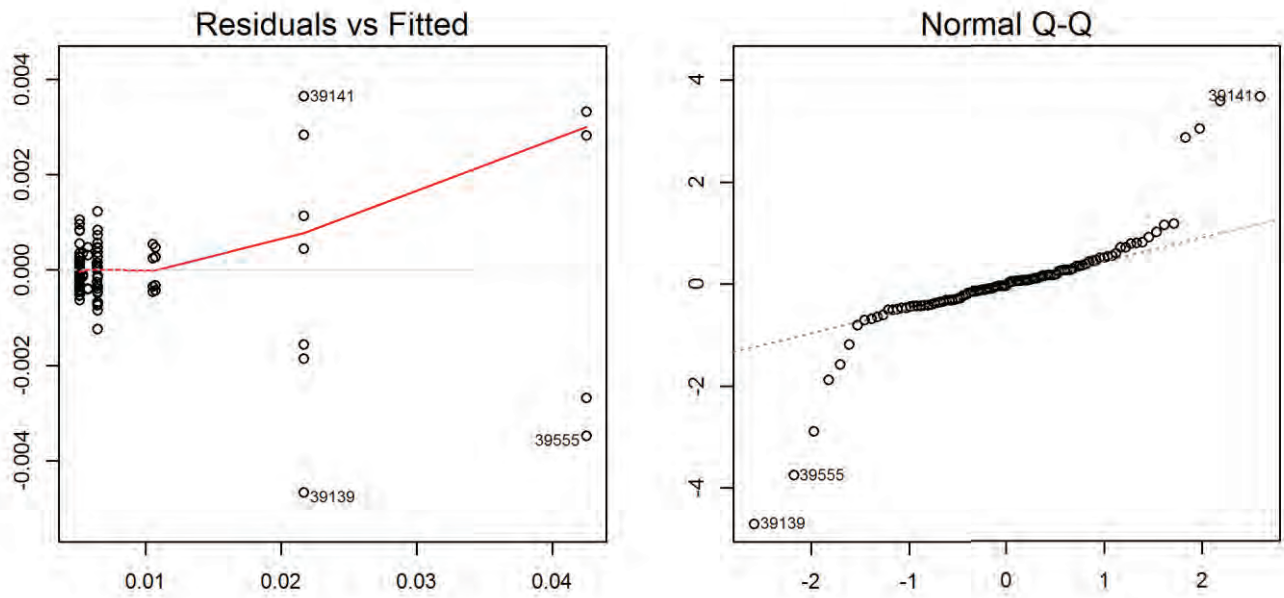
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

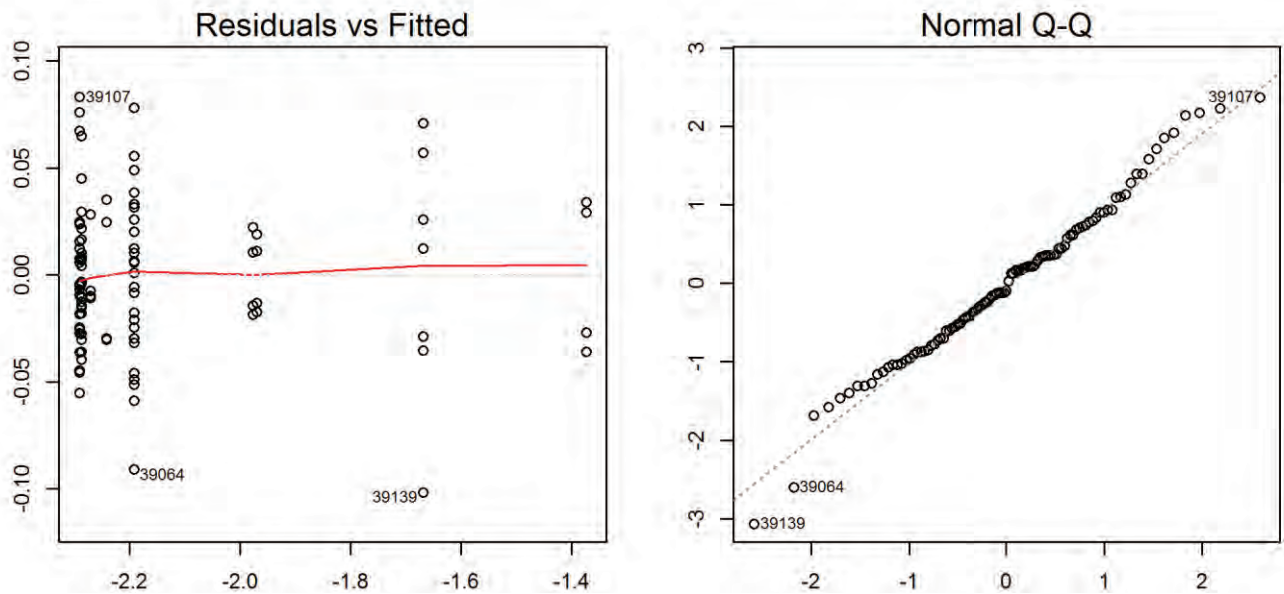
```
##          site year month season
## 38736 Vulture 1996 April  winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0	0.98	0.98
Log-10	0.04	0.98	0.98

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

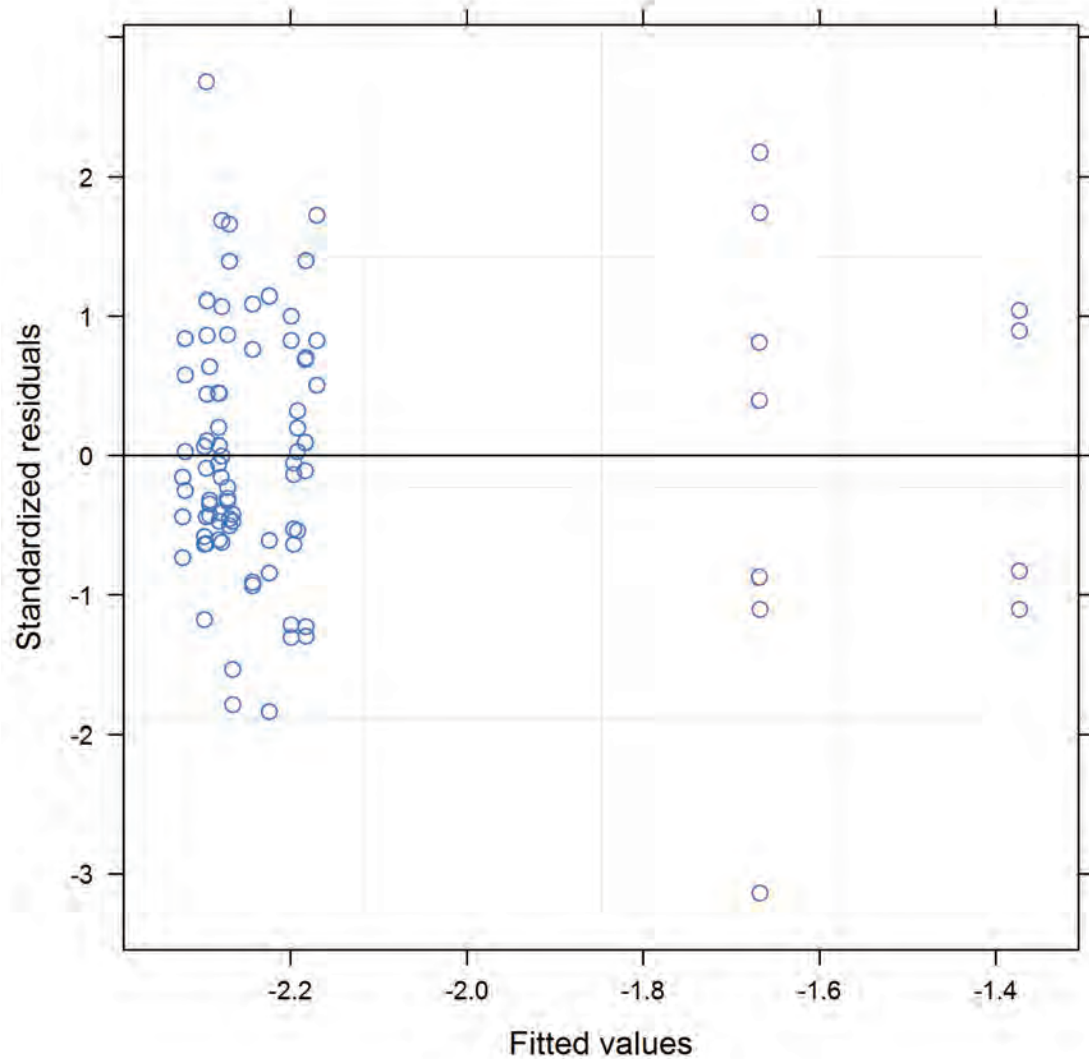
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-293.17	155.58		
LME	10	-303.27	161.63	12.1	5.04×10 ⁻⁴

Conclusion:

The most appropriate model for total strontium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	82	67490	<.0001
## site	3	82	1311	<.0001
## period	1	5	10	0.025
## site:period	3	82	50	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.26	-0.31	-0.2	sig.
Counts	-0.3	-0.36	-0.25	sig.
Vulture	-0.29	-0.34	-0.23	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total strontium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

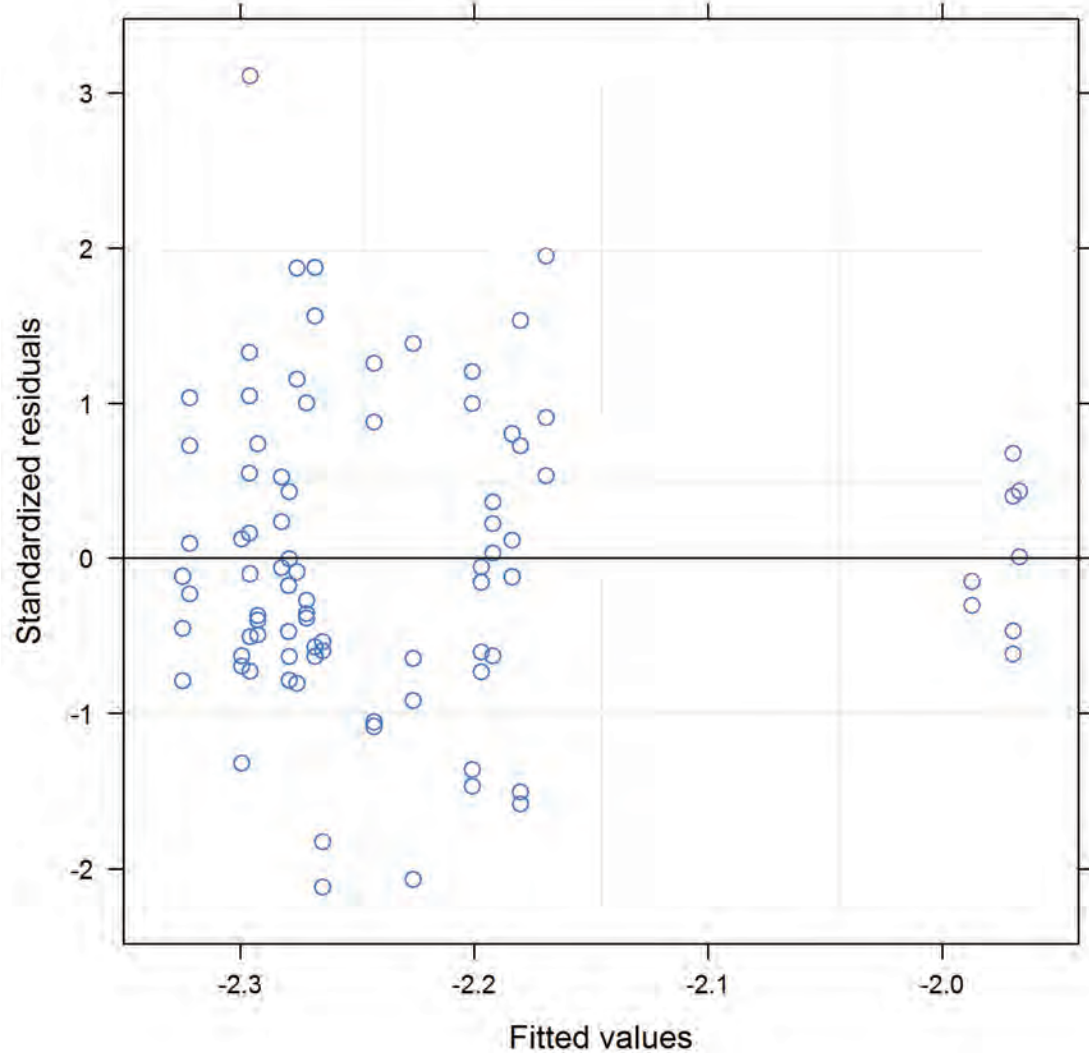
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-298.21	158.11		
LME	10	-315	167.5	18.79	1.46×10^{-5}

Conclusion:

The most appropriate model for total strontium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	79	68307	<.0001
## site	3	79	274	<.0001
## period	1	5	1	0.45
## site:period	3	79	2	0.15

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	0.04	-0.01	0.09	not sig.
Counts	-0.01	-0.06	0.04	not sig.
Vulture	0.01	-0.04	0.06	not sig.

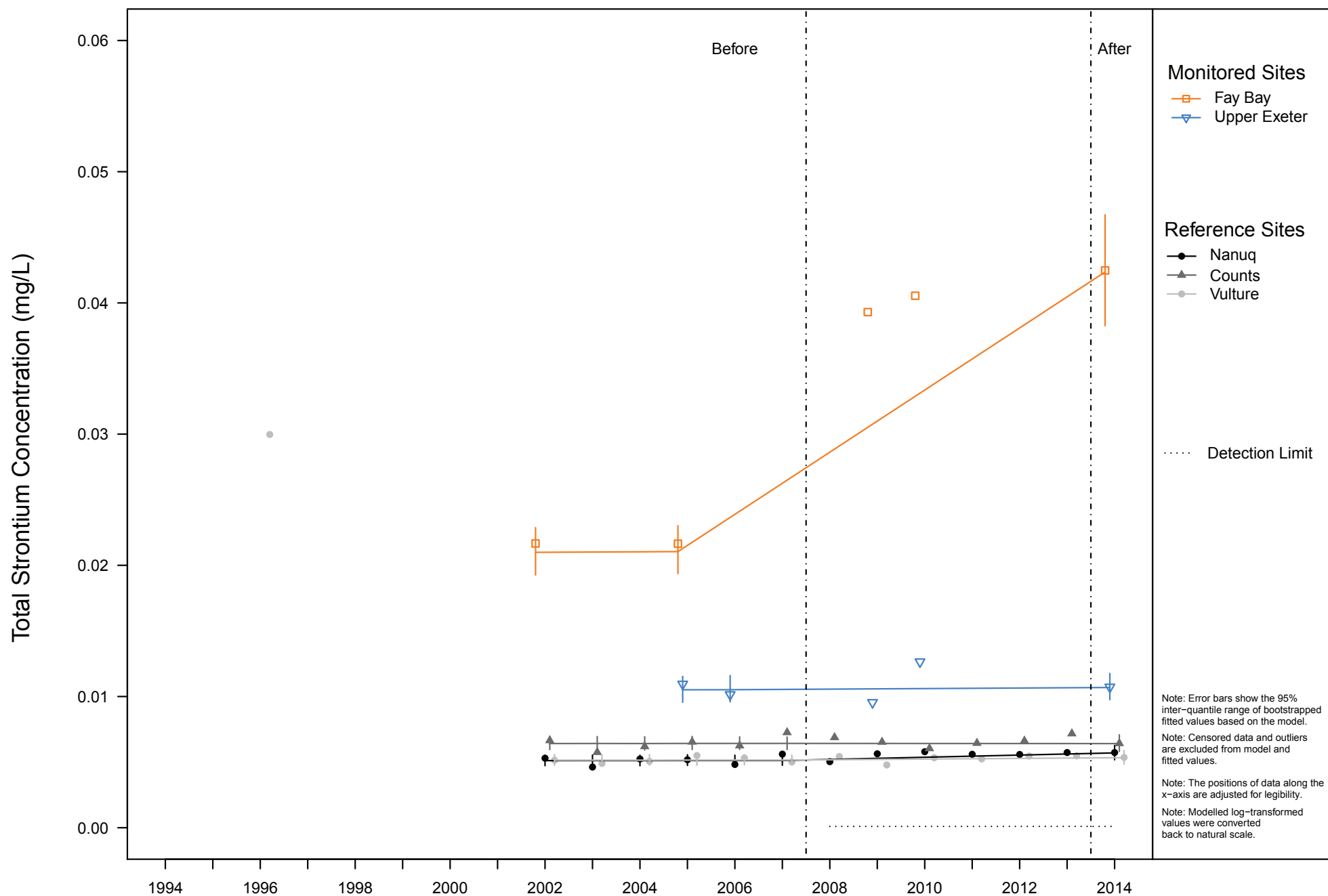
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total strontium concentrations at the Upper Exeter site were not significantly ($p = 0.149$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

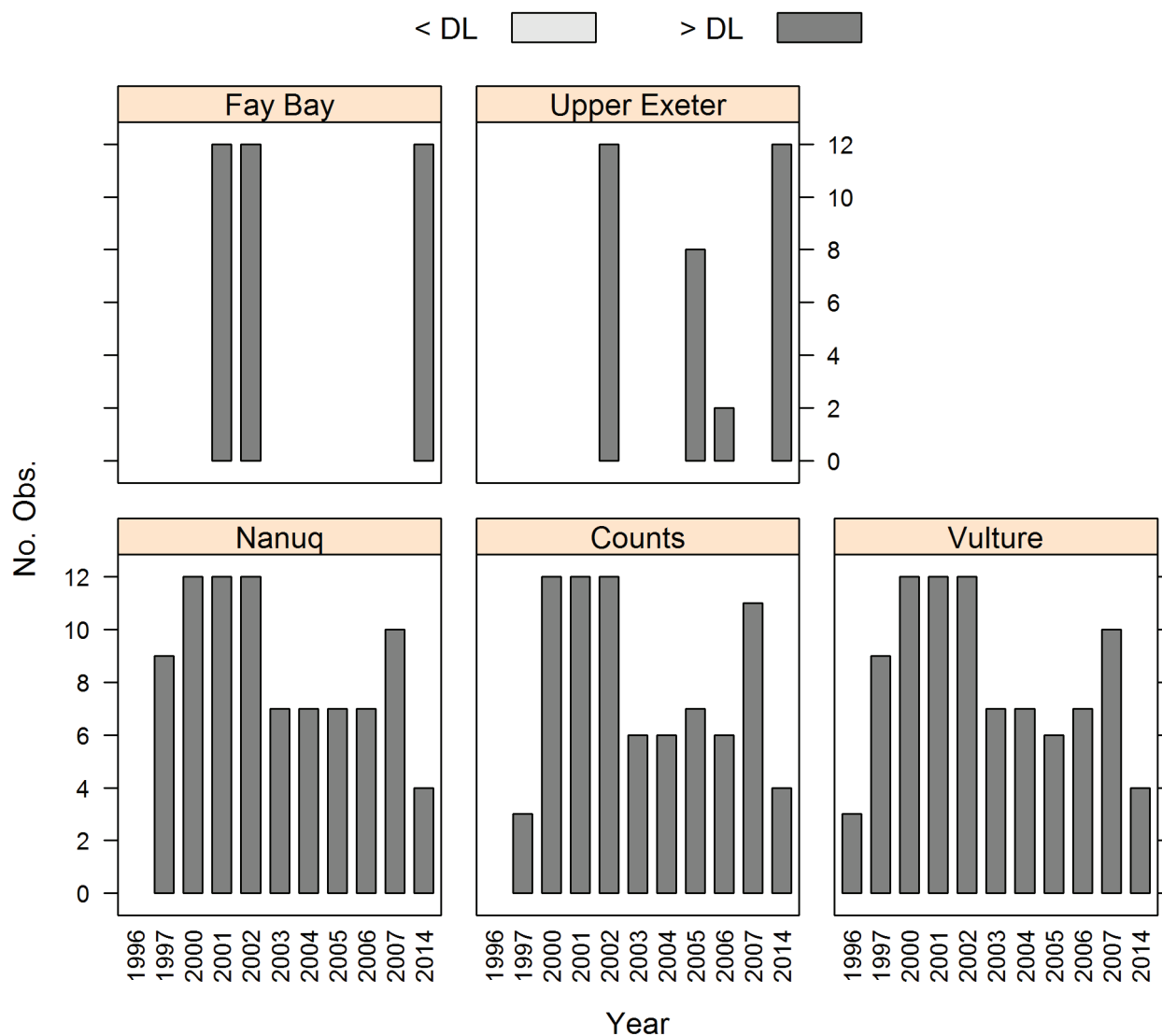


Analysis of Summer Total Strontium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

```
## No outliers were identified.
```


Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	4.78×10 ⁻⁴	0.96	0.96
Log-10	0.03	0.95	0.95

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

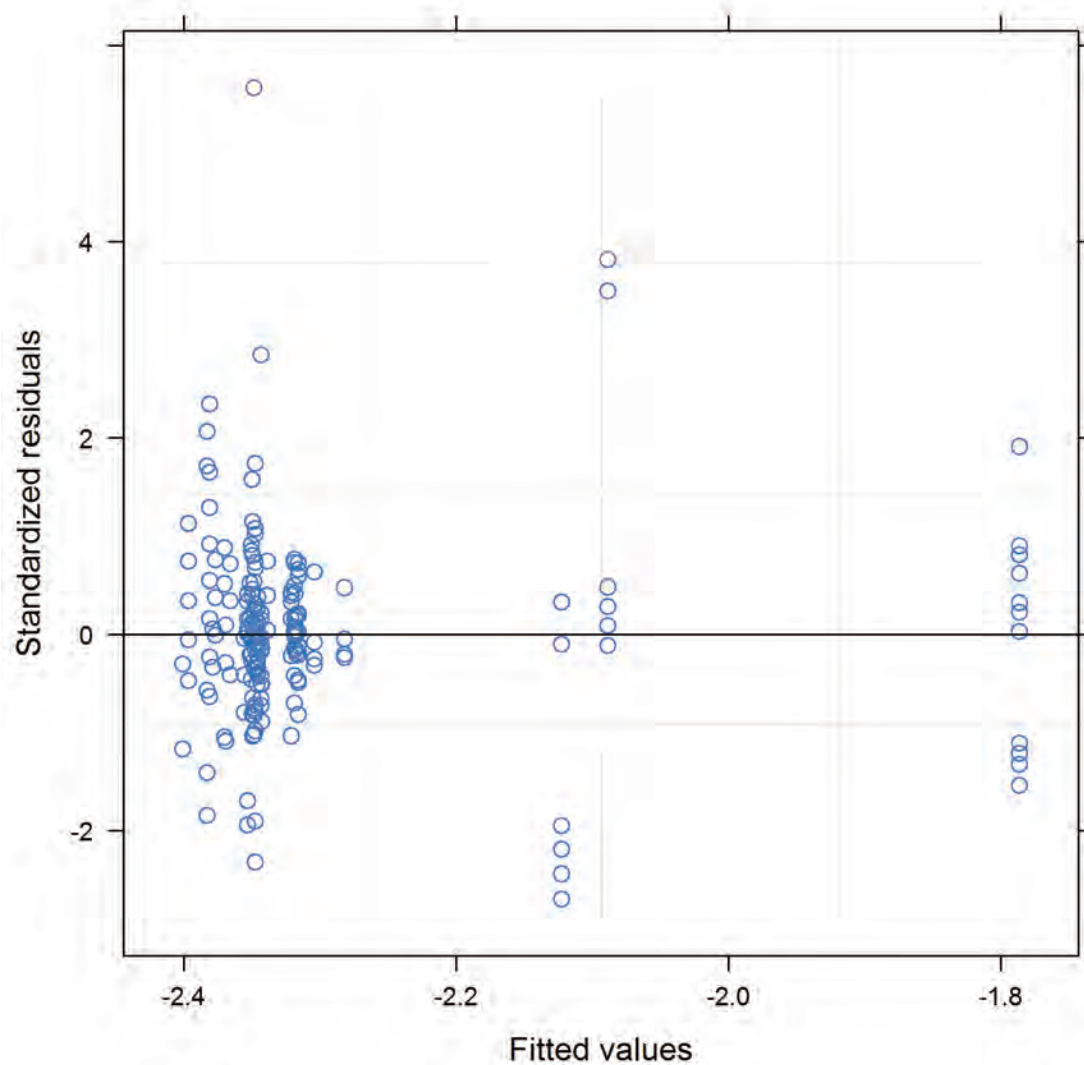
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-1100.31	559.16		
LME	10	-1183.59	601.79	85.28	0

Conclusion:

The most appropriate model for total strontium at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	274	124174	<.0001
## site	3	274	1185	<.0001
## period	1	9	49	1e-04
## site:period	3	274	154	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.26	-0.3	-0.23	sig.
Counts	-0.27	-0.31	-0.24	sig.
Vulture	-0.27	-0.3	-0.24	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total strontium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

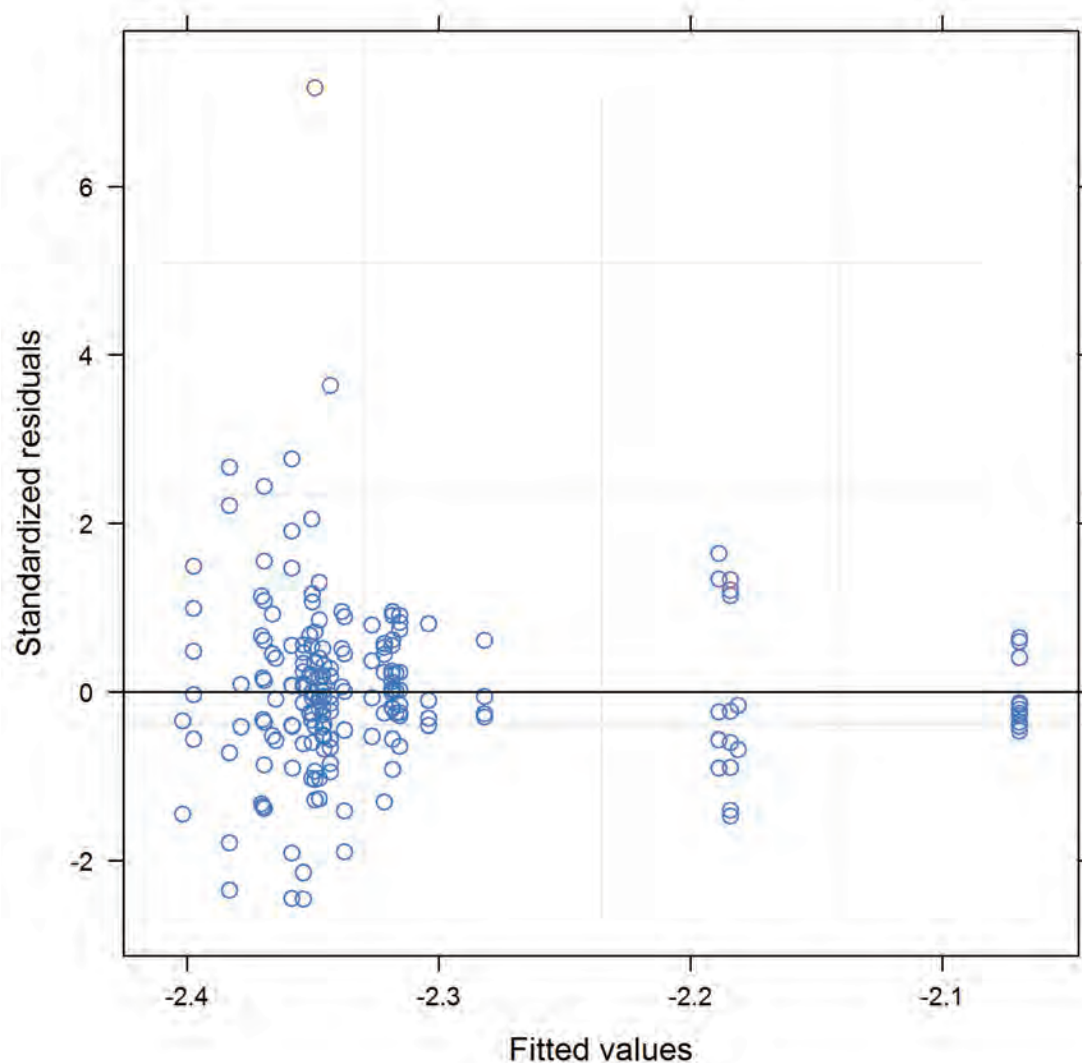
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-1213.6	615.8		
LME	10	-1311.5	665.75	99.9	0

Conclusion:

The most appropriate model for total strontium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	272	146613	<.0001
## site	3	272	605	<.0001
## period	1	9	15	0.0034
## site:period	3	272	19	<.0001

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-0.07	-0.1	-0.05	sig.
Counts	-0.08	-0.1	-0.05	sig.
Vulture	-0.08	-0.1	-0.05	sig.

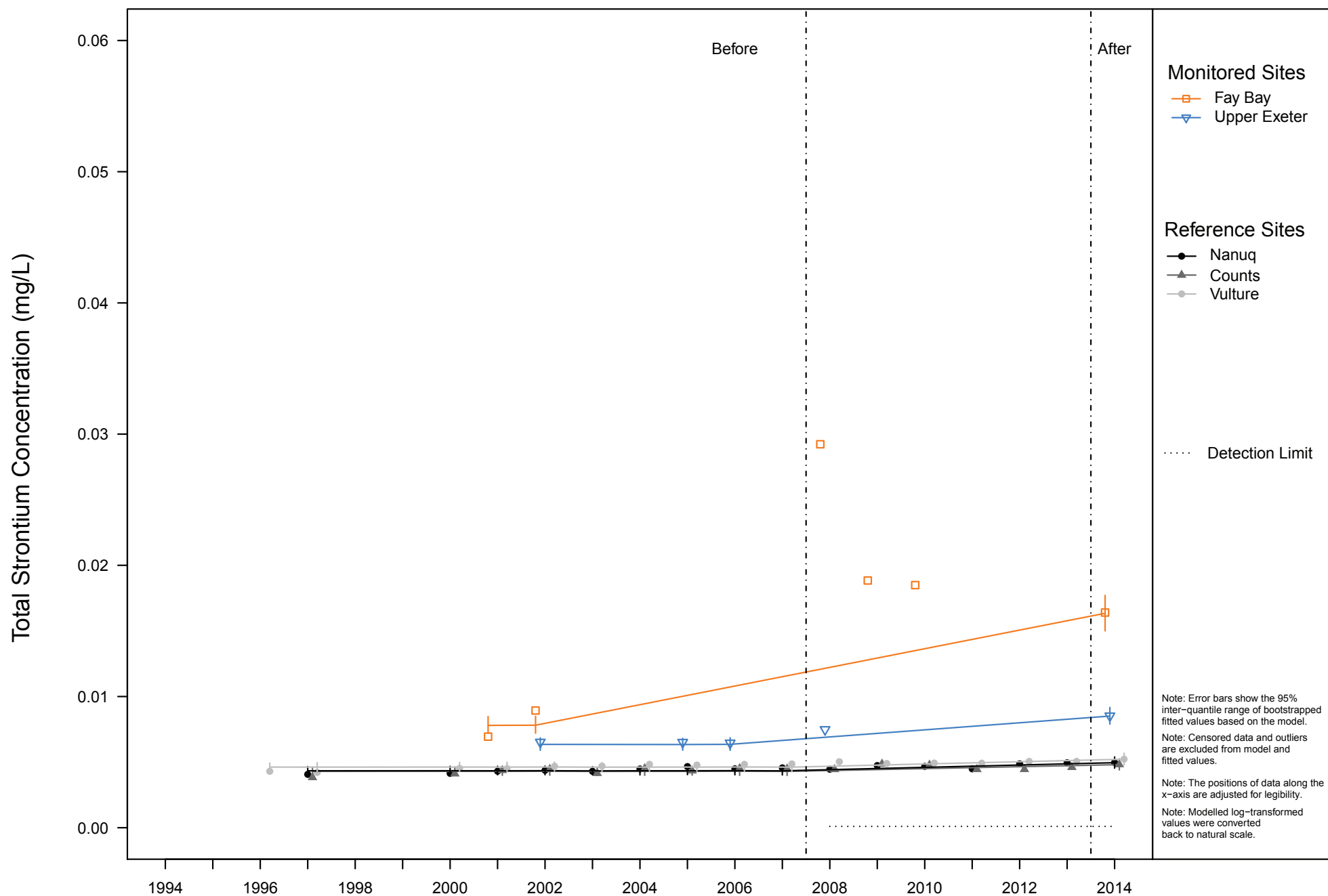
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total strontium concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

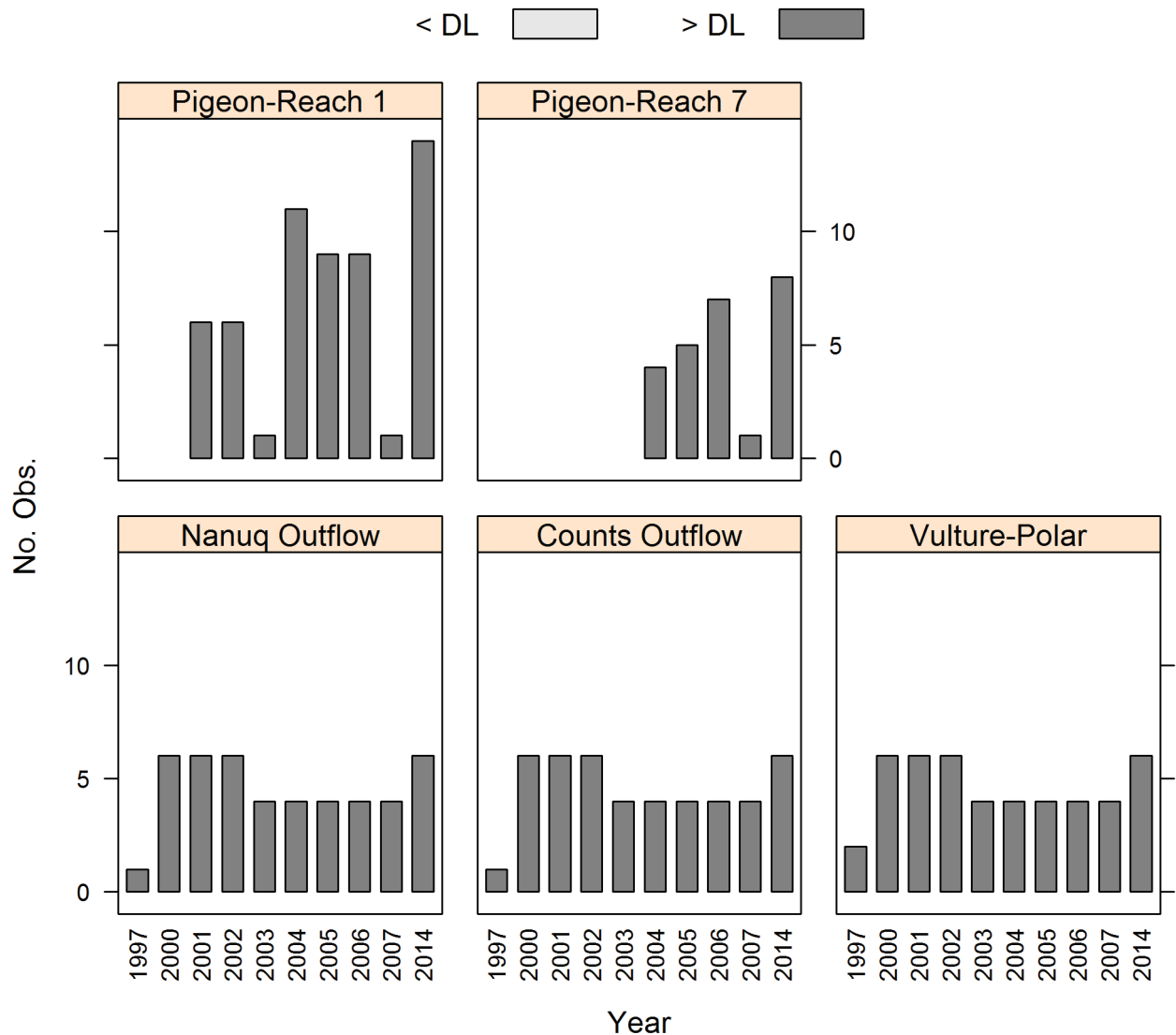


Analysis of Summer Total Strontium Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

No censored data were identified.

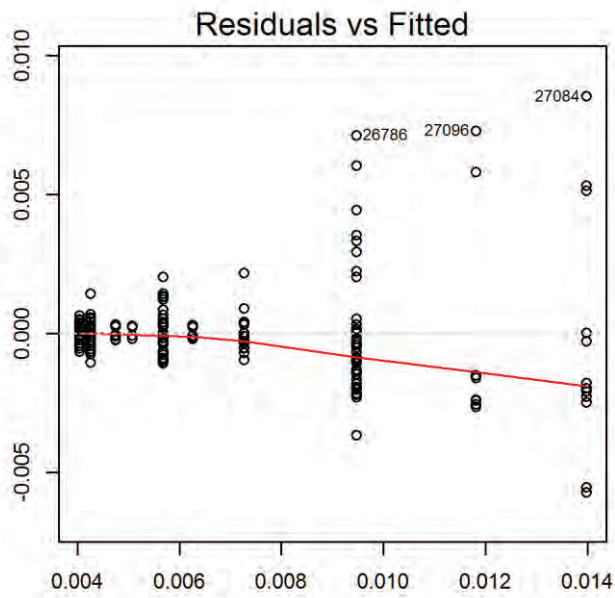
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

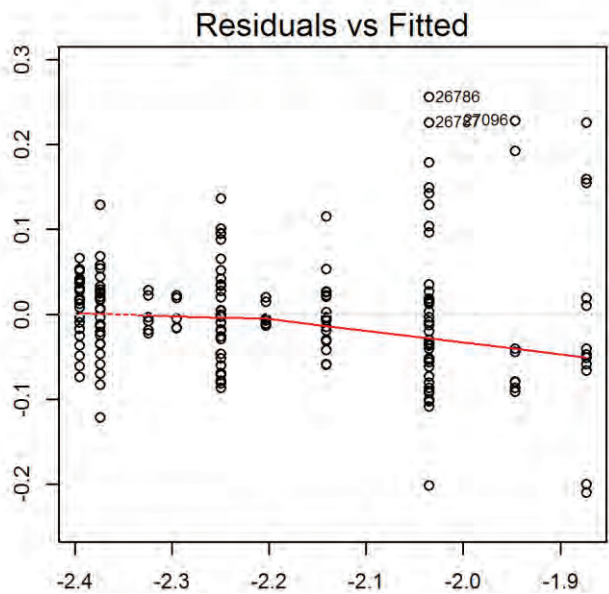
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0	0.75	0.74
Log-10	0.07	0.85	0.85

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

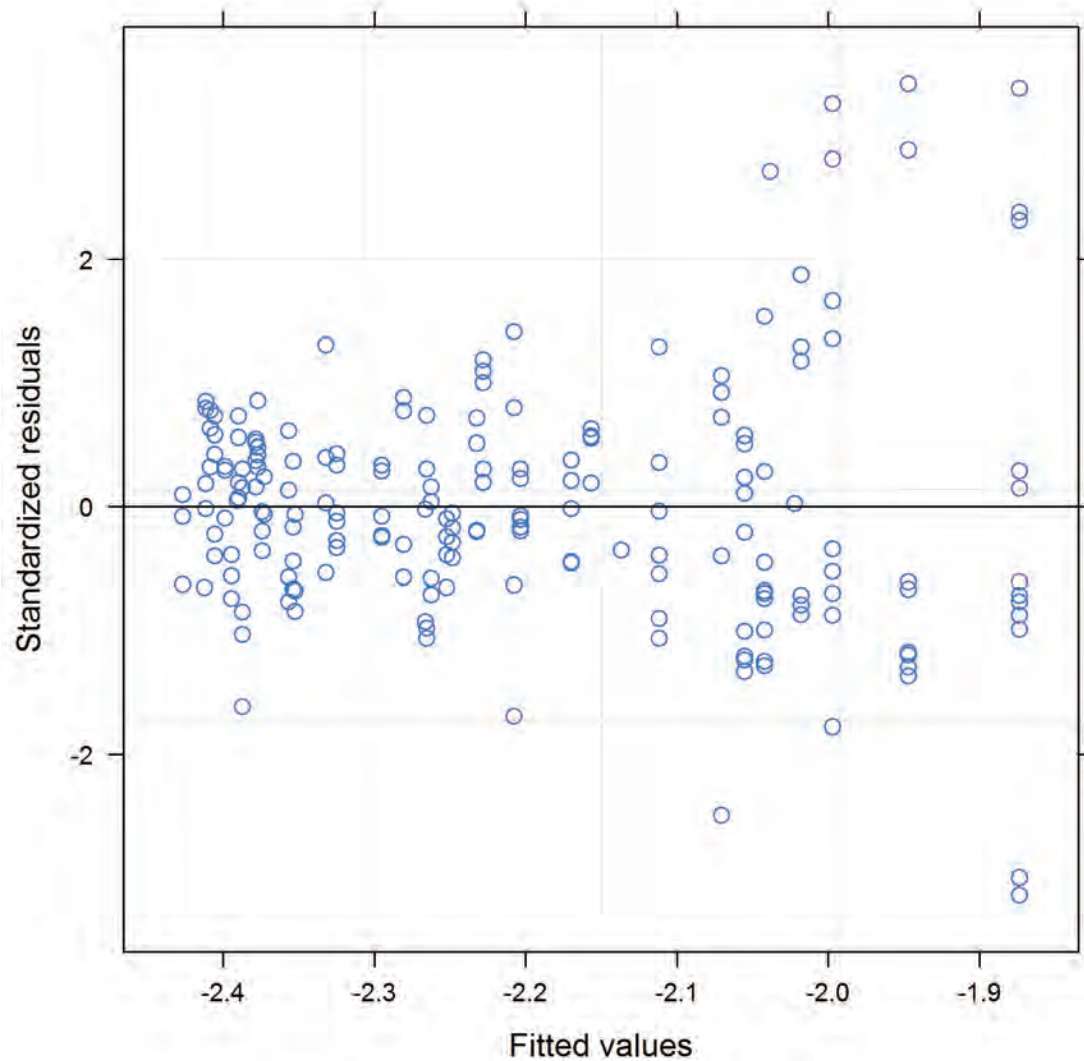
Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-460.86	241.43		
LME	12	-473.68	248.84	14.82	1.18×10 ⁻⁴

Conclusion:

The most appropriate model for total strontium at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	200	50965	<.0001
## site	4	200	256	<.0001
## period	1	8	15	0.0045
## site:period	4	200	6	0.0001

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.12	-0.19	-0.04	sig.
Counts Outflow	-0.07	-0.14	0.01	not sig.
Vulture-Polar	-0.12	-0.19	-0.05	sig.
Pigeon-Reach 7	0.04	-0.03	0.11	not sig.

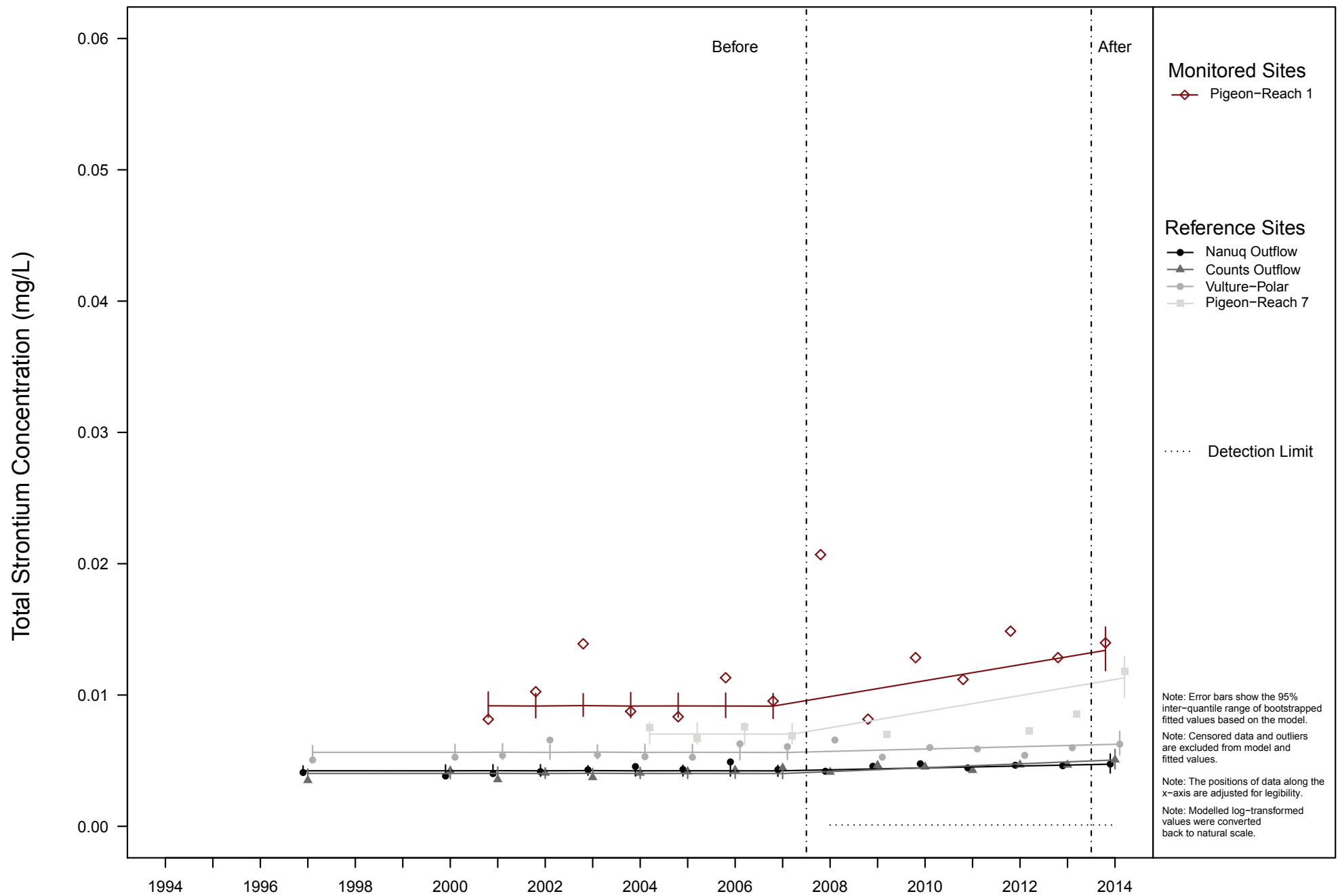
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total strontium concentrations at the Pigeon-Reach 1 site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

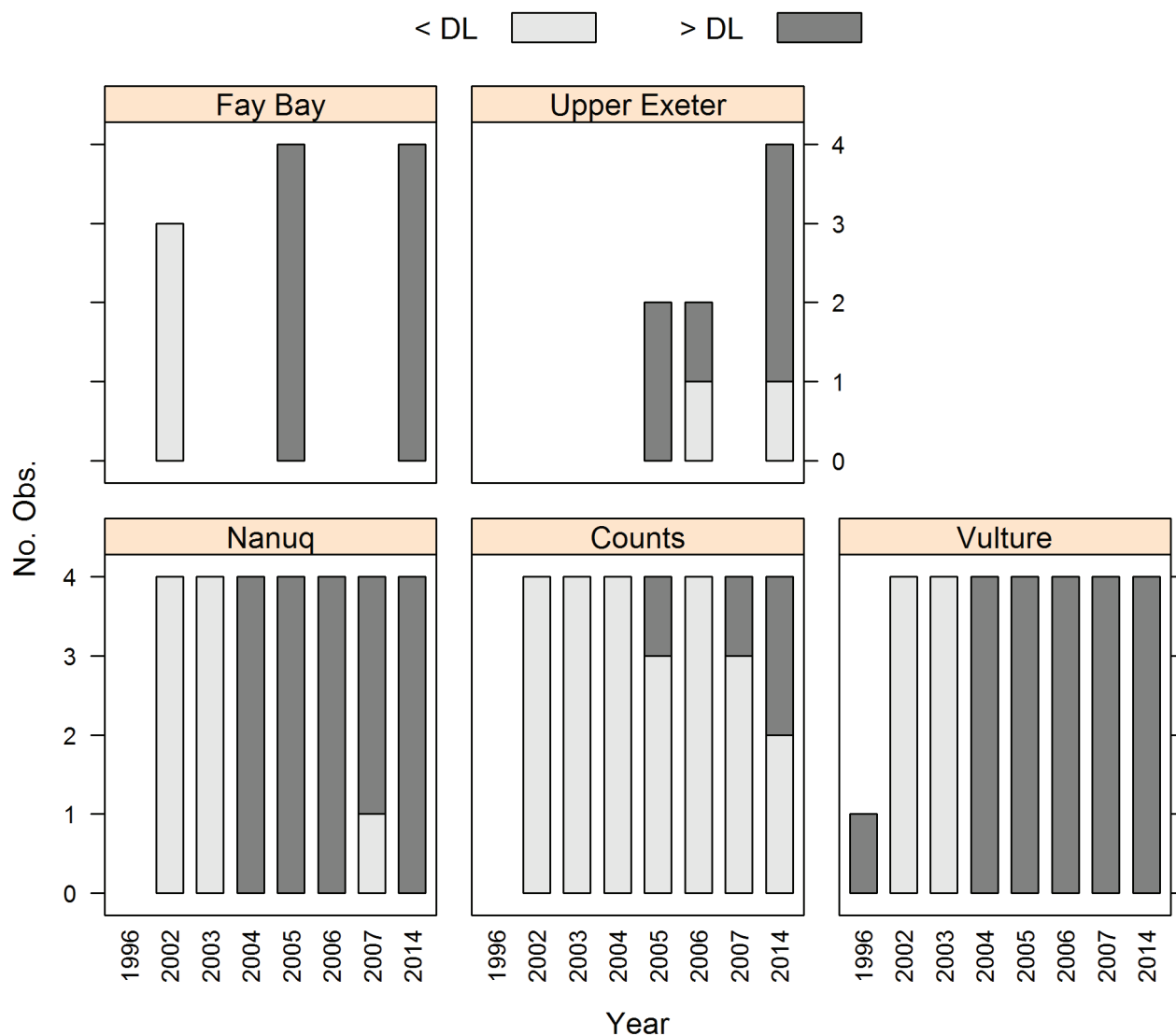


Analysis of Winter Total Uranium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	year	month	season
## 39869	Counts	2002	April	winter
## 39870	Counts	2002	April	winter
## 39871	Counts	2002	April	winter
## 39872	Counts	2002	April	winter
## 39885	Fay Bay	2002	April	winter
## 39886	Fay Bay	2002	April	winter
## 39887	Fay Bay	2002	April	winter
## 39900	Nanuq	2002	April	winter
## 39901	Nanuq	2002	April	winter
## 39902	Nanuq	2002	April	winter
## 39903	Nanuq	2002	April	winter
## 39928	Vulture	2002	April	winter
## 39929	Vulture	2002	April	winter
## 39930	Vulture	2002	April	winter
## 39931	Vulture	2002	April	winter
## 39944	Counts	2003	April	winter
## 39945	Counts	2003	April	winter
## 39946	Counts	2003	April	winter
## 39947	Counts	2003	April	winter
## 39954	Nanuq	2003	April	winter
## 39955	Nanuq	2003	April	winter
## 39956	Nanuq	2003	April	winter
## 39957	Nanuq	2003	April	winter
## 39965	Vulture	2003	April	winter
## 39966	Vulture	2003	April	winter
## 39967	Vulture	2003	April	winter
## 39968	Vulture	2003	April	winter
## 39976	Counts	2004	April	winter
## 39977	Counts	2004	April	winter
## 39978	Counts	2004	April	winter
## 39979	Counts	2004	April	winter
## 40008	Counts	2005	April	winter
## 40009	Counts	2005	April	winter
## 40010	Counts	2005	April	winter
## 40011	Counts	2005	April	winter
## 40054	Counts	2006	April	winter
## 40055	Counts	2006	April	winter
## 40056	Counts	2006	April	winter
## 40057	Counts	2006	April	winter
## 40090	Counts	2007	April	winter
## 40091	Counts	2007	April	winter
## 40092	Counts	2007	April	winter

```
## 40093 Counts 2007 April winter
## 40425 Counts 2014 April winter
## 40426 Counts 2014 April winter
## 40427 Counts 2014 April winter
## 40428 Counts 2014 April winter
```

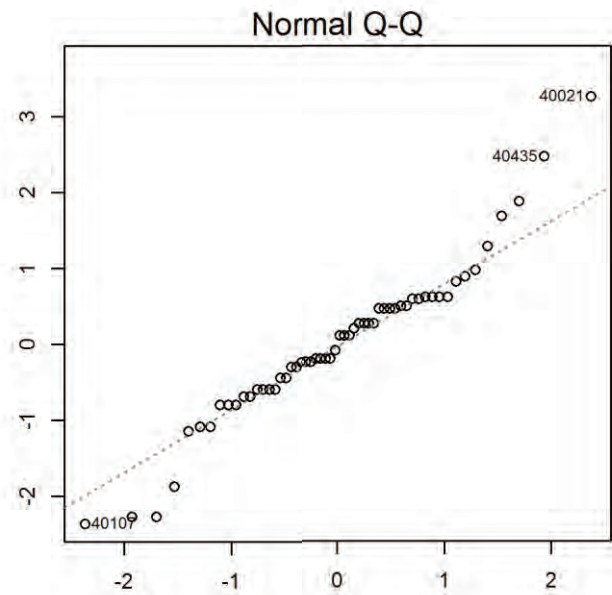
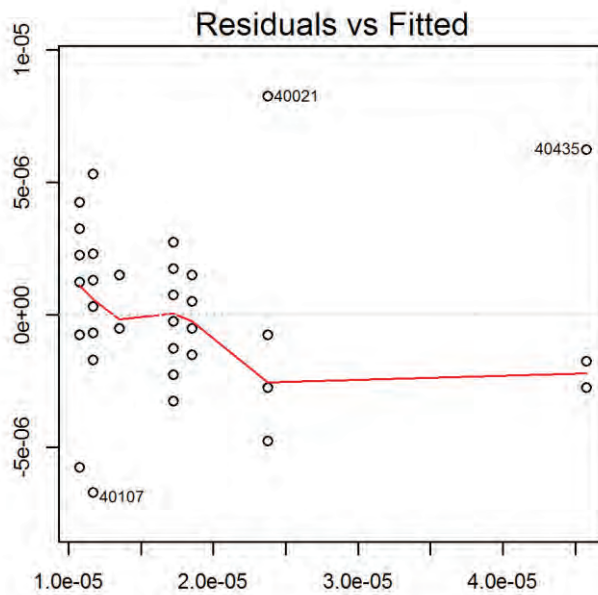
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

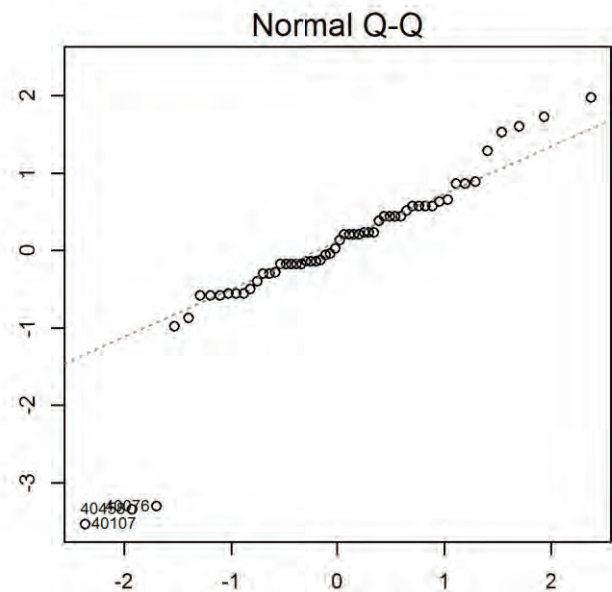
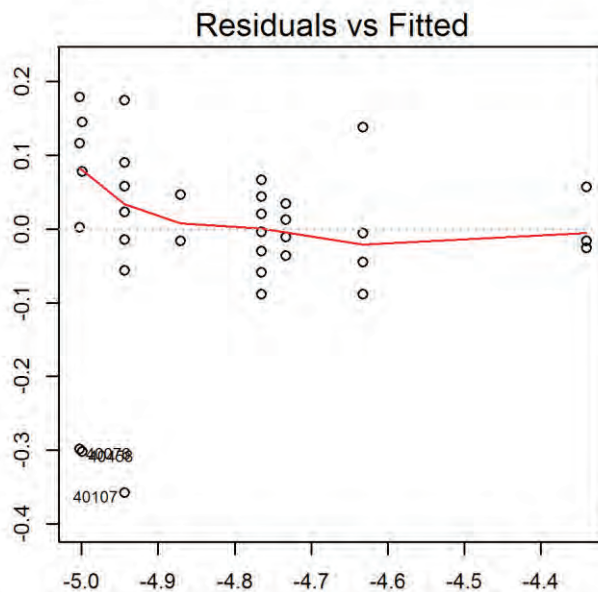
```
##          site year month season
## 39616 Vulture 1996 April winter
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	2.92×10 ⁻⁶	0.91	0.9
Log-10	0.1	0.76	0.72

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

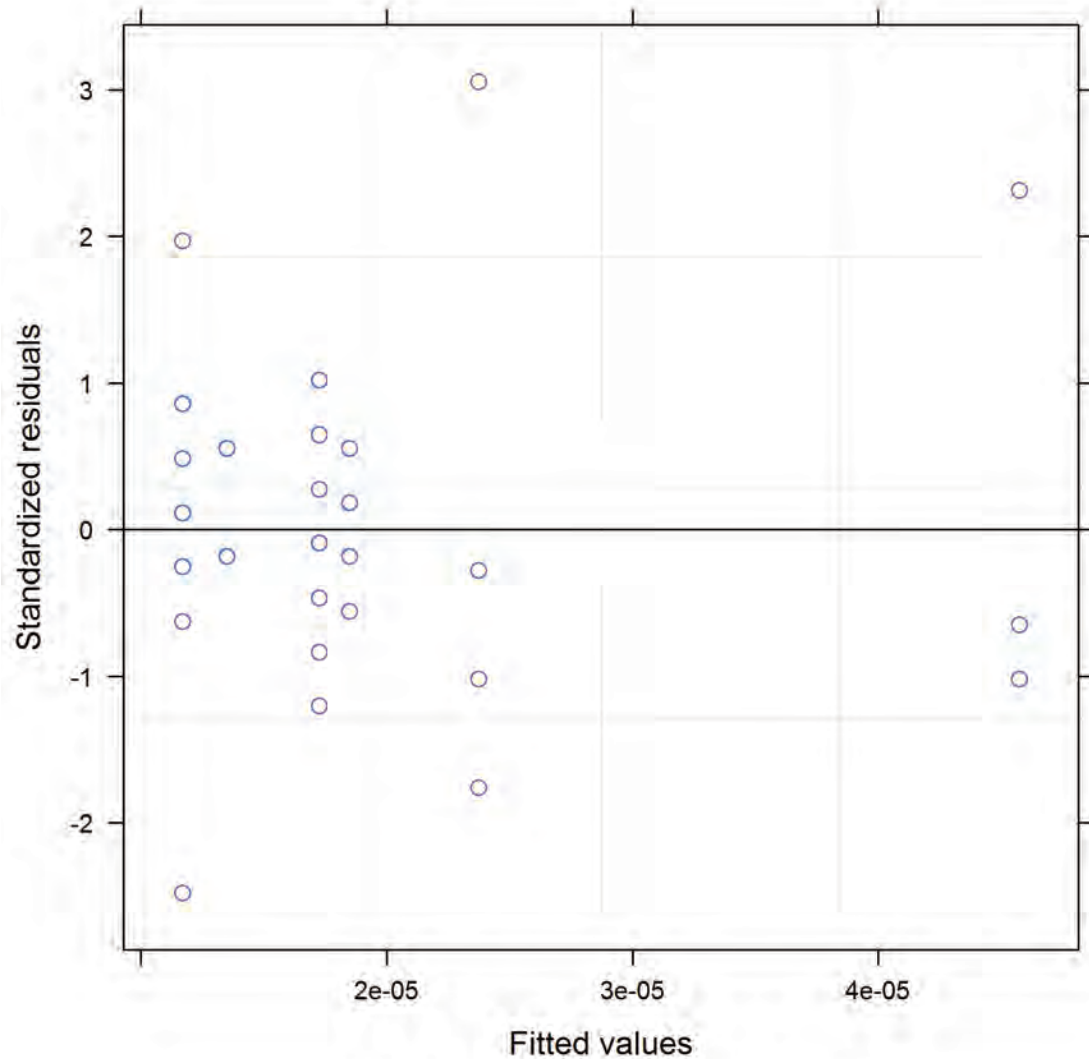
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	7	-932.82	473.41		
LME	8	-932.83	474.41	2	0.16

Conclusion:

The most appropriate model for total uranium at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.157$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 42
##          numDF F-value p-value
## (Intercept)    1   2160 <.0001
## site           2    203 <.0001
## period         1     47 <.0001
## site:period     2     44 <.0001
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	-2.02×10^{-5}	-2.51×10^{-5}	-1.53×10^{-5}	sig.
Counts	NA	NA	NA	NA
Vulture	-2.07×10^{-5}	-2.57×10^{-5}	-1.58×10^{-5}	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total uranium concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

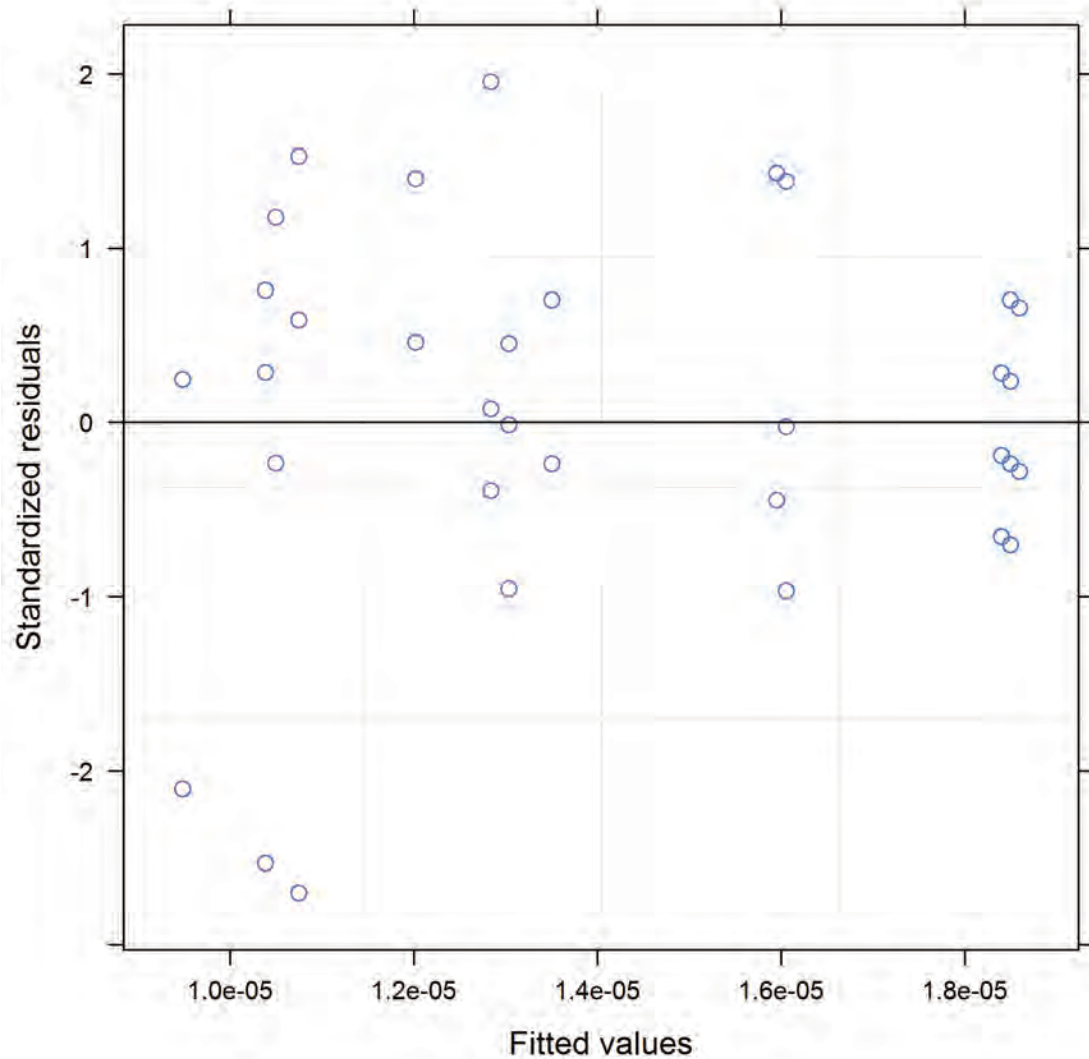
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	7	-939.99	476.99		
LME	8	-945.52	480.76	7.53	0.01

Conclusion:

The most appropriate model for total uranium at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p = 0.006$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	39	332	<.0001
## site	2	39	46	<.0001
## period	1	3	0	0.58
## site:period	2	39	0	0.67

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq	1.74×10^{-6}	-2.19×10^{-6}	5.61×10^{-6}	not sig.
Counts	NA	NA	NA	NA
Vulture	1.17×10^{-6}	-2.82×10^{-6}	5.02×10^{-6}	not sig.

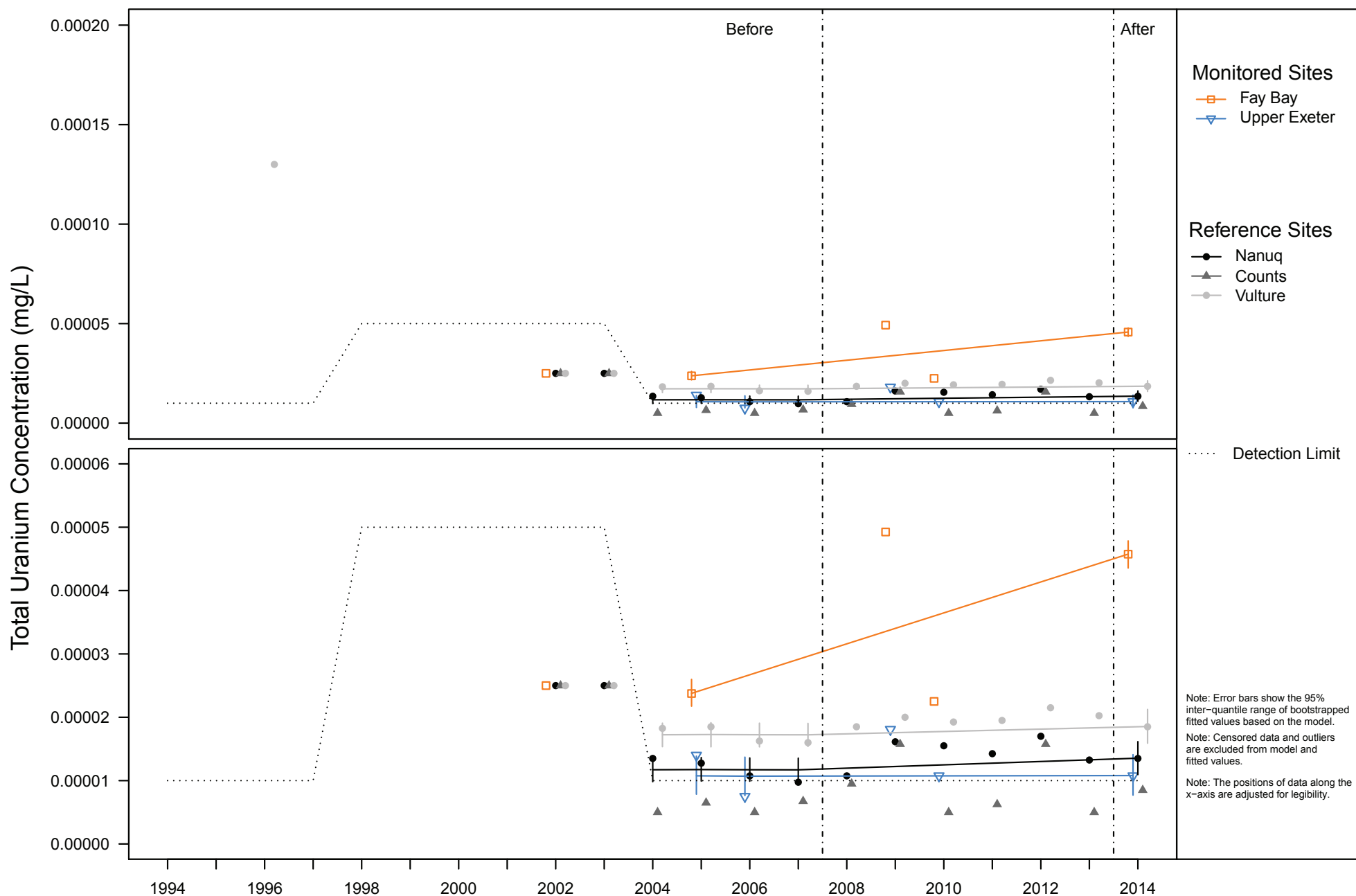
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total uranium concentrations at the Upper Exeter site were not significantly ($p = 0.674$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

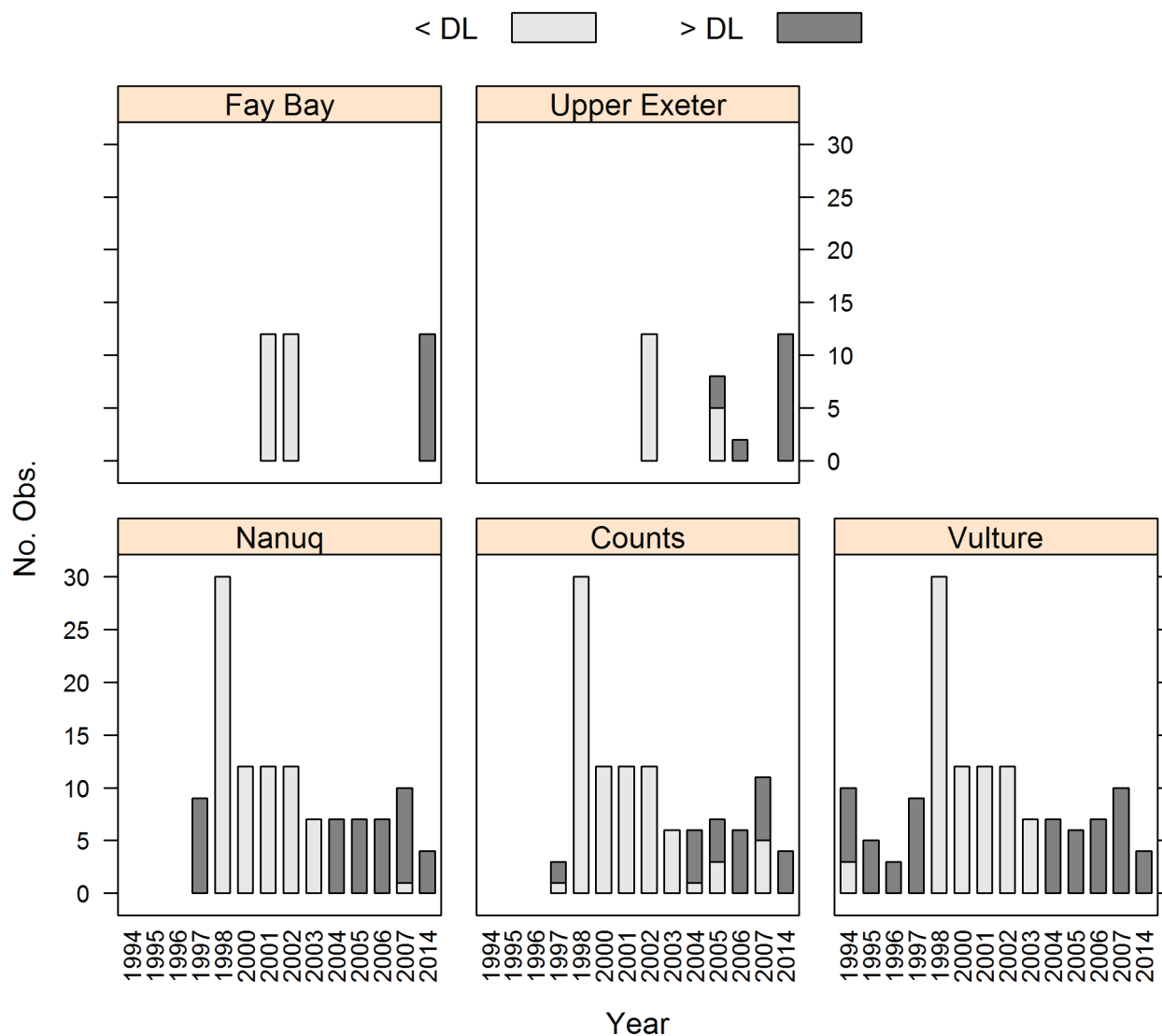


Analysis of Summer Total Uranium Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

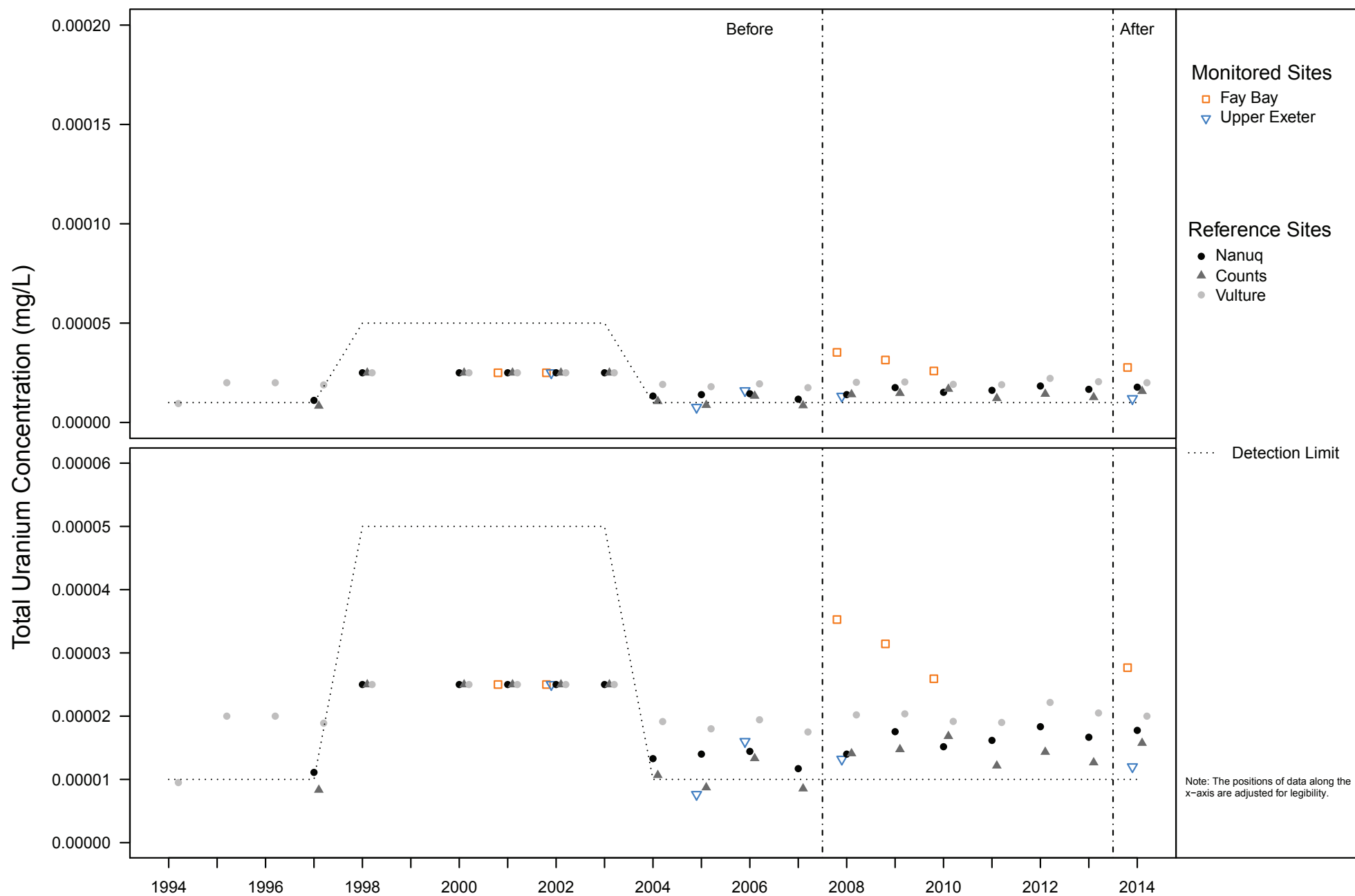
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Uranium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

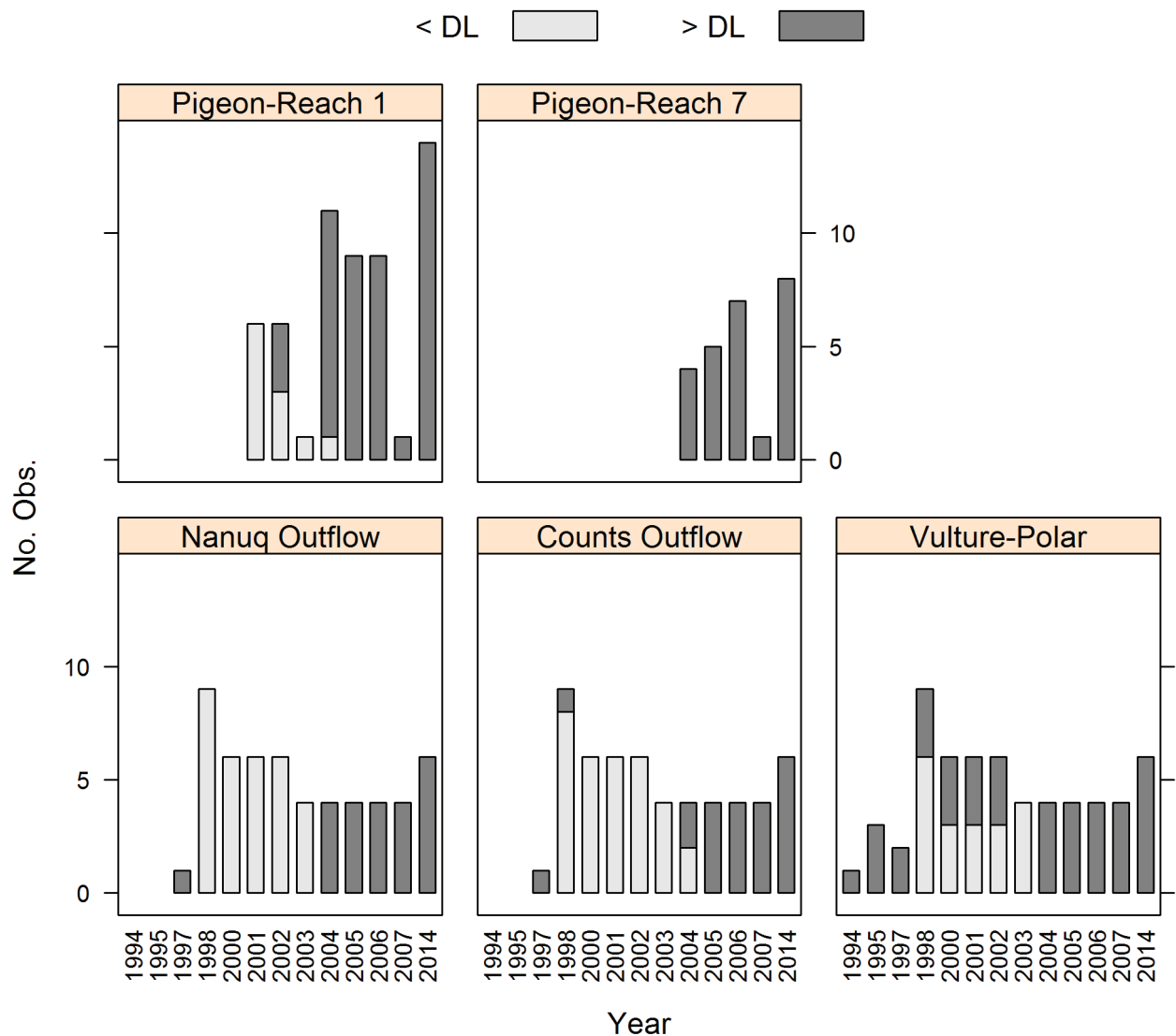


Analysis of Summer Total Uranium Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##		site	year	month	season
## 27122	Counts	Outflow	1998	July	summer
## 27123	Counts	Outflow	1998	July	summer
## 27124	Counts	Outflow	1998	July	summer
## 27125	Counts	Outflow	1998	August	summer
## 27126	Counts	Outflow	1998	August	summer
## 27127	Counts	Outflow	1998	August	summer
## 27128	Counts	Outflow	1998	September	summer
## 27129	Counts	Outflow	1998	September	summer
## 27130	Counts	Outflow	1998	September	summer
## 27135	Nanuq	Outflow	1998	July	summer
## 27136	Nanuq	Outflow	1998	July	summer
## 27137	Nanuq	Outflow	1998	July	summer
## 27138	Nanuq	Outflow	1998	August	summer
## 27139	Nanuq	Outflow	1998	August	summer
## 27140	Nanuq	Outflow	1998	August	summer
## 27141	Nanuq	Outflow	1998	September	summer
## 27142	Nanuq	Outflow	1998	September	summer
## 27143	Nanuq	Outflow	1998	September	summer
## 27148	Vulture-Polar	1998	July	summer	
## 27149	Vulture-Polar	1998	July	summer	
## 27150	Vulture-Polar	1998	July	summer	
## 27151	Vulture-Polar	1998	August	summer	
## 27152	Vulture-Polar	1998	August	summer	
## 27153	Vulture-Polar	1998	August	summer	
## 27154	Vulture-Polar	1998	September	summer	
## 27155	Vulture-Polar	1998	September	summer	
## 27156	Vulture-Polar	1998	September	summer	
## 27187	Counts	Outflow	2000	August	summer
## 27188	Counts	Outflow	2000	August	summer
## 27189	Counts	Outflow	2000	August	summer
## 27190	Counts	Outflow	2000	September	summer
## 27191	Counts	Outflow	2000	September	summer
## 27192	Counts	Outflow	2000	September	summer
## 27196	Nanuq	Outflow	2000	August	summer
## 27197	Nanuq	Outflow	2000	August	summer
## 27198	Nanuq	Outflow	2000	August	summer
## 27199	Nanuq	Outflow	2000	September	summer
## 27200	Nanuq	Outflow	2000	September	summer
## 27201	Nanuq	Outflow	2000	September	summer
## 27213	Counts	Outflow	2001	August	summer
## 27214	Counts	Outflow	2001	August	summer
## 27215	Counts	Outflow	2001	August	summer


```

## 27216 Counts Outflow 2001 September summer
## 27217 Counts Outflow 2001 September summer
## 27218 Counts Outflow 2001 September summer
## 27222 Nanuq Outflow 2001 August summer
## 27223 Nanuq Outflow 2001 August summer
## 27224 Nanuq Outflow 2001 August summer
## 27225 Nanuq Outflow 2001 September summer
## 27226 Nanuq Outflow 2001 September summer
## 27227 Nanuq Outflow 2001 September summer
## 27231 Pigeon-Reach 1 2001 August summer
## 27232 Pigeon-Reach 1 2001 August summer
## 27233 Pigeon-Reach 1 2001 August summer
## 27234 Pigeon-Reach 1 2001 September summer
## 27235 Pigeon-Reach 1 2001 September summer
## 27236 Pigeon-Reach 1 2001 September summer
## 27249 Counts Outflow 2002 August summer
## 27250 Counts Outflow 2002 August summer
## 27251 Counts Outflow 2002 August summer
## 27252 Counts Outflow 2002 September summer
## 27253 Counts Outflow 2002 September summer
## 27254 Counts Outflow 2002 September summer
## 27258 Nanuq Outflow 2002 August summer
## 27259 Nanuq Outflow 2002 August summer
## 27260 Nanuq Outflow 2002 August summer
## 27261 Nanuq Outflow 2002 September summer
## 27262 Nanuq Outflow 2002 September summer
## 27263 Nanuq Outflow 2002 September summer
## 27284 Counts Outflow 2003 August summer
## 27285 Counts Outflow 2003 August summer
## 27286 Counts Outflow 2003 September summer
## 27287 Counts Outflow 2003 September summer
## 27290 Nanuq Outflow 2003 August summer
## 27291 Nanuq Outflow 2003 August summer
## 27292 Nanuq Outflow 2003 September summer
## 27293 Nanuq Outflow 2003 September summer
## 27295 Pigeon-Reach 1 2003 September summer
## 27298 Vulture-Polar 2003 August summer
## 27299 Vulture-Polar 2003 August summer
## 27300 Vulture-Polar 2003 September summer
## 27301 Vulture-Polar 2003 September summer

```

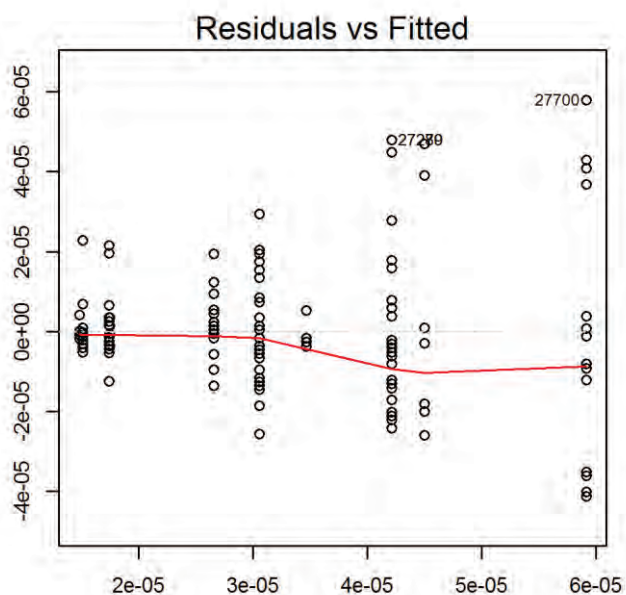
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

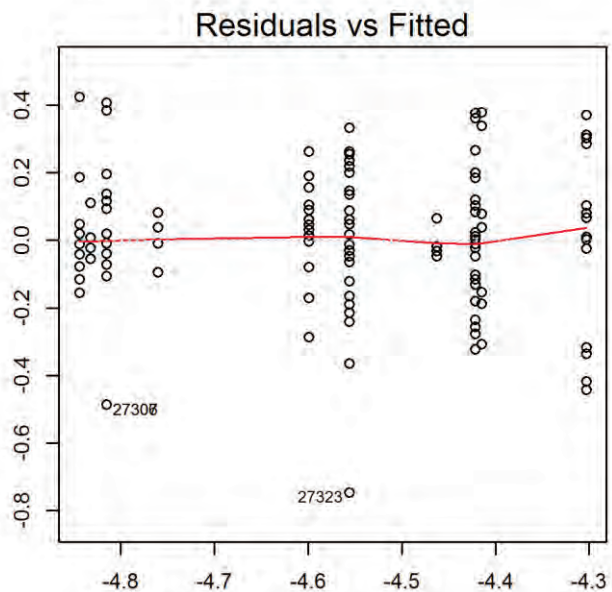
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.71×10 ⁻⁵	0.38	0.34
Log-10	0.2	0.46	0.42

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

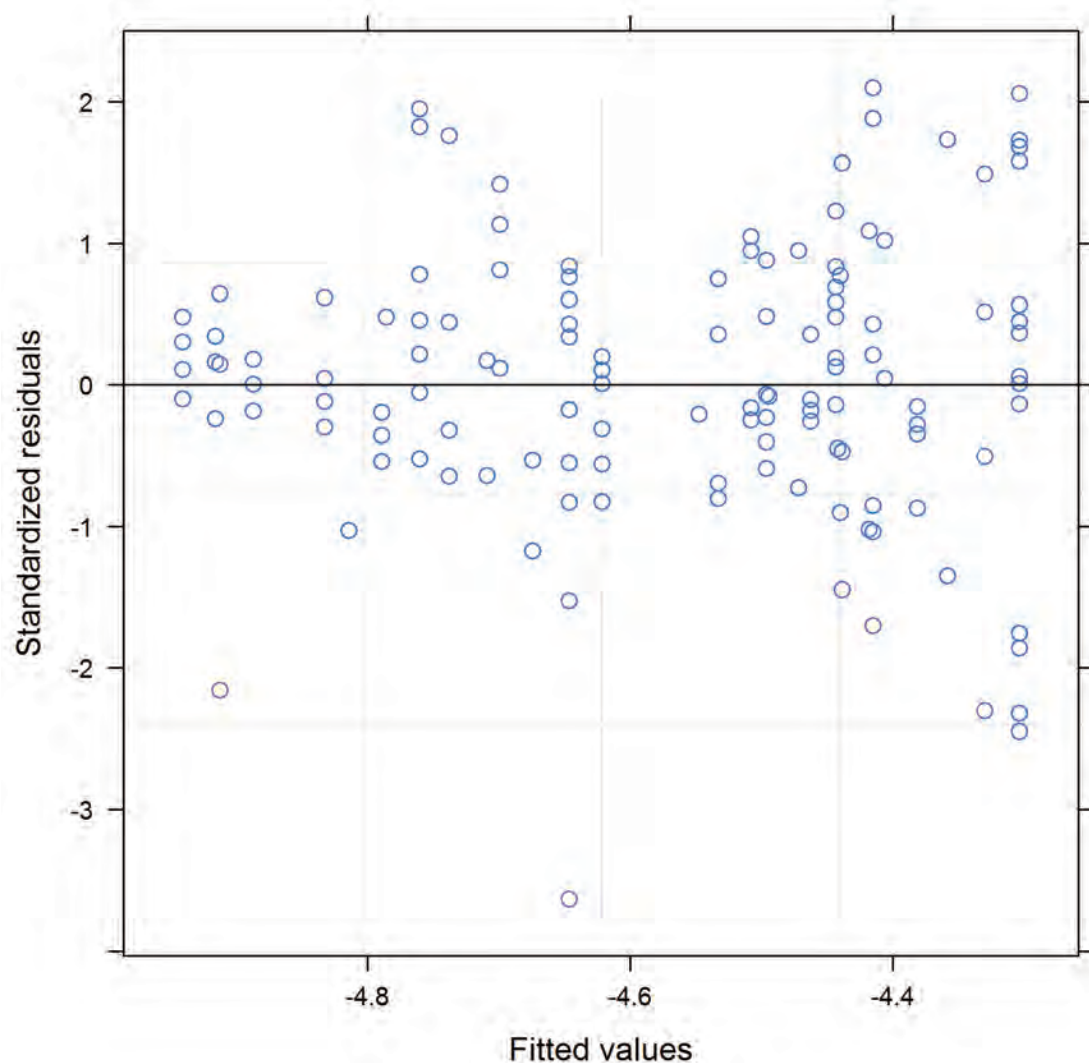
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	11	-16.72	19.36		
LME	12	-33.17	28.59	18.45	1.74×10 ⁻⁵

Conclusion:

The most appropriate model for total uranium at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	148	21728	<.0001
## site	4	148	29	<.0001
## period	1	9	1	0.288
## site:period	4	148	3	0.031

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	-0.23	-0.43	-0.04	sig.
Counts Outflow	-0.19	-0.39	0.01	not sig.
Vulture-Polar	-0.27	-0.46	-0.09	sig.
Pigeon-Reach 7	-0.06	-0.24	0.13	not sig.

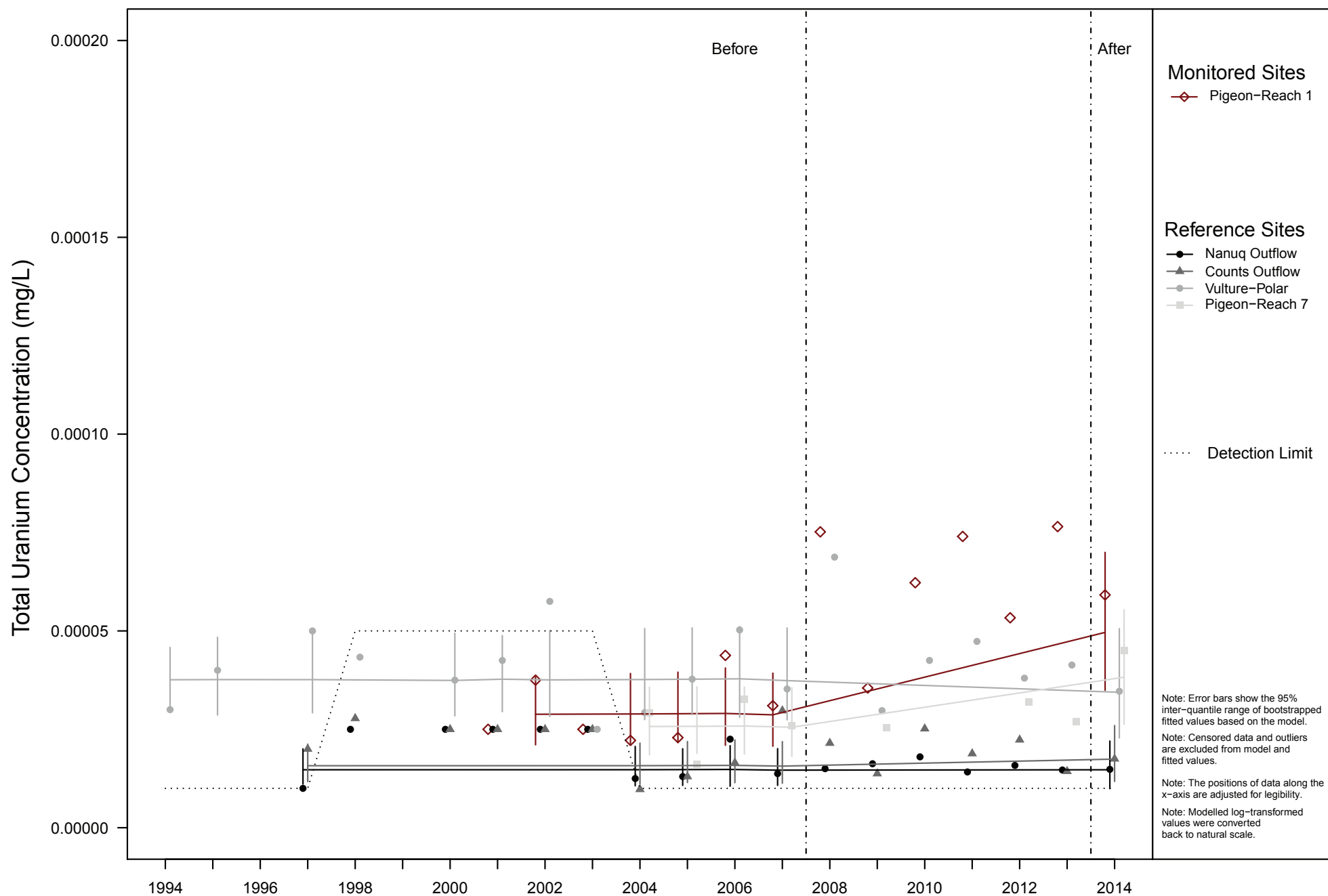
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total uranium concentrations at the Pigeon-Reach 1 site were significantly ($p = 0.031$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

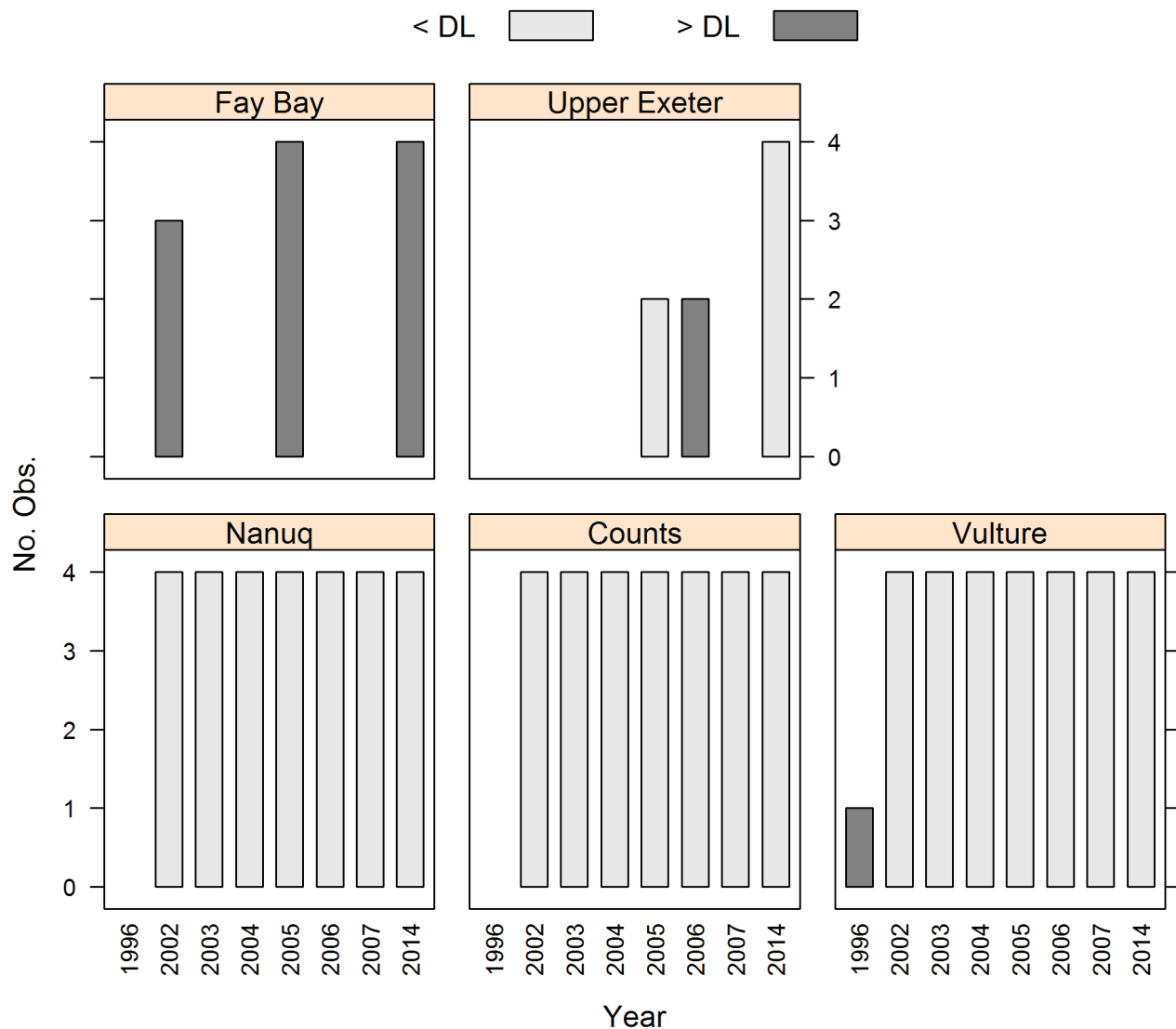


Analysis of Winter Total Vanadium Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

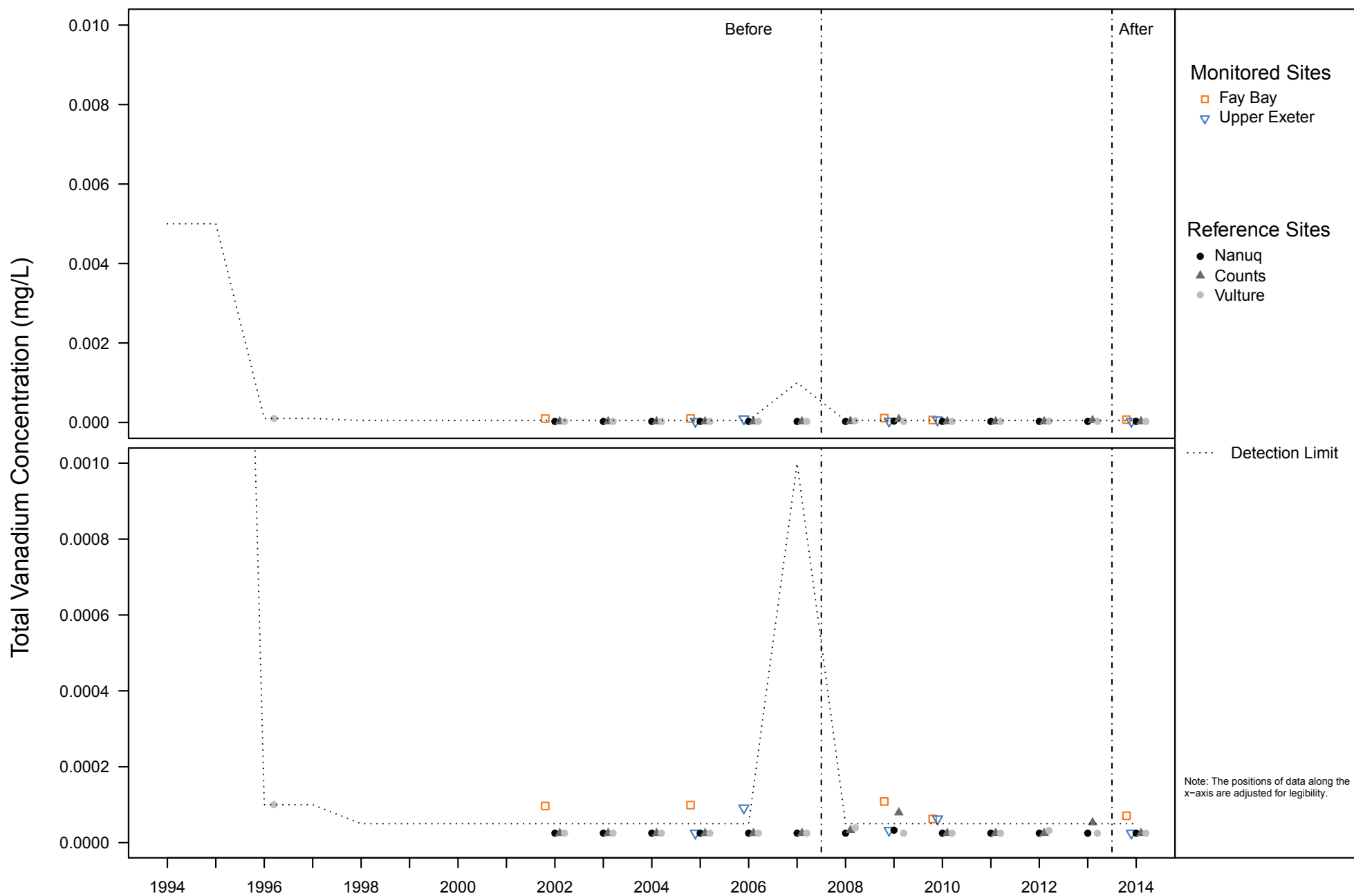
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Vanadium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

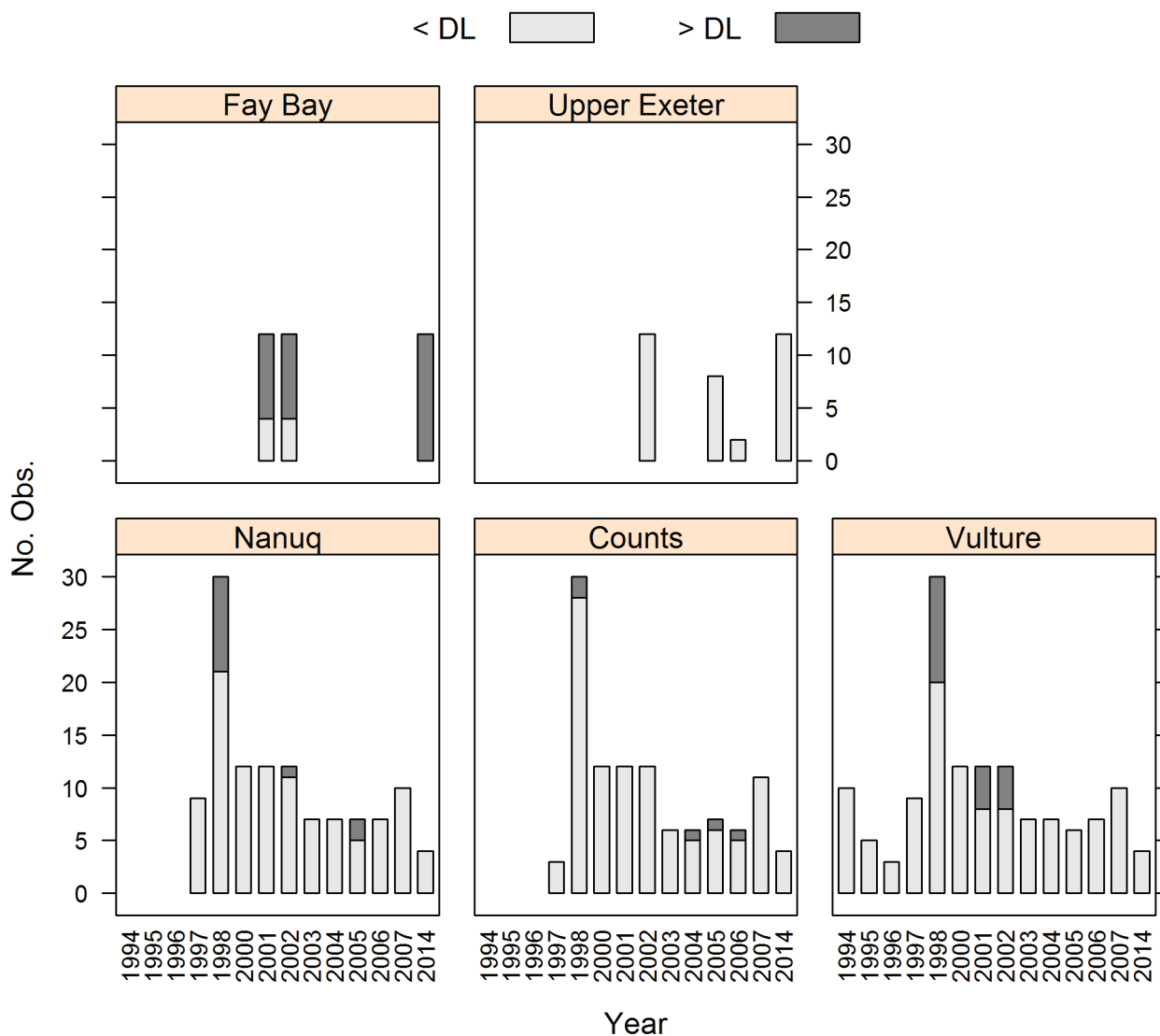


Analysis of Summer Total Vanadium Water Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2015

1 Censored Data

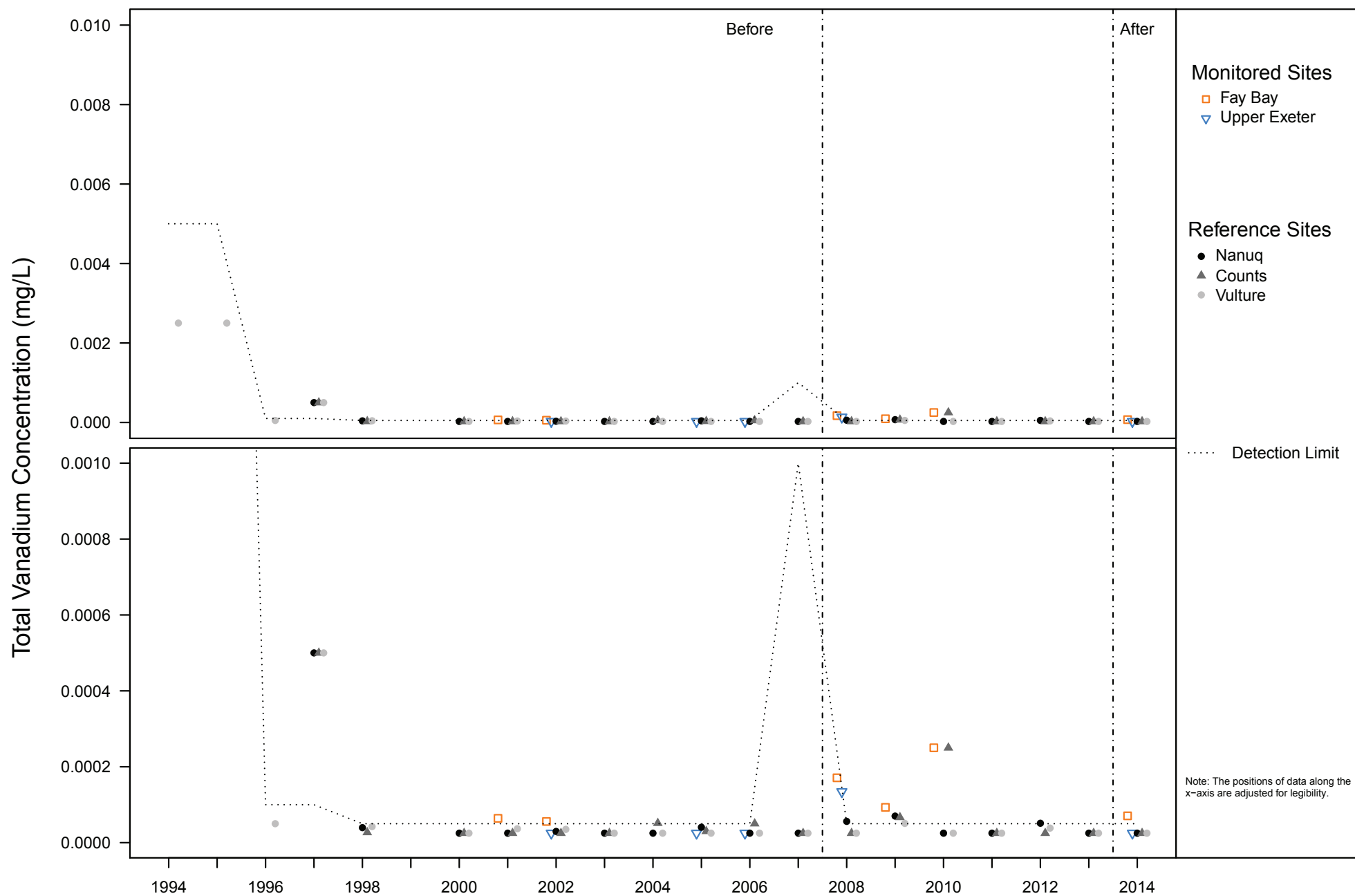
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Vanadium water concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

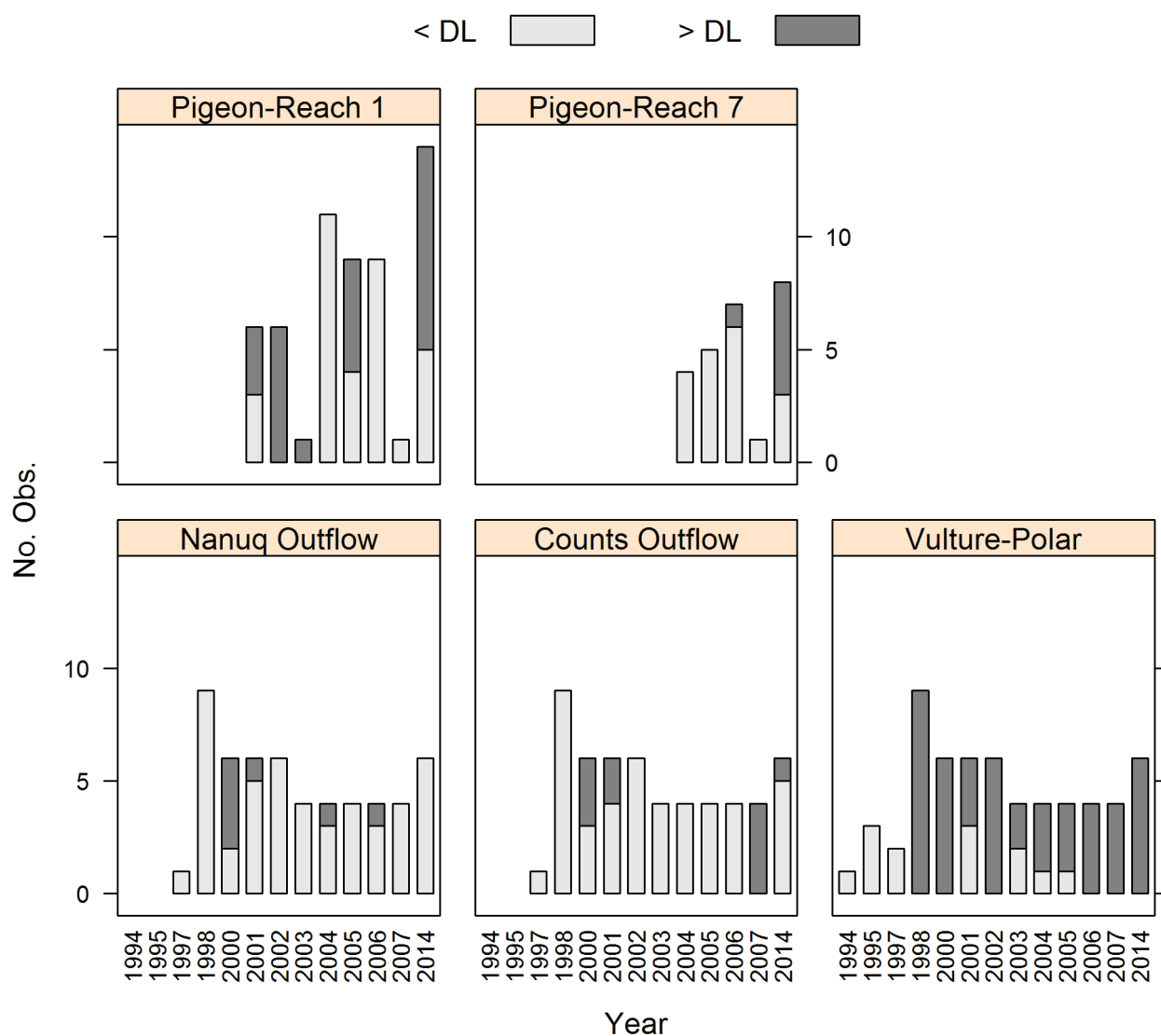


Analysis of Summer Total Vanadium Concentrations in Streams of the Pigeon-Fay and Upper Exeter Watershed

January 26, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##		site	year	month	season
## 27724	Vulture-Polar	1994	August	summer	
## 27725	Vulture-Polar	1995	July	summer	
## 27726	Vulture-Polar	1995	August	summer	
## 27727	Vulture-Polar	1995	September	summer	
## 27730	Counts Outflow	1997	September	summer	
## 27731	Nanuq Outflow	1997	September	summer	
## 27732	Vulture-Polar	1997	July	summer	
## 27733	Vulture-Polar	1997	September	summer	
## 27738	Counts Outflow	1998	July	summer	
## 27739	Counts Outflow	1998	July	summer	
## 27740	Counts Outflow	1998	July	summer	
## 27741	Counts Outflow	1998	August	summer	
## 27742	Counts Outflow	1998	August	summer	
## 27743	Counts Outflow	1998	August	summer	
## 27744	Counts Outflow	1998	September	summer	
## 27745	Counts Outflow	1998	September	summer	
## 27746	Counts Outflow	1998	September	summer	
## 27751	Nanuq Outflow	1998	July	summer	
## 27752	Nanuq Outflow	1998	July	summer	
## 27753	Nanuq Outflow	1998	July	summer	
## 27754	Nanuq Outflow	1998	August	summer	
## 27755	Nanuq Outflow	1998	August	summer	
## 27756	Nanuq Outflow	1998	August	summer	
## 27757	Nanuq Outflow	1998	September	summer	
## 27758	Nanuq Outflow	1998	September	summer	
## 27759	Nanuq Outflow	1998	September	summer	
## 27803	Counts Outflow	2000	August	summer	
## 27804	Counts Outflow	2000	August	summer	
## 27805	Counts Outflow	2000	August	summer	
## 27806	Counts Outflow	2000	September	summer	
## 27807	Counts Outflow	2000	September	summer	
## 27808	Counts Outflow	2000	September	summer	
## 27812	Nanuq Outflow	2000	August	summer	
## 27813	Nanuq Outflow	2000	August	summer	
## 27814	Nanuq Outflow	2000	August	summer	
## 27815	Nanuq Outflow	2000	September	summer	
## 27816	Nanuq Outflow	2000	September	summer	
## 27817	Nanuq Outflow	2000	September	summer	
## 27829	Counts Outflow	2001	August	summer	
## 27830	Counts Outflow	2001	August	summer	
## 27831	Counts Outflow	2001	August	summer	
## 27832	Counts Outflow	2001	September	summer	

##	27833	Counts	Outflow	2001	September	summer
##	27834	Counts	Outflow	2001	September	summer
##	27838	Nanuq	Outflow	2001	August	summer
##	27839	Nanuq	Outflow	2001	August	summer
##	27840	Nanuq	Outflow	2001	August	summer
##	27841	Nanuq	Outflow	2001	September	summer
##	27842	Nanuq	Outflow	2001	September	summer
##	27843	Nanuq	Outflow	2001	September	summer
##	27865	Counts	Outflow	2002	August	summer
##	27866	Counts	Outflow	2002	August	summer
##	27867	Counts	Outflow	2002	August	summer
##	27868	Counts	Outflow	2002	September	summer
##	27869	Counts	Outflow	2002	September	summer
##	27870	Counts	Outflow	2002	September	summer
##	27874	Nanuq	Outflow	2002	August	summer
##	27875	Nanuq	Outflow	2002	August	summer
##	27876	Nanuq	Outflow	2002	August	summer
##	27877	Nanuq	Outflow	2002	September	summer
##	27878	Nanuq	Outflow	2002	September	summer
##	27879	Nanuq	Outflow	2002	September	summer
##	27900	Counts	Outflow	2003	August	summer
##	27901	Counts	Outflow	2003	August	summer
##	27902	Counts	Outflow	2003	September	summer
##	27903	Counts	Outflow	2003	September	summer
##	27906	Nanuq	Outflow	2003	August	summer
##	27907	Nanuq	Outflow	2003	August	summer
##	27908	Nanuq	Outflow	2003	September	summer
##	27909	Nanuq	Outflow	2003	September	summer
##	27920	Counts	Outflow	2004	August	summer
##	27921	Counts	Outflow	2004	August	summer
##	27922	Counts	Outflow	2004	September	summer
##	27923	Counts	Outflow	2004	September	summer
##	27926	Nanuq	Outflow	2004	August	summer
##	27927	Nanuq	Outflow	2004	August	summer
##	27928	Nanuq	Outflow	2004	September	summer
##	27929	Nanuq	Outflow	2004	September	summer
##	27933	Pigeon-Reach	1	2004	July	summer
##	27934	Pigeon-Reach	1	2004	July	summer
##	27935	Pigeon-Reach	1	2004	July	summer
##	27936	Pigeon-Reach	1	2004	July	summer
##	27937	Pigeon-Reach	1	2004	August	summer
##	27938	Pigeon-Reach	1	2004	August	summer
##	27939	Pigeon-Reach	1	2004	August	summer
##	27940	Pigeon-Reach	1	2004	August	summer
##	27941	Pigeon-Reach	1	2004	September	summer
##	27942	Pigeon-Reach	1	2004	September	summer
##	27943	Pigeon-Reach	1	2004	September	summer
##	27944	Pigeon-Reach	7	2004	July	summer
##	27945	Pigeon-Reach	7	2004	July	summer
##	27946	Pigeon-Reach	7	2004	July	summer

##	27947	Pigeon-Reach 7	2004	July	summer
##	27956	Counts Outflow	2005	August	summer
##	27957	Counts Outflow	2005	August	summer
##	27958	Counts Outflow	2005	September	summer
##	27959	Counts Outflow	2005	September	summer
##	27962	Nanuq Outflow	2005	August	summer
##	27963	Nanuq Outflow	2005	August	summer
##	27964	Nanuq Outflow	2005	September	summer
##	27965	Nanuq Outflow	2005	September	summer
##	27985	Pigeon-Reach 7	2005	August	summer
##	27986	Pigeon-Reach 7	2005	August	summer
##	27987	Pigeon-Reach 7	2005	August	summer
##	27988	Pigeon-Reach 7	2005	September	summer
##	27989	Pigeon-Reach 7	2005	September	summer
##	27998	Counts Outflow	2006	August	summer
##	27999	Counts Outflow	2006	August	summer
##	28000	Counts Outflow	2006	September	summer
##	28001	Counts Outflow	2006	September	summer
##	28004	Nanuq Outflow	2006	August	summer
##	28005	Nanuq Outflow	2006	August	summer
##	28006	Nanuq Outflow	2006	September	summer
##	28007	Nanuq Outflow	2006	September	summer
##	28011	Pigeon-Reach 1	2006	July	summer
##	28012	Pigeon-Reach 1	2006	July	summer
##	28013	Pigeon-Reach 1	2006	July	summer
##	28014	Pigeon-Reach 1	2006	August	summer
##	28015	Pigeon-Reach 1	2006	August	summer
##	28016	Pigeon-Reach 1	2006	August	summer
##	28017	Pigeon-Reach 1	2006	September	summer
##	28018	Pigeon-Reach 1	2006	September	summer
##	28019	Pigeon-Reach 1	2006	September	summer
##	28022	Pigeon-Reach 7	2006	July	summer
##	28023	Pigeon-Reach 7	2006	July	summer
##	28024	Pigeon-Reach 7	2006	July	summer
##	28025	Pigeon-Reach 7	2006	July	summer
##	28026	Pigeon-Reach 7	2006	August	summer
##	28027	Pigeon-Reach 7	2006	August	summer
##	28028	Pigeon-Reach 7	2006	September	summer
##	28036	Counts Outflow	2007	August	summer
##	28037	Counts Outflow	2007	August	summer
##	28038	Counts Outflow	2007	September	summer
##	28039	Counts Outflow	2007	September	summer
##	28041	Nanuq Outflow	2007	August	summer
##	28042	Nanuq Outflow	2007	August	summer
##	28043	Nanuq Outflow	2007	September	summer
##	28044	Nanuq Outflow	2007	September	summer
##	28050	Pigeon-Reach 1	2007	July	summer
##	28064	Pigeon-Reach 7	2007	July	summer
##	28289	Counts Outflow	2014	July	summer
##	28290	Counts Outflow	2014	July	summer


```

## 28291 Counts Outflow 2014      August summer
## 28292 Counts Outflow 2014      August summer
## 28293 Counts Outflow 2014 September summer
## 28294 Counts Outflow 2014 September summer
## 28297 Nanuq Outflow 2014        July summer
## 28298 Nanuq Outflow 2014        July summer
## 28299 Nanuq Outflow 2014        August summer
## 28300 Nanuq Outflow 2014        August summer
## 28301 Nanuq Outflow 2014 September summer
## 28302 Nanuq Outflow 2014 September summer
## 28321 Pigeon-Reach 7 2014       July summer
## 28322 Pigeon-Reach 7 2014       July summer
## 28323 Pigeon-Reach 7 2014       August summer
## 28324 Pigeon-Reach 7 2014       August summer
## 28325 Pigeon-Reach 7 2014 September summer
## 28326 Pigeon-Reach 7 2014 September summer
## 28327 Pigeon-Reach 7 2014       October summer
## 28328 Pigeon-Reach 7 2014       October summer

```

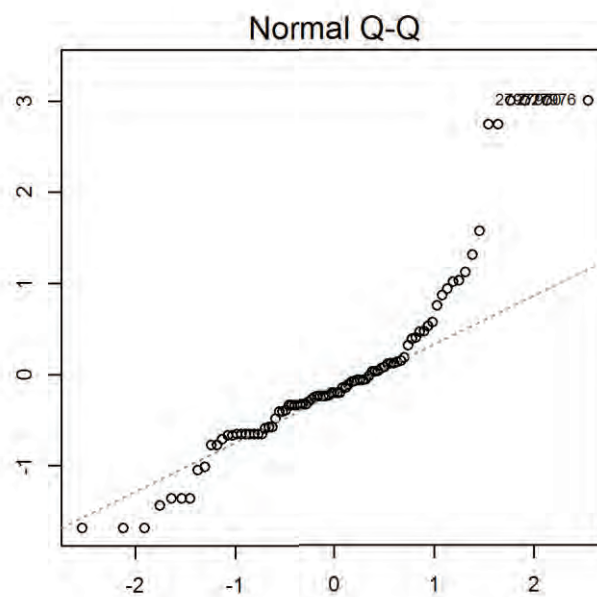
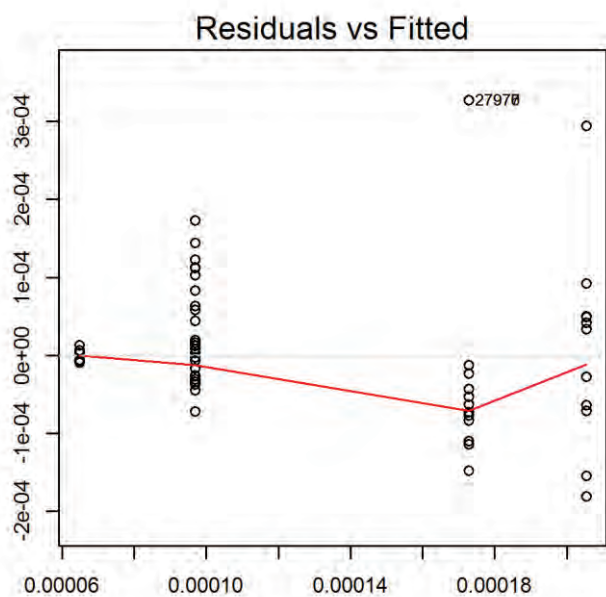
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

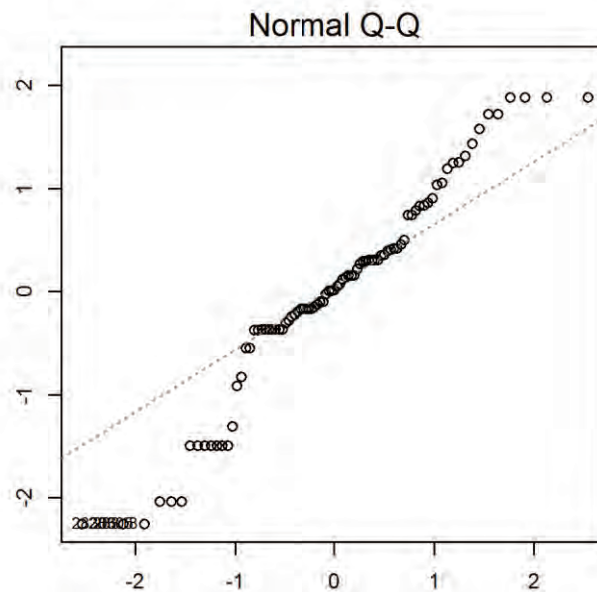
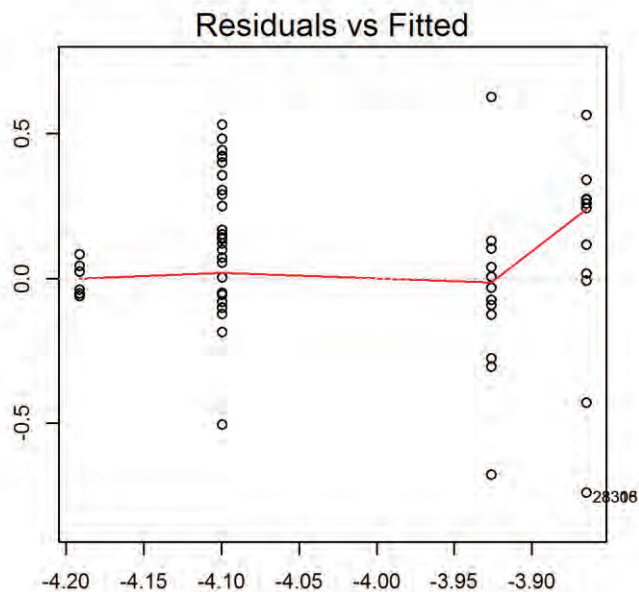
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1.11×10 ⁻⁴	0.16	0.13
Log-10	0.34	0.09	0.06

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

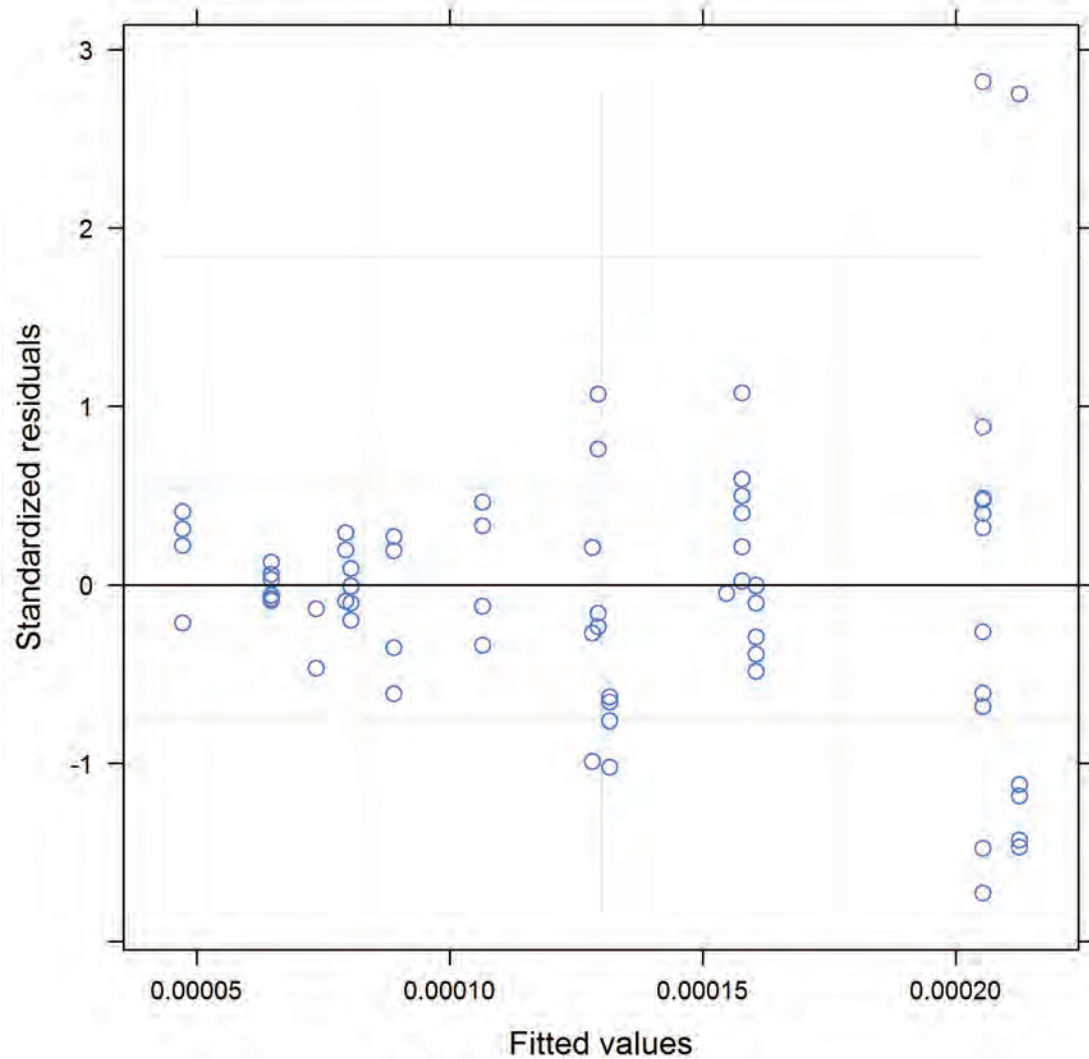
4. Before-After Control-Impact Linear Modeling**4.1 Pigeon-Reach 1 Monitoring Location**

Likelihood ratio test for model selection for the Pigeon-Reach 1 statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	5	-1284.72	647.36		
LME	6	-1287.06	649.53	4.34	0.04

Conclusion:

The most appropriate model for total vanadium at the Pigeon-Reach 1 monitoring site was the LME with a year term for interannual variation ($p = 0.037$).

Plot of Standardized Residuals and Fitted Values for Pigeon-Reach 1 Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	77	43	<.0001
## site	1	77	14	0.0003
## period	1	8	0	0.9989
## site:period	1	77	1	0.3205

Summary of BACI contrasts for changes between the *before* and *after* in Pigeon-Reach 1 by reference site, with 95% confidence intervals:

Pigeon-Reach 1 vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Nanuq Outflow	NA	NA	NA	NA
Counts Outflow	NA	NA	NA	NA
Vulture-Polar	-5.95×10^{-5}	-1.74×10^{-5}	5.52×10^{-5}	not sig.
Pigeon-Reach 7	NA	NA	NA	NA

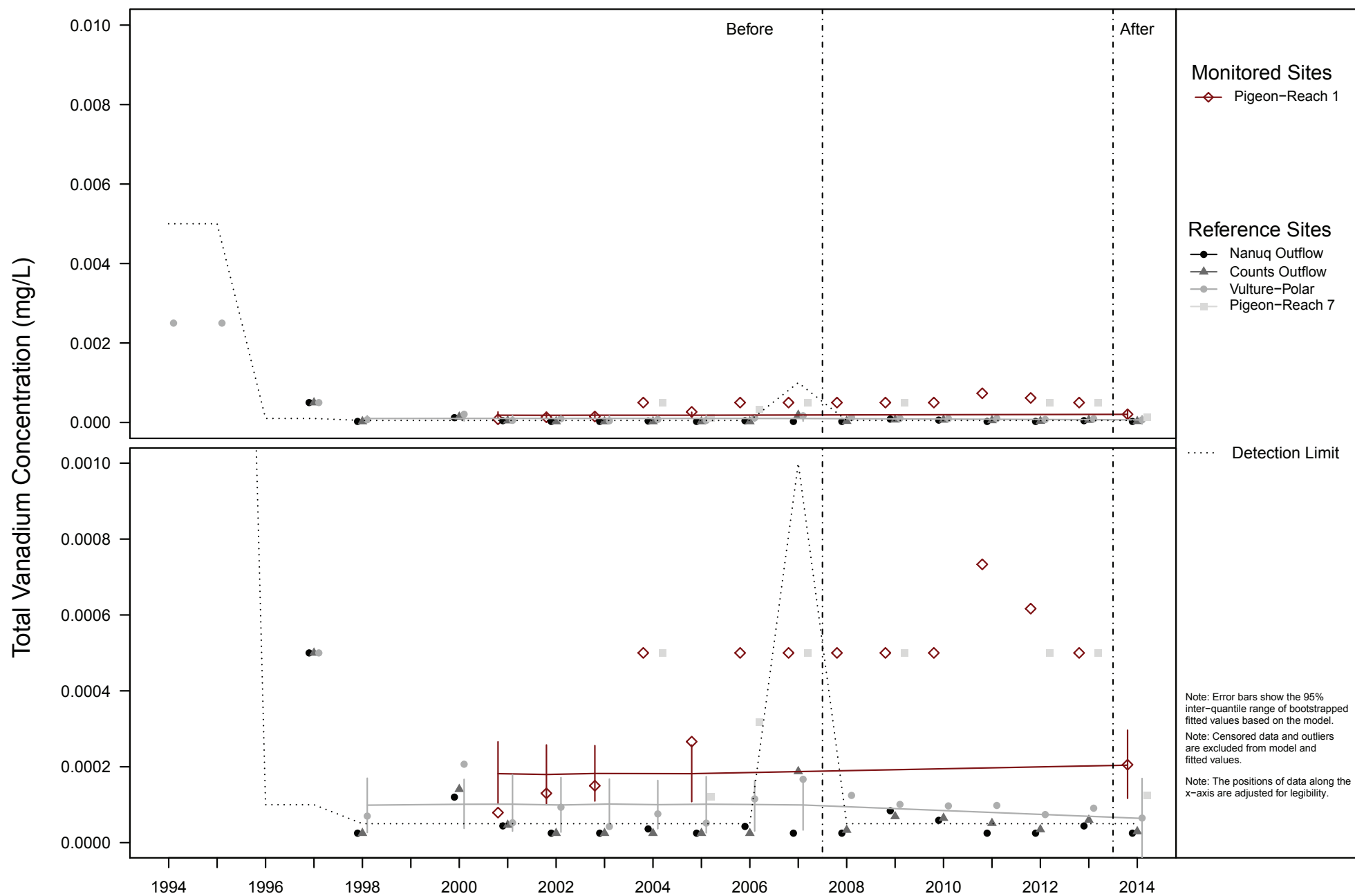
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total vanadium concentrations at the Pigeon-Reach 1 site were not significantly ($p = 0.321$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

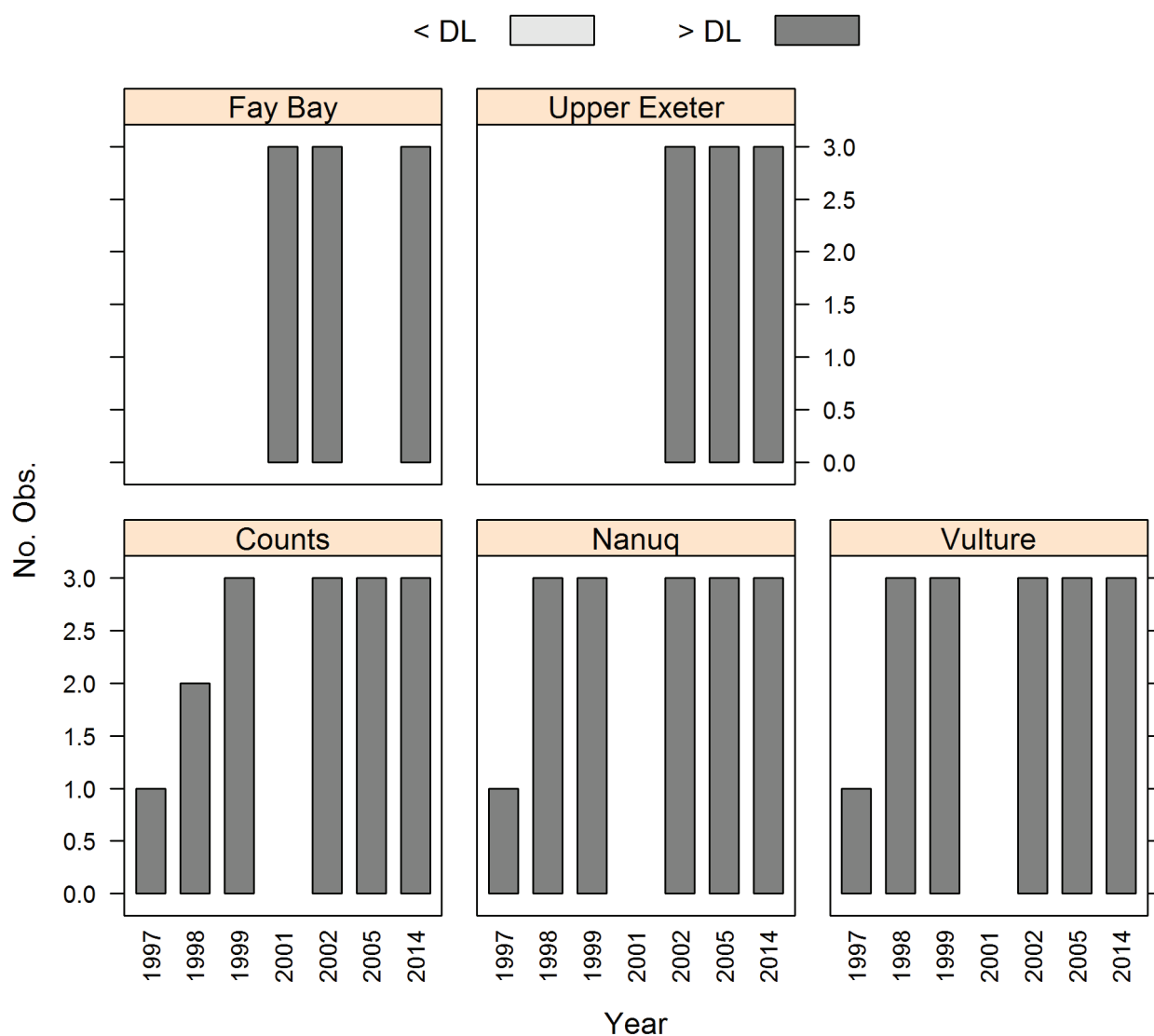


Analysis of Sediment Total Organic Carbon Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

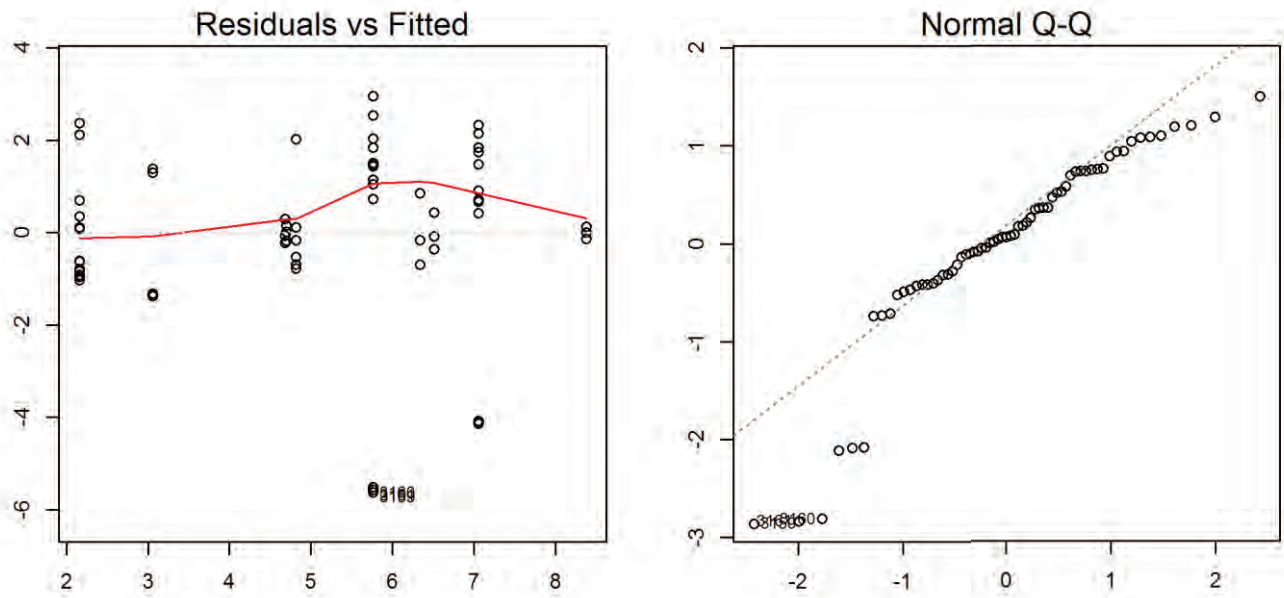
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

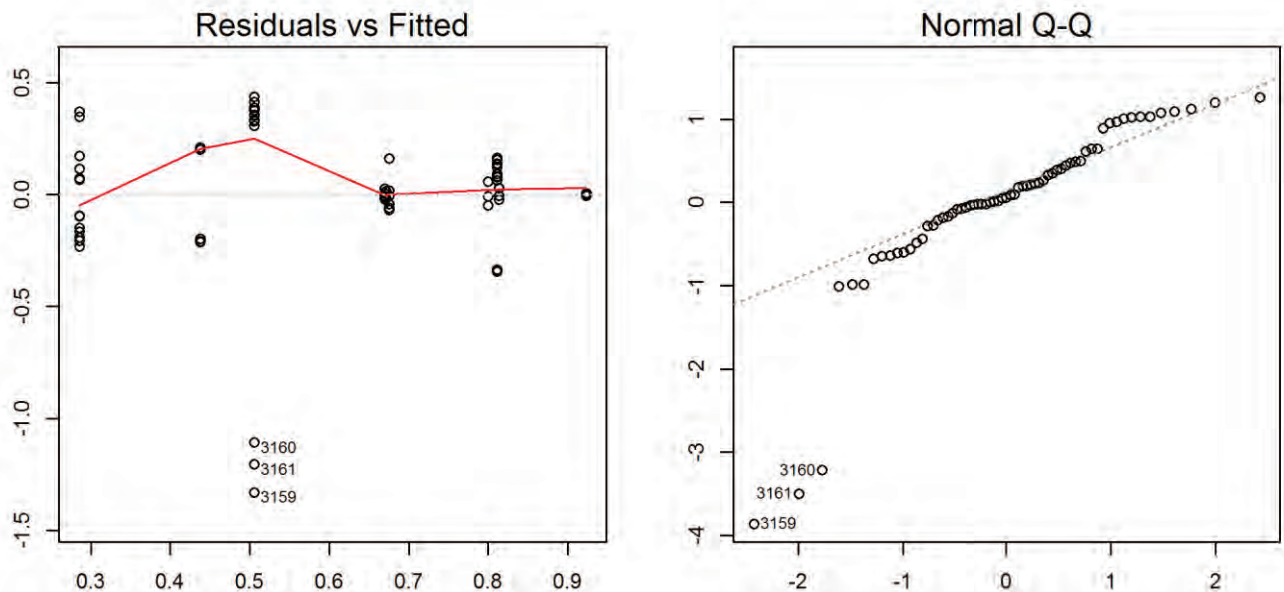
```
## No outliers were identified.
```


3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	2.05	0.5	0.42
Log-10	0.36	0.28	0.16

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

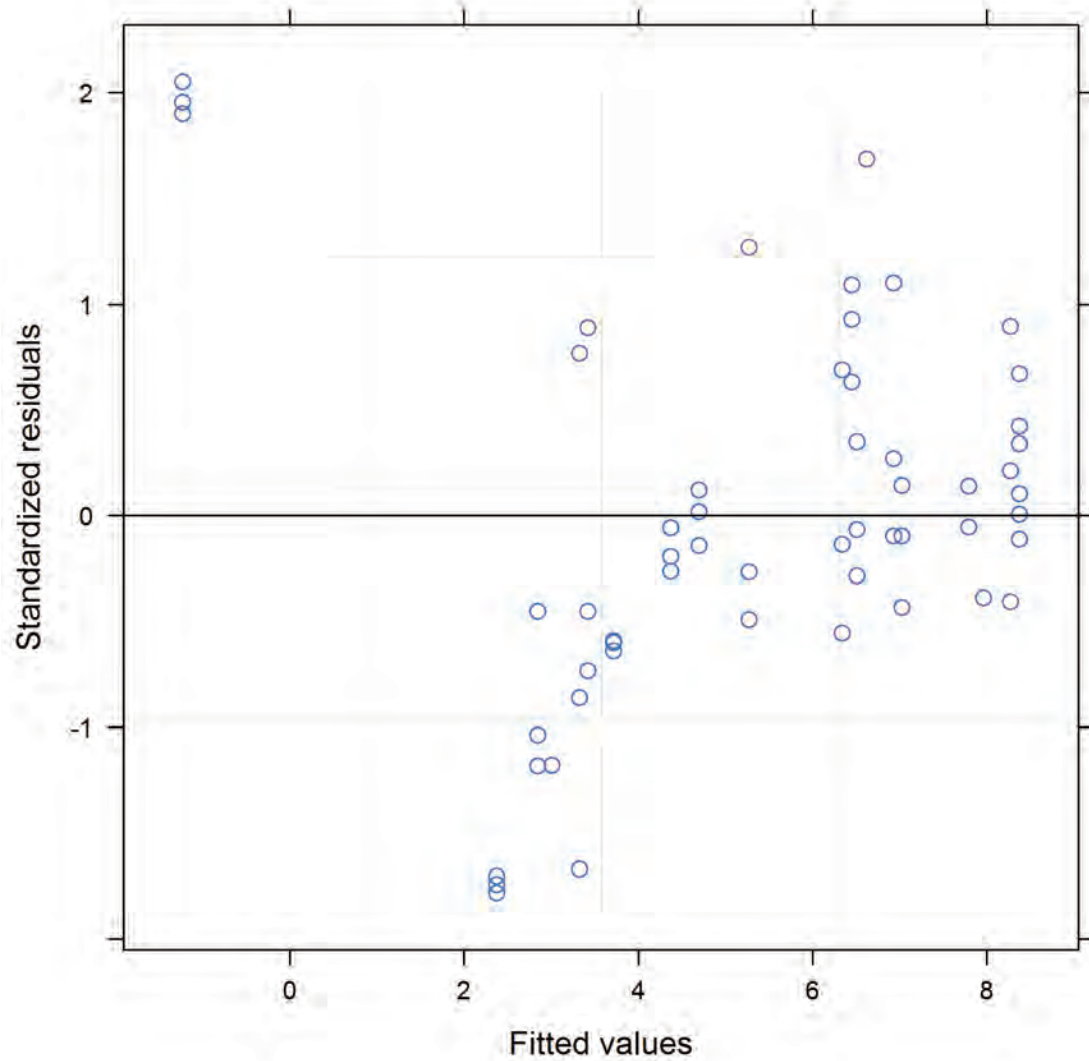
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	240.89	-111.45		
LME	10	204.85	-92.43	38.04	6.92×10 ⁻¹⁰

Conclusion:

The most appropriate model for total organic carbon at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	43	44	<.0001
## site	3	43	37	<.0001
## period	1	5	0	0.5451
## site:period	3	43	5	0.0055

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-4.18	-6.88	-1.54	sig.
Nanuq	-0.79	-3.49	1.87	not sig.
Vulture	-0.87	-3.66	1.8	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Fay Bay site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

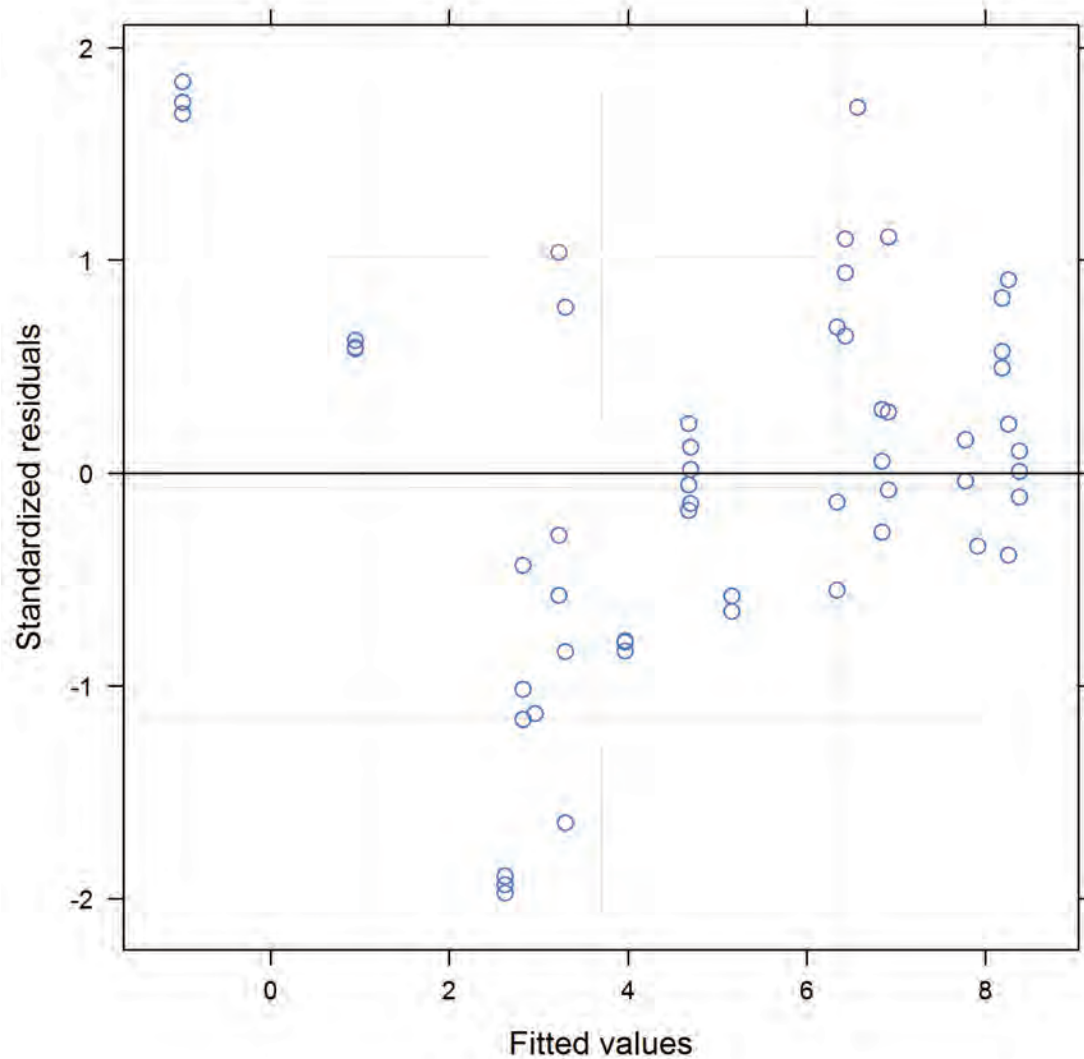
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	242.05	-112.02		
LME	10	203.26	-91.63	40.78	1.7×10^{-10}

Conclusion:

The most appropriate model for total organic carbon at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
##          numDF denDF F-value p-value
## (Intercept)      1    44      42 <.0001
## site             3    44      38 <.0001
## period           1     4       0  0.603
## site:period       3    44       4  0.012
## Computing bootstrap confidence intervals ...
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-1.36	-3.82	1.08	not sig.
Nanuq	2.03	-0.33	4.4	not sig.
Vulture	1.95	-0.39	4.32	not sig.

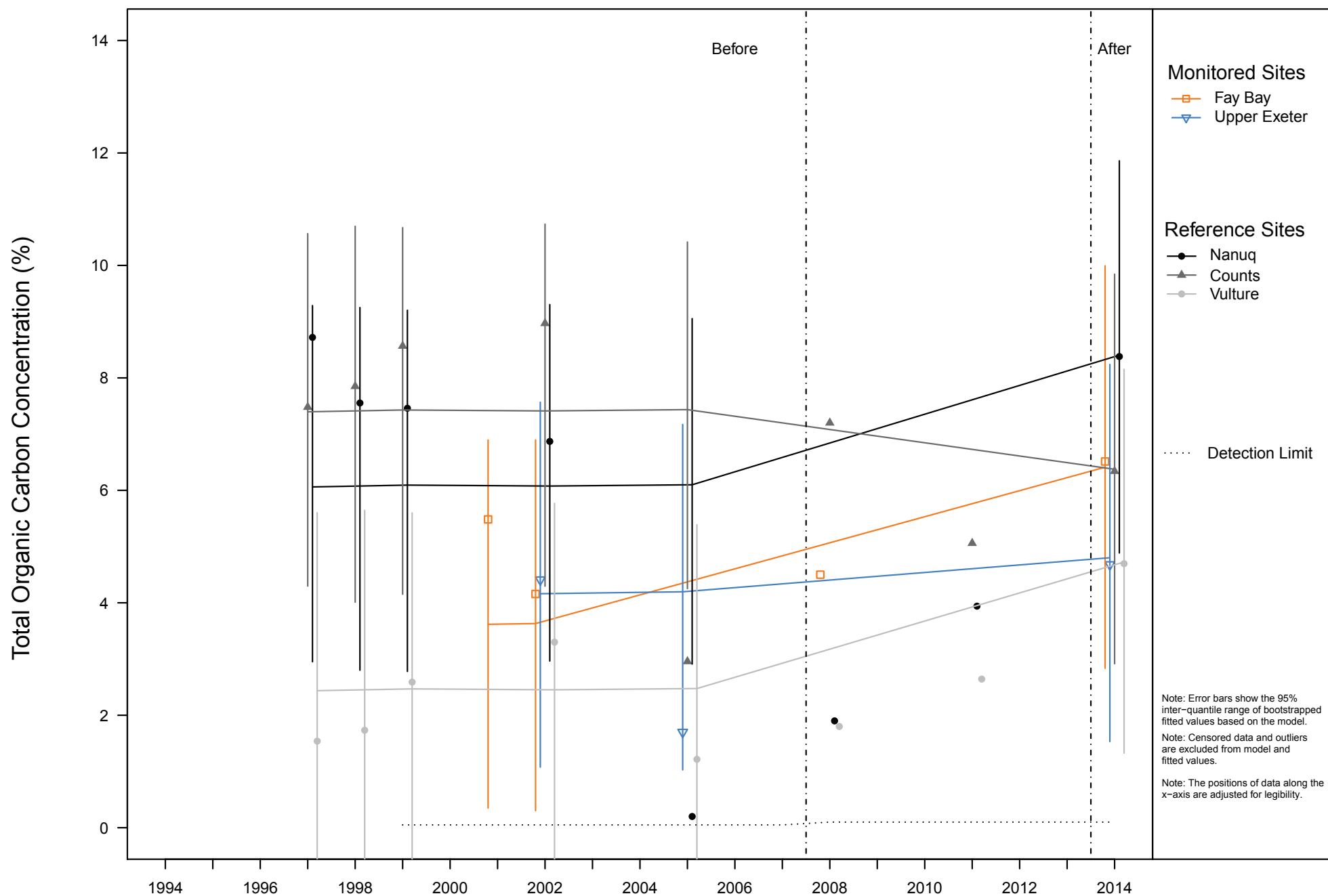
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total organic carbon concentrations at the Upper Exeter site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

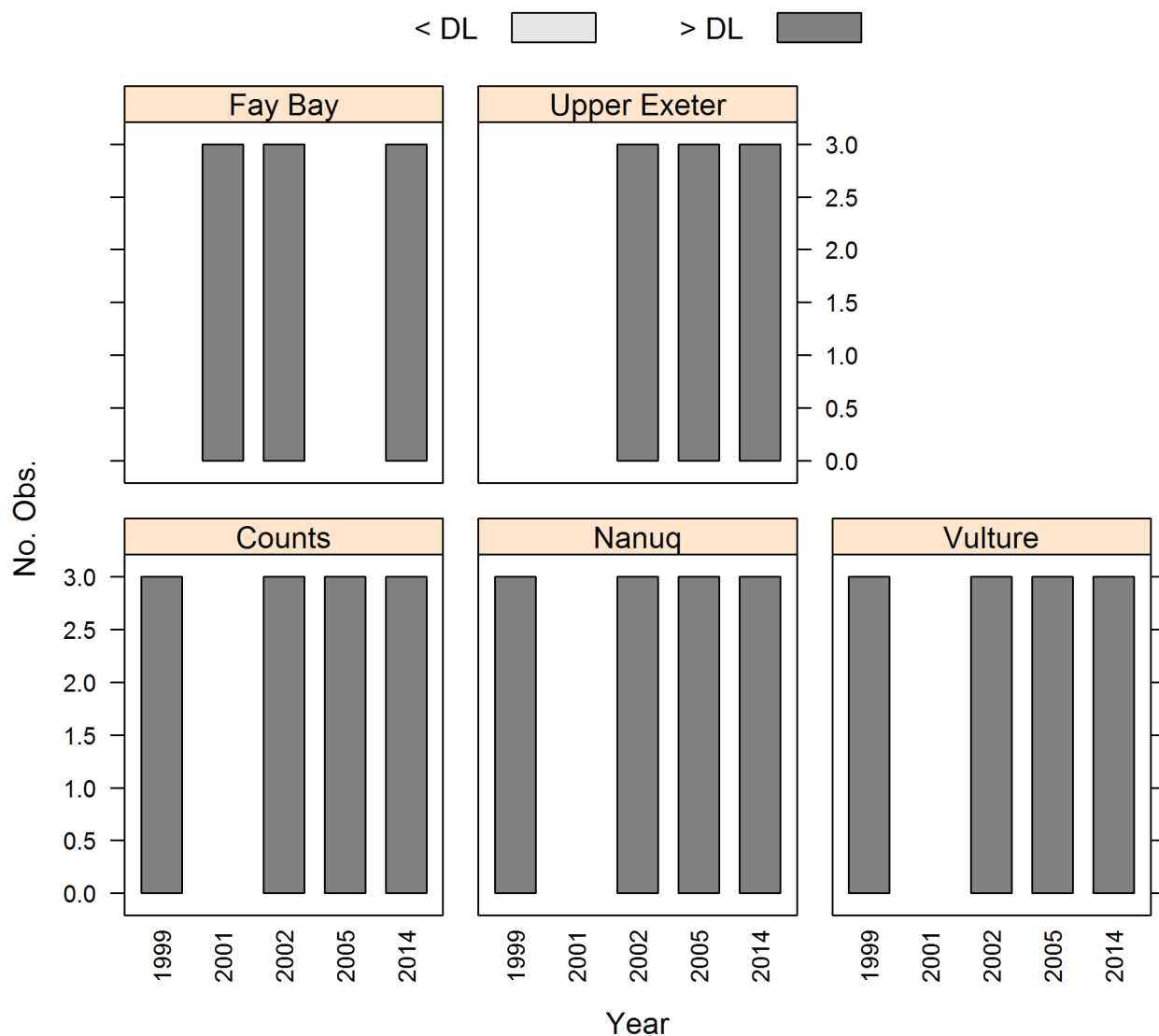


Analysis of Sediment Available Phosphorus Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

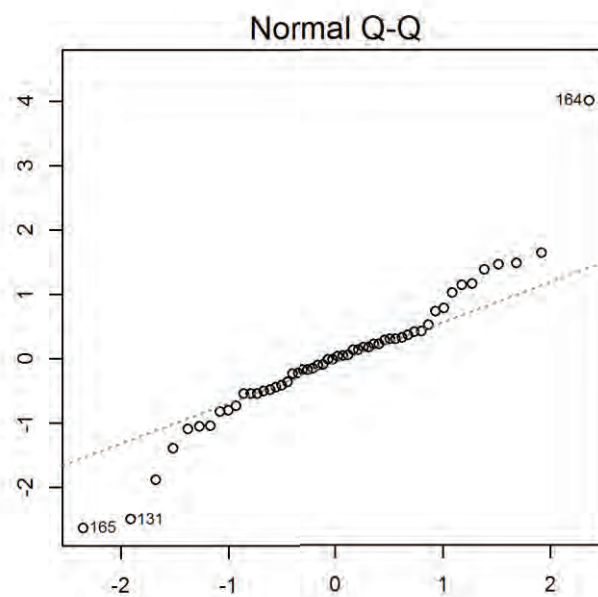
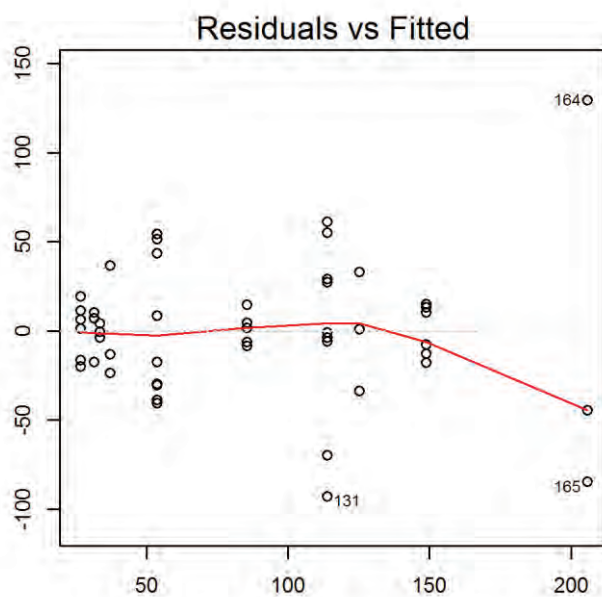
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

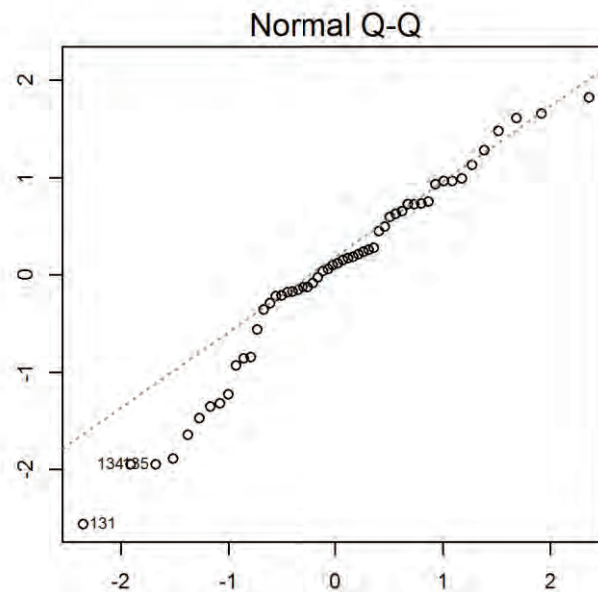
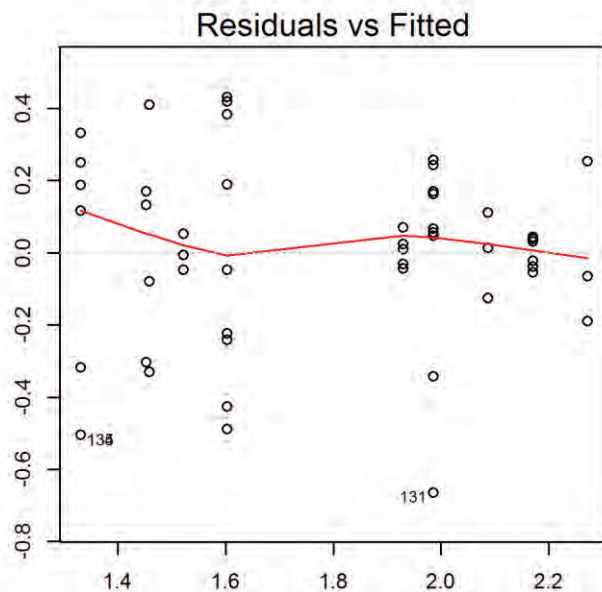
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	39.49	0.68	0.61
Log-10	0.28	0.62	0.54

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

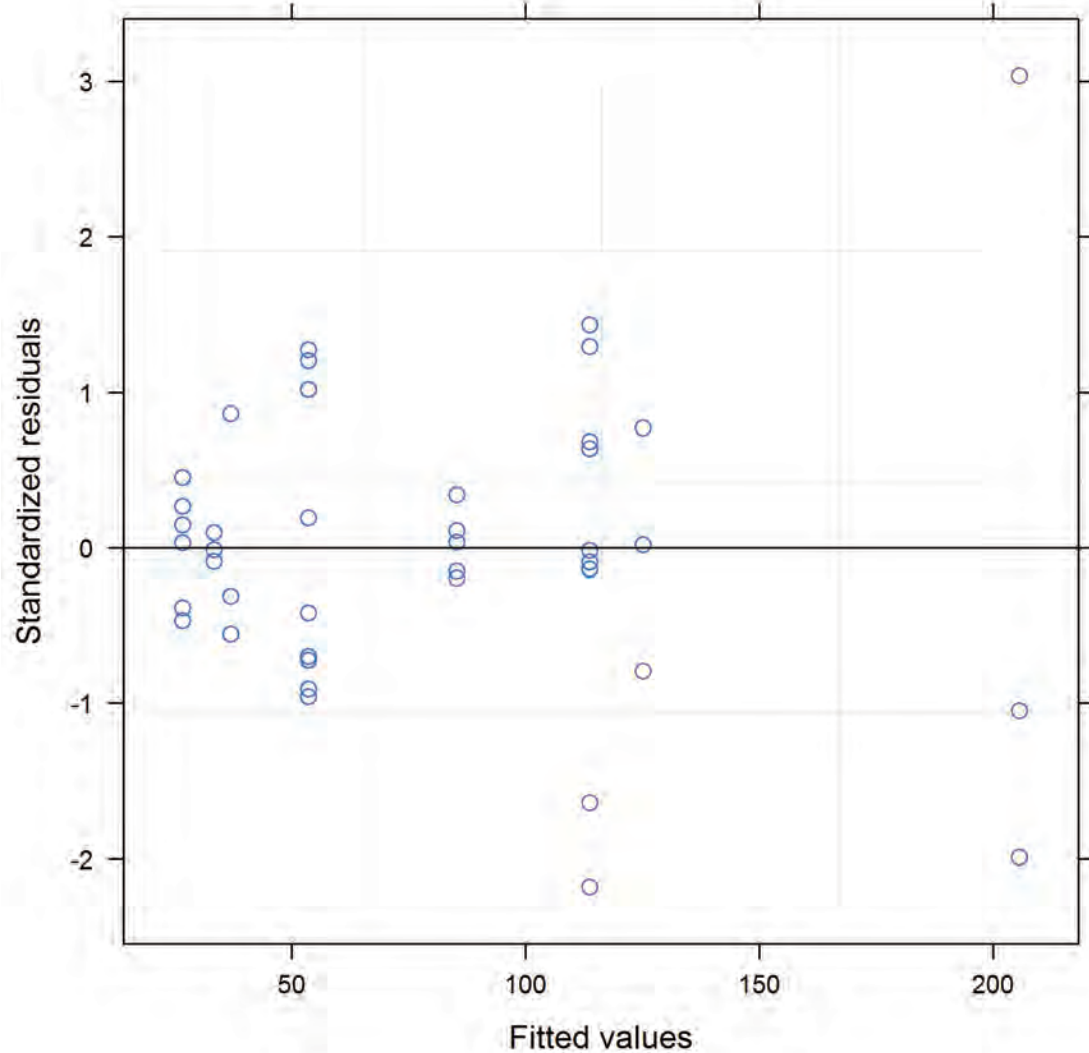
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	413.4	-197.7		
LME	10	415.33	-197.66	0.08	0.78

Conclusion:

The most appropriate model for available phosphorus at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.783$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 37
##          numDF F-value p-value
## (Intercept)    1    147 <.0001
## site           3     16 <.0001
## period         1      4  0.043
## site:period     3      3  0.057
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	52.12	-31.75	135.99	not sig.
Nanuq	-33	-116.87	50.87	not sig.
Vulture	-56.43	-140.3	27.44	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Available phosphorus concentrations at the Fay Bay site were not significantly ($p = 0.06$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

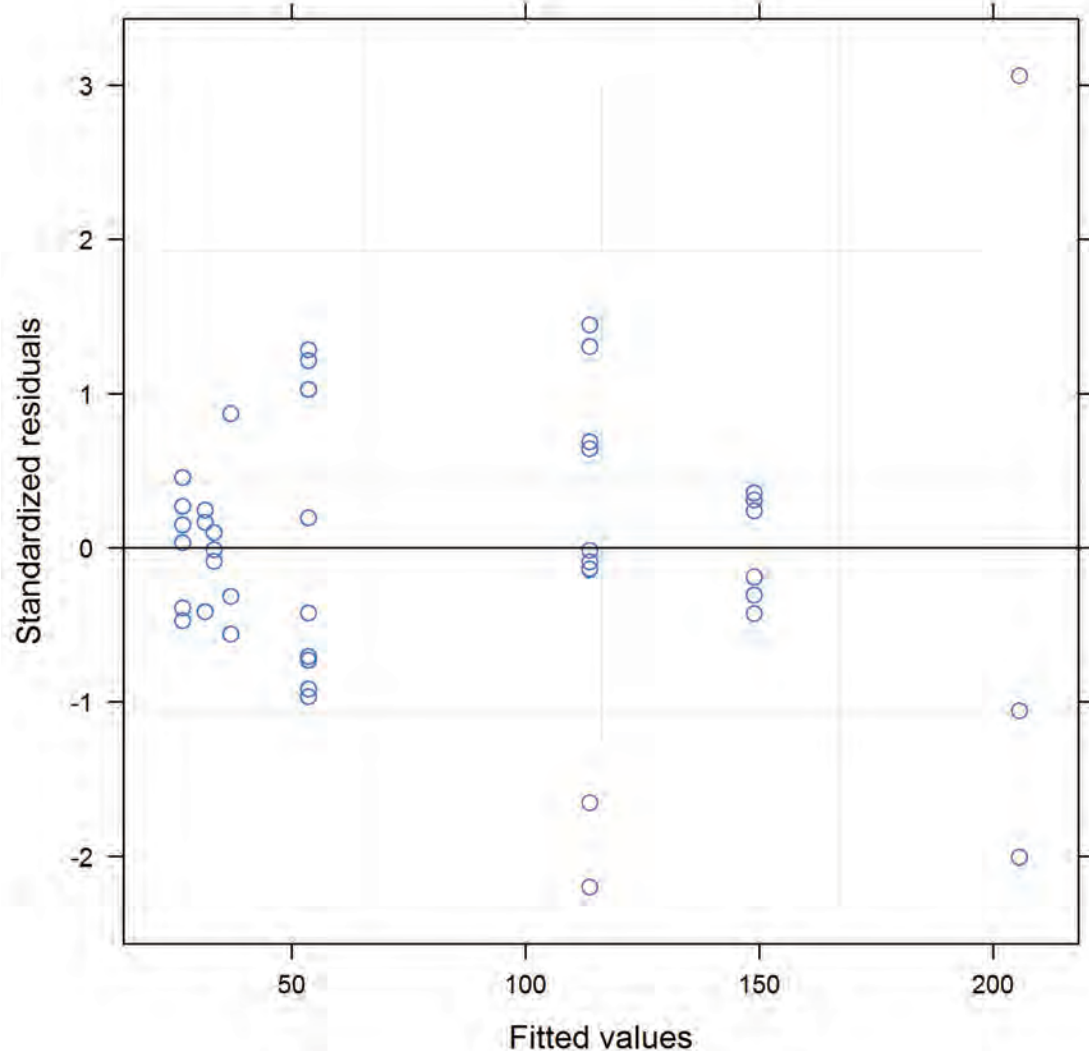
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	412.79	-197.39		
LME	10	414.69	-197.34	0.1	0.75

Conclusion:

The most appropriate model for available phosphorus at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.75$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 37
##          numDF F-value p-value
## (Intercept)    1    158 <.0001
## site          3     17 <.0001
## period        1      0 0.6898
## site:period    3      9 0.0002
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	209.26	126.08	292.43	sig.
Nanuq	124.13	40.96	207.31	sig.
Vulture	100.7	17.52	183.88	sig.

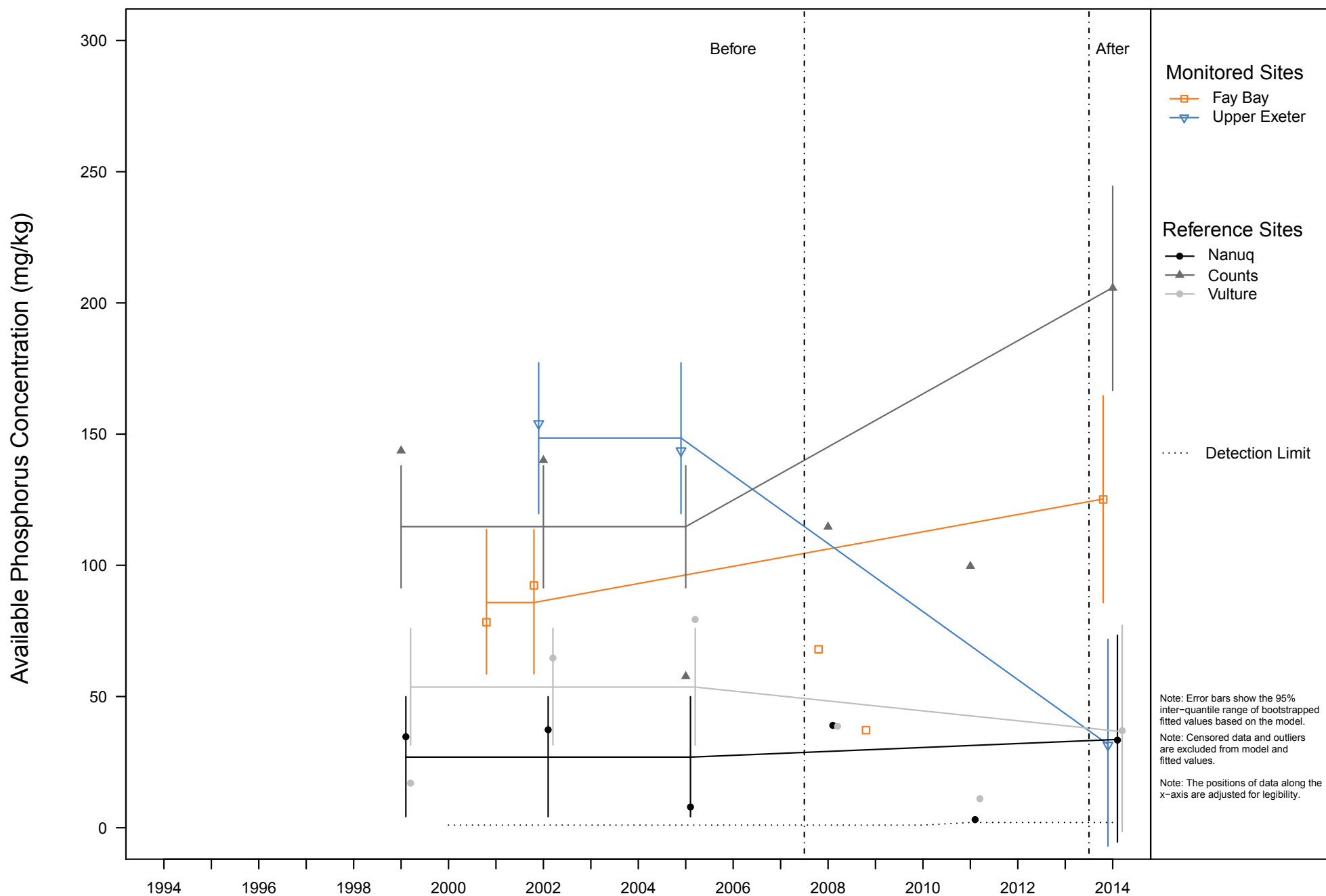
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Available phosphorus concentrations at the Upper Exeter site were significantly ($p = 1.59 \times 10^{-4}$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

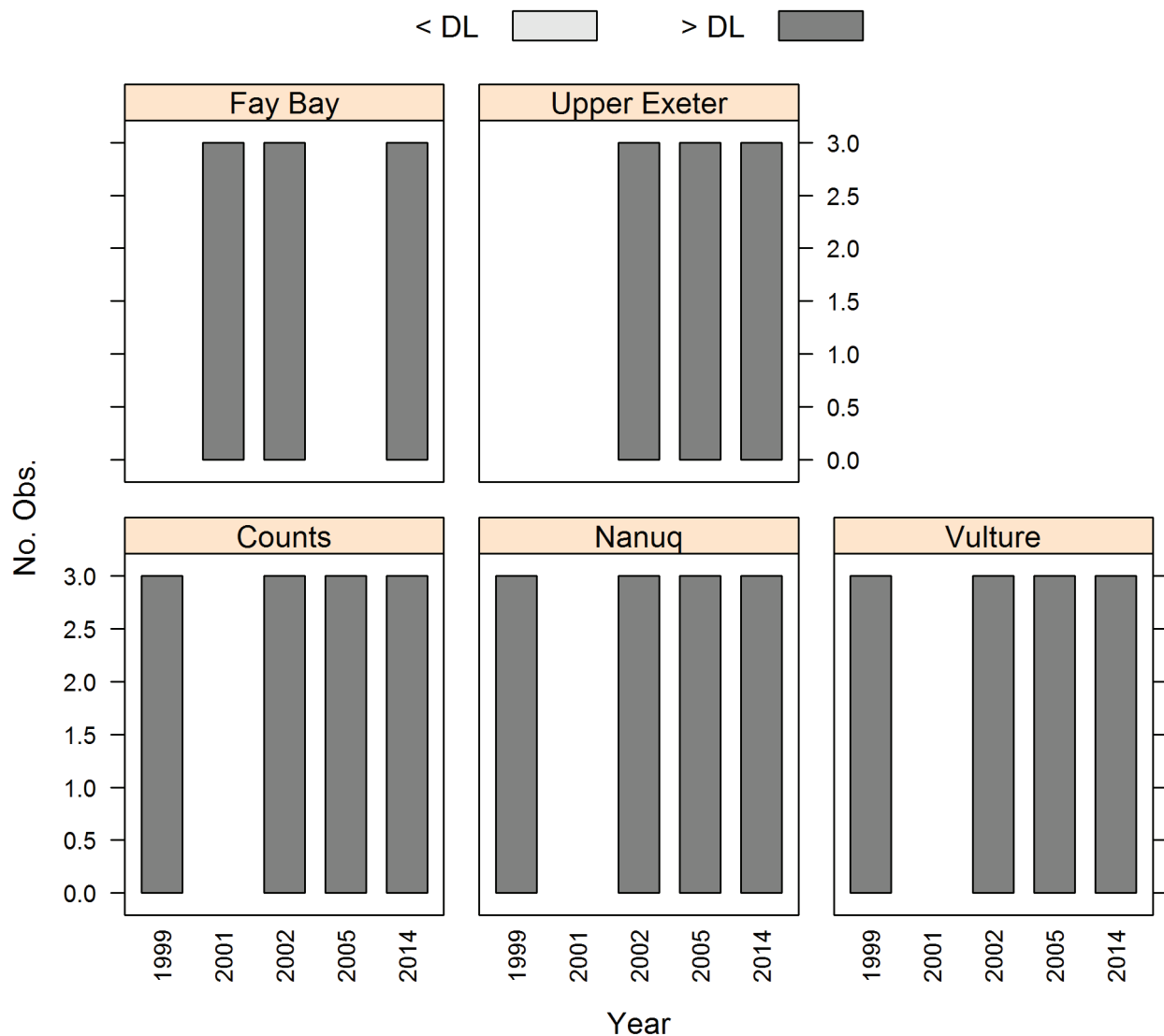


Analysis of Sediment Total Nitrogen Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

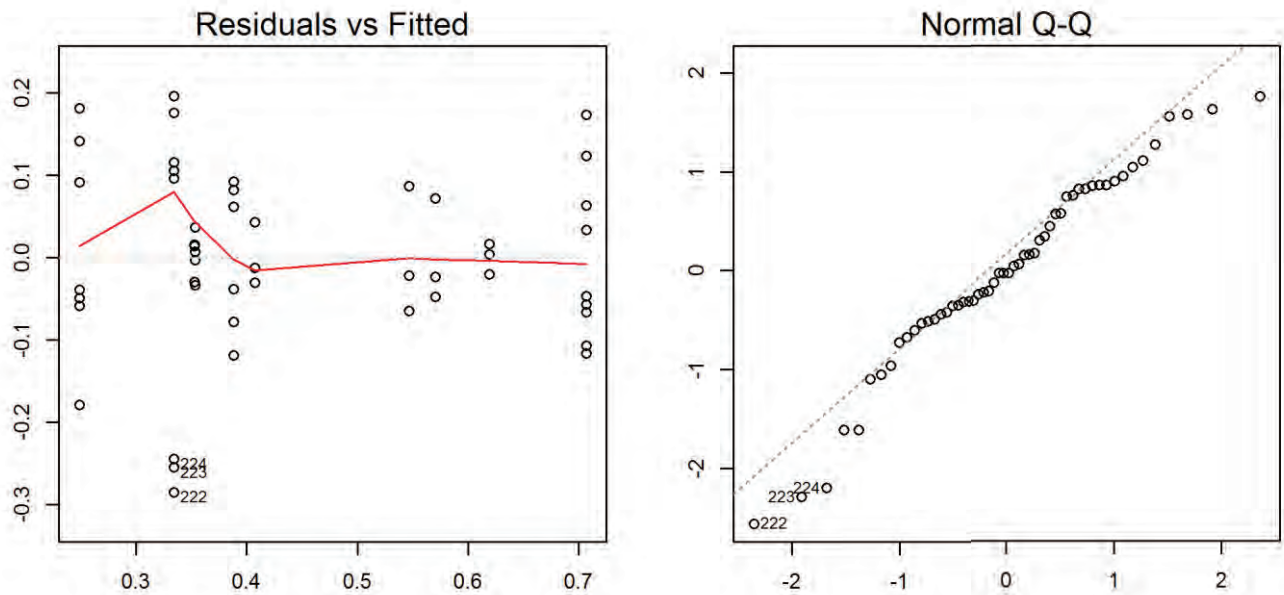
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

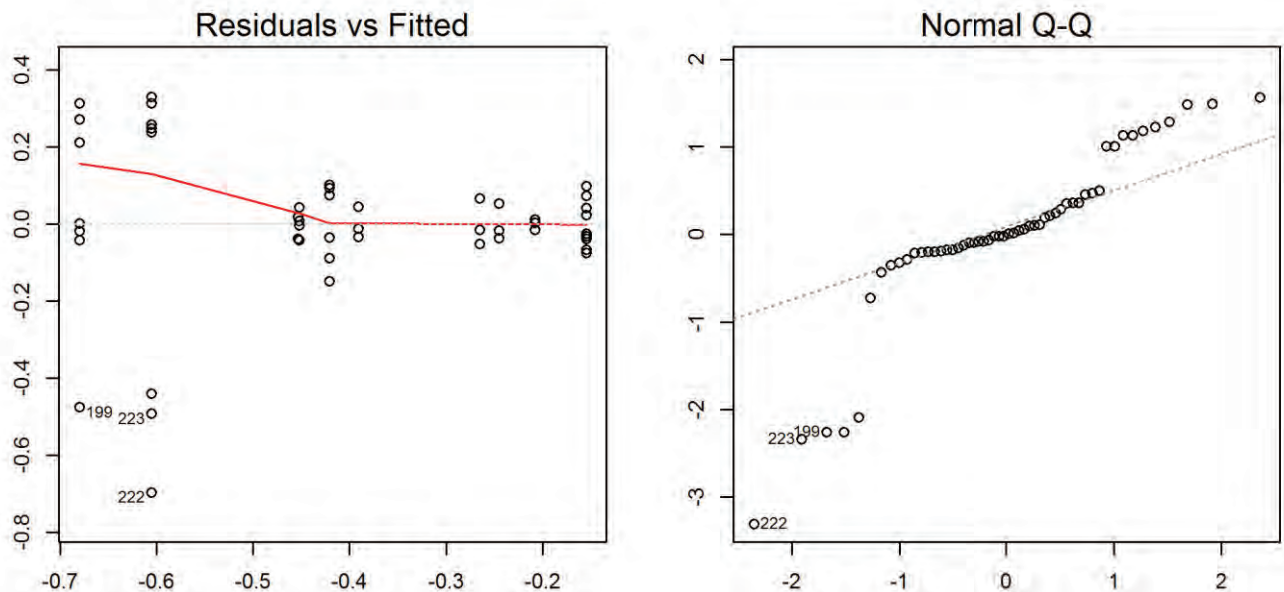
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.12	0.69	0.62
Log-10	0.22	0.46	0.35

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

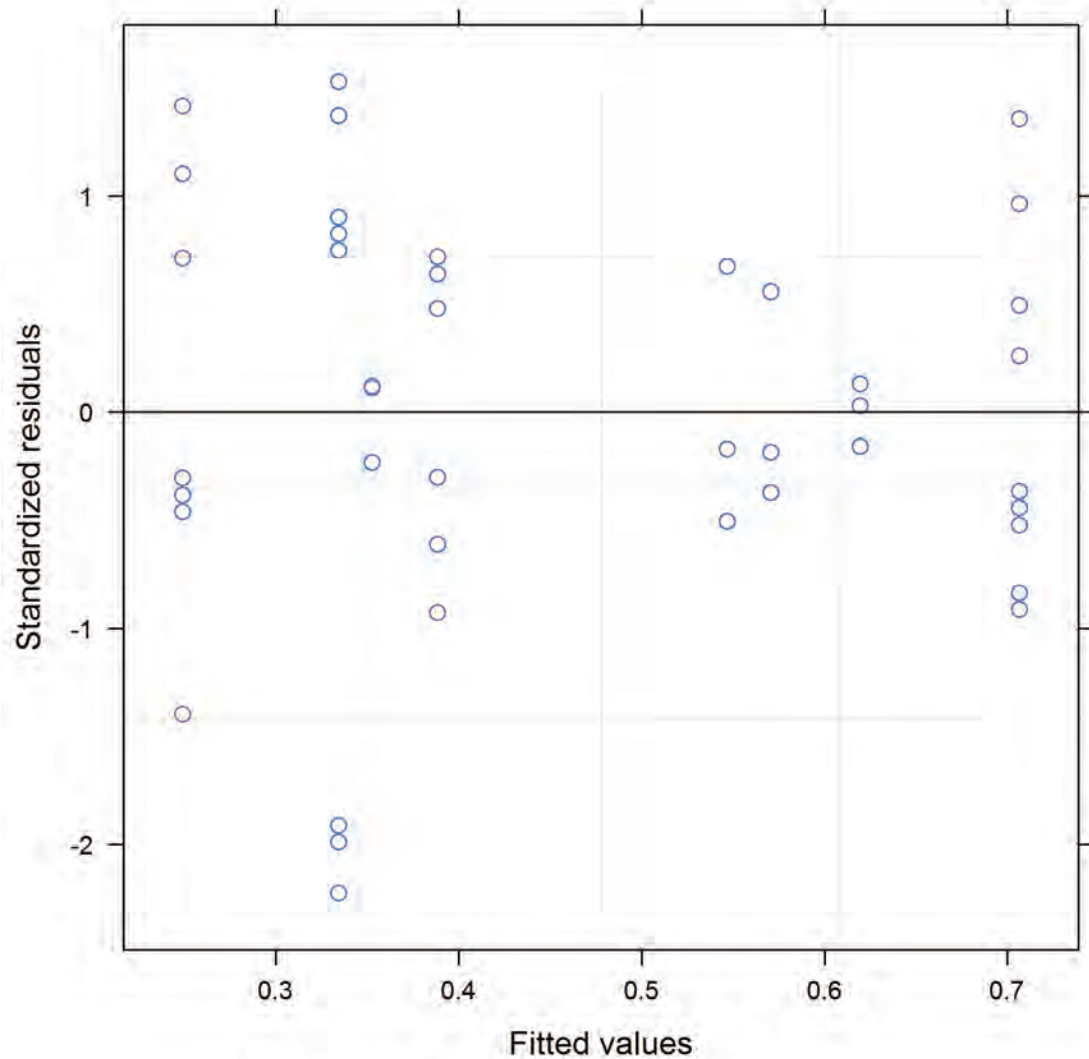
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-16.38	17.19		
LME	10	-14.38	17.19	7.31×10^{-10}	1

Conclusion:

The most appropriate model for total nitrogen at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 1$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 37
##          numDF F-value p-value
## (Intercept)      1      554 <.0001
## site           3       19 <.0001
## period         1        5 0.0258
## site:period     3        5 0.0055
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.34	-0.59	-0.09	sig.
Nanuq	0.1	-0.15	0.35	not sig.
Vulture	-0.08	-0.33	0.17	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nitrogen concentrations at the Fay Bay site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

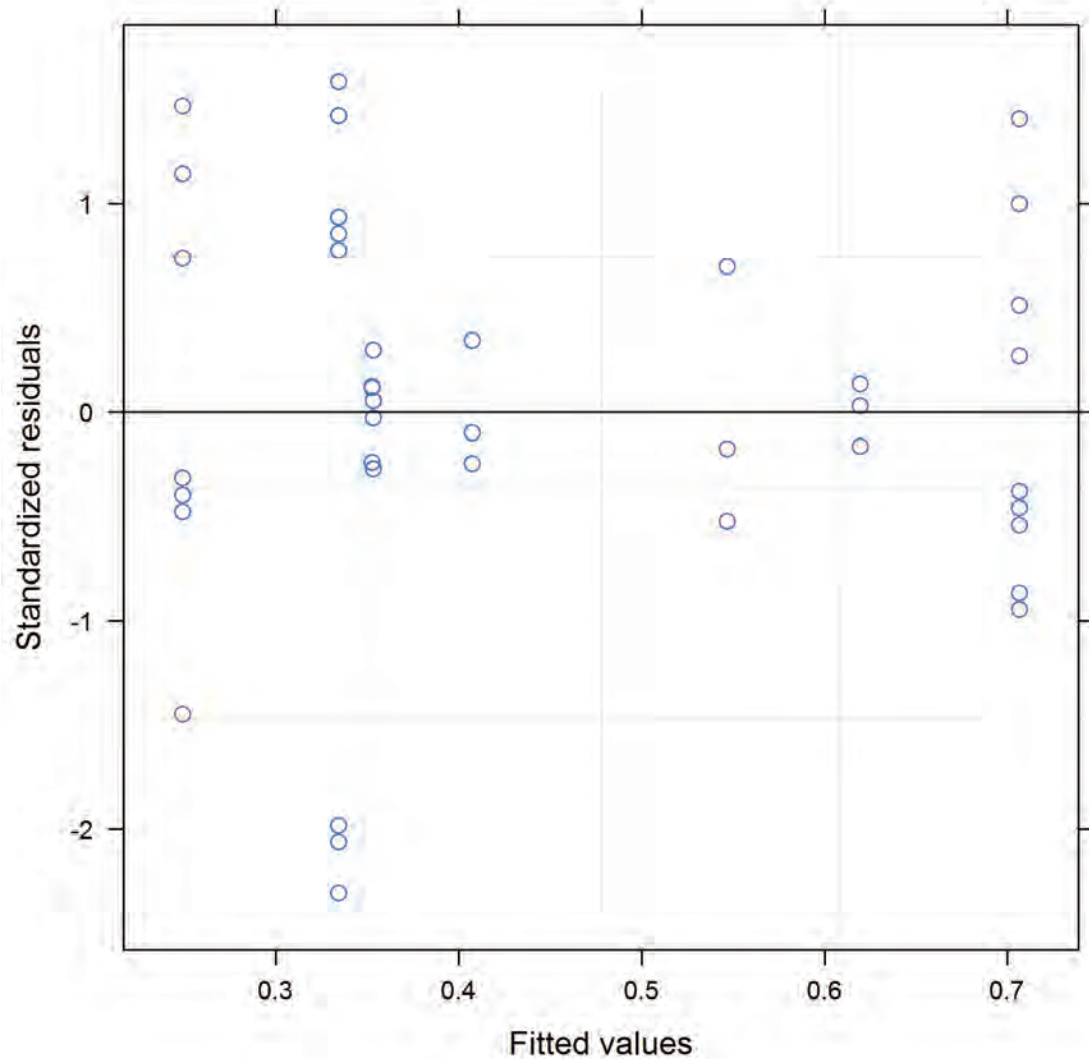
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-19.1	18.55		
LME	10	-17.1	18.55	1.19×10^{-9}	1

Conclusion:

The most appropriate model for total nitrogen at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 1$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 37
##          numDF F-value p-value
## (Intercept)    1     556 <.0001
## site           3      22 <.0001
## period         1       3 0.0963
## site:period     3       5 0.0054
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.21	-0.46	0.03	not sig.
Nanuq	0.23	-0.01	0.47	not sig.
Vulture	0.05	-0.19	0.29	not sig.

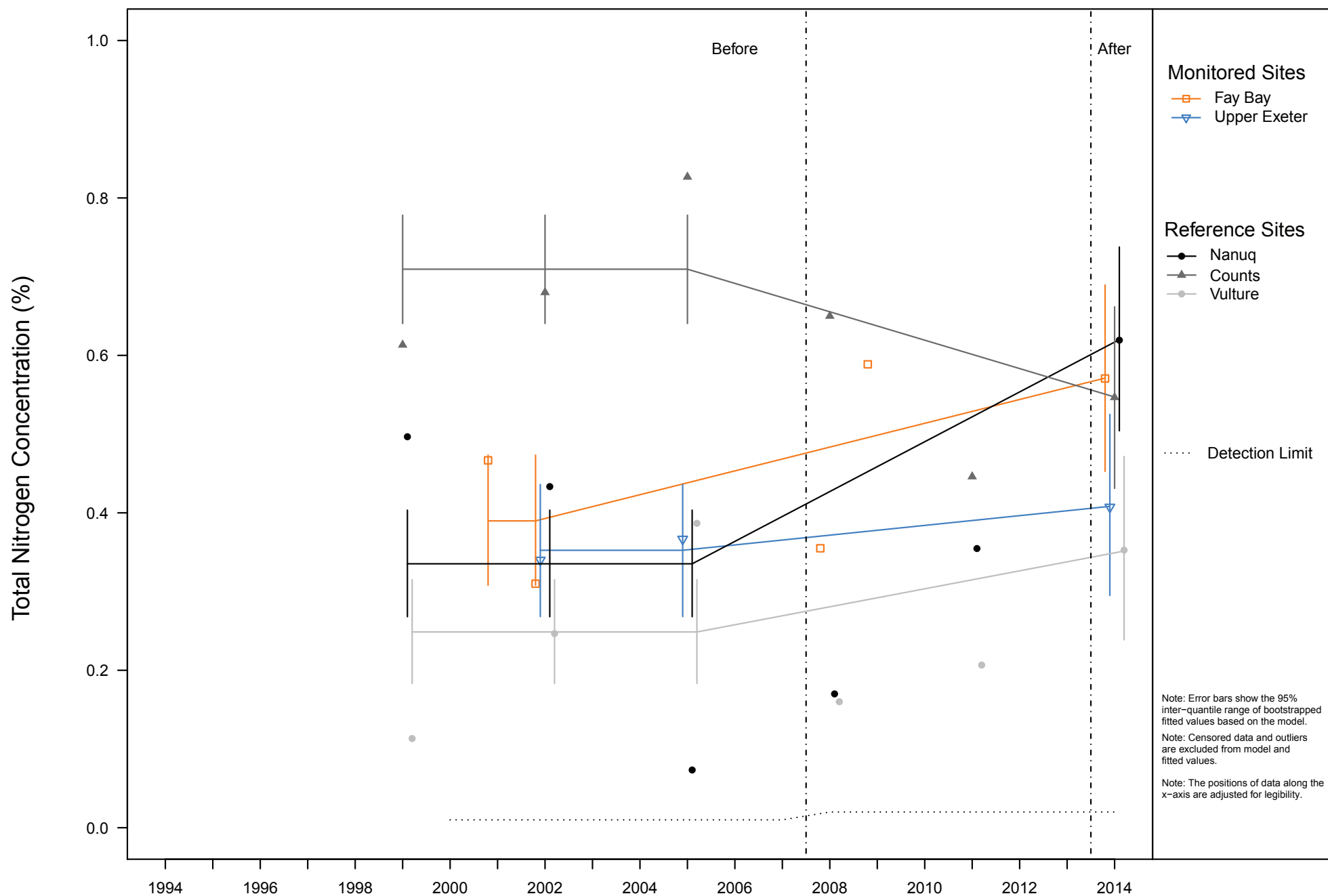
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nitrogen concentrations at the Upper Exeter site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

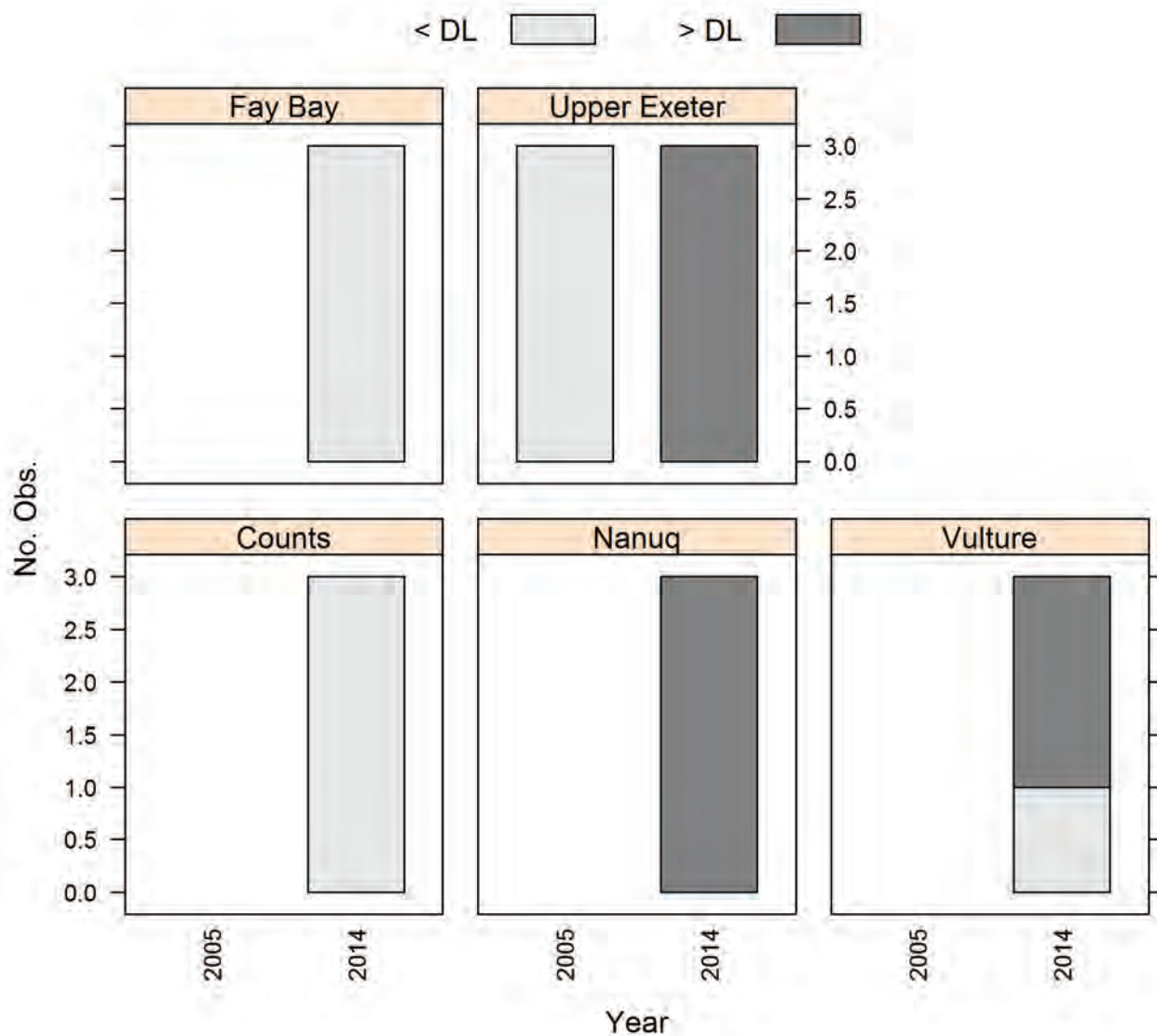


Analysis of Sediment Antimony Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 19, 2015

1 Censored Data

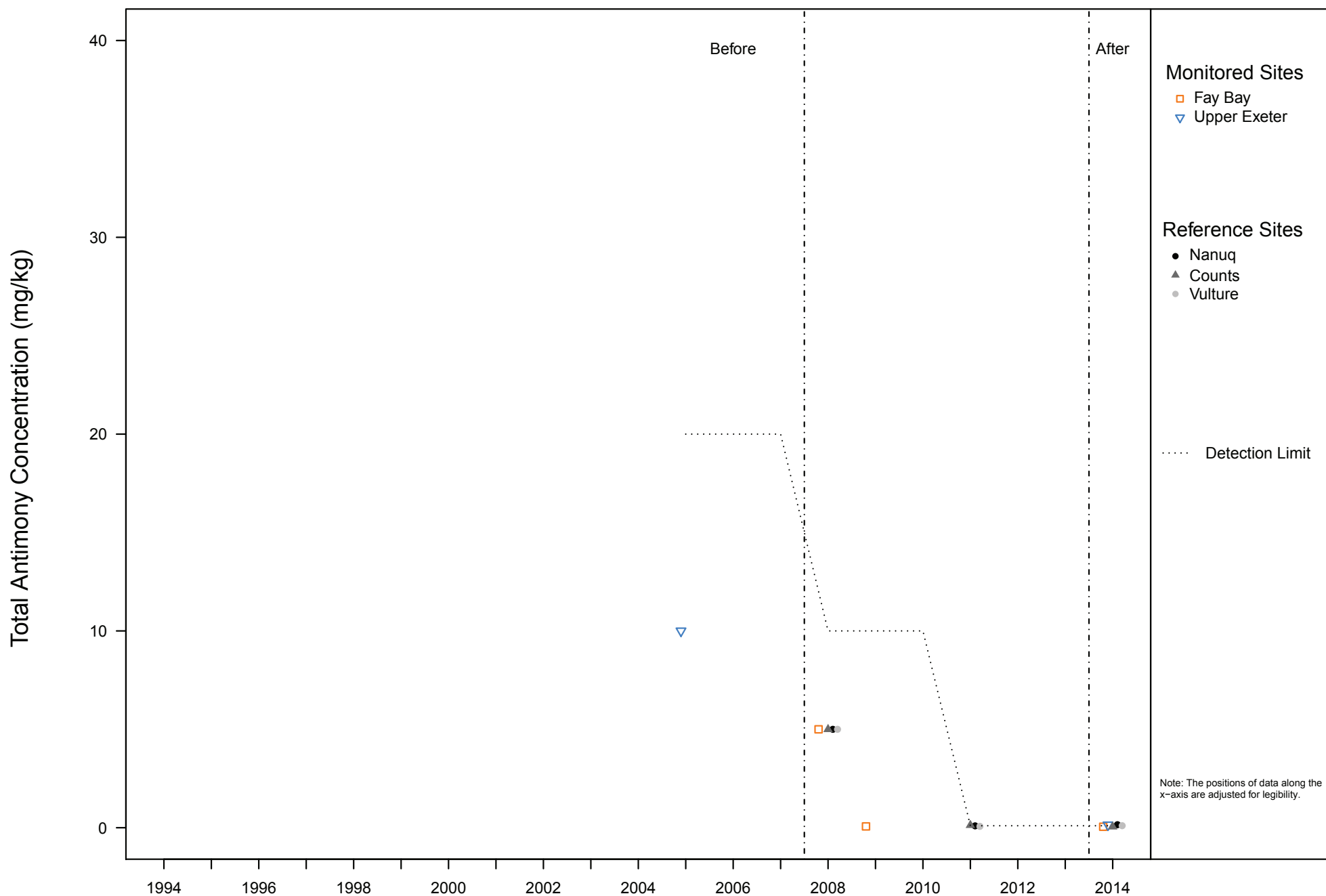
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion

Antimony sediment concentration statistical analyses were not conducted because of the censoring of observations. Below is a summary figure of all observations in the Pigeon watershed dataset. Mean observations for each site for each year are shown as symbols.

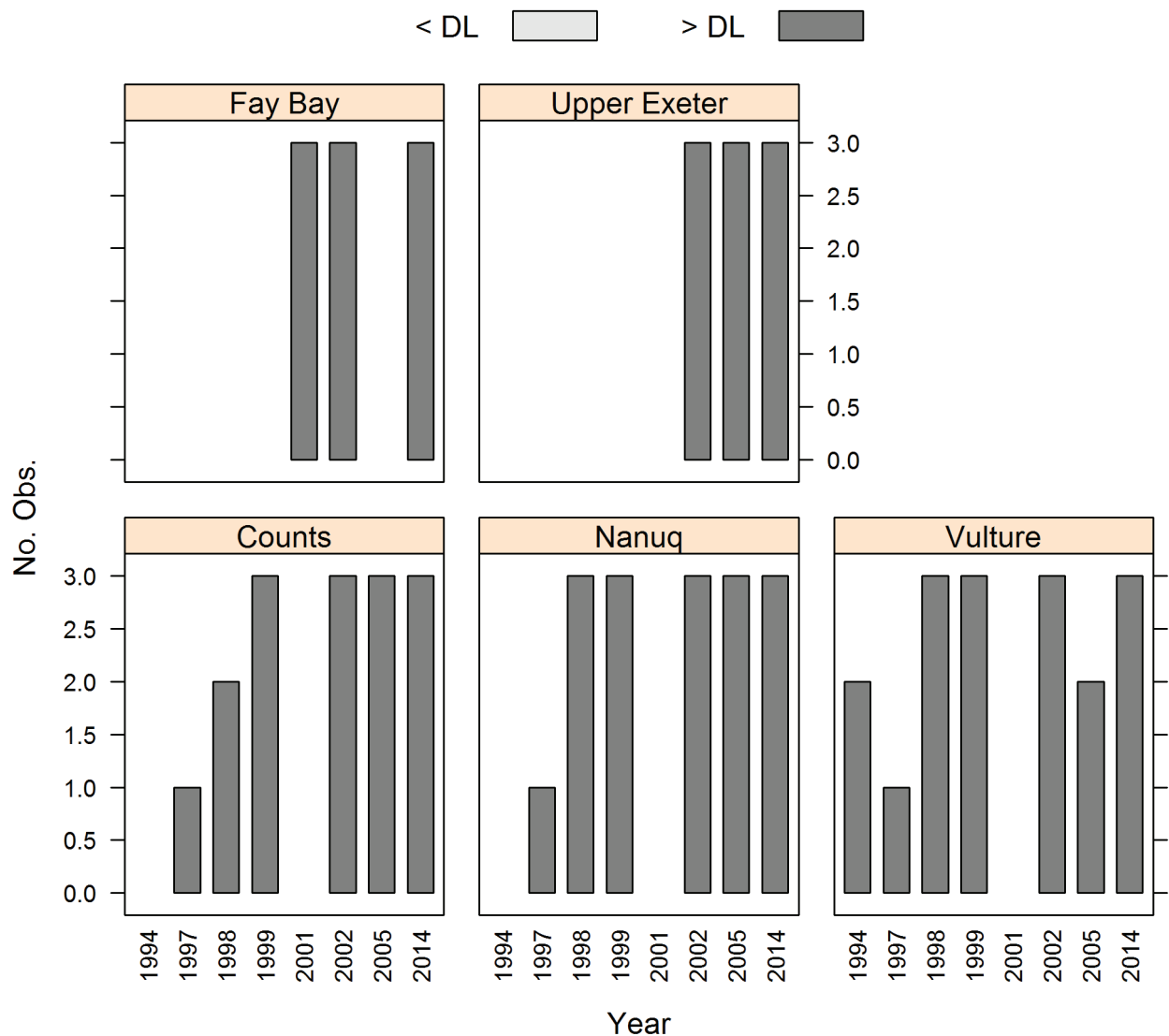


Analysis of Sediment Total Arsenic Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

No censored data were identified.

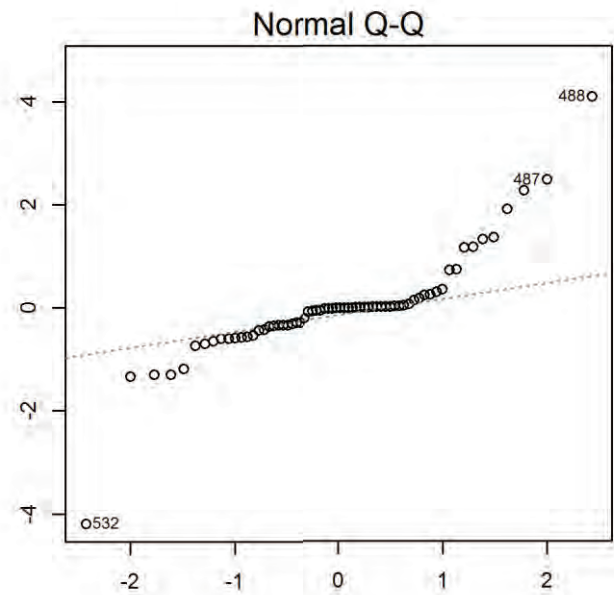
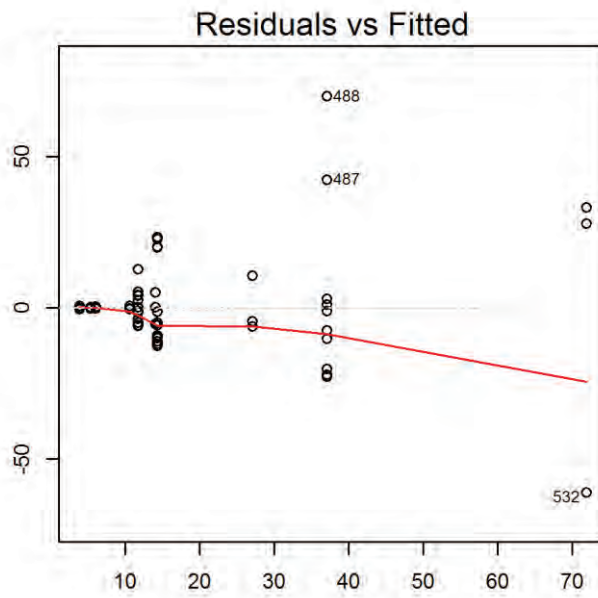
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

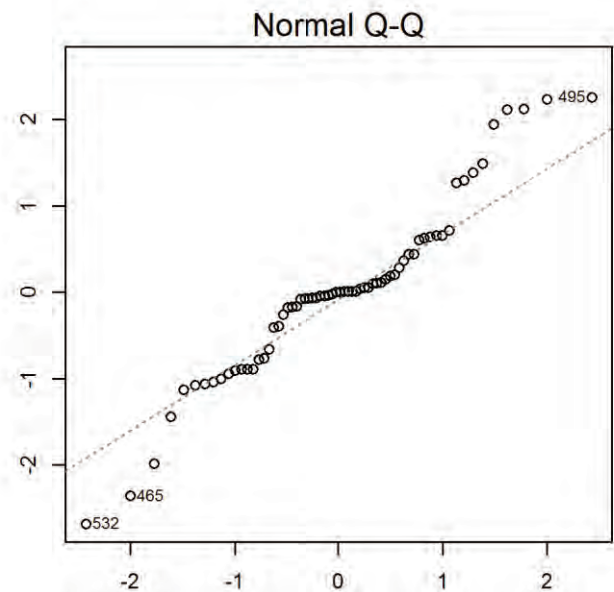
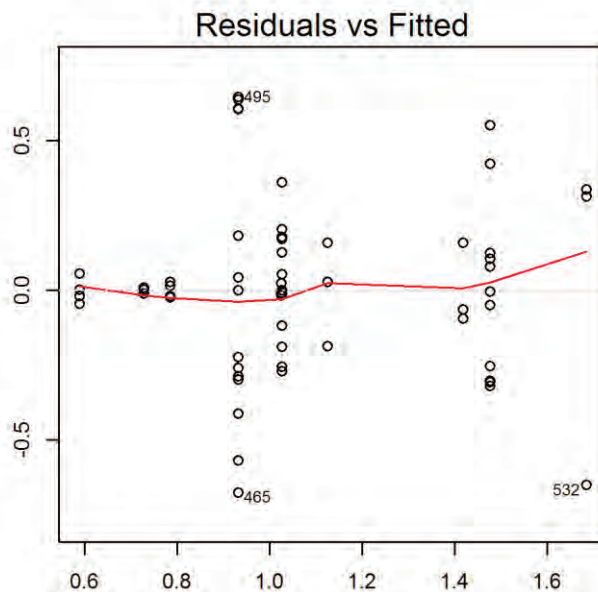
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	17.84	0.48	0.4
Log-10	0.3	0.55	0.48

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

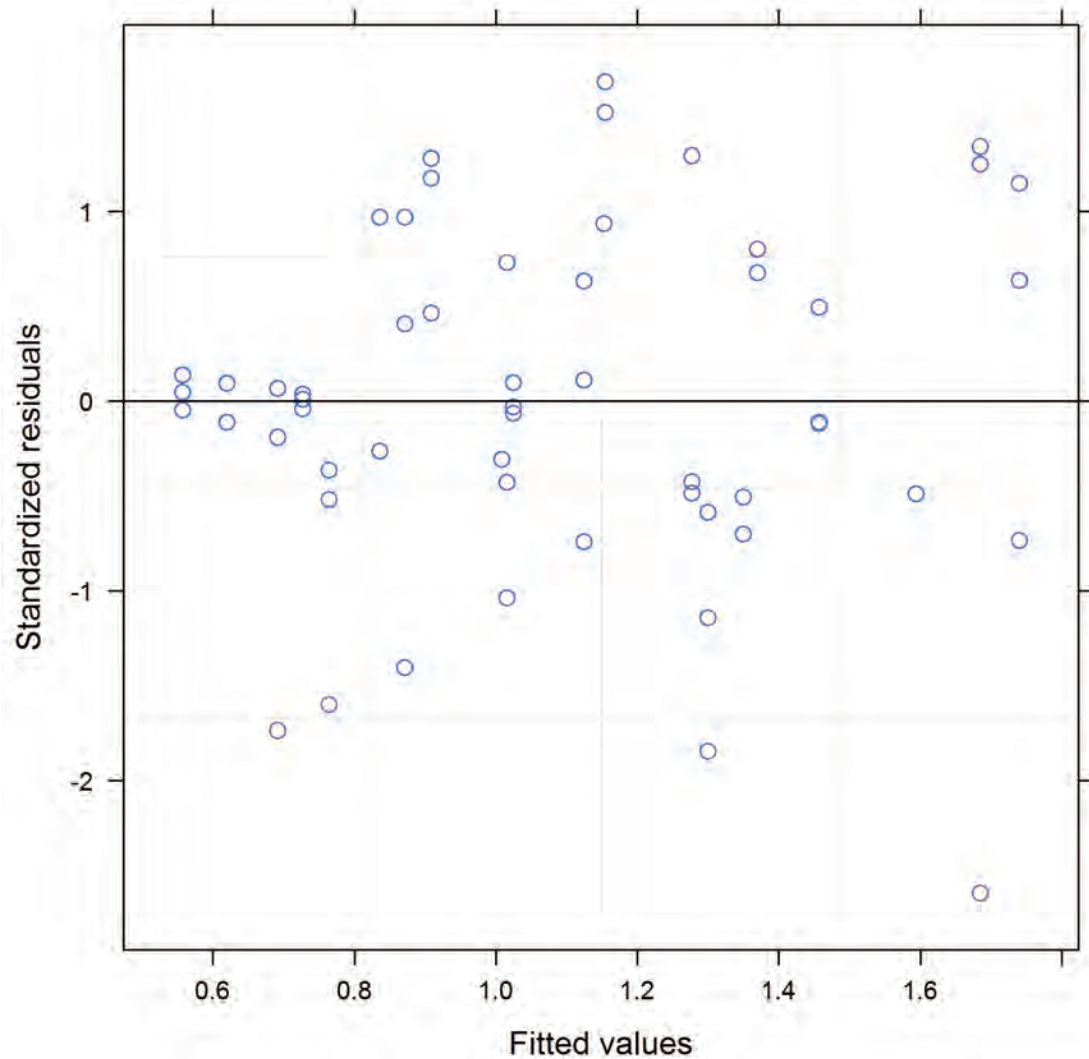
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	58.33	-20.17		
LME	10	48.27	-14.14	12.06	5.15×10 ⁻⁴

Conclusion:

The most appropriate model for total arsenic at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	43	119	<.0001
## site	3	43	15	<.0001
## period	1	6	0	0.7936
## site:period	3	43	9	0.0001

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.5	-1.01	0.03	not sig.
Nanuq	-0.16	-0.7	0.36	not sig.
Vulture	0.64	0.13	1.18	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total arsenic concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

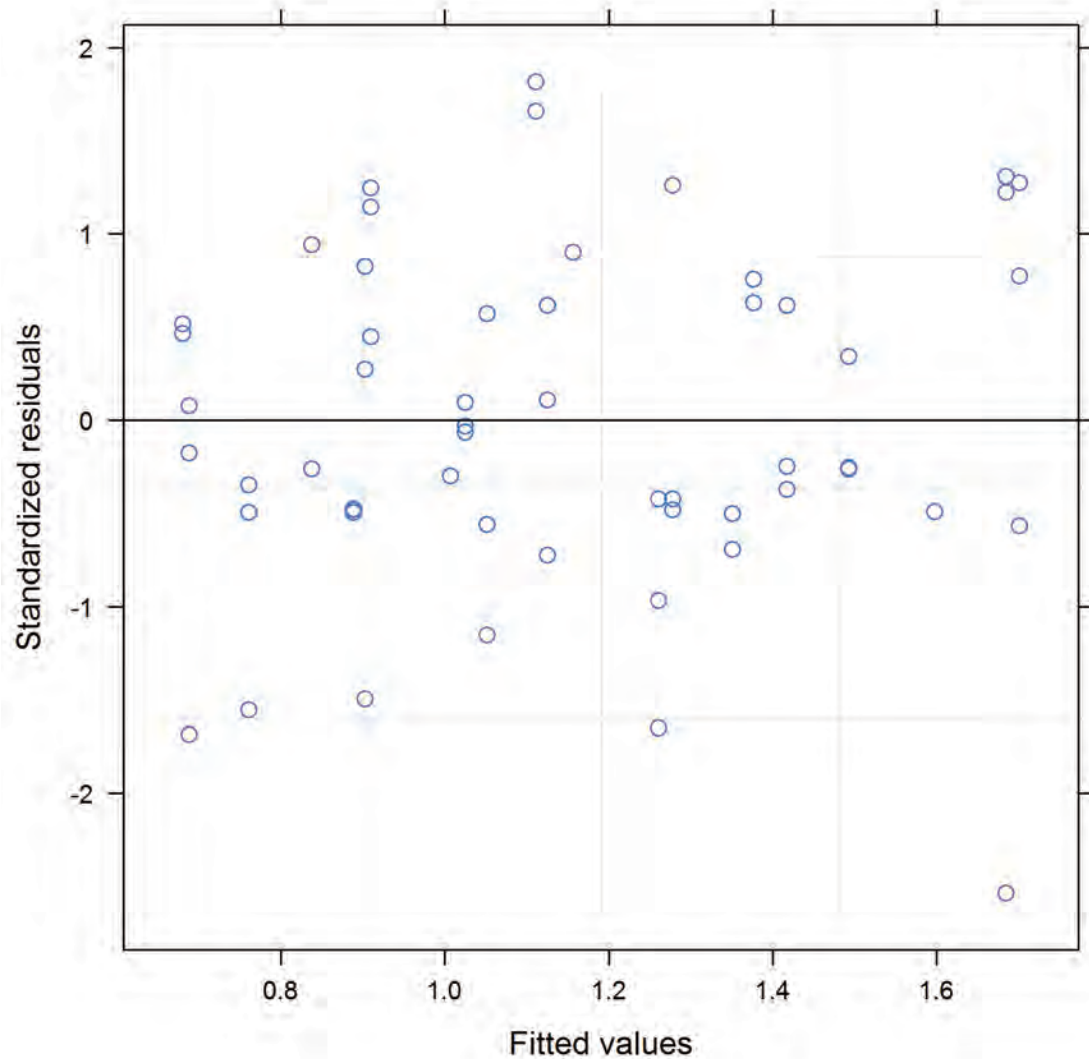
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	58.68	-20.34		
LME	10	49.83	-14.92	10.85	9.89×10^{-4}

Conclusion:

The most appropriate model for total arsenic at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
##          numDF denDF F-value p-value
## (Intercept)      1   44    111 <.0001
## site             3   44      9 0.0001
## period           1    5      0 0.5526
## site:period       3   44     11 <.0001
## Computing bootstrap confidence intervals ...
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-1.11	-1.6	-0.61	sig.
Nanuq	-0.76	-1.27	-0.24	sig.
Vulture	0.04	-0.45	0.54	not sig.

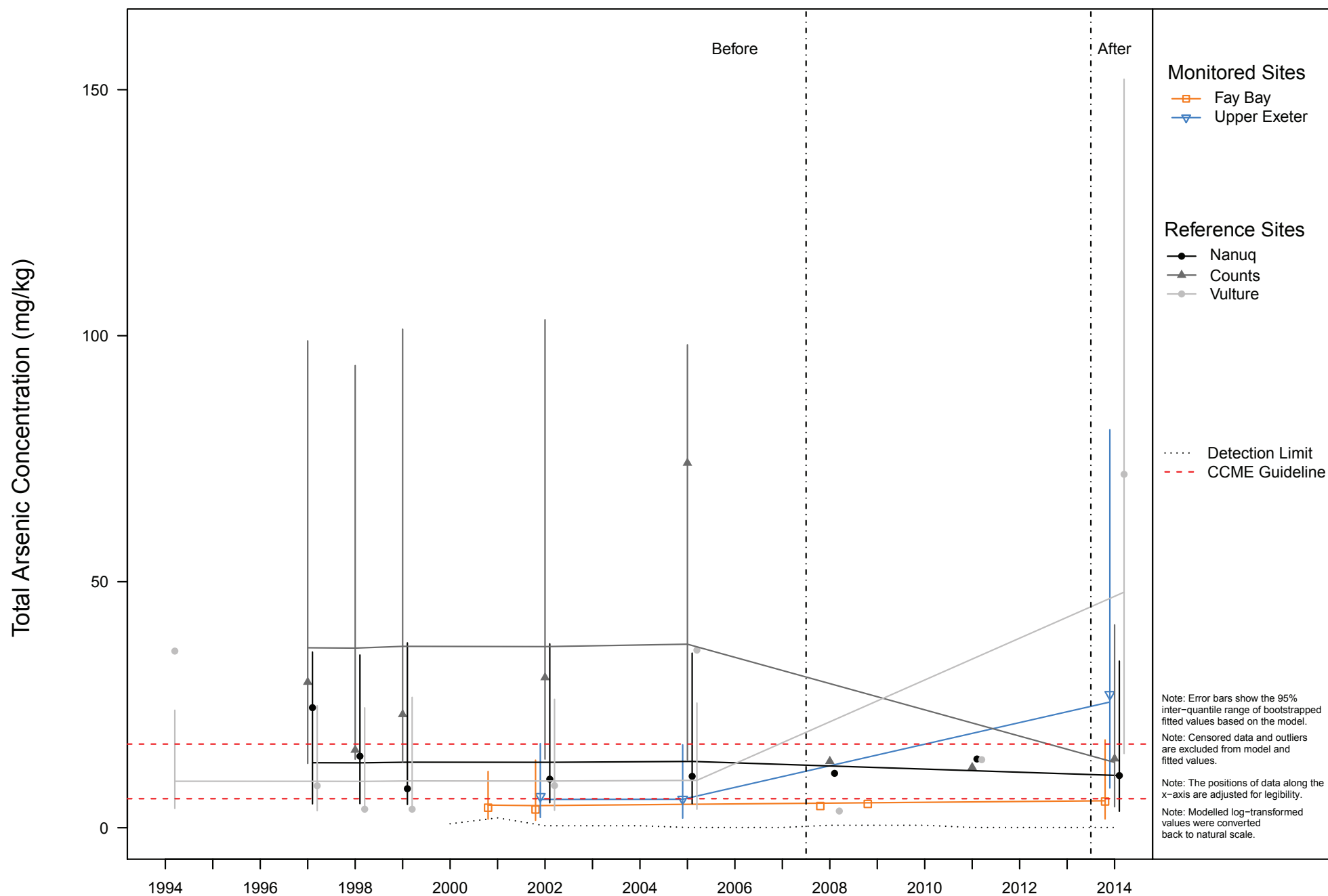
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total arsenic concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

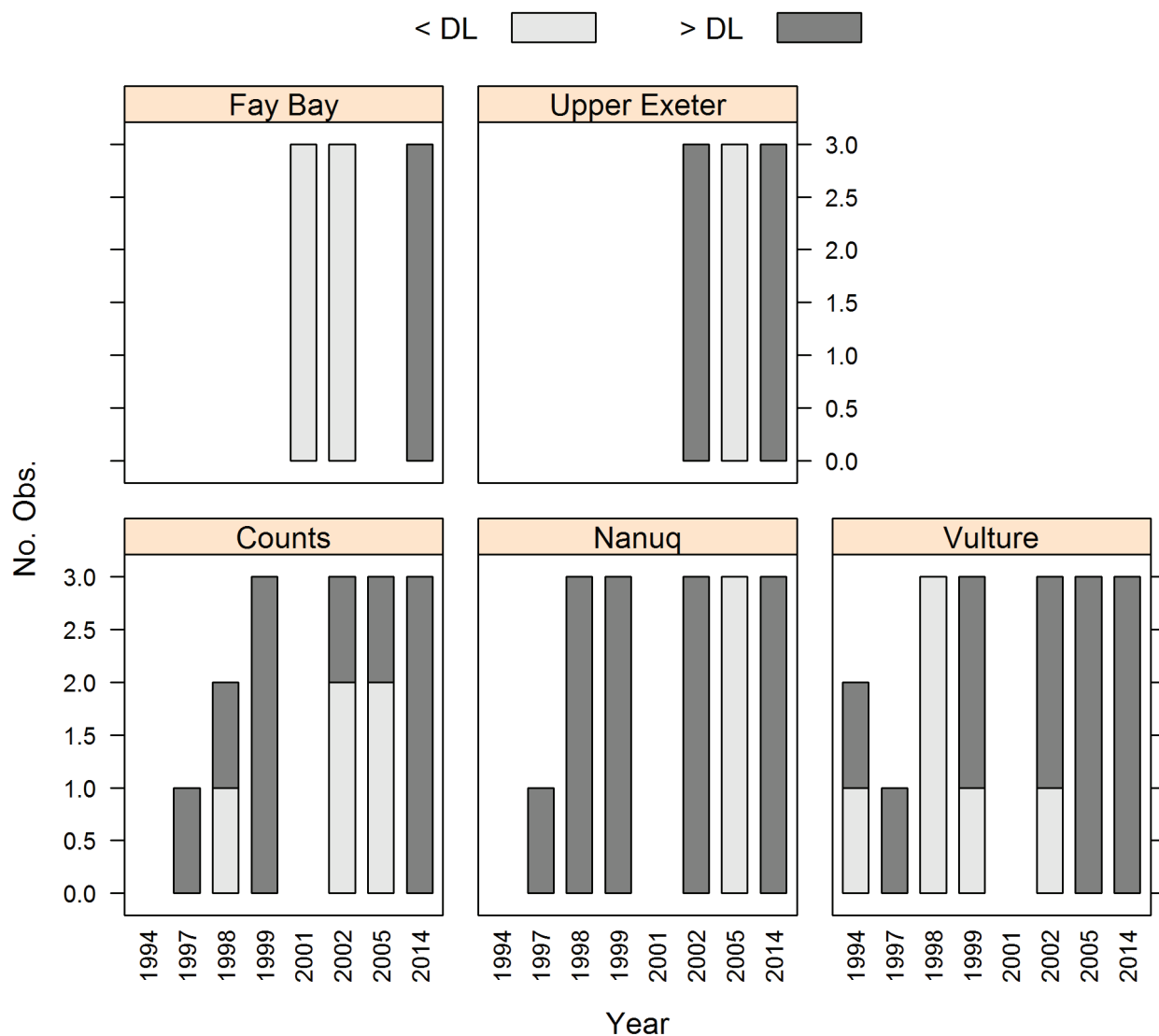


Analysis of Sediment Total Cadmium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	date	year	class
## 895	Vulture	1997-08-04	1997	ref
## 896	Counts	1998-08-04	1998	ref
## 897	Counts	1998-08-04	1998	ref
## 901	Vulture	1998-08-07	1998	ref
## 902	Vulture	1998-08-07	1998	ref
## 903	Vulture	1998-08-07	1998	ref
## 913	Fay Bay	2001-08-05	2001	monit
## 914	Fay Bay	2001-08-05	2001	monit
## 915	Fay Bay	2001-08-05	2001	monit
## 916	Counts	2002-08-07	2002	ref
## 917	Counts	2002-08-07	2002	ref
## 918	Counts	2002-08-07	2002	ref
## 919	Fay Bay	2002-08-08	2002	monit
## 920	Fay Bay	2002-08-08	2002	monit
## 921	Fay Bay	2002-08-08	2002	monit
## 931	Counts	2005-08-07	2005	ref
## 932	Counts	2005-08-07	2005	ref
## 933	Counts	2005-08-07	2005	ref
## 934	Nanuq	2005-08-01	2005	ref
## 935	Nanuq	2005-08-01	2005	ref
## 936	Nanuq	2005-08-01	2005	ref
## 937	Upper Exeter	2005-08-19	2005	monit
## 938	Upper Exeter	2005-08-19	2005	monit
## 939	Upper Exeter	2005-08-19	2005	monit

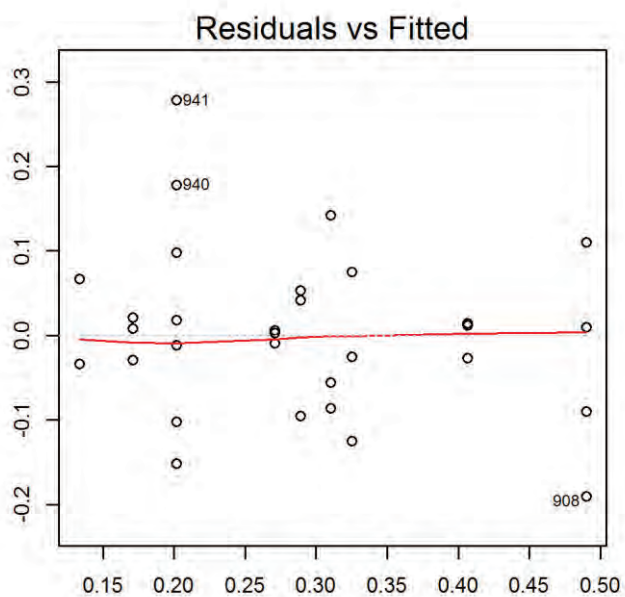
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

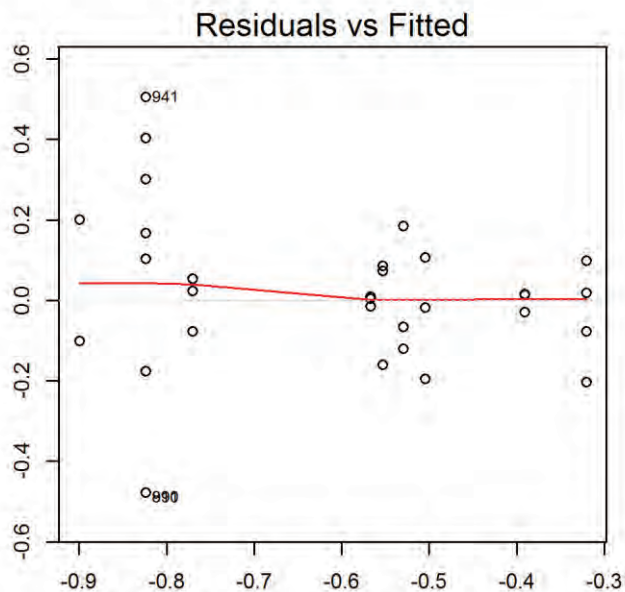
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.11	0.61	0.52
Log-10	0.22	0.52	0.41

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

The BACI modeling analysis was not conducted on the Fay Bay data because insufficient observations were available for the analysis due to censoring or outliers.

4.2 Upper Exeter Monitoring Location

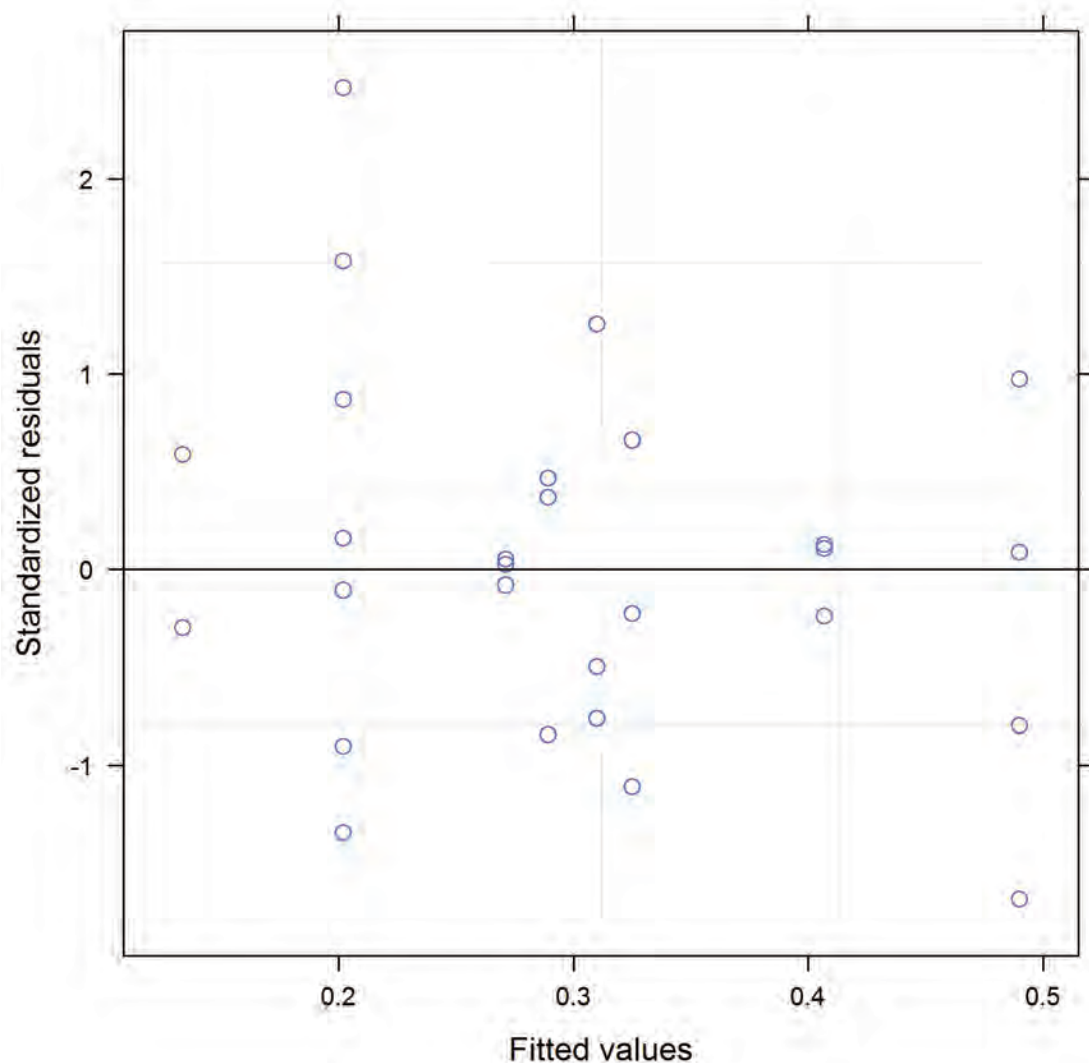
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-19.24	18.62		
LME	10	-18.65	19.32	1.4	0.24

Conclusion:

The most appropriate model for total cadmium at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.236$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 32
##          numDF F-value p-value
## (Intercept)    1    314 <.0001
## site           3     14 <.0001
## period         1      0  0.54
## site:period    3      2  0.23
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.15	-0.41	0.1	not sig.
Nanuq	-0.22	-0.46	0.02	not sig.
Vulture	-0.05	-0.29	0.19	not sig.

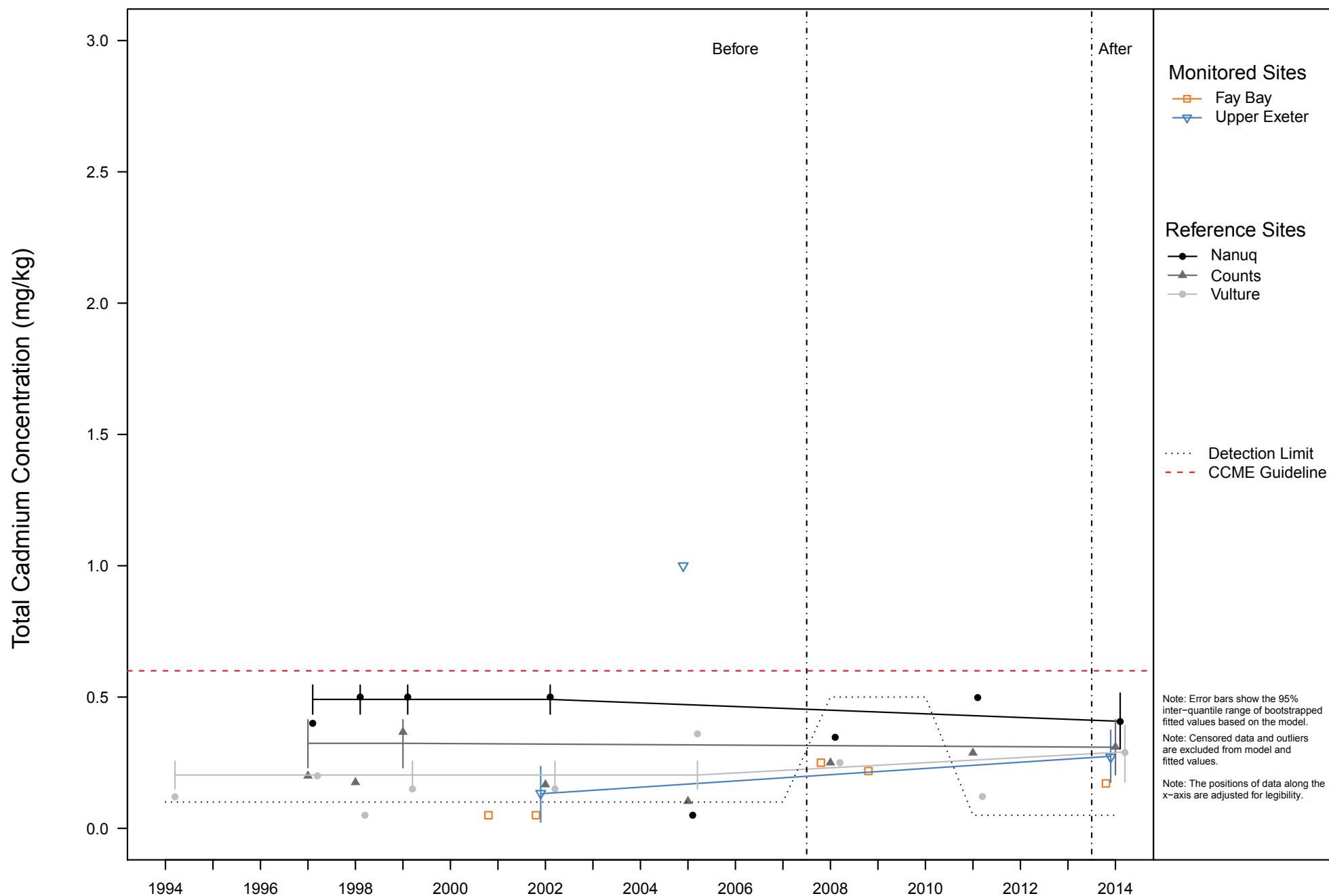
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total cadmium concentrations at the Upper Exeter site were not significantly ($p = 0$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

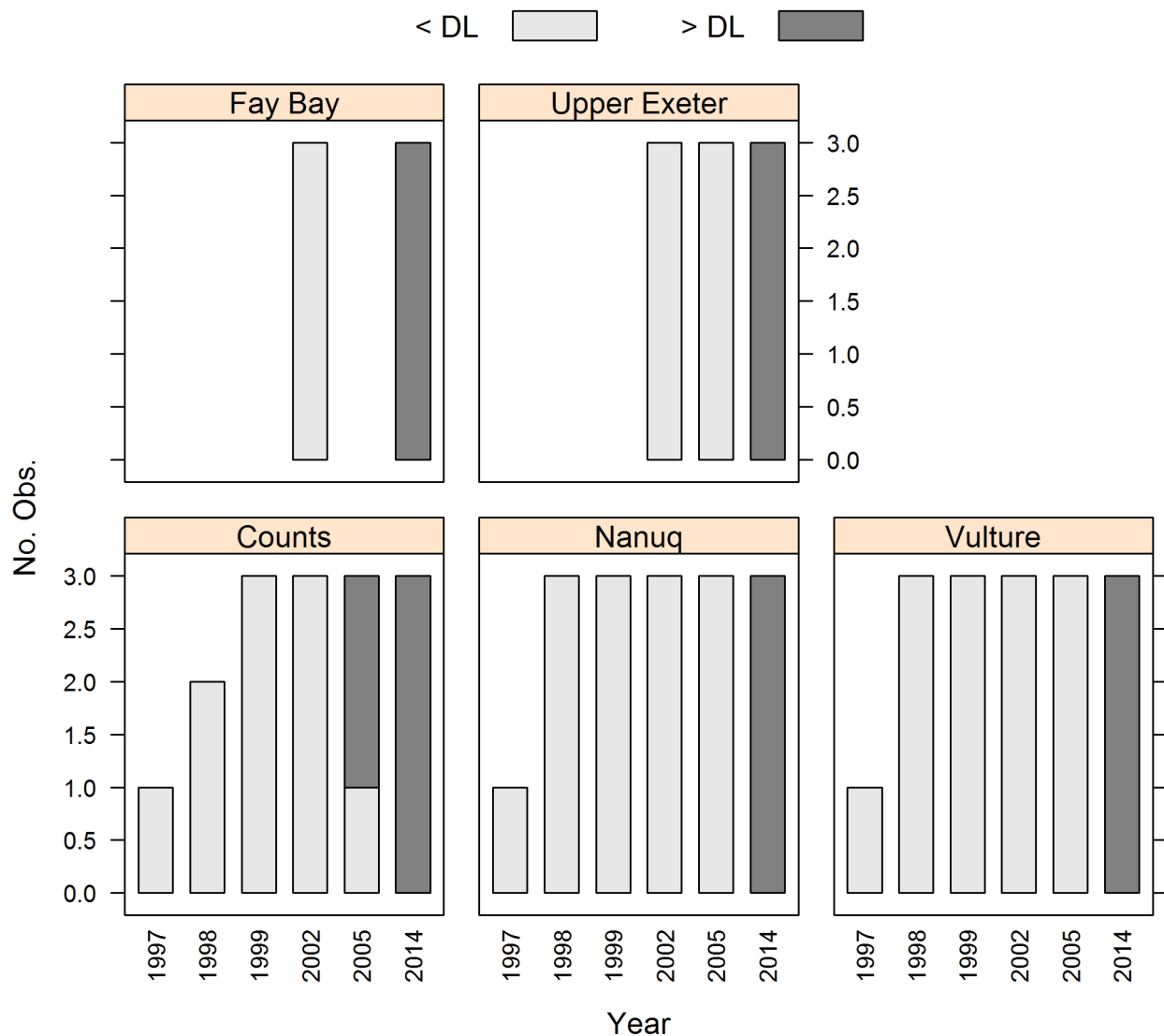


Analysis of Sediment Molybdenum Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2015

1 Censored Data

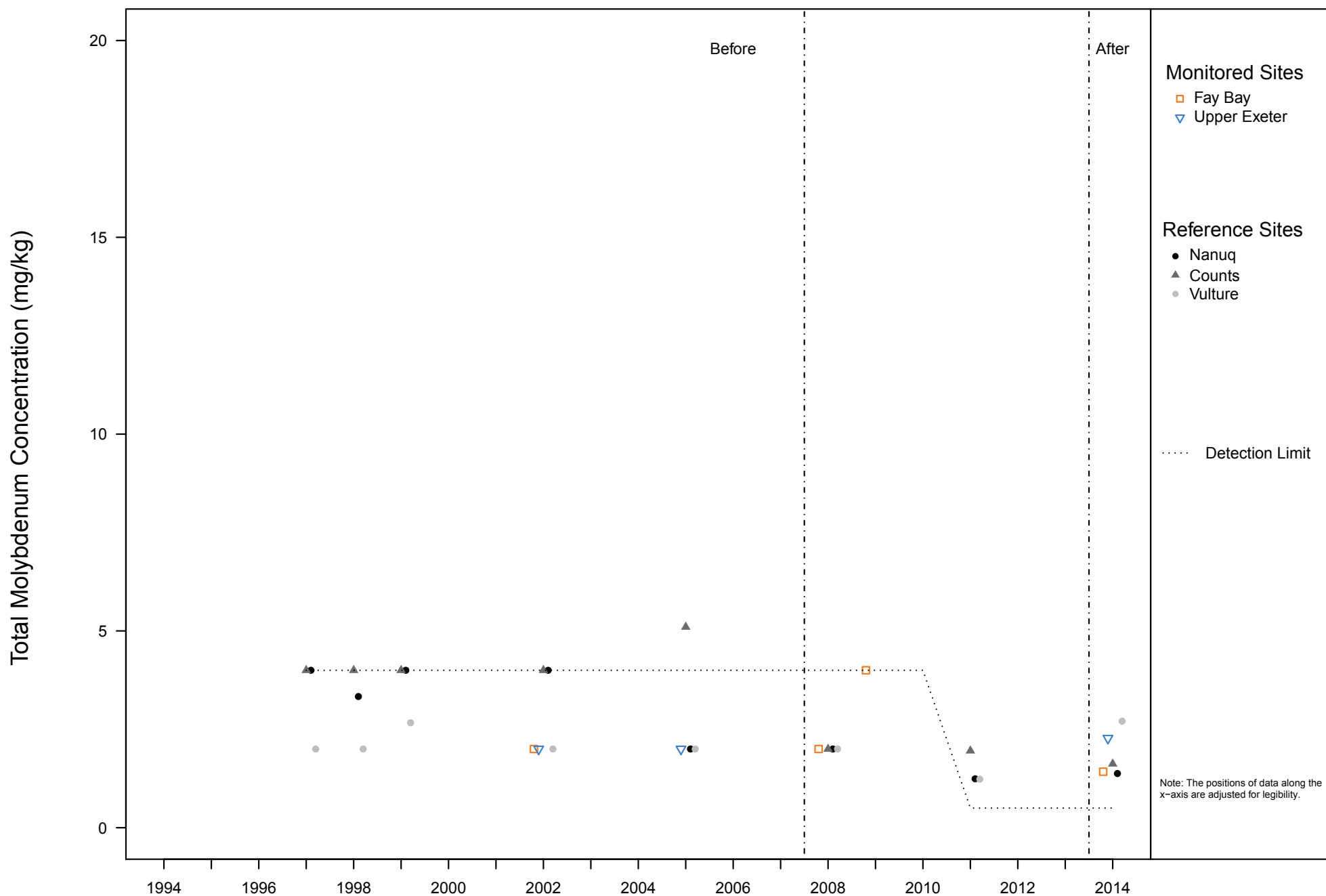
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Molybdenum sediment concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

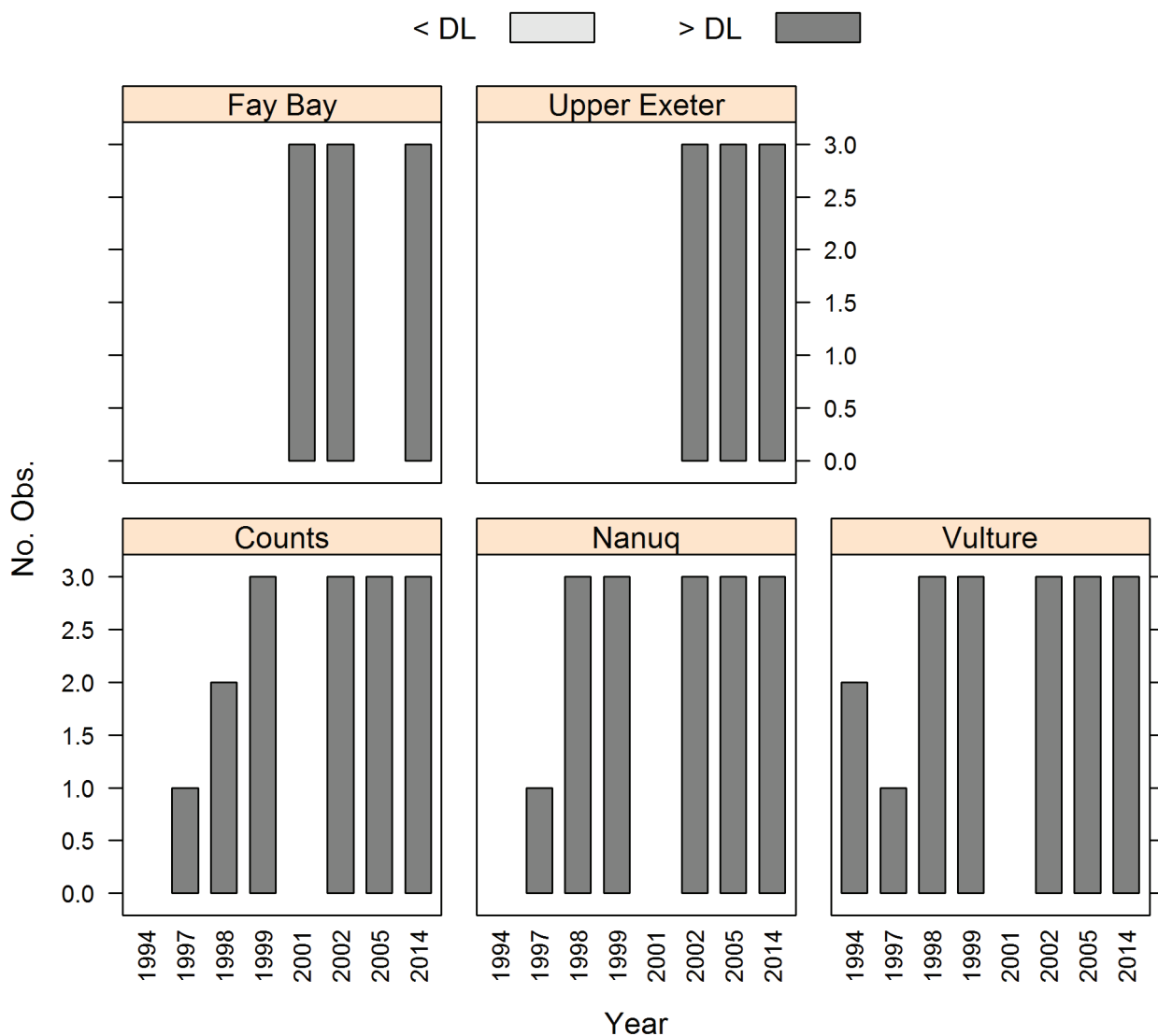


Analysis of Sediment Total Nickel Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

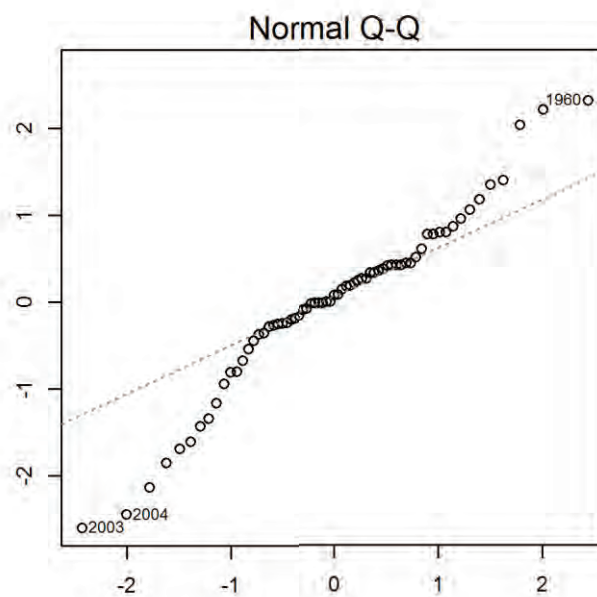
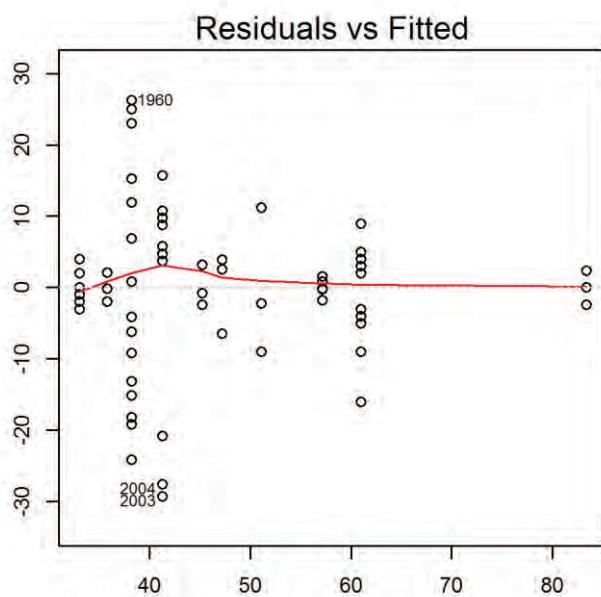
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

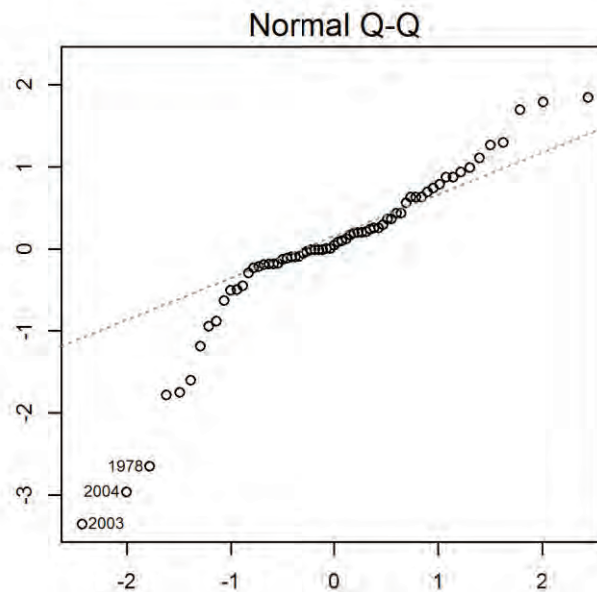
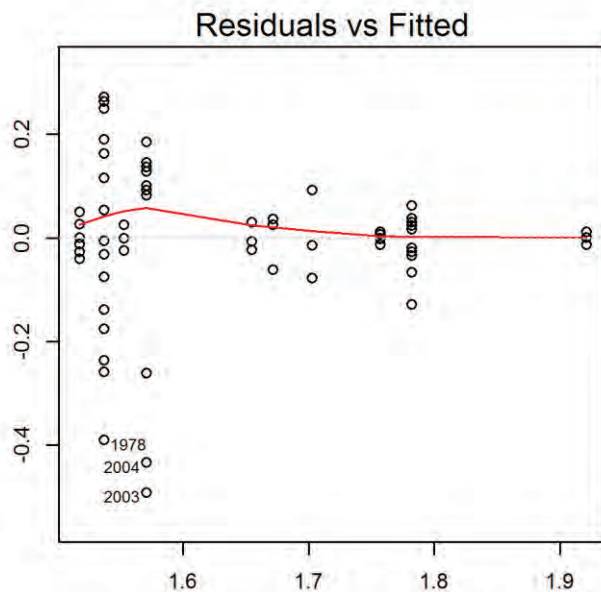
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	11.73	0.56	0.5
Log-10	0.15	0.41	0.31

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

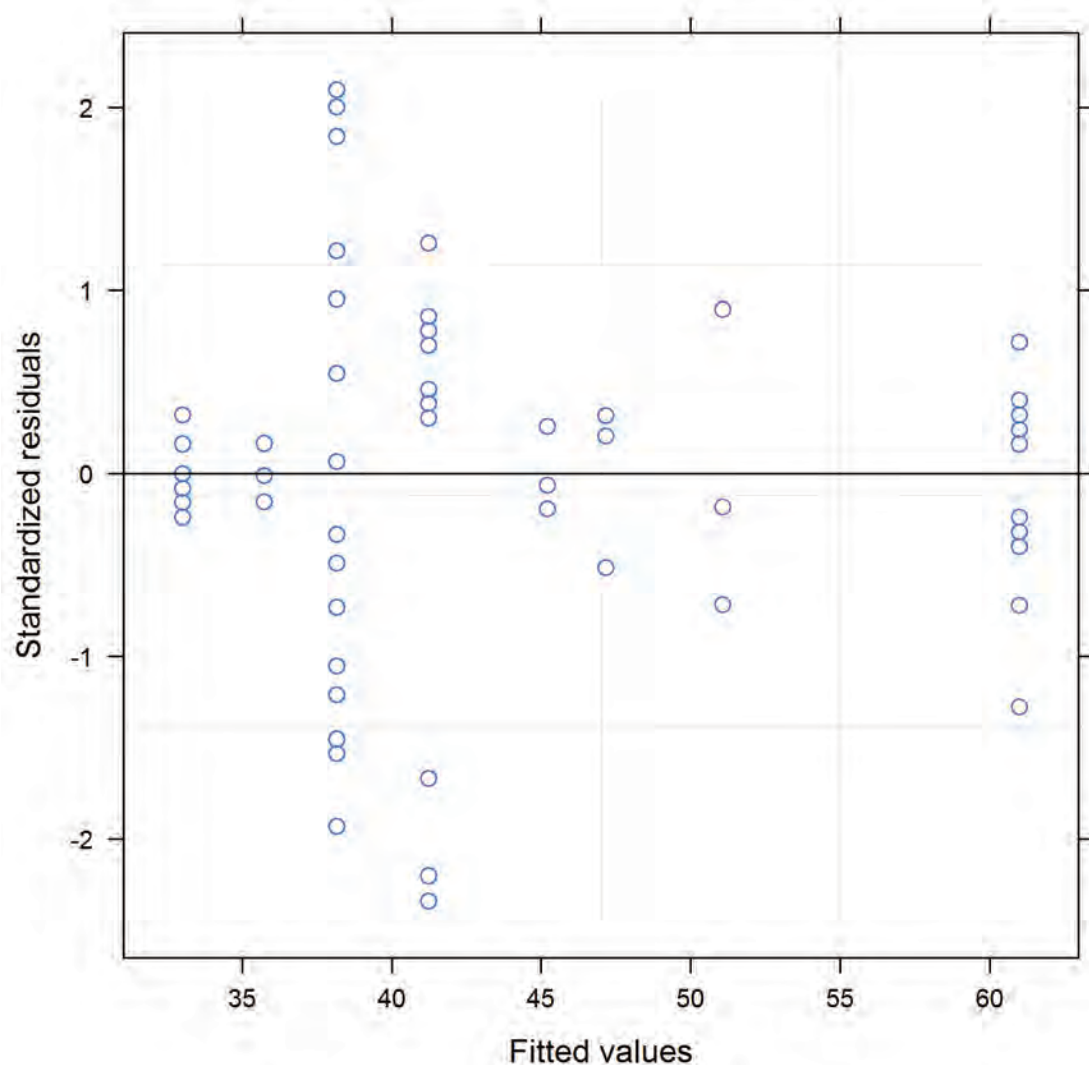
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	426.52	-204.26		
LME	10	426.81	-203.4	1.71	0.19

Conclusion:

The most appropriate model for total nickel at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.191$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 50
##          numDF F-value p-value
## (Intercept)    1    731  <.0001
## site           3     9  0.0001
## period         1     0  0.8013
## site:period     3     2  0.1777
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-22.13	-46.2	1.93	not sig.
Nanuq	-17.71	-41.69	6.27	not sig.
Vulture	-3.19	-27.03	20.66	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Fay Bay site were not significantly ($p = 0$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

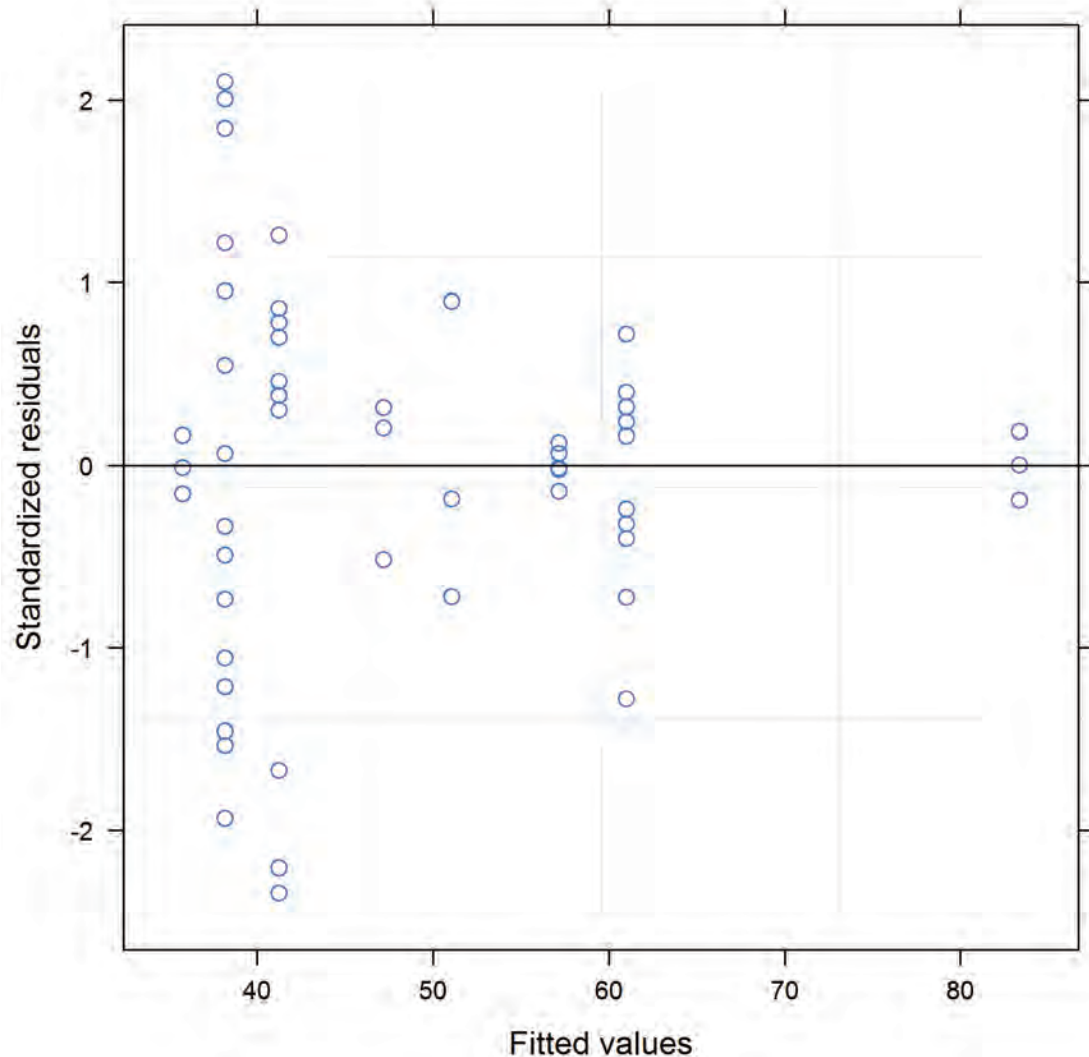
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	426.31	-204.15		
LME	10	426.92	-203.46	1.39	0.24

Conclusion:

The most appropriate model for total nickel at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.239$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 50
##          numDF F-value p-value
## (Intercept)    1    889 <.0001
## site           3     15 <.0001
## period         1      1  0.328
## site:period    3      4  0.017
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-36.13	-60.15	-12.12	sig.
Nanuq	-31.71	-55.63	-7.78	sig.
Vulture	-17.19	-40.98	6.61	not sig.

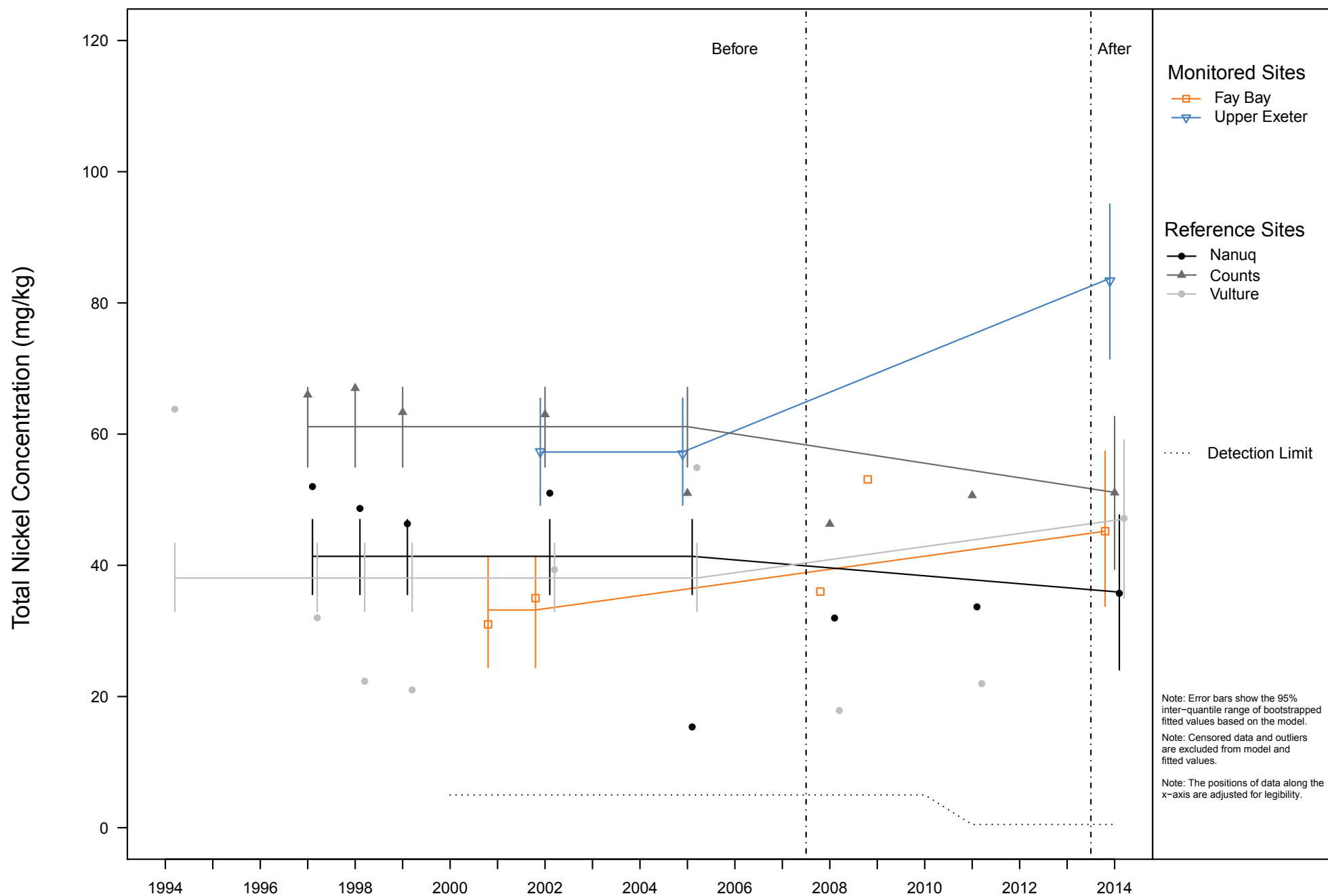
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total nickel concentrations at the Upper Exeter site were significantly ($p = 0$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

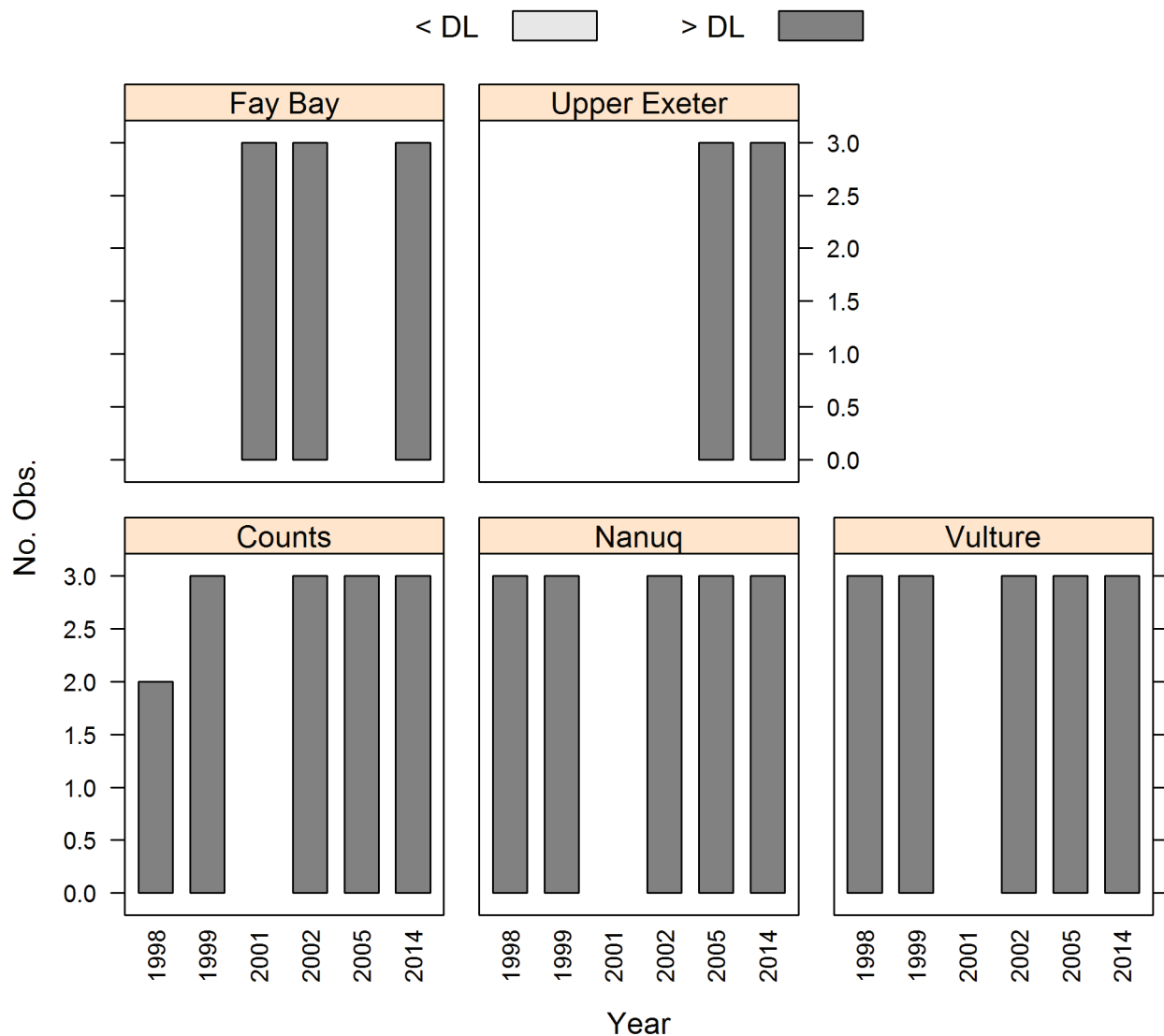


Analysis of Sediment Phosphorus Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

No censored data were identified.

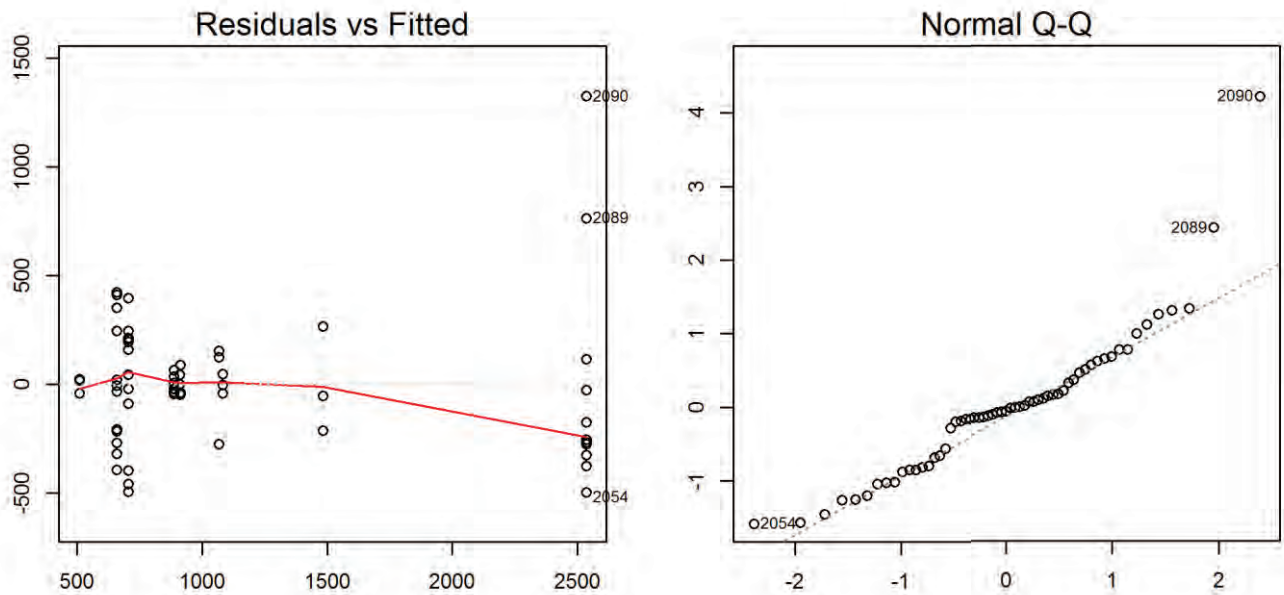
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

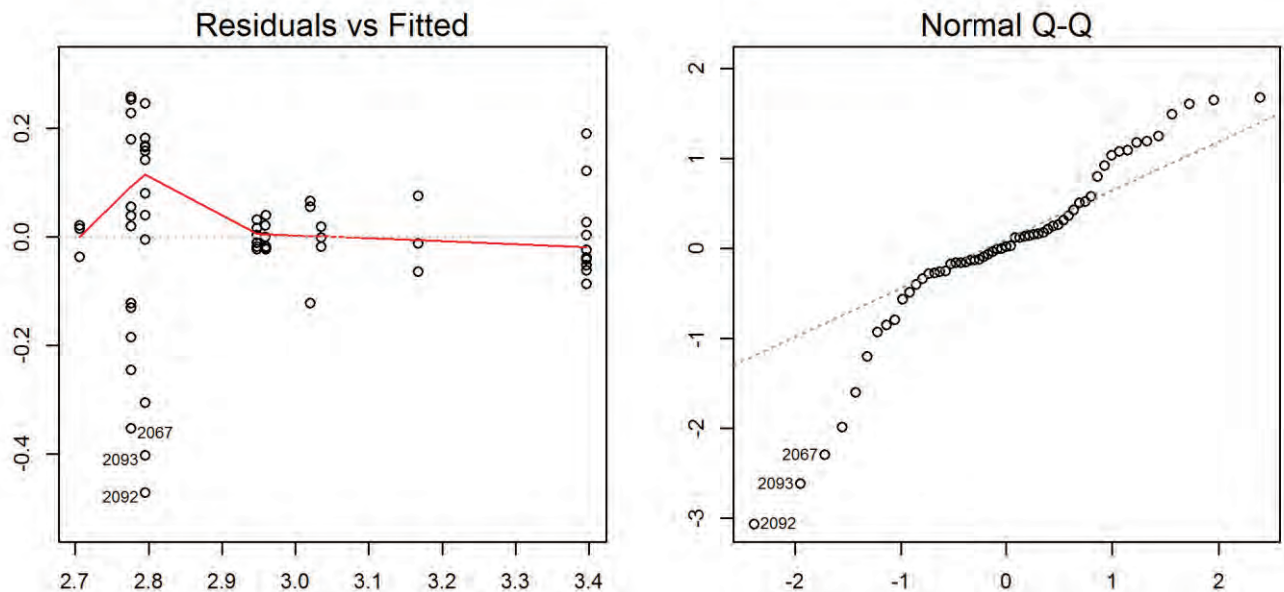
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	328.65	0.84	0.82
Log-10	0.16	0.72	0.66

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

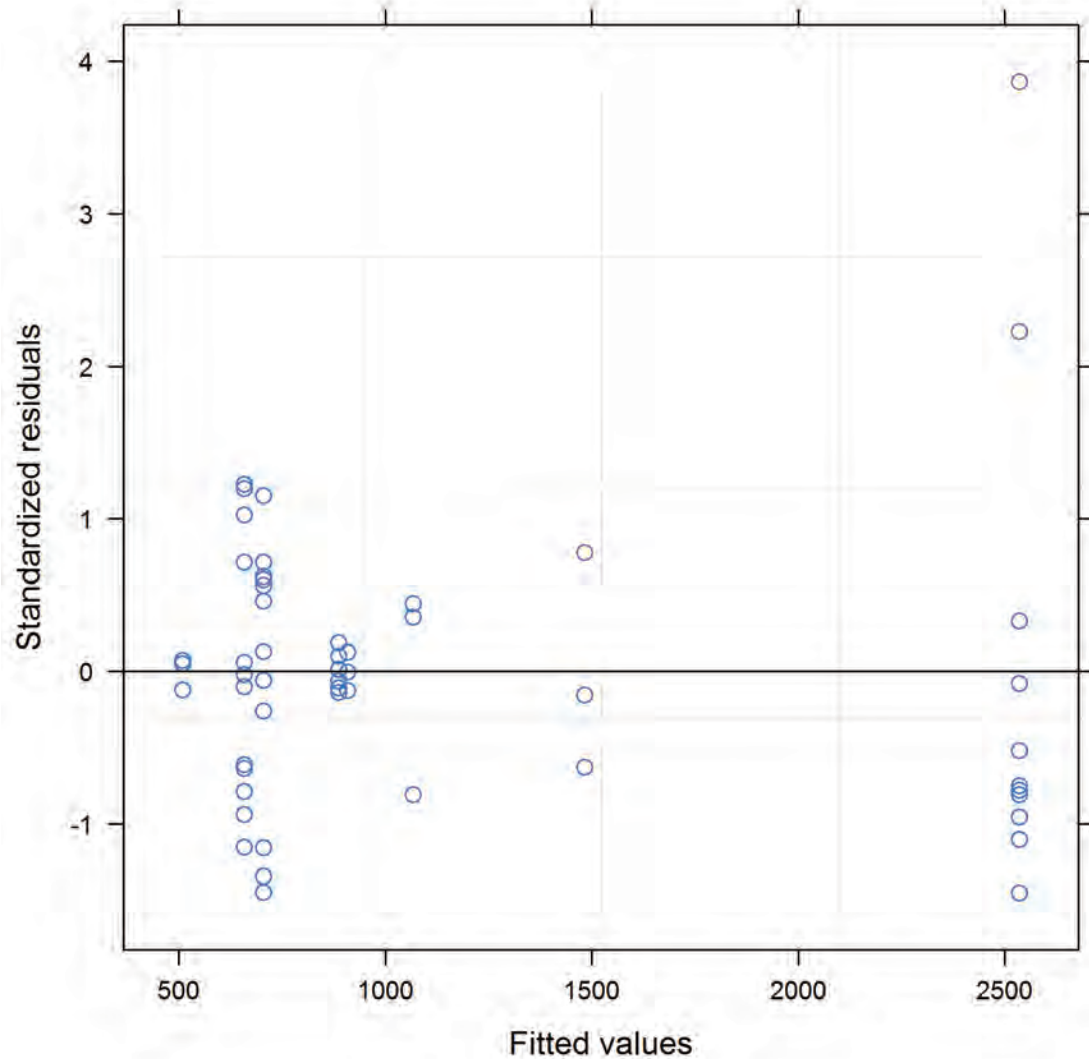
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	684.51	-333.25		
LME	10	686.1	-333.05	0.41	0.52

Conclusion:

The most appropriate model for total phosphorus at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.524$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 45
##          numDF F-value p-value
## (Intercept)    1    608 <.0001
## site           3     72 <.0001
## period         1      3 0.0693
## site:period     3      8 0.0003
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-1075.86	-1738.94	-412.78	sig.
Nanuq	-219.25	-879.61	441.11	not sig.
Vulture	385.25	-275.11	1045.61	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphorus concentrations at the Fay Bay site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

4.2 Upper Exeter Monitoring Location

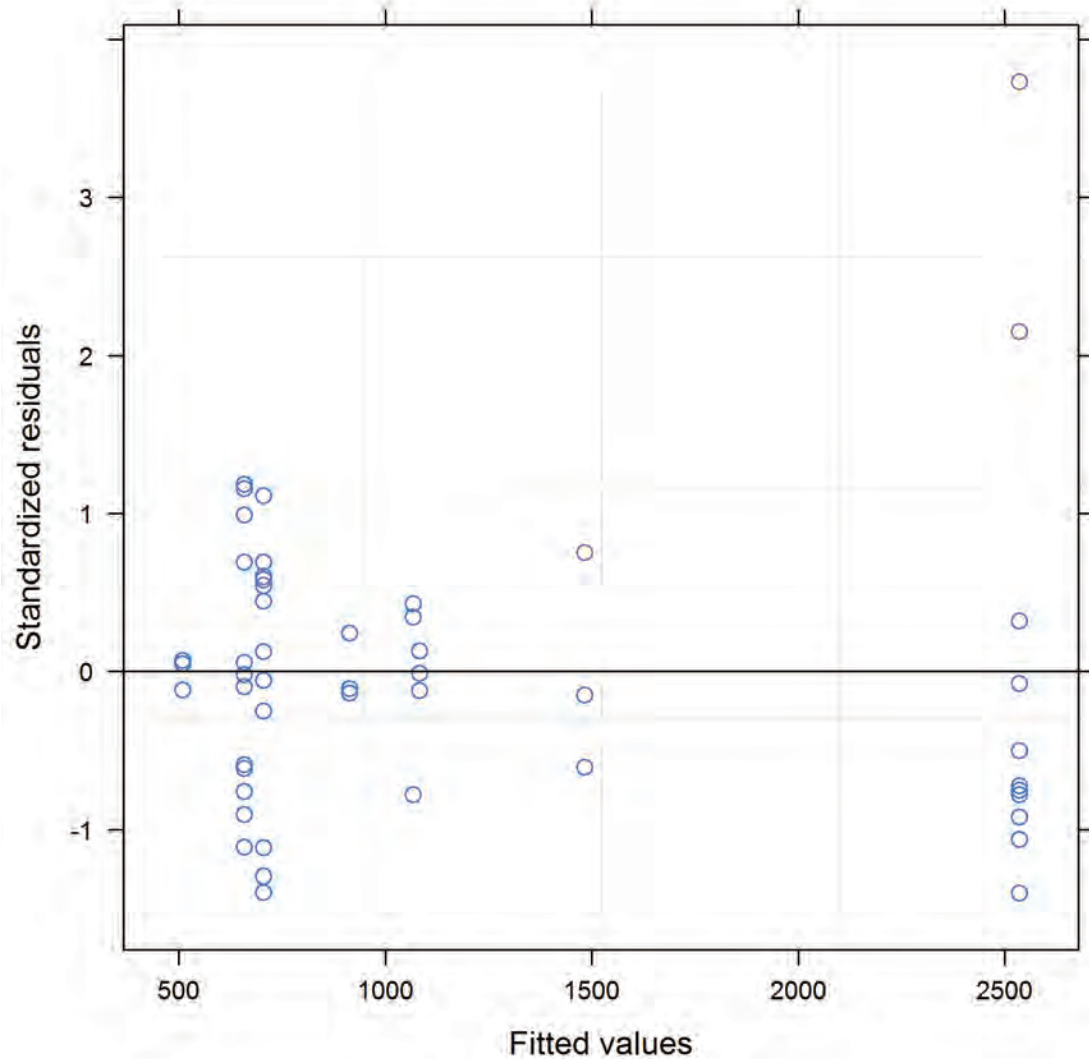
Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	643.2	-312.6		
LME	10	644.76	-312.38	0.44	0.51

Conclusion:

The most appropriate model for total phosphorus at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.508$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.



Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 42
##          numDF F-value p-value
## (Intercept)    1    562 <.0001
## site           3     66 <.0001
## period         1      5 0.0384
## site:period    3      7 0.0007
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-882.7	-1630	-135.4	sig.
Nanuq	-26.08	-770.78	718.62	not sig.
Vulture	578.42	-166.28	1323.12	not sig.

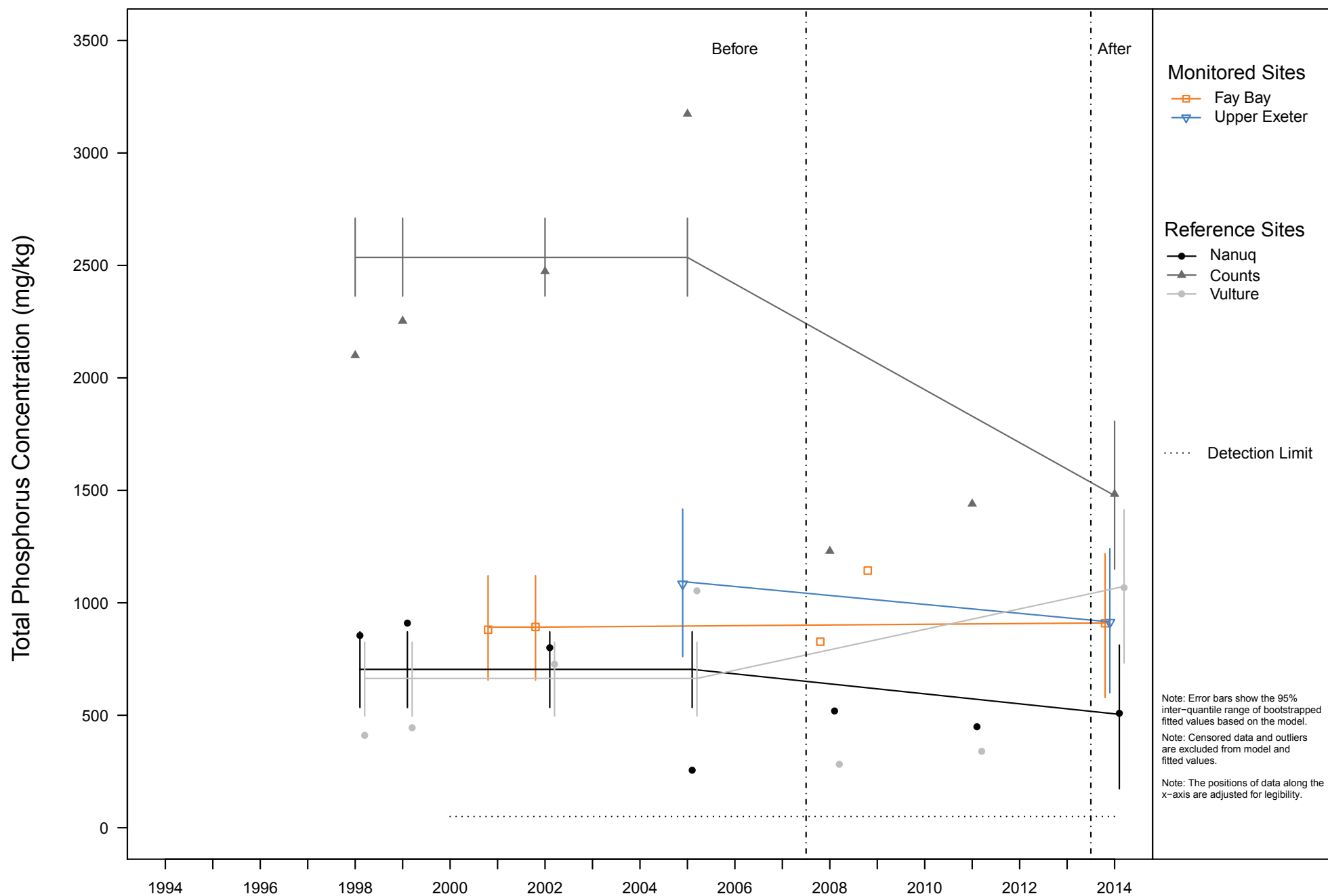
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total phosphorus concentrations at the Upper Exeter site were significantly ($p < 0.001$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

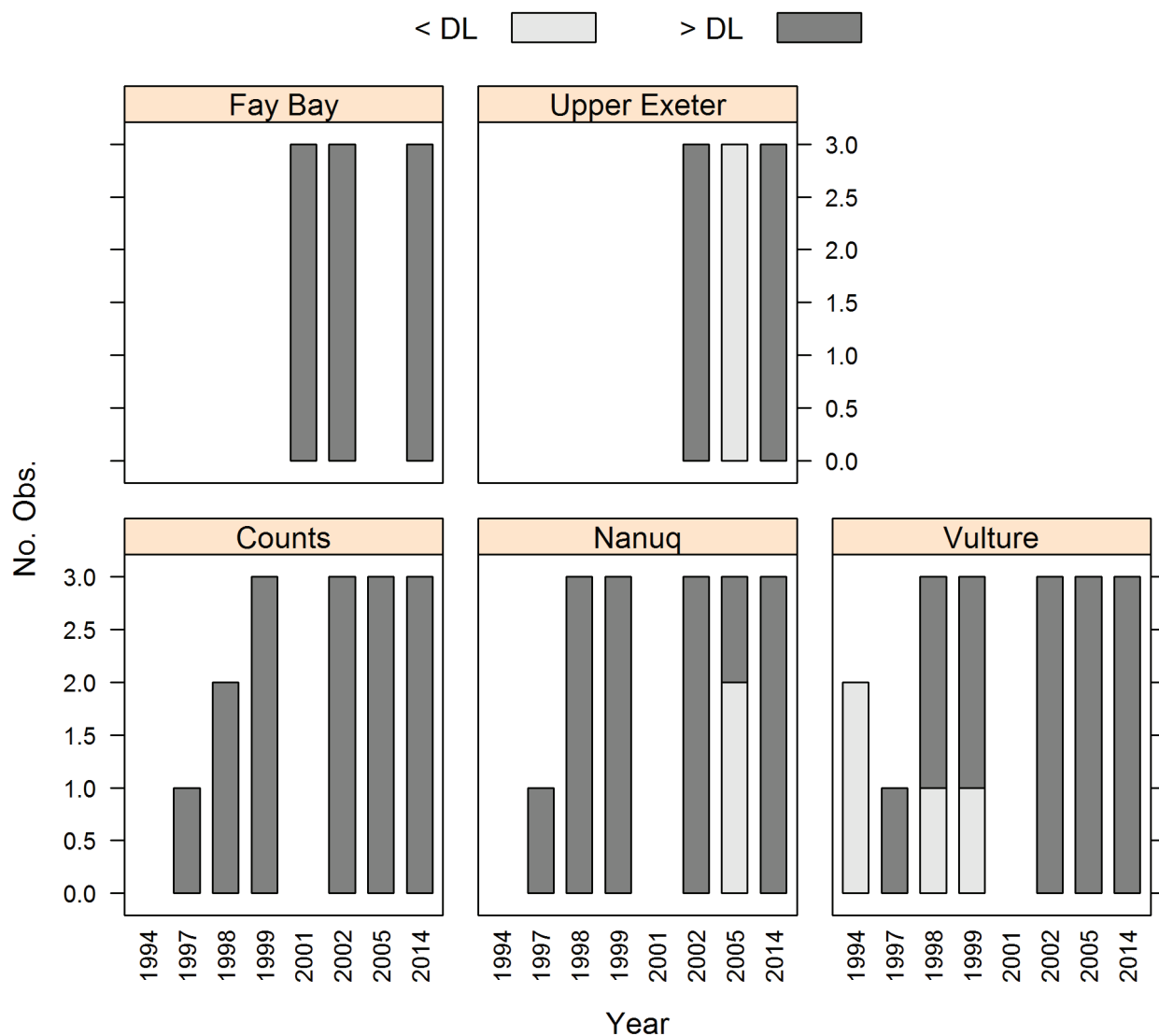


Analysis of Sediment Total Selenium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 5, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

##	site	date	year	class
## 2226	Vulture	1994-07-01	1994	ref
## 2227	Vulture	1994-08-13	1994	ref
## 2269	Nanuq	2005-08-01	2005	ref
## 2270	Nanuq	2005-08-01	2005	ref
## 2271	Nanuq	2005-08-01	2005	ref
## 2272	Upper Exeter	2005-08-19	2005	monit
## 2273	Upper Exeter	2005-08-19	2005	monit
## 2274	Upper Exeter	2005-08-19	2005	monit

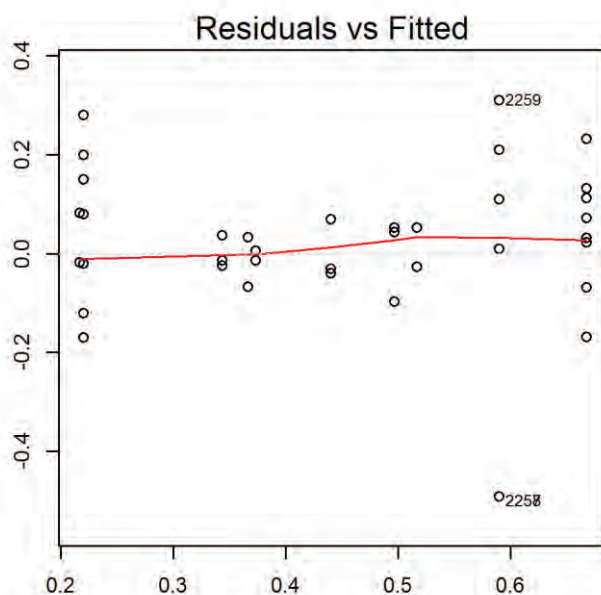
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

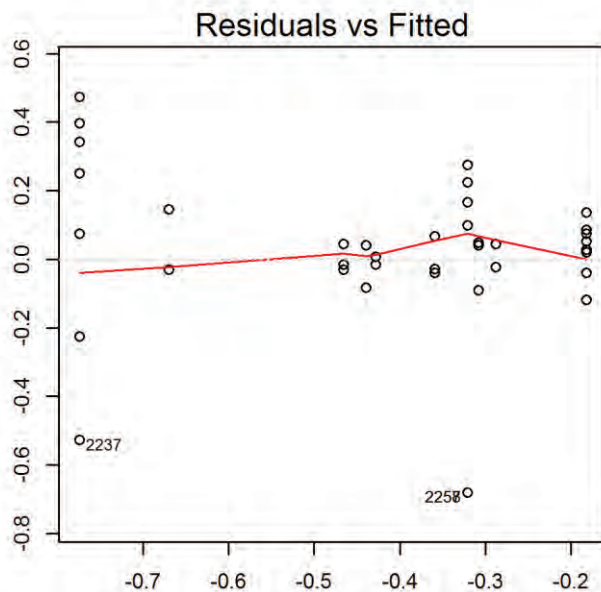
No outliers were identified.

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.15	0.61	0.54
Log-10	0.24	0.51	0.42

Based on the summary statistics and examination of the residuals, the untransformed data were selected for analysis.

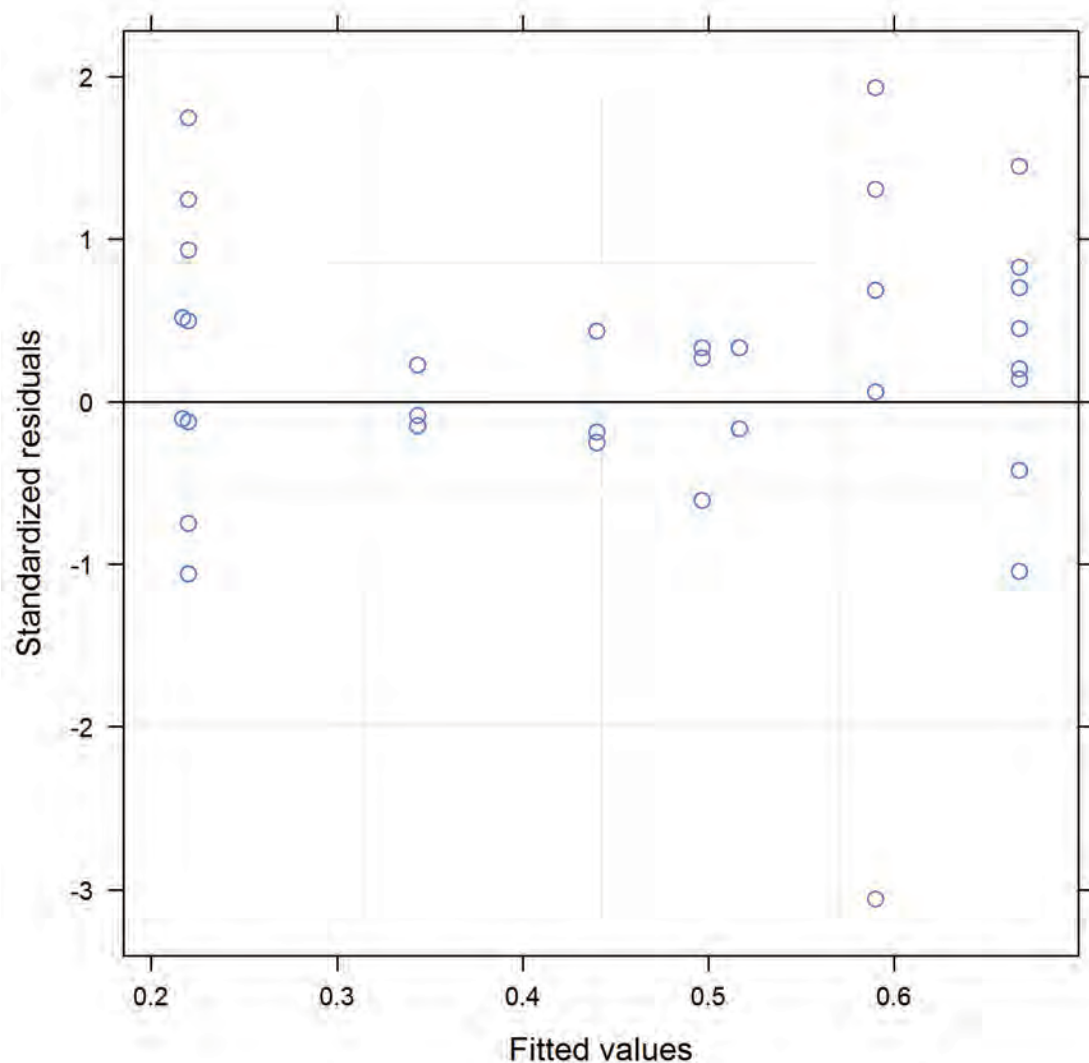
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-5.51	11.76		
LME	10	-3.58	11.79	0.07	0.79

Conclusion:

The most appropriate model for total selenium at the Fay Bay monitoring site was the simpler GLS model without a year term ($p = 0.787$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 45
##          numDF F-value p-value
## (Intercept)    1    404 <.0001
## site           3     19 <.0001
## period         1      0 0.6633
## site:period     3      5 0.0073
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.35	-0.66	-0.05	sig.
Nanuq	-0.2	-0.51	0.11	not sig.
Vulture	0.15	-0.16	0.46	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total selenium concentrations at the Fay Bay site were significantly ($p = 0.007$) different in the *after* period, according to the test on the BACI term (*site:period*). The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

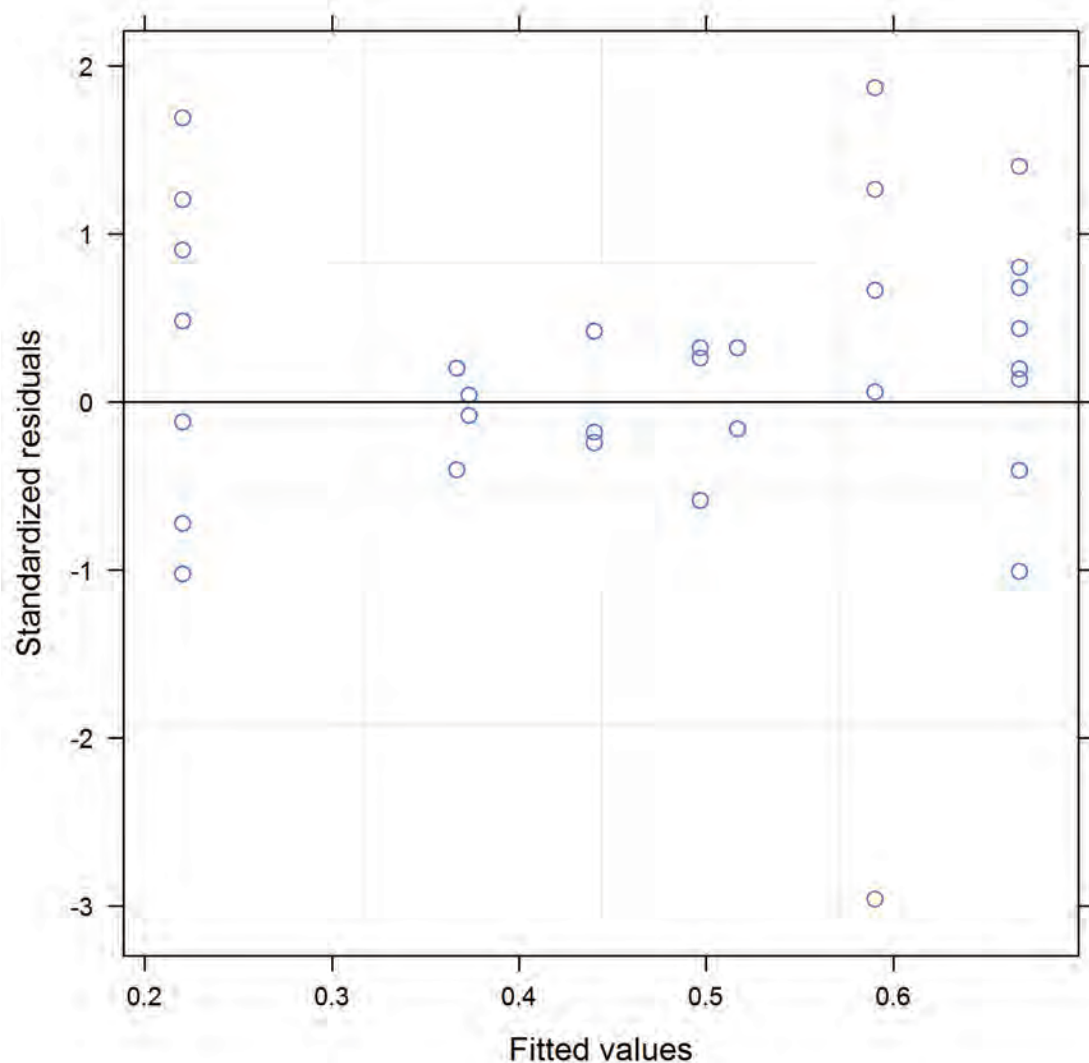
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	-0.96	9.48		
LME	10	0.96	9.52	0.08	0.78

Conclusion:

The most appropriate model for total selenium at the Upper Exeter monitoring site was the simpler GLS model without a year term ($p = 0.784$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

```
## Denom. DF: 42
##          numDF F-value p-value
## (Intercept)    1    397 <.0001
## site           3     14 <.0001
## period         1      0  0.950
## site:period    3      4  0.015
```


Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.23	-0.58	0.11	not sig.
Nanuq	-0.08	-0.43	0.27	not sig.
Vulture	0.27	-0.08	0.62	not sig.

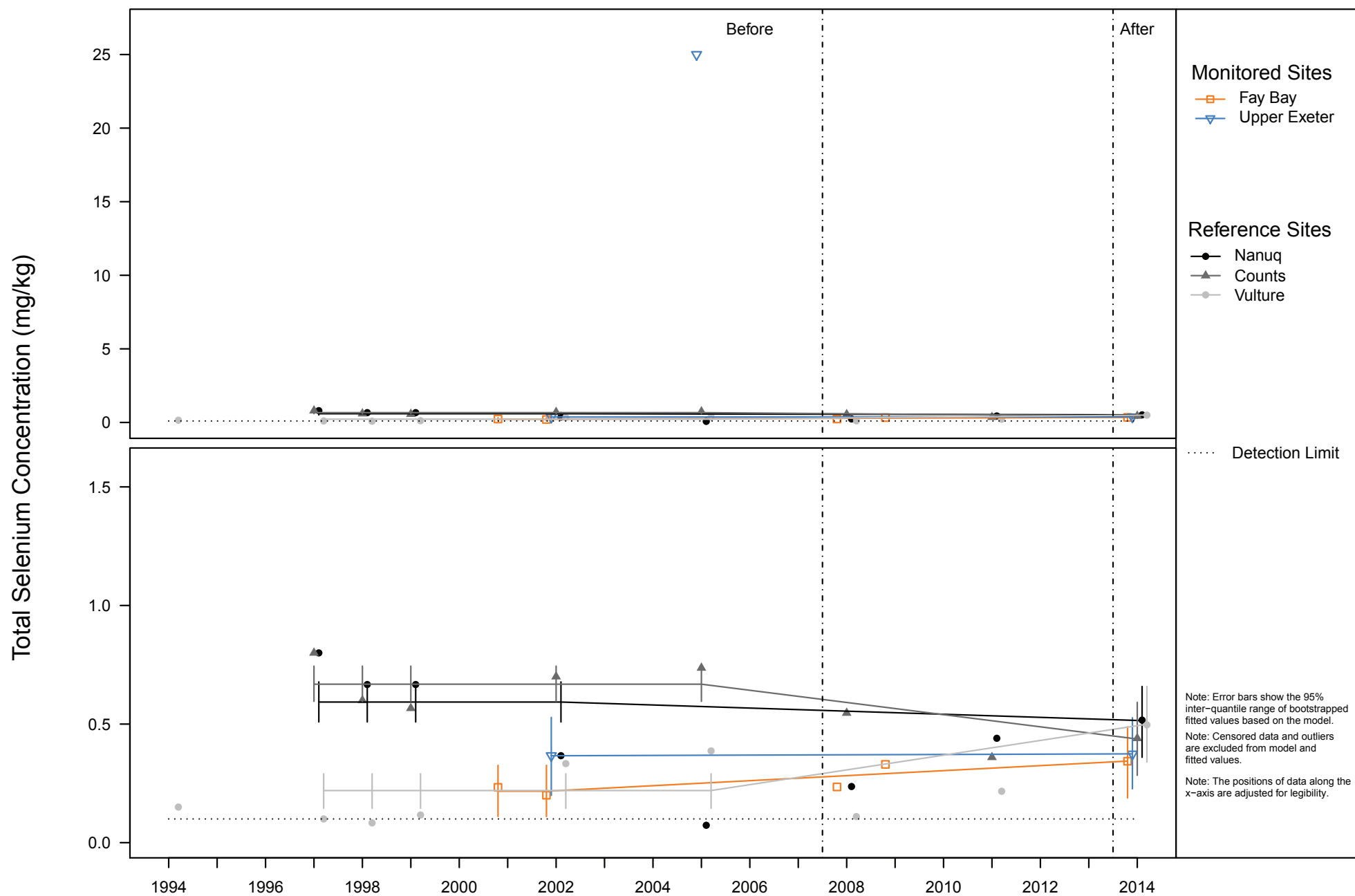
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Total selenium concentrations at the Upper Exeter site were significantly ($p = 0.015$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. The BACI results should be interpreted with caution because at least 10% of the observations within one of the sites were below analytical detection limits.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

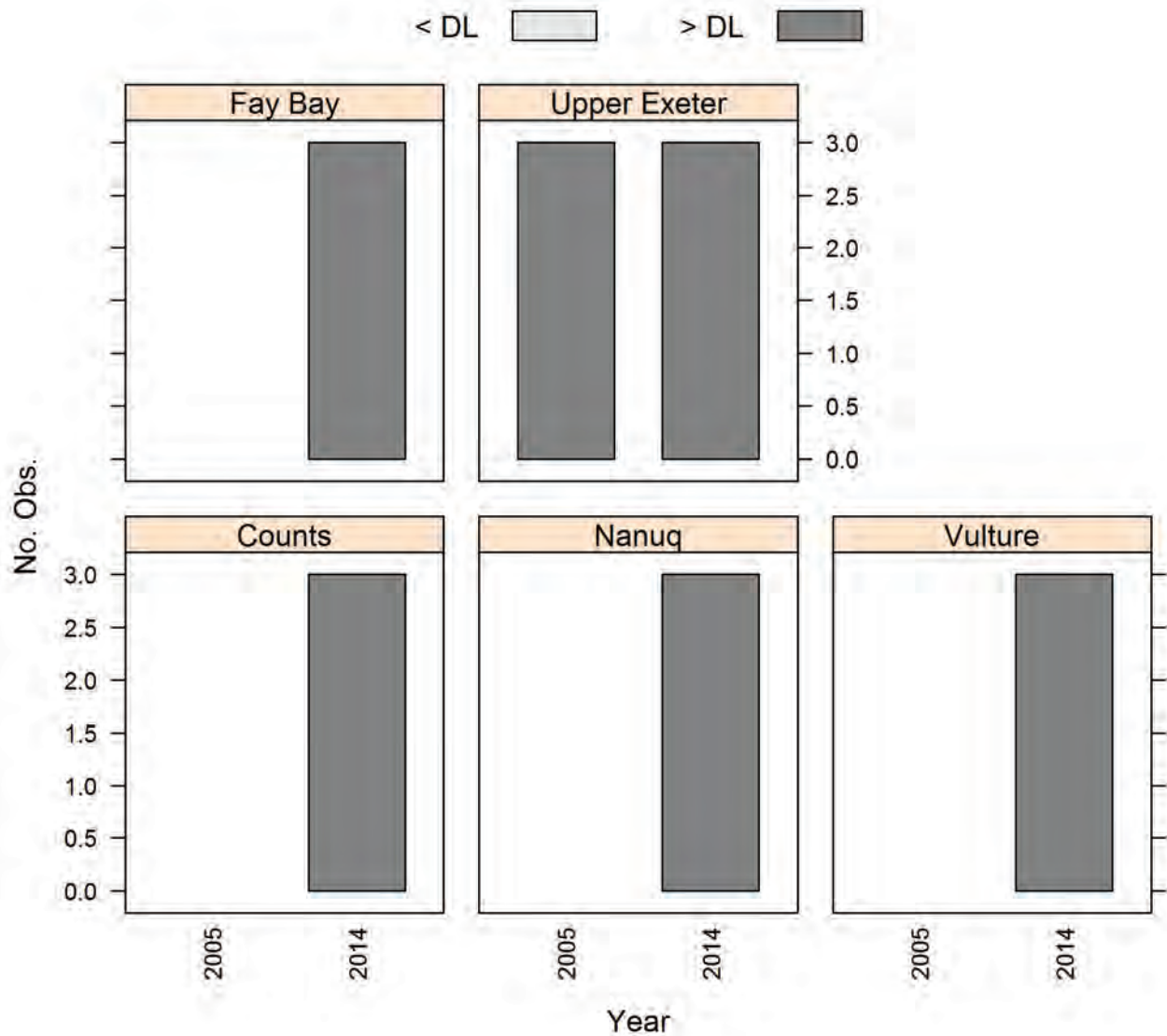


Analysis of Sediment Strontium Concentrations in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 19, 2015

1 Censored Data

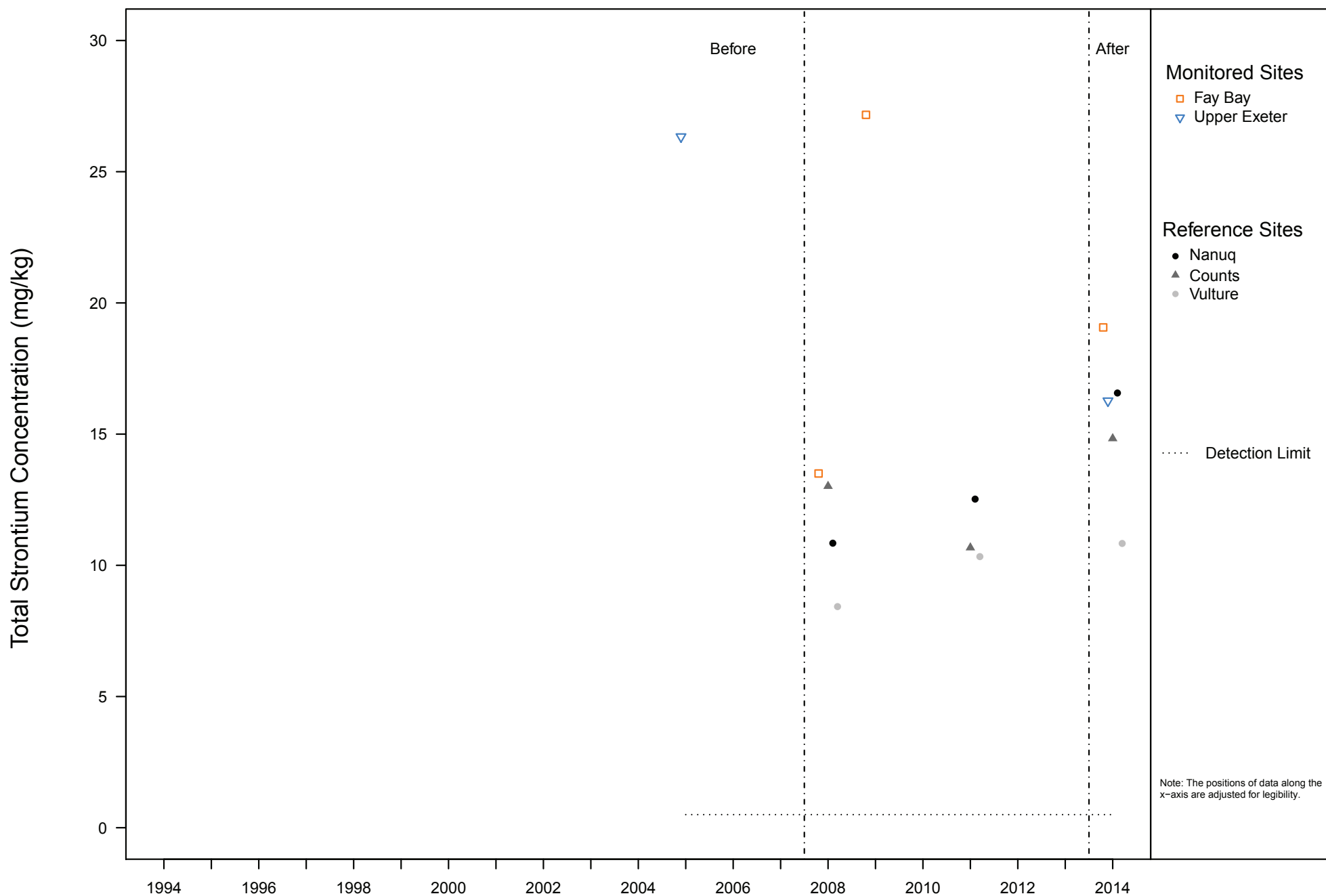
The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

Conclusion:

Strontium sediment concentration statistical analyses were not conducted because of the censoring or availability of observations. Below is a summary figure of all observations in the Pigeon-Fay and Upper Exeter Watershed watershed dataset. Mean observations for each site for each year are shown as symbols.

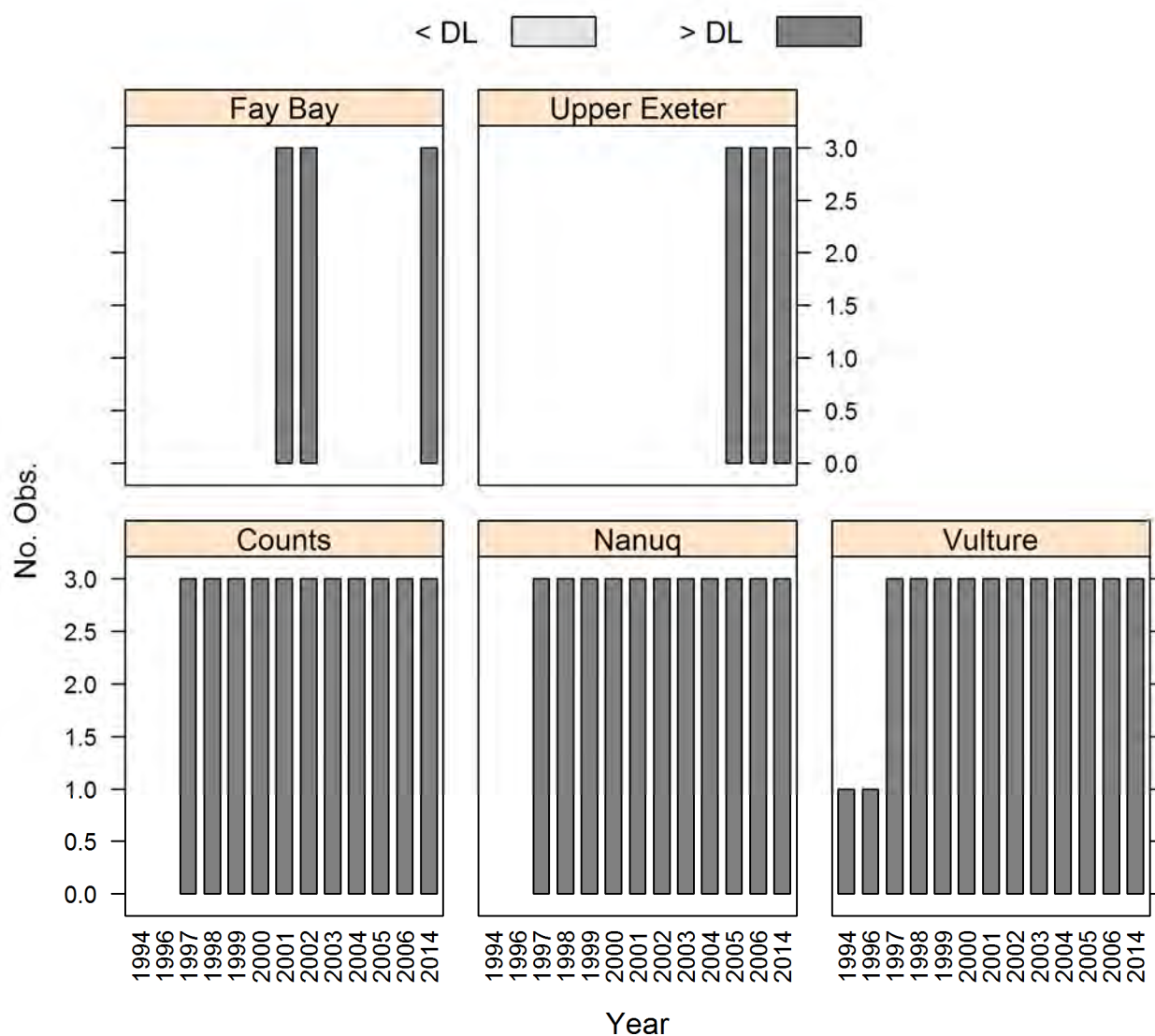


Analysis of Lake Chlorophyll a in Lakes of the Pigeon-Fay and Upper Exeter Watershed

February 10, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

```
## No censored data were identified.
```

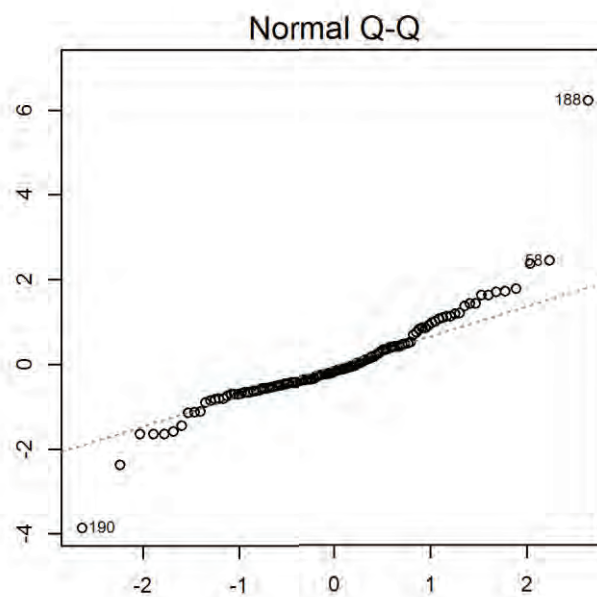
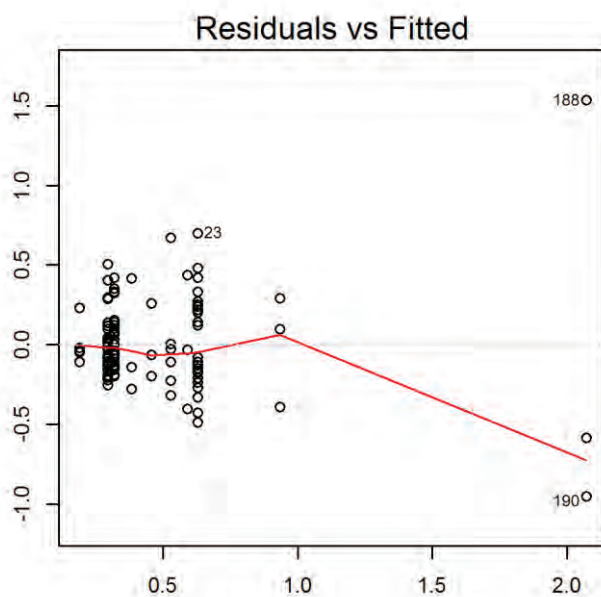
2 Outliers

The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

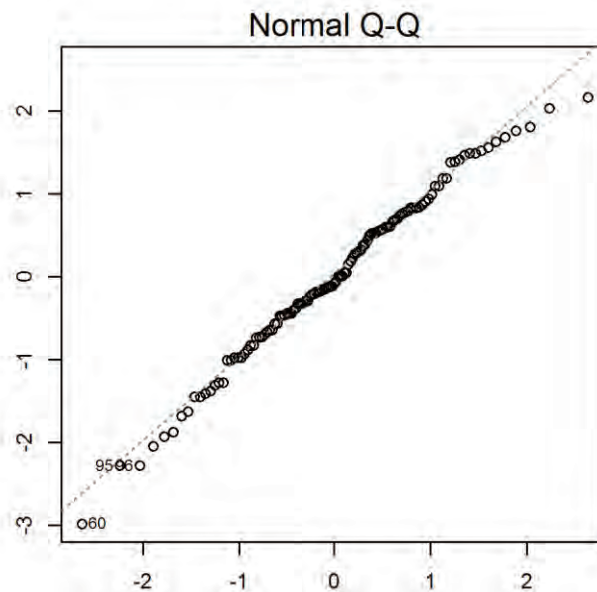
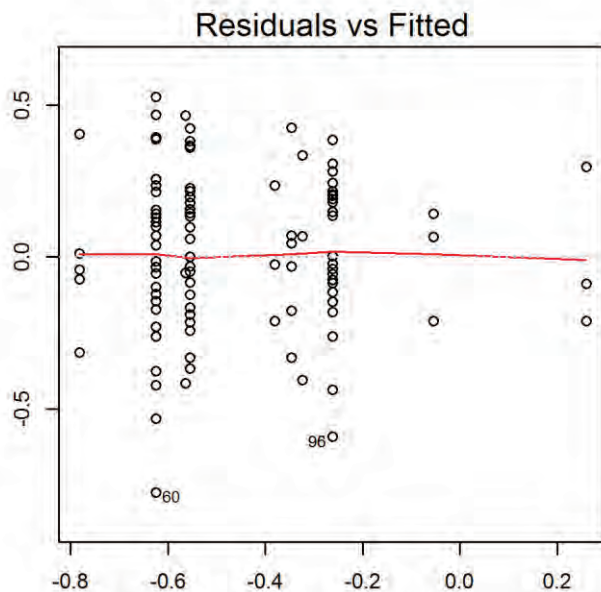
```
## No outliers were identified.
```

3 Initial Model Fit

Natural Scale Model



Log-10 Transformed Model



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	0.3	0.53	0.49
Log-10	0.26	0.4	0.35

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

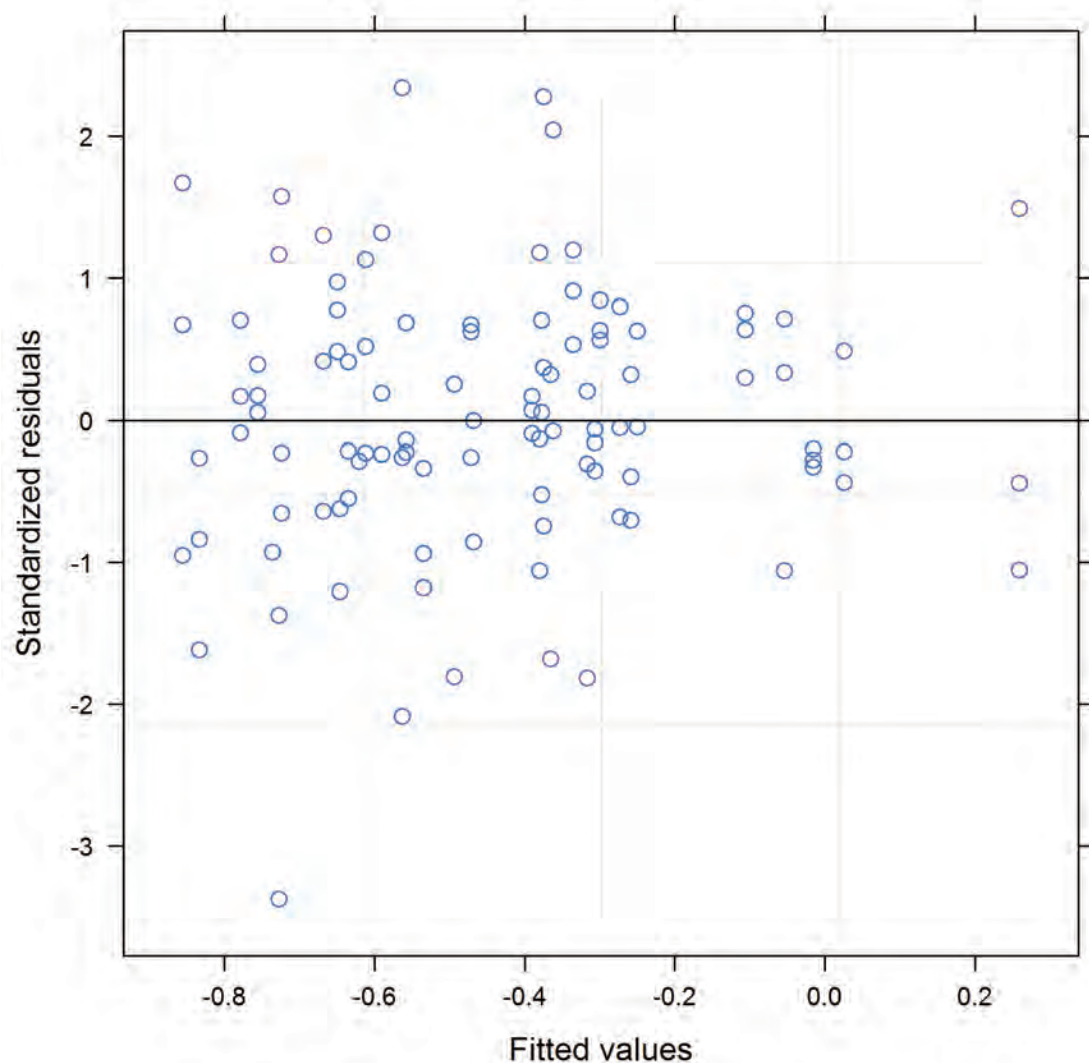
4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	51.28	-16.64		
LME	10	18.18	0.91	35.1	3.12×10 ⁻⁹

Conclusion:

The most appropriate model for biomass at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	91	67	<.0001
## site	3	91	28	<.0001
## period	1	11	1	0.277
## site:period	3	91	2	0.097

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.32	-0.71	0.05	not sig.
Nanuq	-0.47	-0.86	-0.09	sig.
Vulture	-0.37	-0.74	0.01	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Biomass at the Fay Bay site were not significantly ($p = 0.1$) different in the *after* period, according to the test on the BACI term (*site:period*). However, the ANOVA significance test and the results of the contrasts analysis return different conclusions. Differing conclusions like this case occur when the probabilities associated with the hypothesis test are close to alpha (0.05), and may indicate the evidence of a significant difference is not strong. The analysis should be interpreted with caution. Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

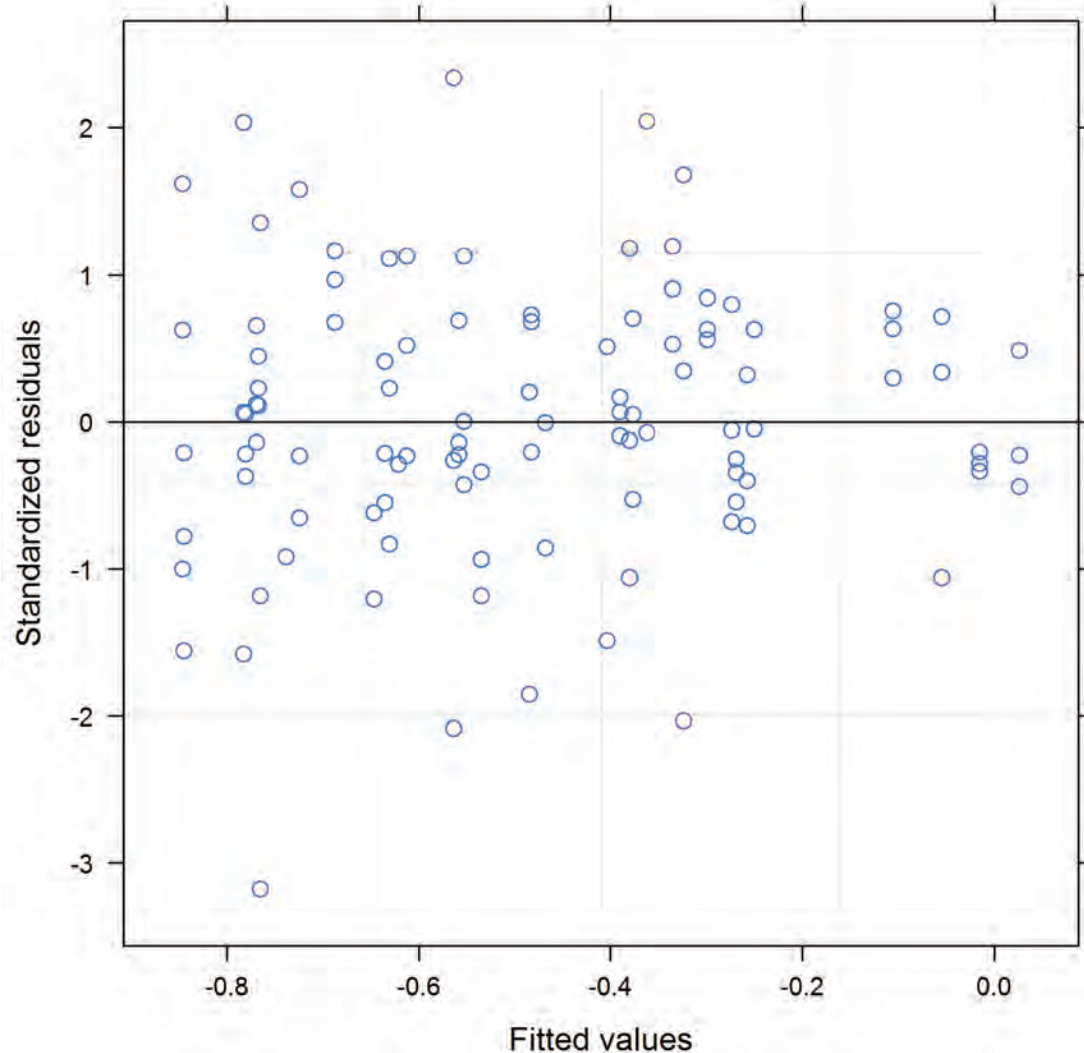
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	52.46	-17.23		
LME	10	18.57	0.71	35.88	2.09×10^{-9}

Conclusion:

The most appropriate model for biomass at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

##	numDF	denDF	F-value	p-value
## (Intercept)	1	91	72	<.0001
## site	3	91	22	<.0001
## period	1	11	1	0.40
## site:period	3	91	0	0.77

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.03	-0.41	0.34	not sig.
Nanuq	-0.18	-0.56	0.21	not sig.
Vulture	-0.07	-0.44	0.3	not sig.

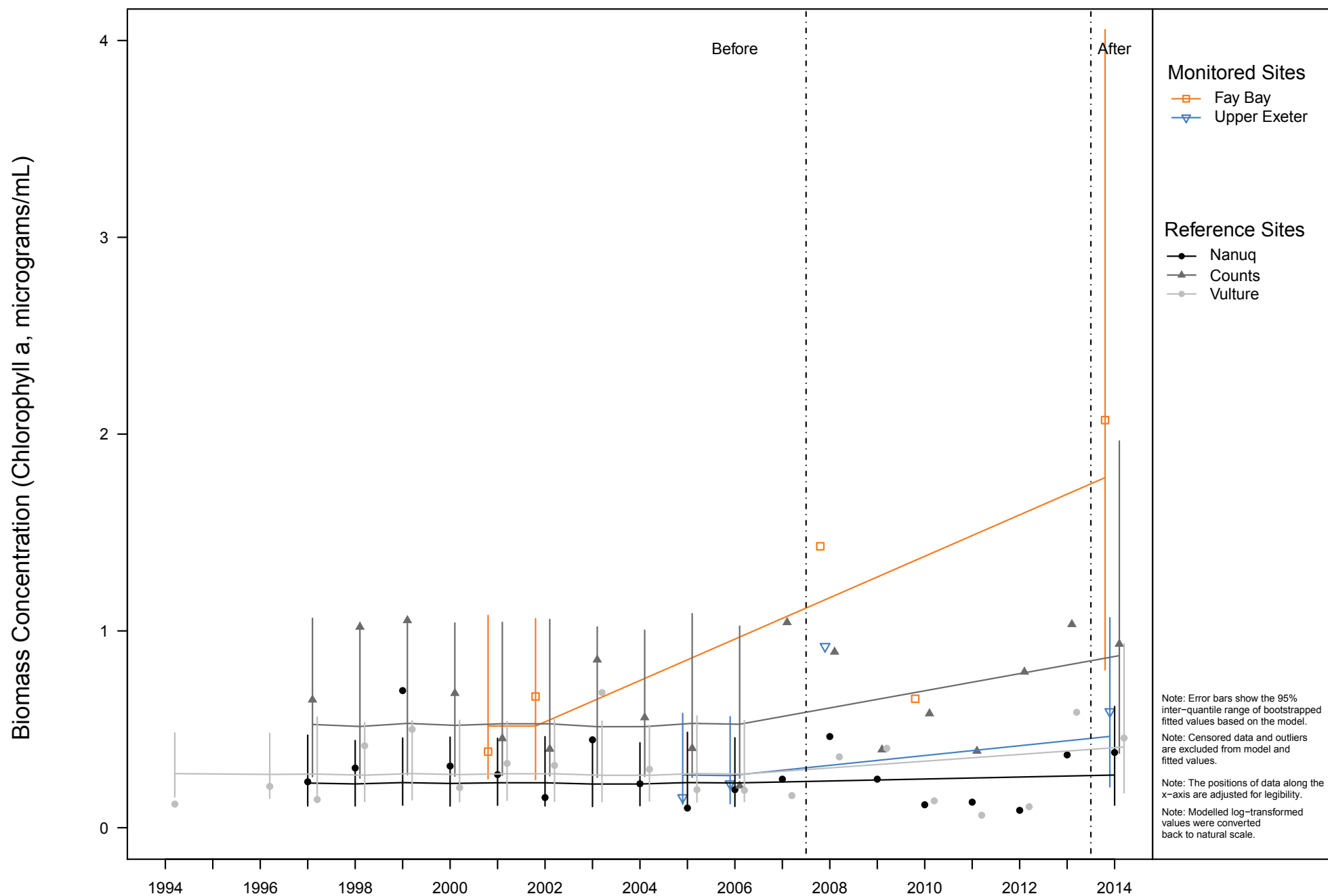
A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Biomass at the Upper Exeter site were not significantly ($p = 0.77$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

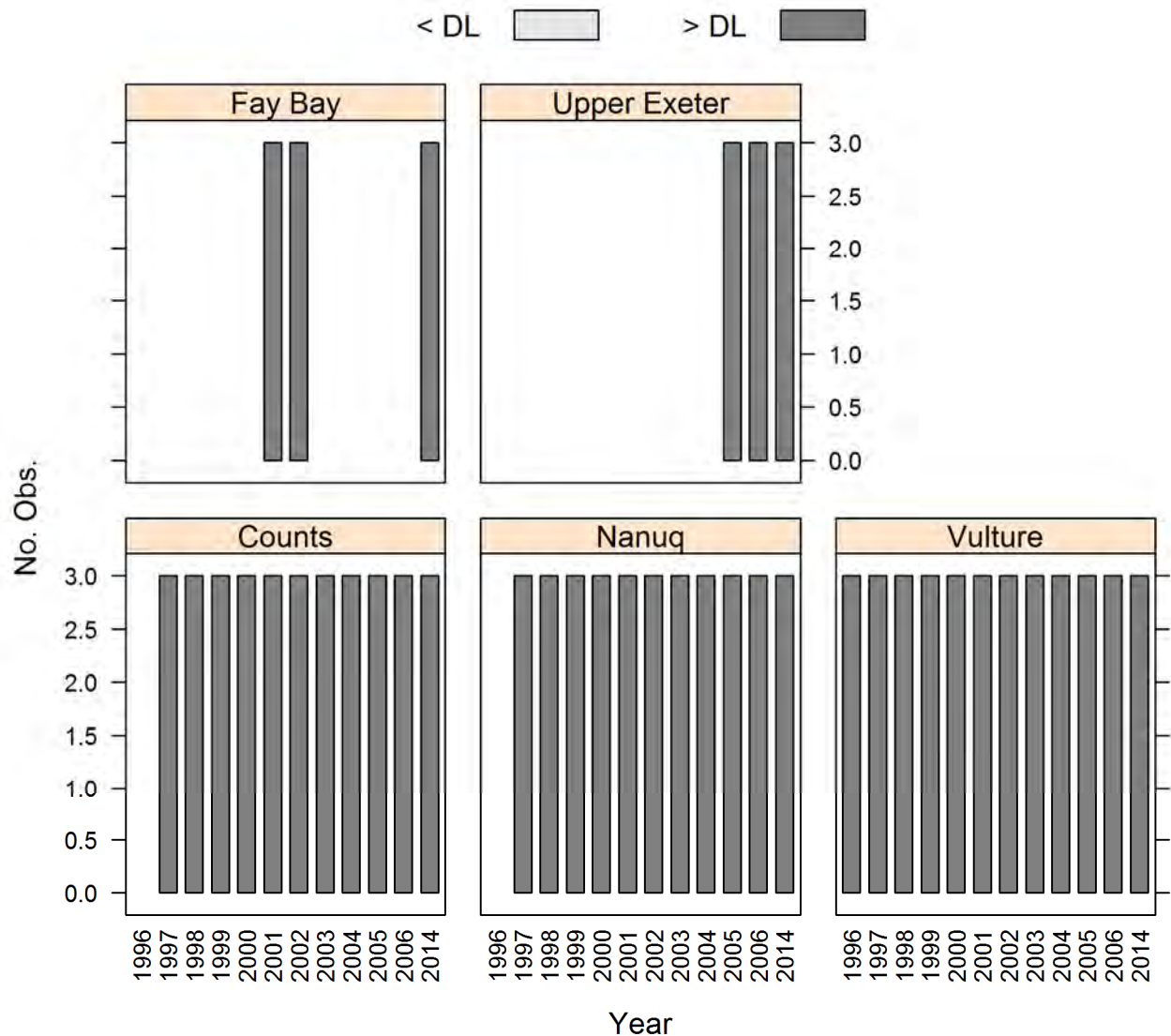


Analysis of Lake Phytoplankton Density in Lakes of the Pigeon-Fay and Upper Exeter Watershed

January 19, 2014

1 Censored Data

The following charts indicate the number of measurements taken in each year from each lake that were below the detection limit (grey) or above the detection limit (dark).



Observations at or below the analytical detection limit were considered censored. Data were excluded from the analysis if greater than 60% of observations from a site in a sampling year were censored. If more than 10% of observations from a site were censored, data were flagged to caution interpretation of results.

The following observations were excluded:

No censored data were identified.

2 Outliers

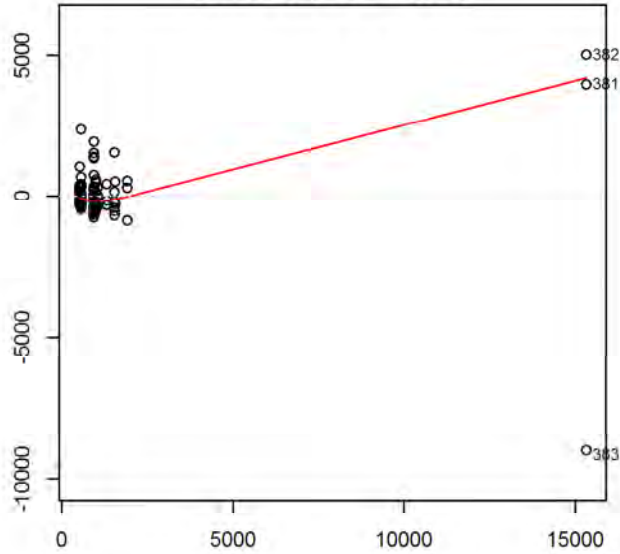
The following is a summary of outliers identified (if any) in the analysis. If any outliers were identified, the values were excluded from all subsequent analyses.

No outliers were identified.

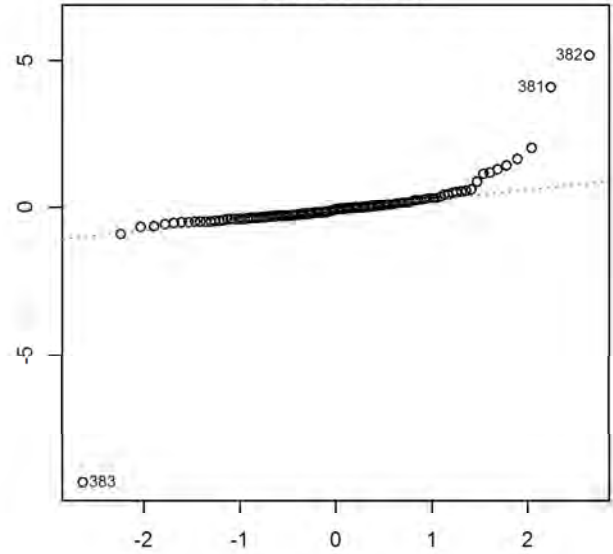
3 Initial Model Fit

Natural Scale Model

Residuals vs Fitted

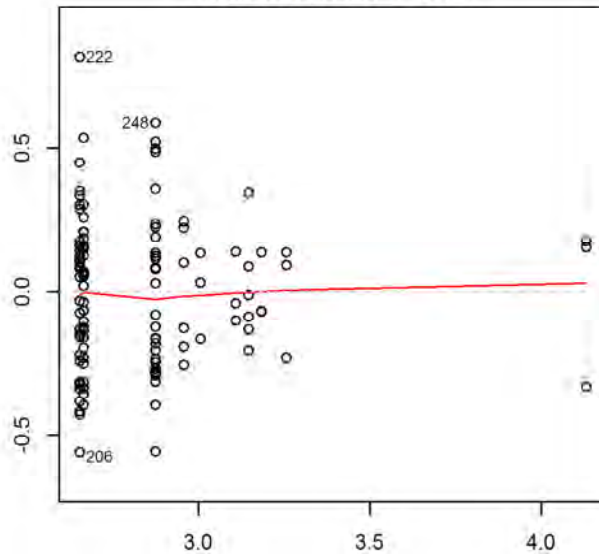


Normal Q-Q

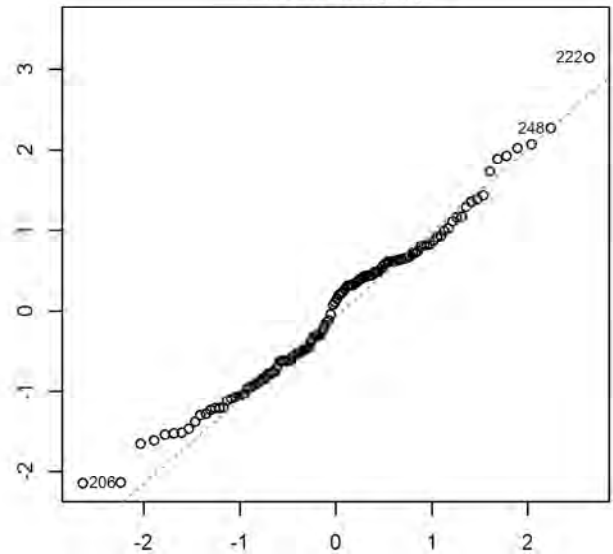


Log-10 Transformed Model

Residuals vs Fitted



Normal Q-Q



Model comparisons for log-transformed data:

Model	Residual SE	R ²	Adjusted R ²
Natural	1184.19	0.8	0.79
Log-10	0.26	0.54	0.5

Based on the summary statistics and examination of the residuals, the log-10 transformed data were selected for analysis.

4. Before-After Control-Impact Linear Modeling**4.1 Fay Bay Monitoring Location**

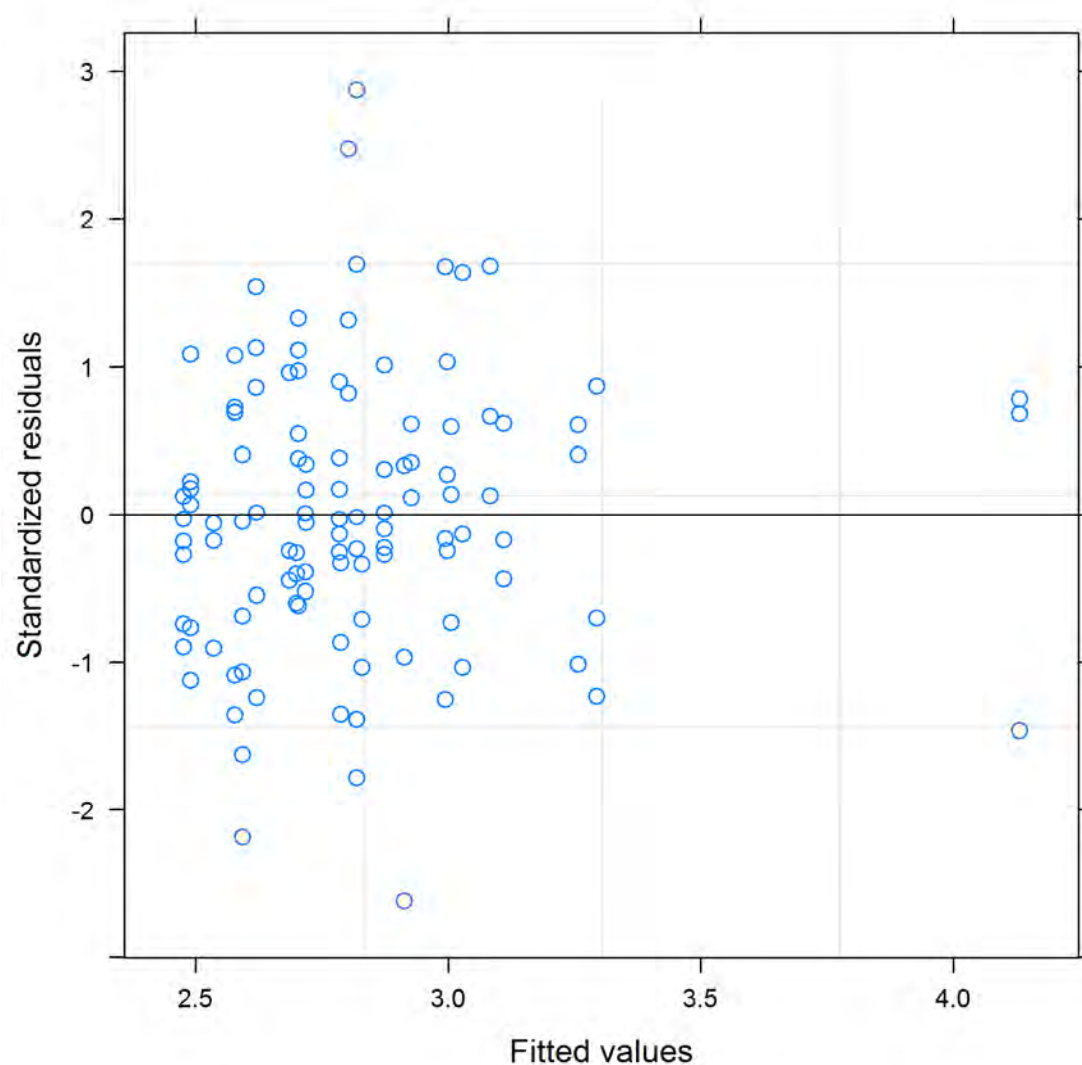
Likelihood ratio test for model selection for the Fay Bay statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	55.15	-18.58		
LME	10	38.65	-9.33	18.5	1.710 ⁻⁵

Conclusion:

The most appropriate model for Density at the Fay Bay monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Fay Bay Model.



Results of the ANOVA test on the fixed effects of the model:

```
##          numDF denDF F-value p-value
## (Intercept)      1   93    3199 <.0001
## site             3   93      22 <.0001
## period           1   10       9 0.0135
## site:period       3   93       4 0.0065
## Computing bootstrap confidence intervals ...
```

Summary of BACI contrasts for changes between the *before* and *after* in Fay Bay by reference site, with 95% confidence intervals:

Fay Bay vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	-0.66	-1.08	-0.26	sig.
Nanuq	-0.7	-1.13	-0.29	sig.
Vulture	-0.6	-1.03	-0.19	sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Density at the Fay Bay site were significantly ($p = 0.01$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

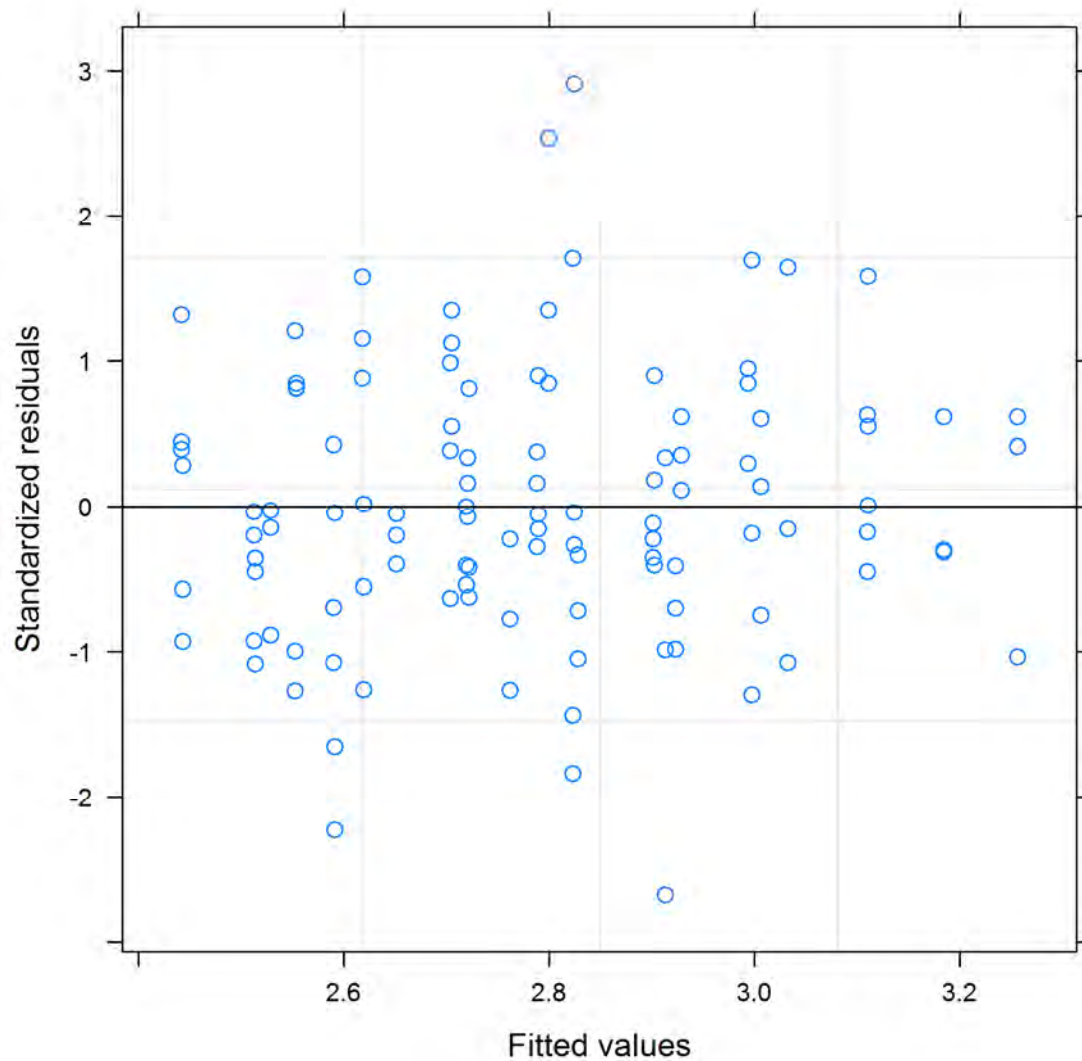
4.2 Upper Exeter Monitoring Location

Likelihood ratio test for model selection for the Upper Exeter statistical model:

Model	D.F.	AIC	log(Like.)	L. Ratio	p
GLS	9	53.87	-17.94		
LME	10	35.71	-7.86	20.16	7.13×10^{-6}

Conclusion:

The most appropriate model for Density at the Upper Exeter monitoring site was the LME with a year term for interannual variation ($p < 0.001$).

Plot of Standardized Residuals and Fitted Values for Upper Exeter Model.

Results of the ANOVA test on the fixed effects of the model:

```
##          numDF denDF F-value p-value
## (Intercept)      1    93   2894 <.0001
## site             3    93     11 <.0001
## period           1    10      3  0.095
## site:period       3    93      1  0.260
## Computing bootstrap confidence intervals ...
```

Summary of BACI contrasts for changes between the *before* and *after* in Upper Exeter by reference site, with 95% confidence intervals:

Upper Exeter vs:	Estimate	Lower C.I.	Upper C.I.	Significance
Counts	0.34	-0.06	0.74	not sig.
Nanuq	0.3	-0.12	0.72	not sig.
Vulture	0.41	-0.01	0.82	not sig.

A BACI contrast is identified as *significant* if the confidence interval does not include 0.

Conclusion:

Density at the Upper Exeter site were not significantly ($p = 0.26$) different in the *after* period, according to the test on the BACI term (*site:period*). Censoring was not likely an issue contributing a bias to the statistical analyses because the percentage of observations below analytical detection was less than 10%.

Model Summary

The overall performance of the model is compared against all of the observations in the Pigeon dataset in the plot below. Mean observations for each site for each year are shown as symbols, with the range of bootstrapped fitted values from the BACI analysis shown as lines and error bars.

