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CHAPTER GREAT SALT LAKE

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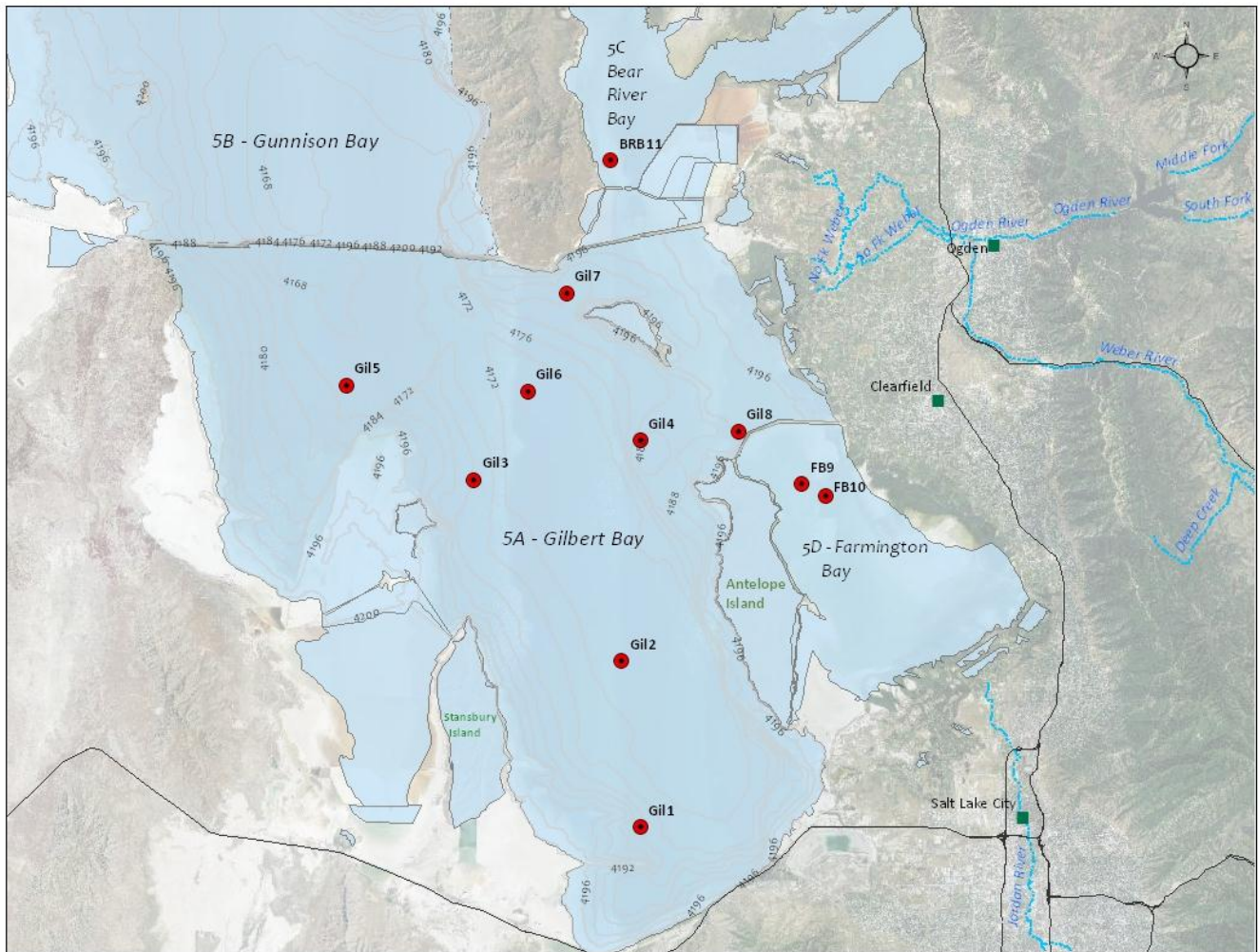


FIGURE 1 GREAT SALT LAKE BASELINE SAMPLE PLAN SAMPLING SITES. THE STUDY AREA INCLUDES THE “OPEN WATERS OF GREAT SALT LAKE” INCLUDING GILBERT BAY, GUNNISON BAY, FARMINGTON BAY, AND BEAR RIVER BAY AT CURRENT LAKE WATER LEVEL. THE UNION PACIFIC RAILROAD CAUSEWAY SEPARATES GILBERT BAY FROM GUNNISON BAY AND BEAR RIVER BAY. THE ANTELOPE ISLAND CAUSEWAY AT THE NORTHERN END OF ANTELOPE ISLAND AND THE ISLAND DIKE ROAD AT THE SOUTHERN END OF ANTELOPE ISLAND SEPARATE GILBERT BAY FROM FARMINGTON BAY.

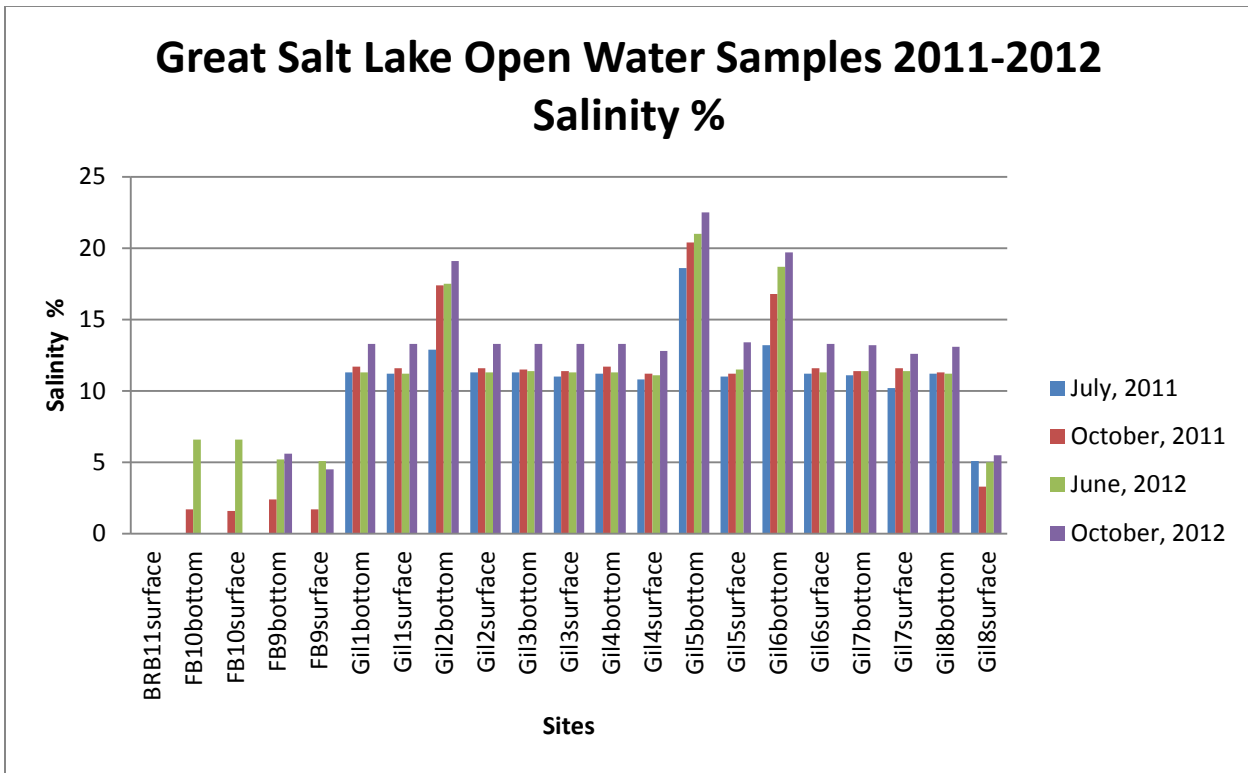


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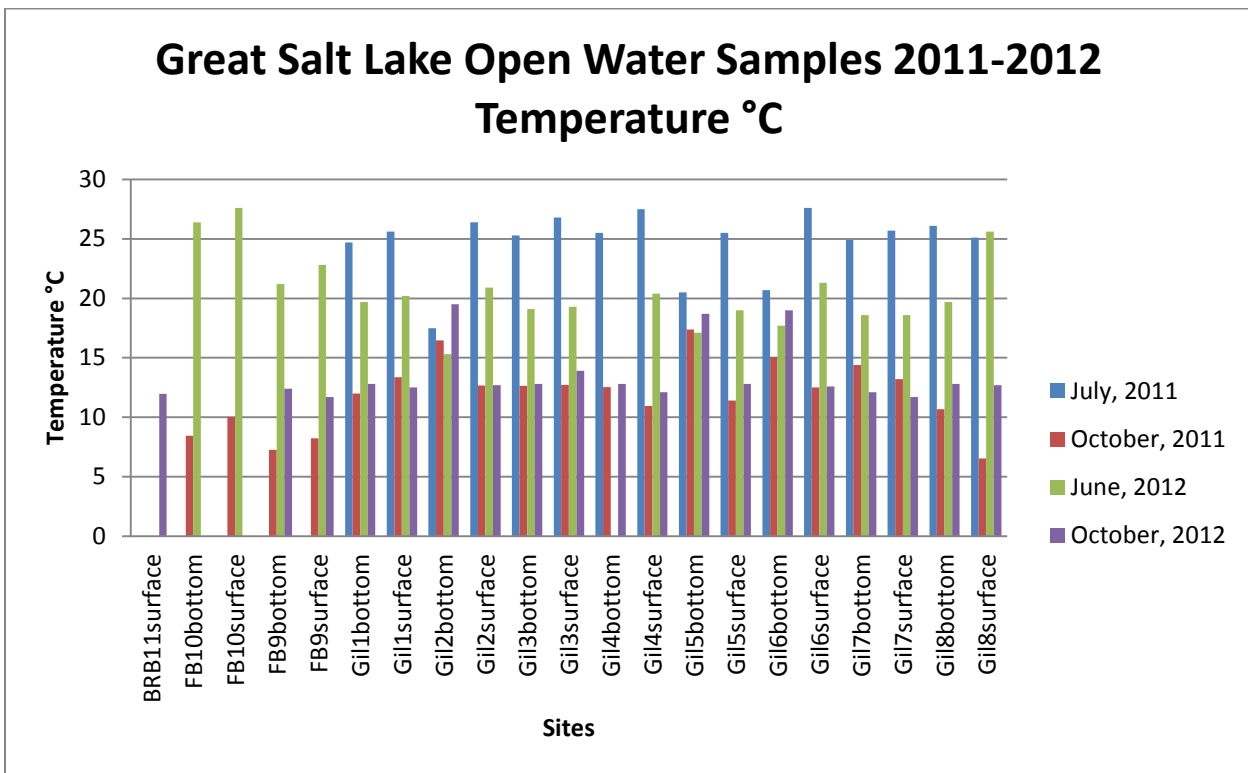


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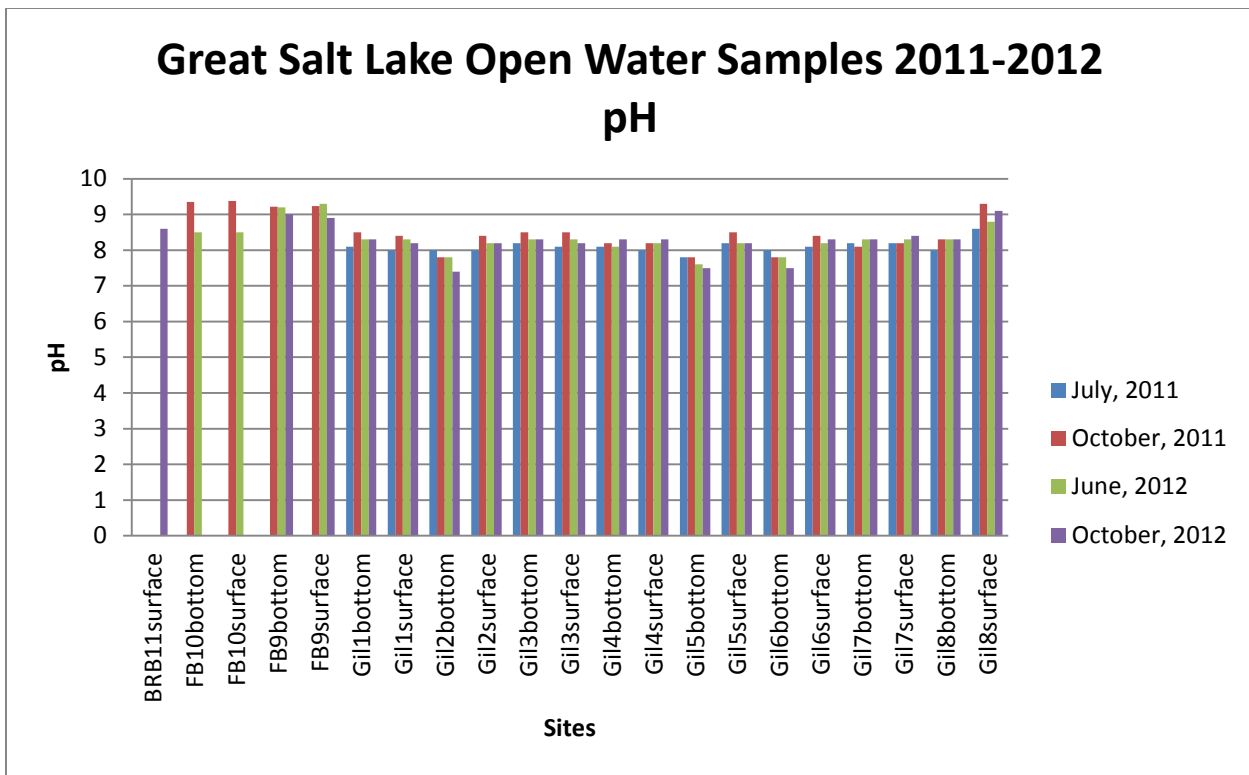


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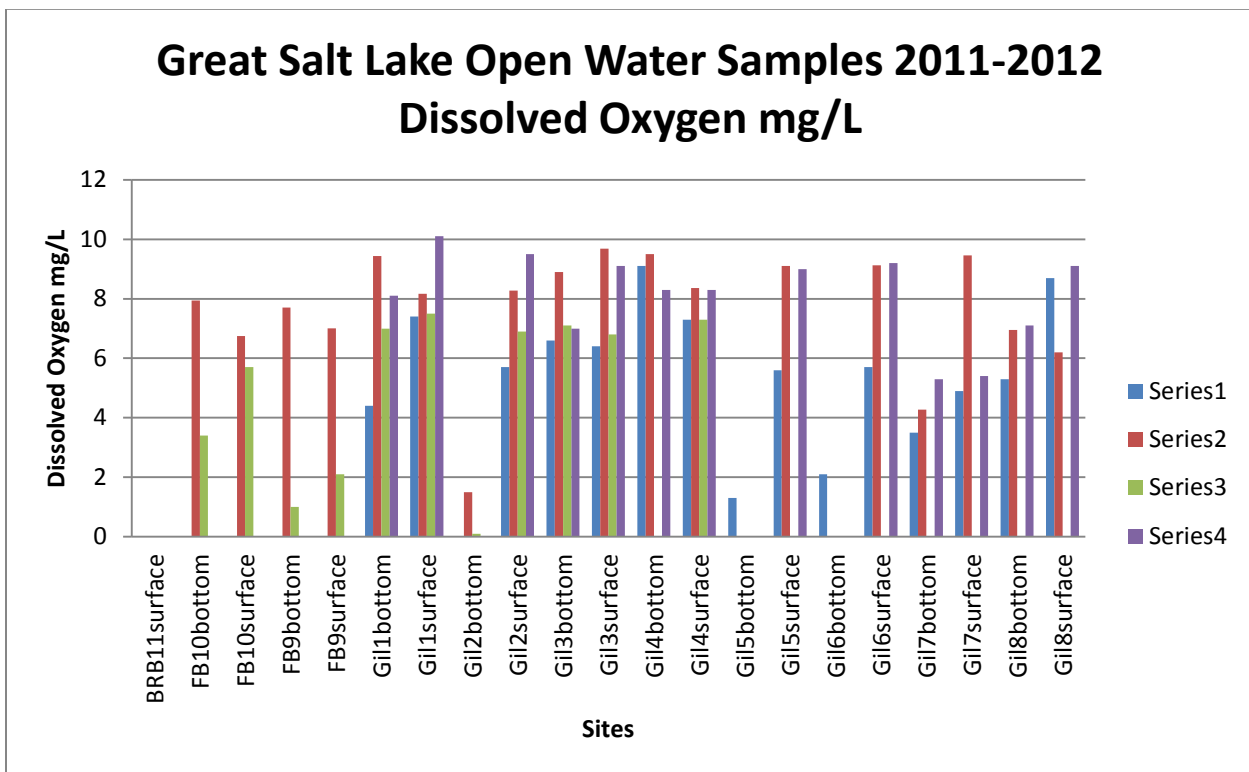


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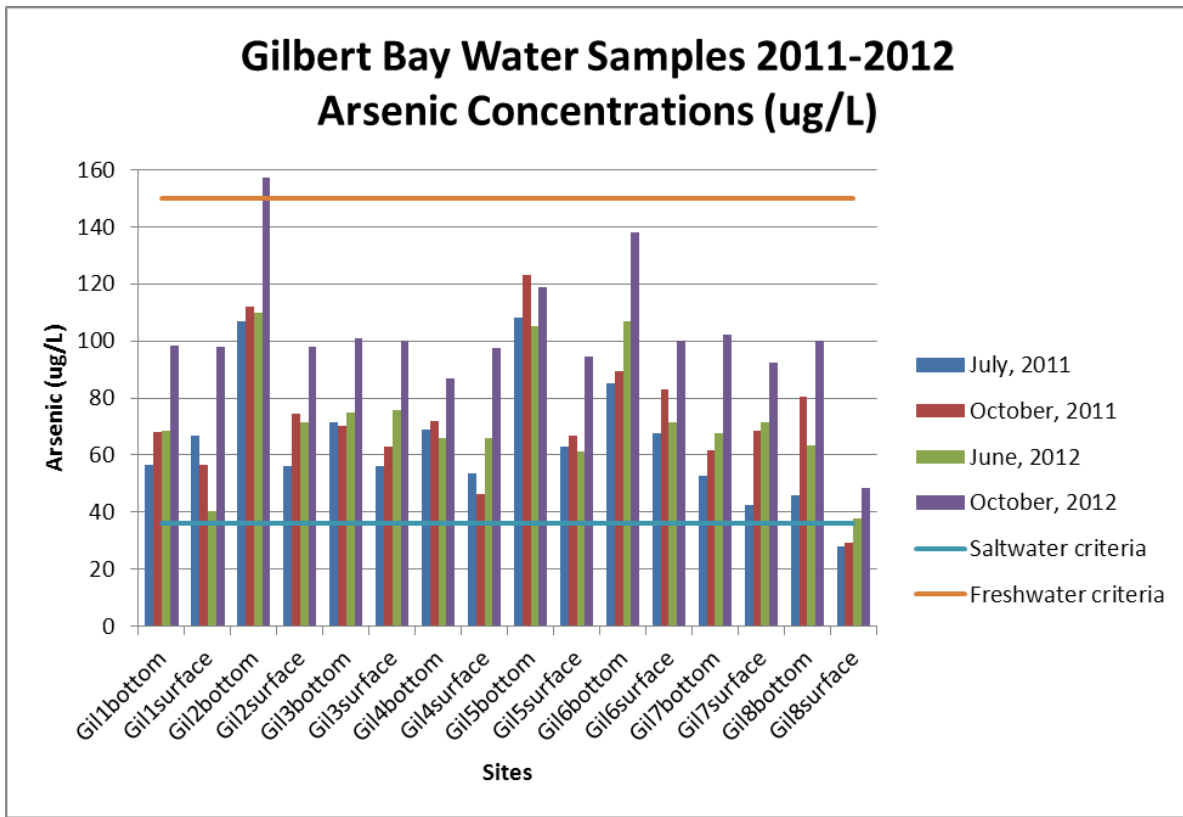


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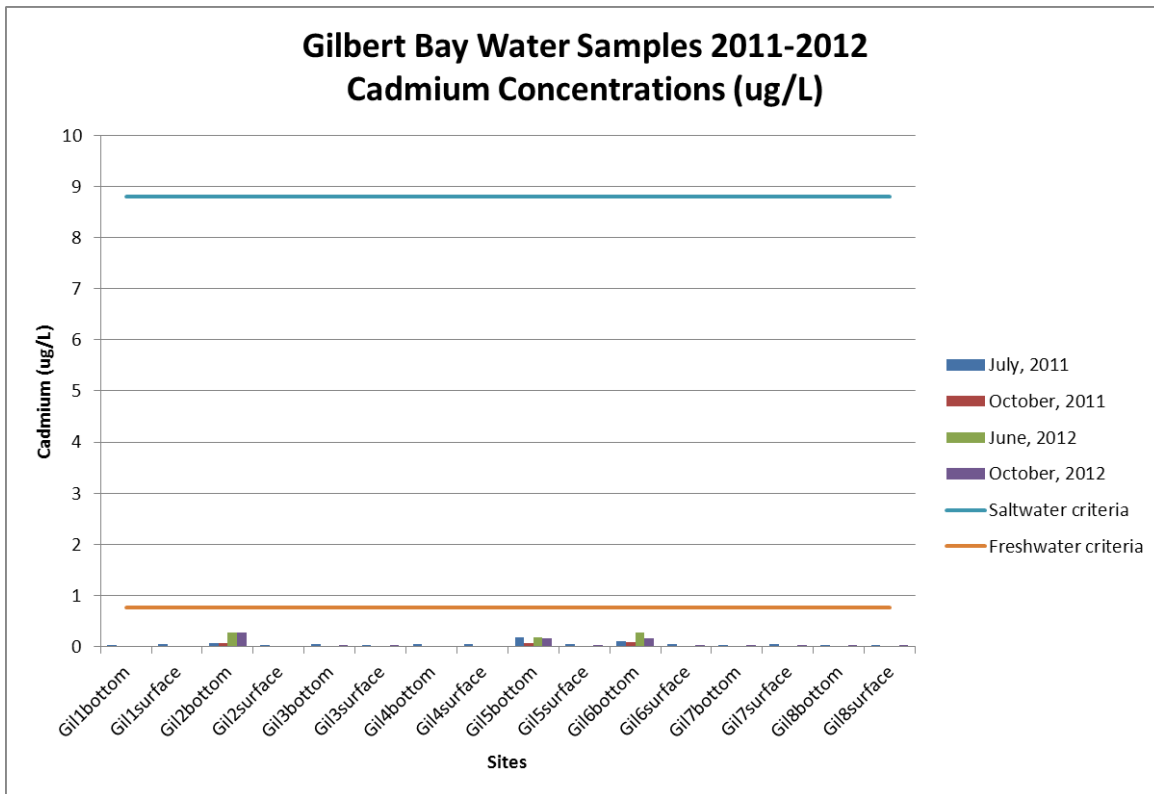


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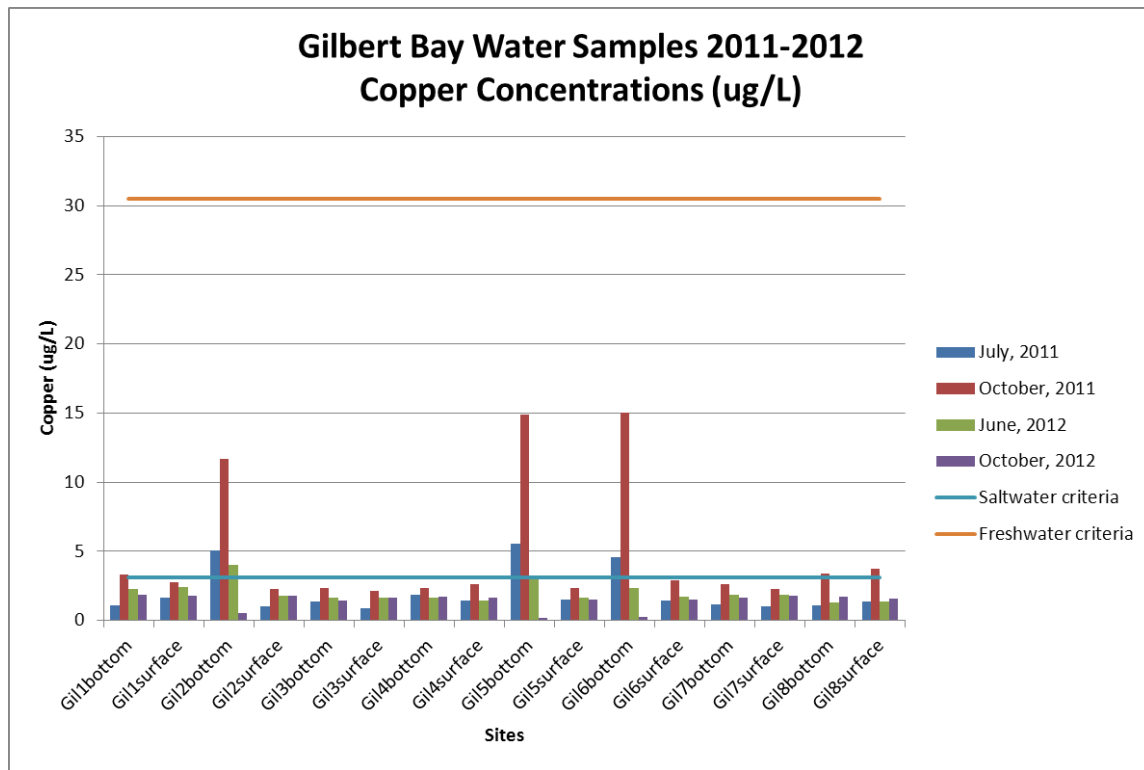


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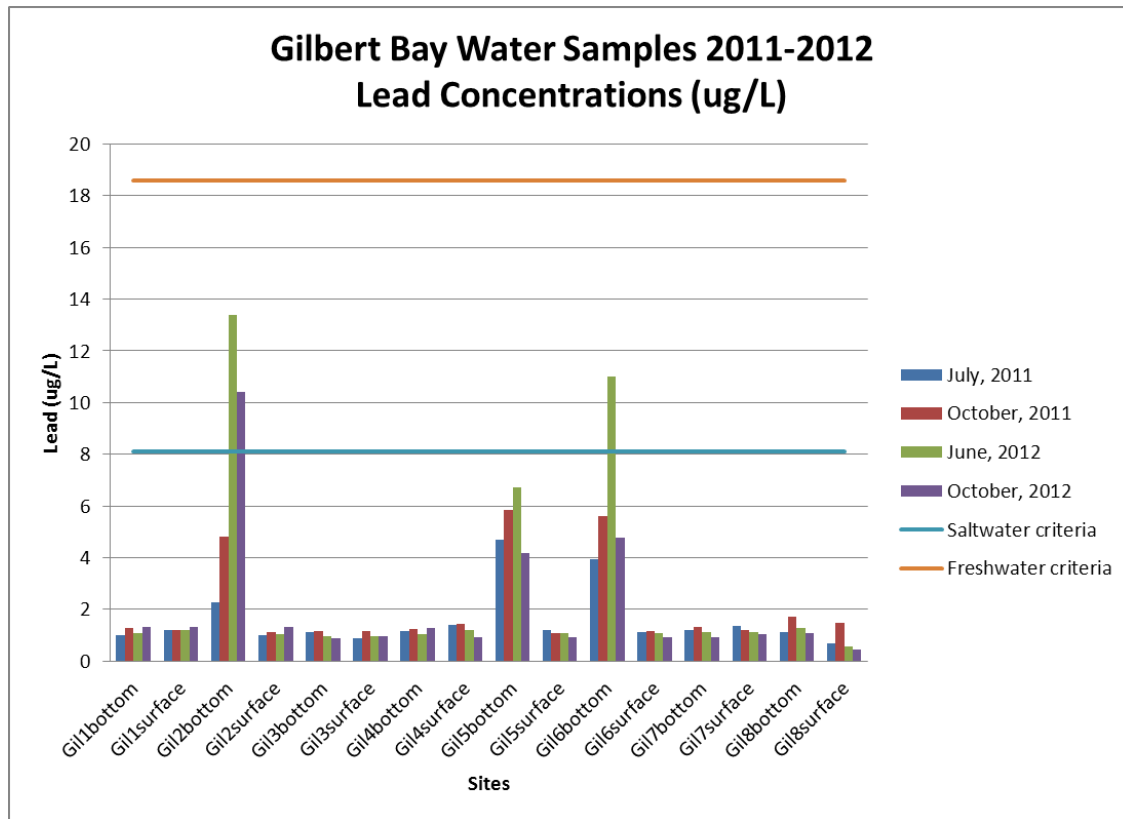


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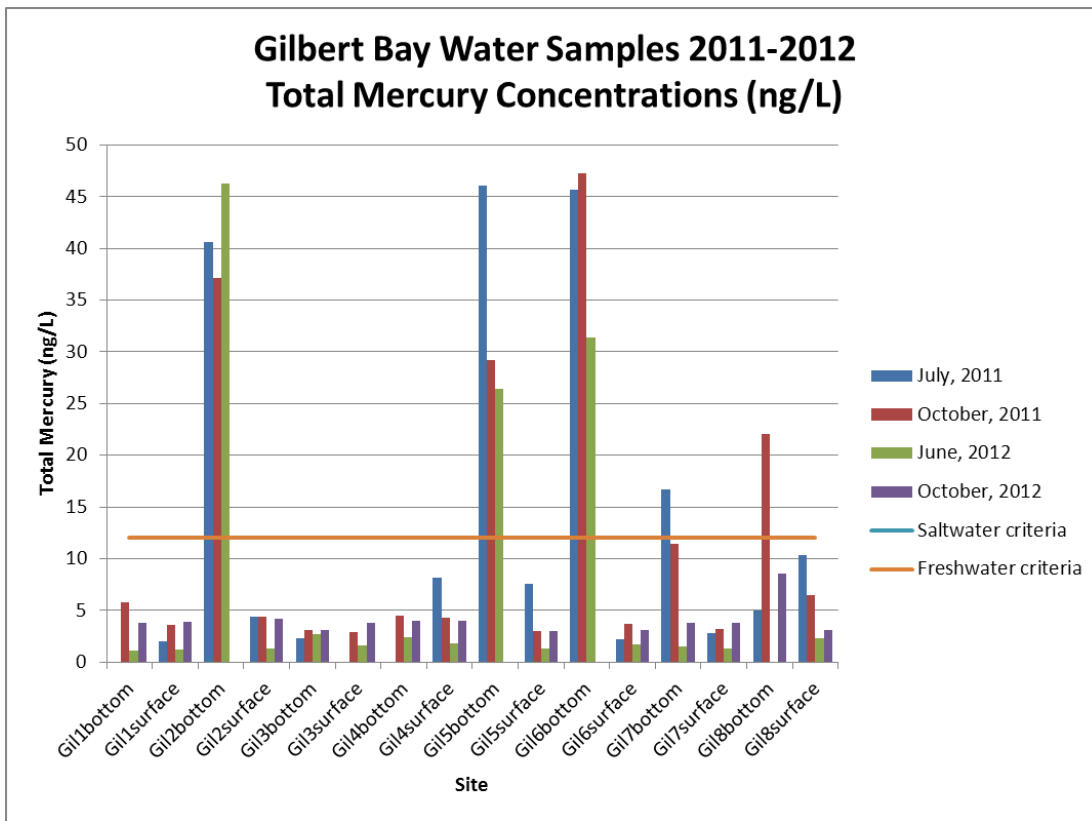


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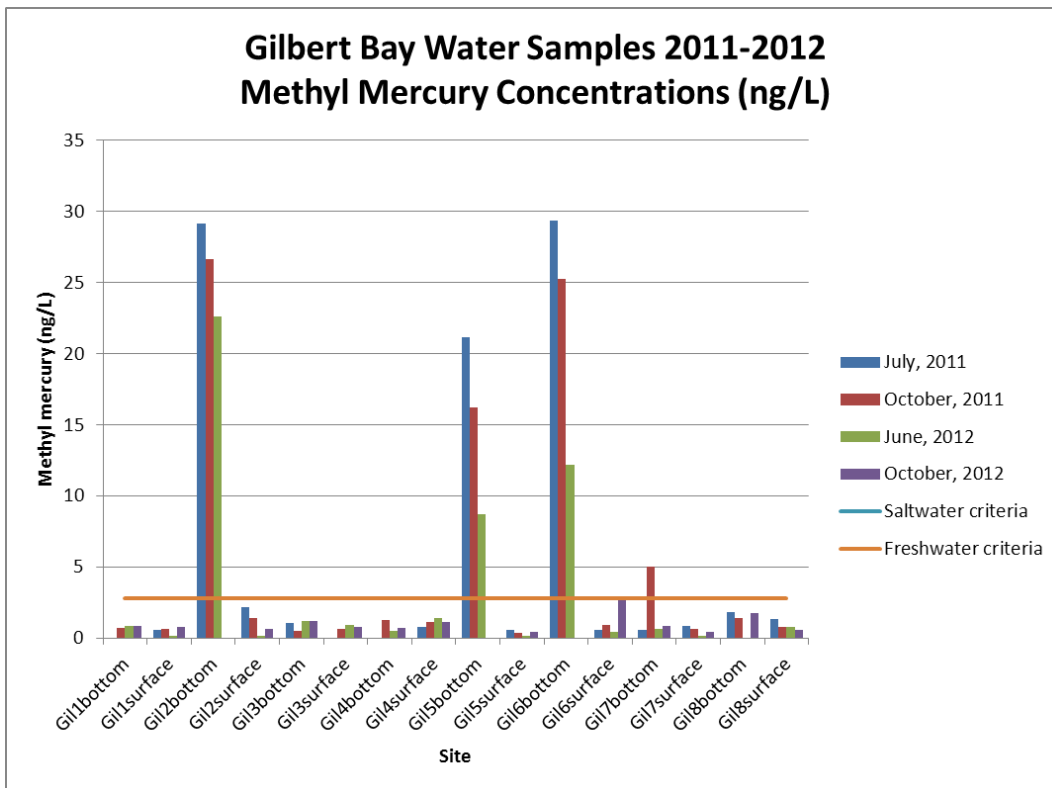


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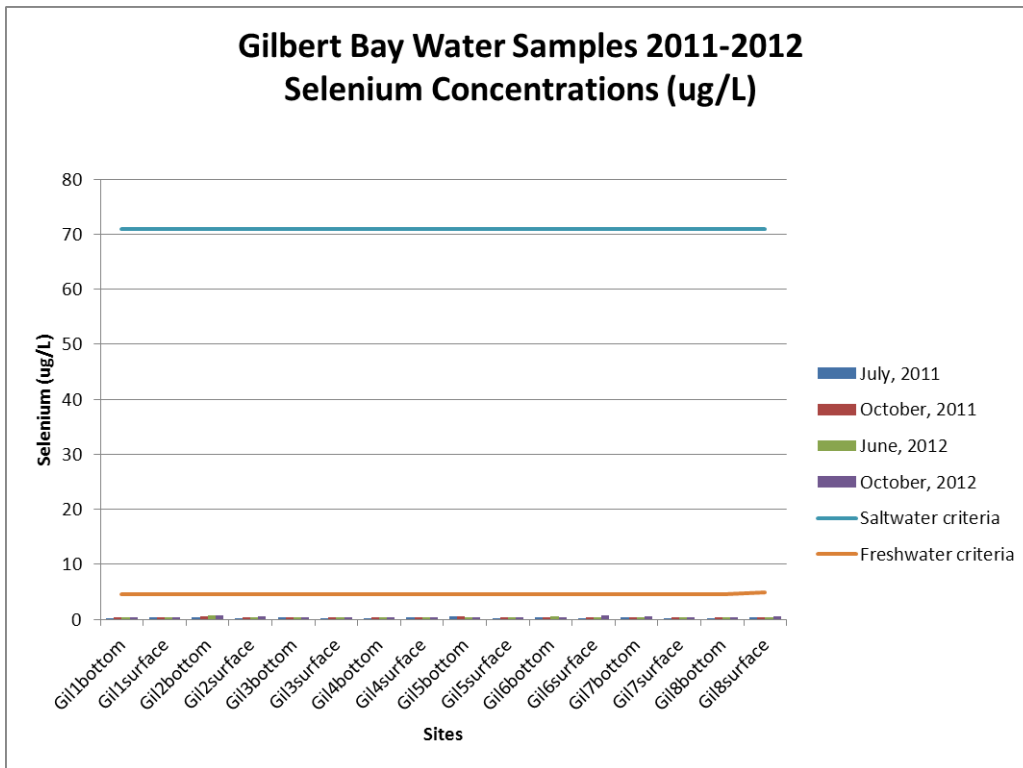


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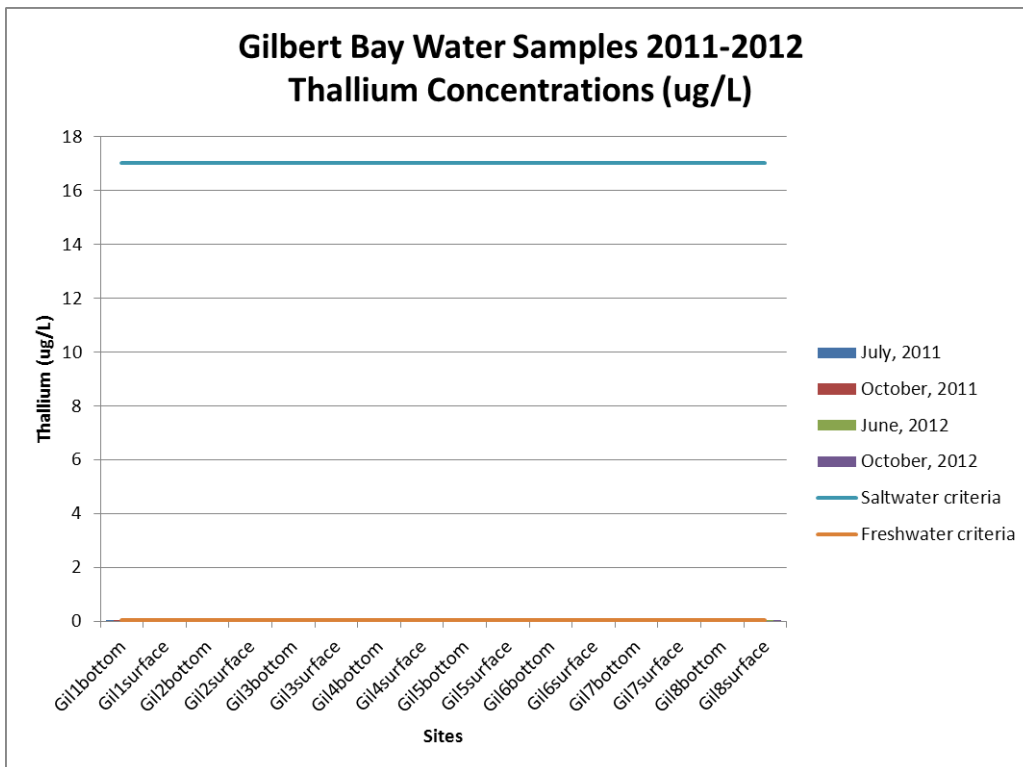


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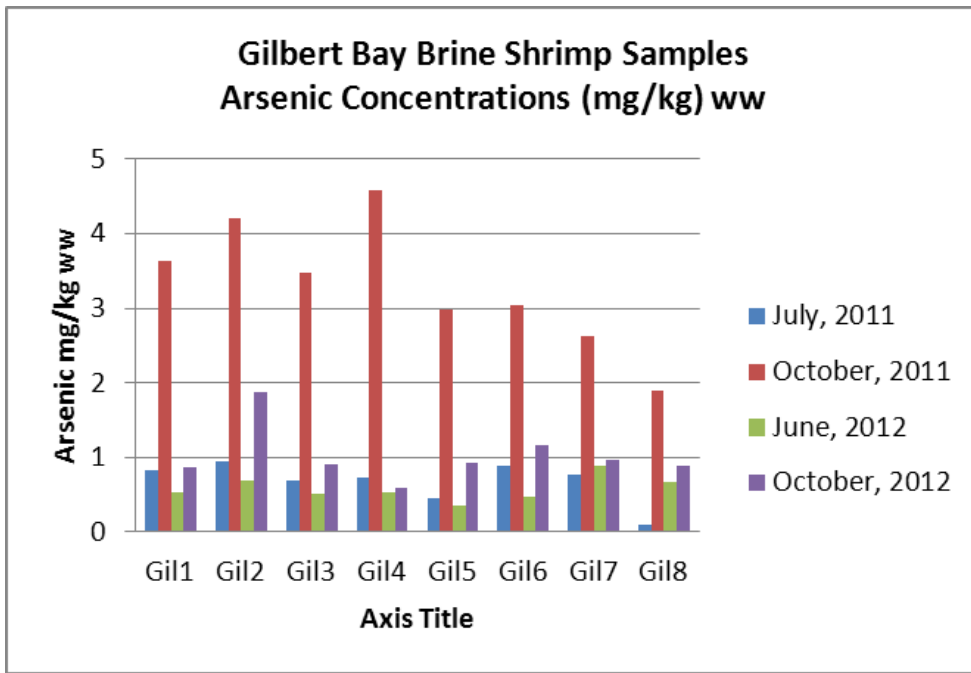


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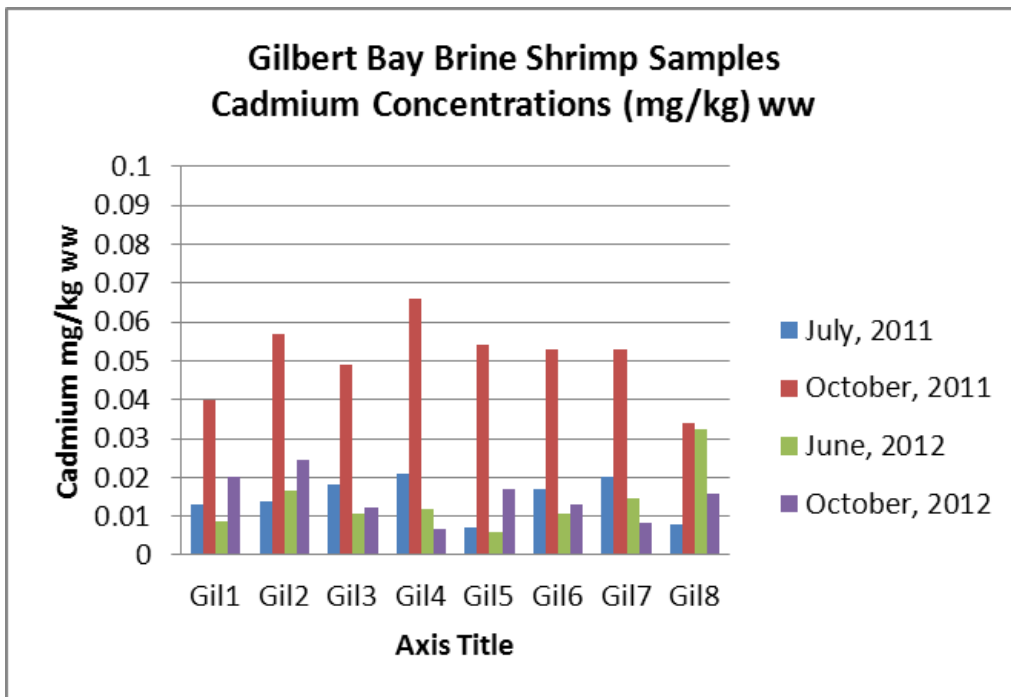


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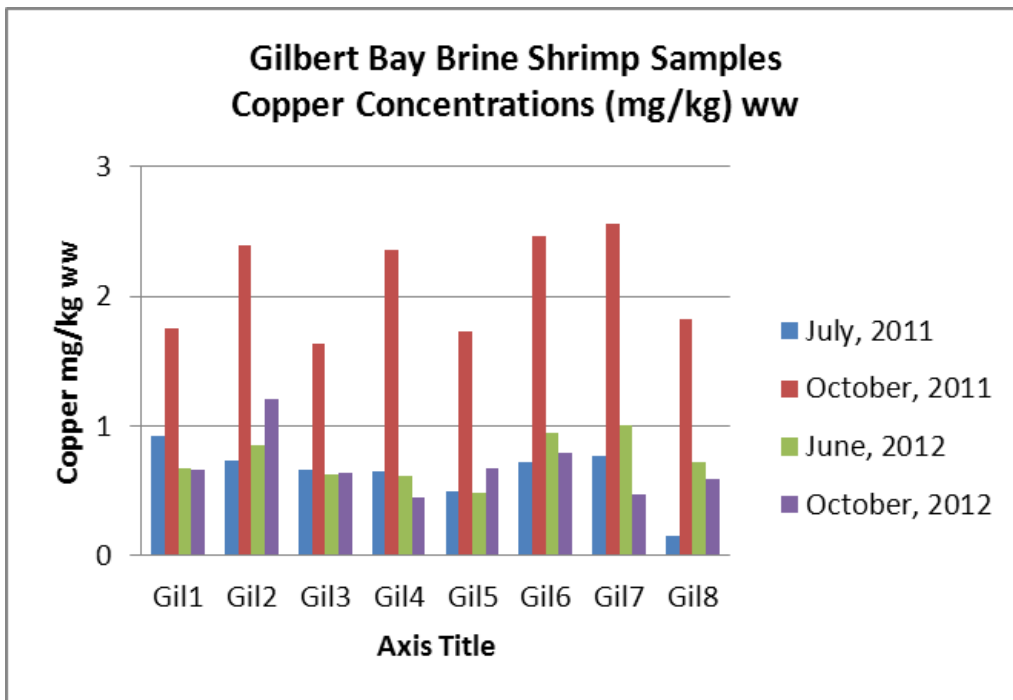


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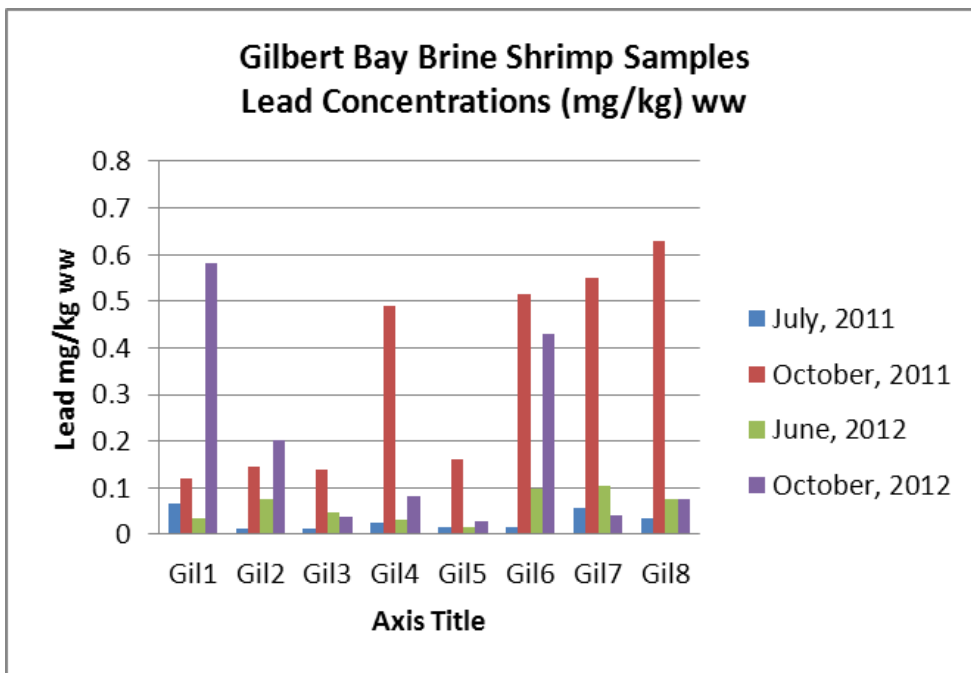


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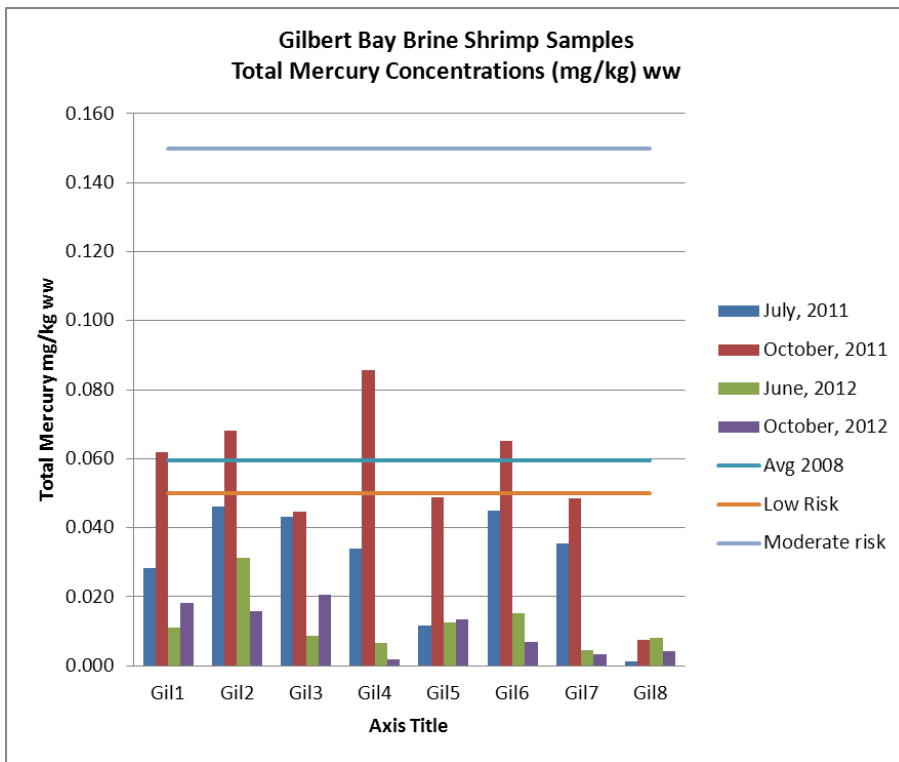


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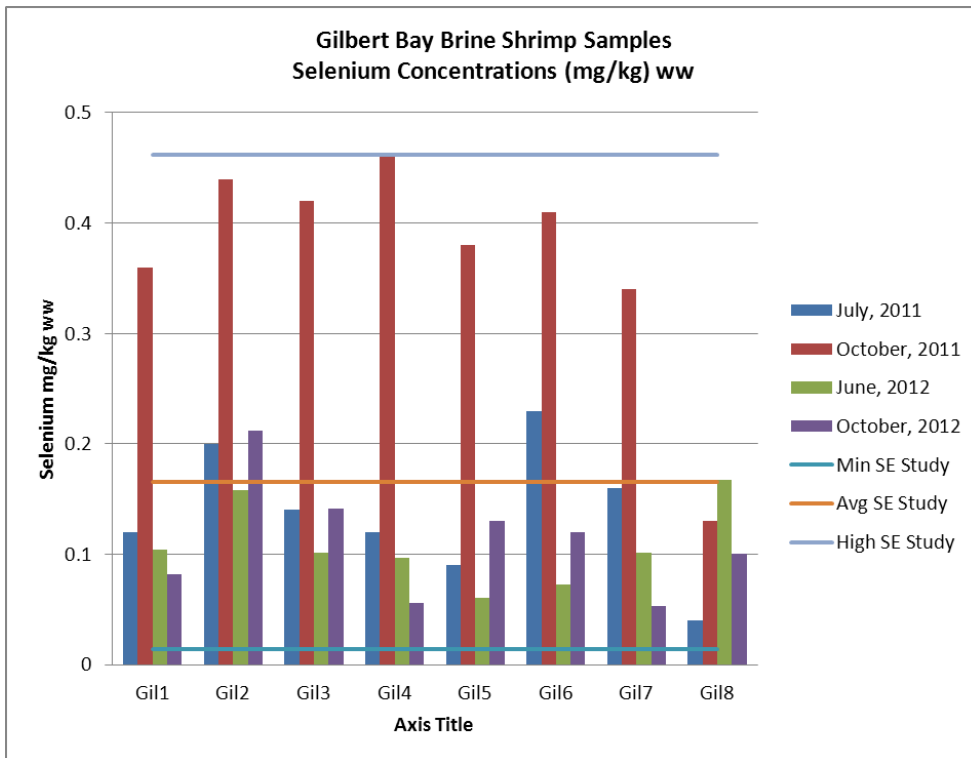


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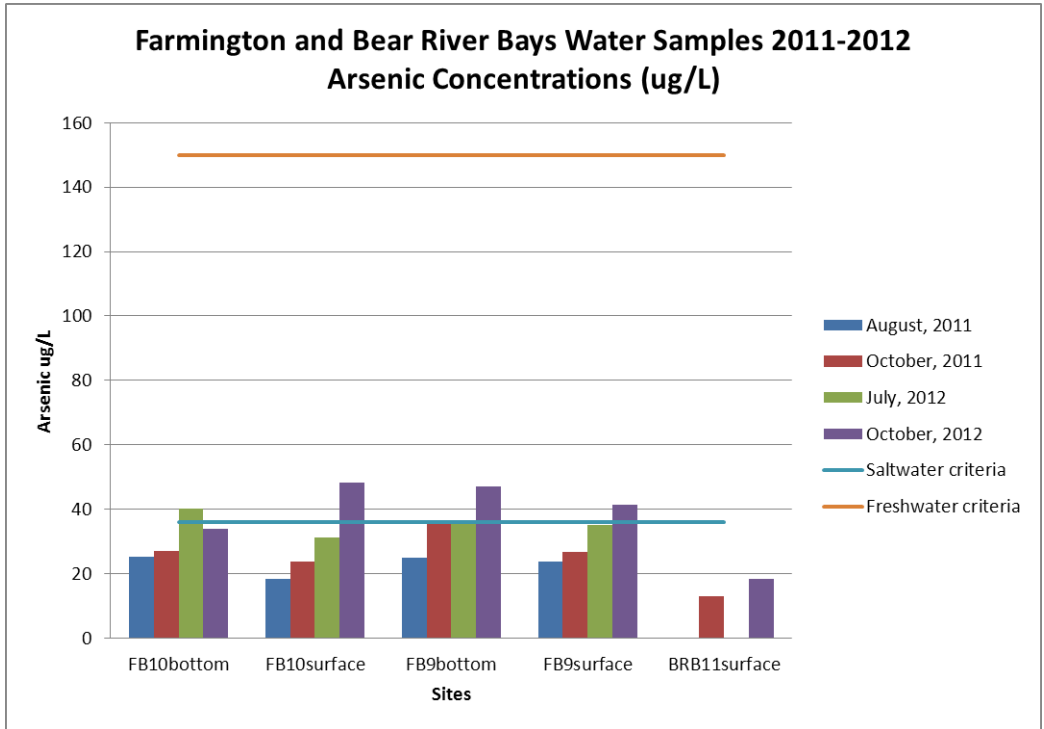


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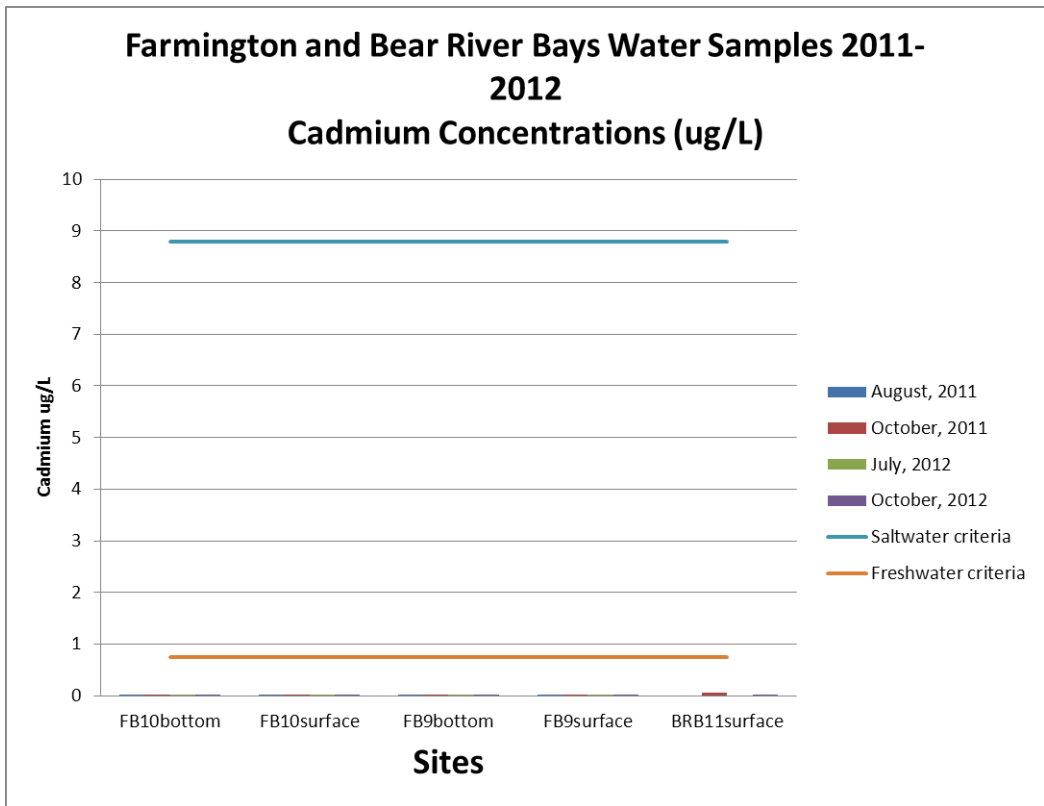


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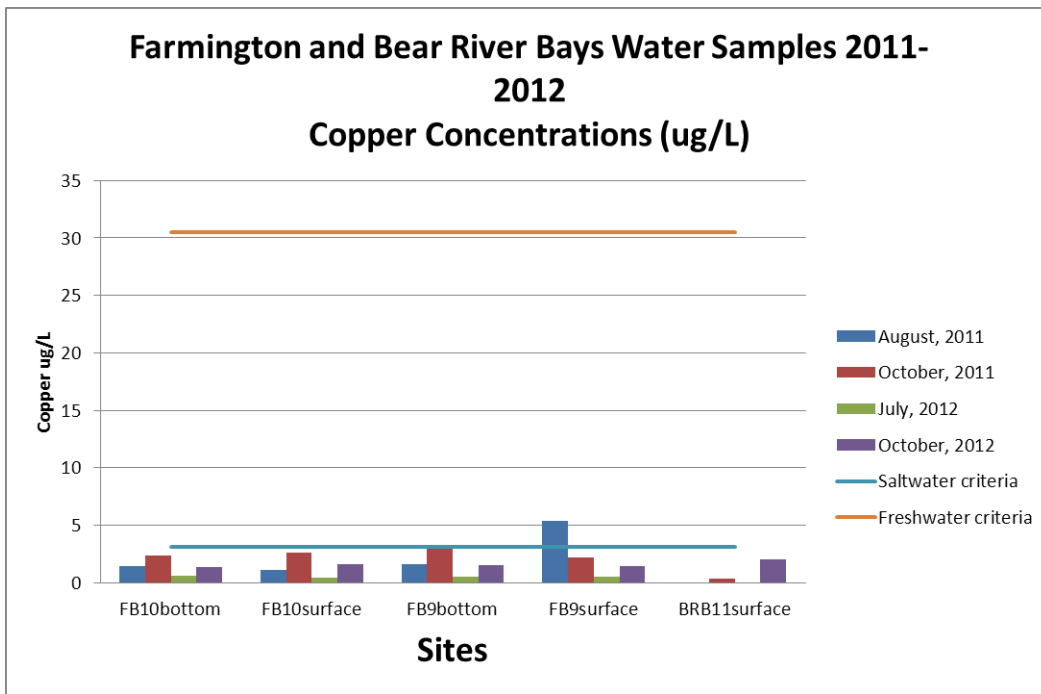


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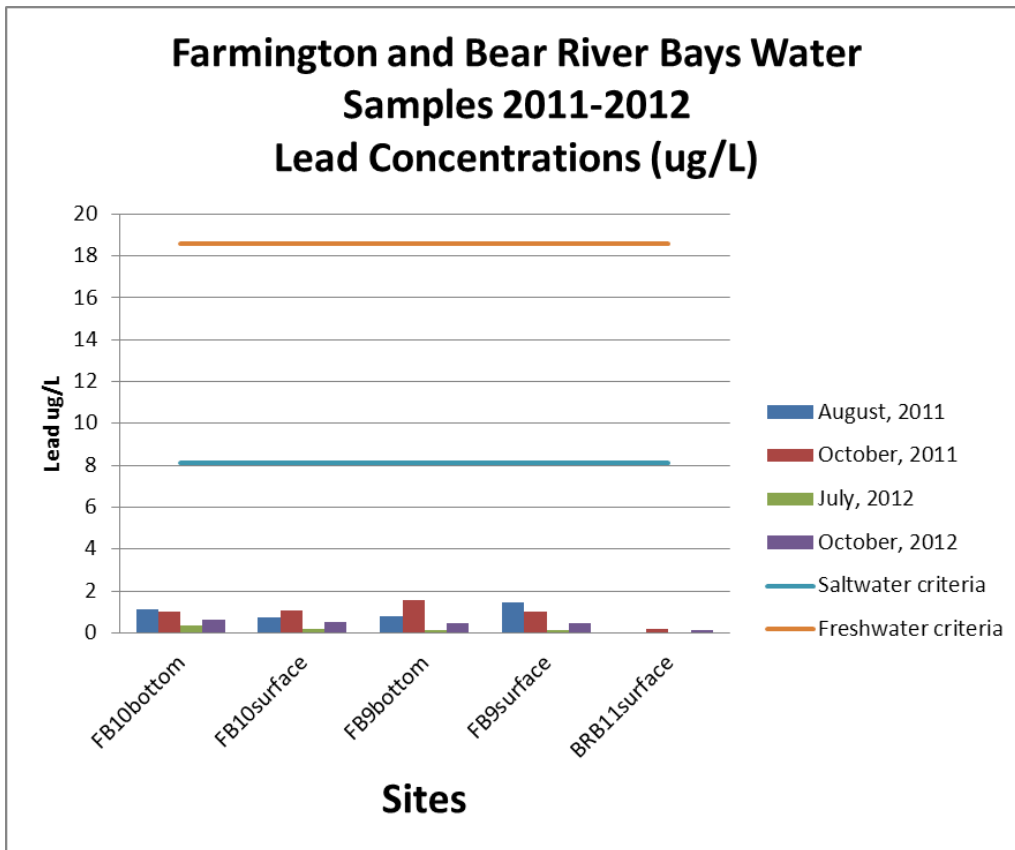


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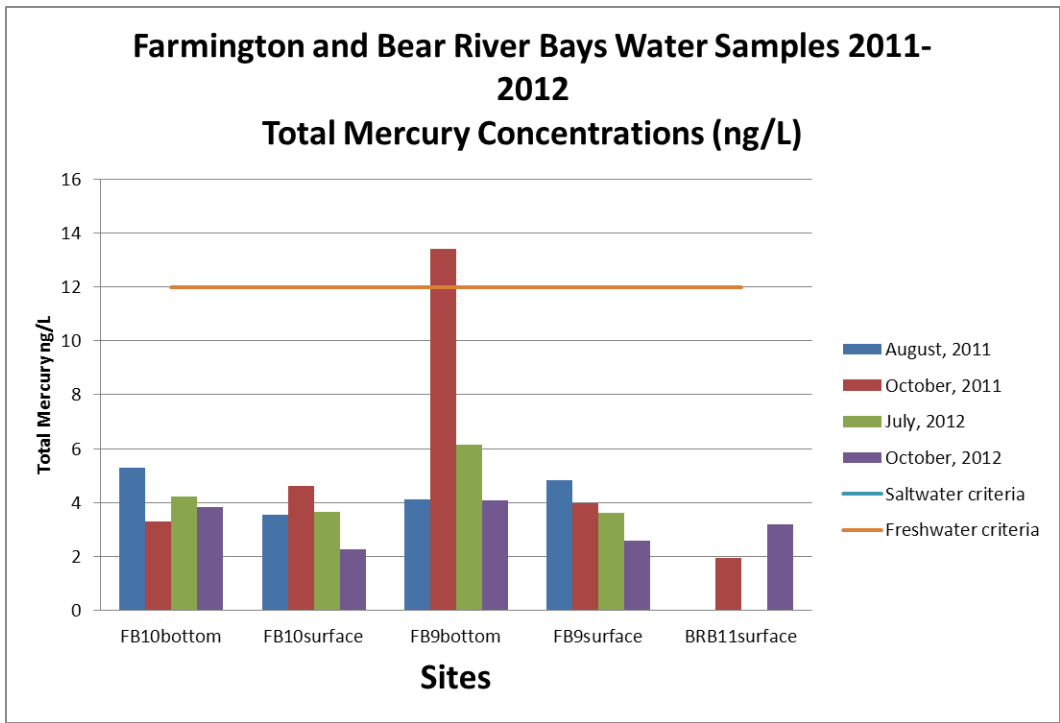


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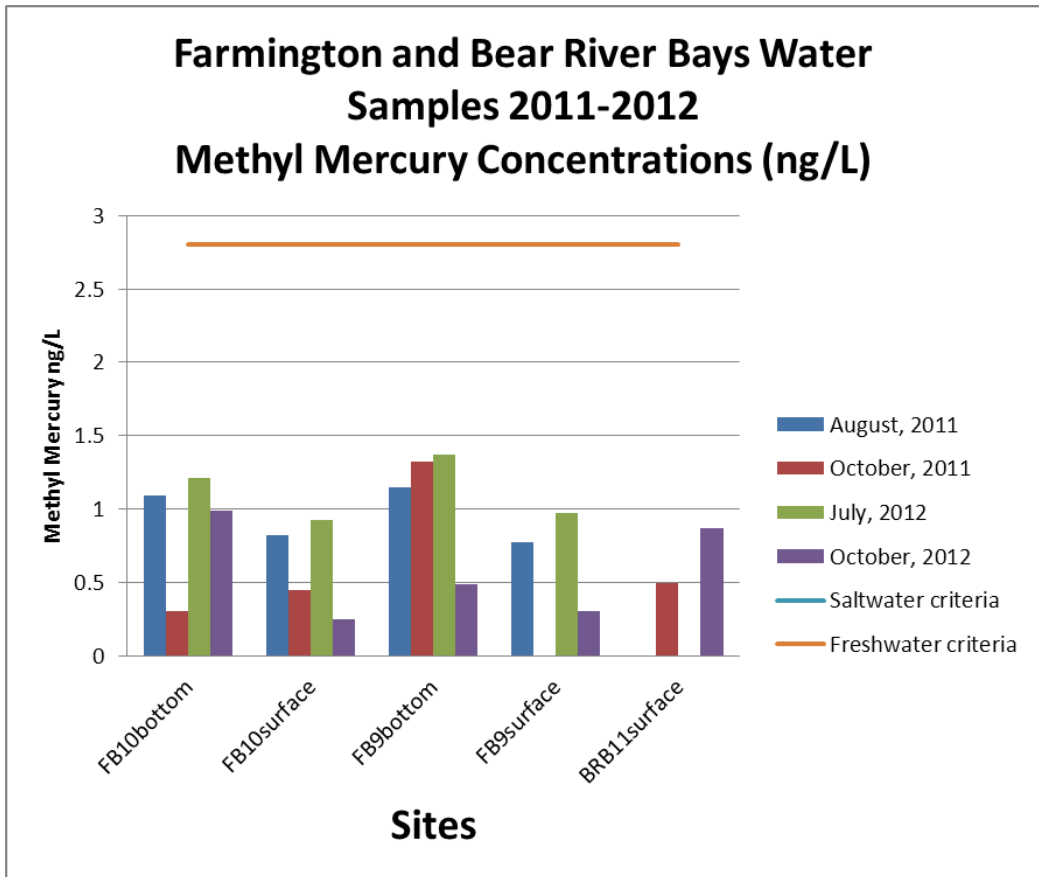


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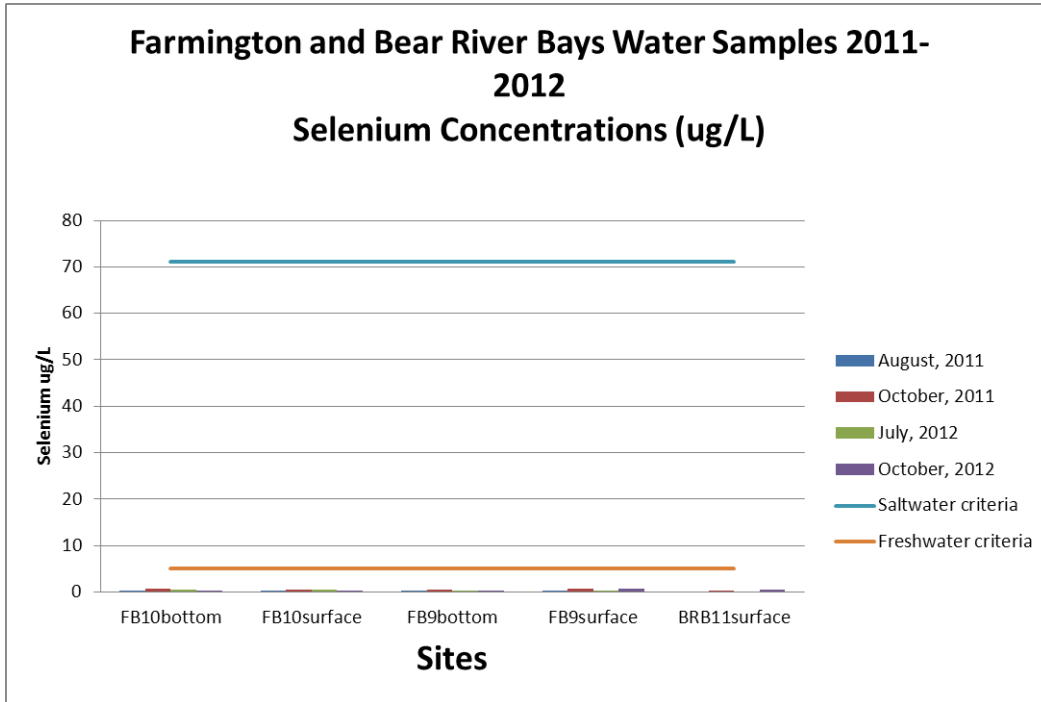


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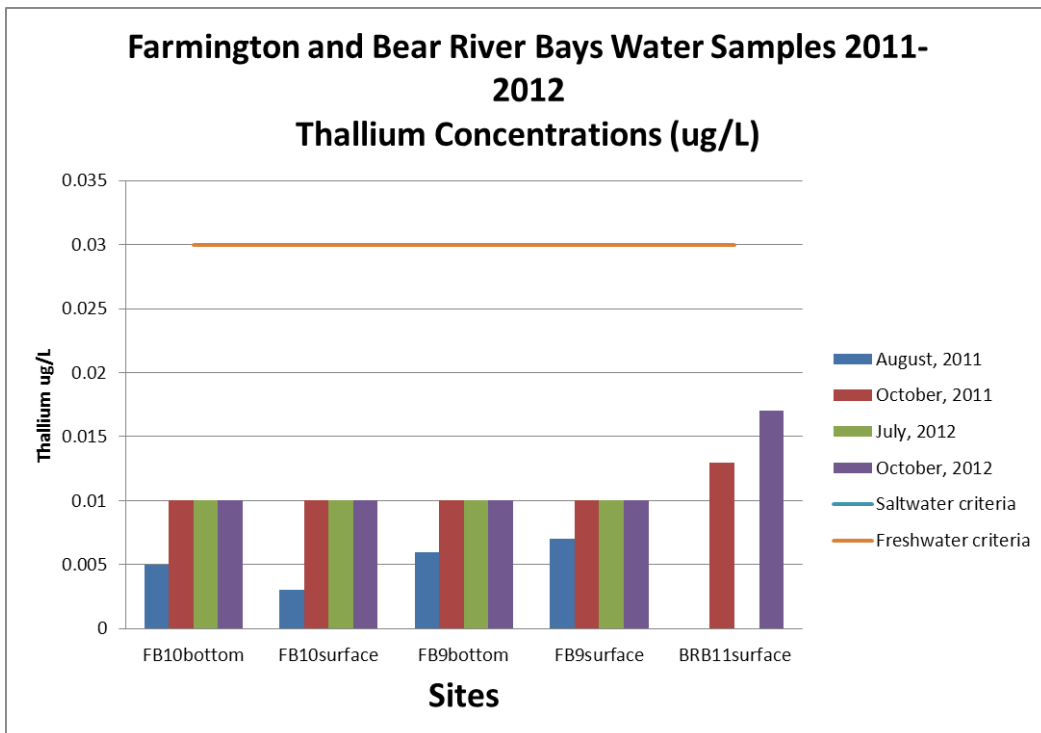


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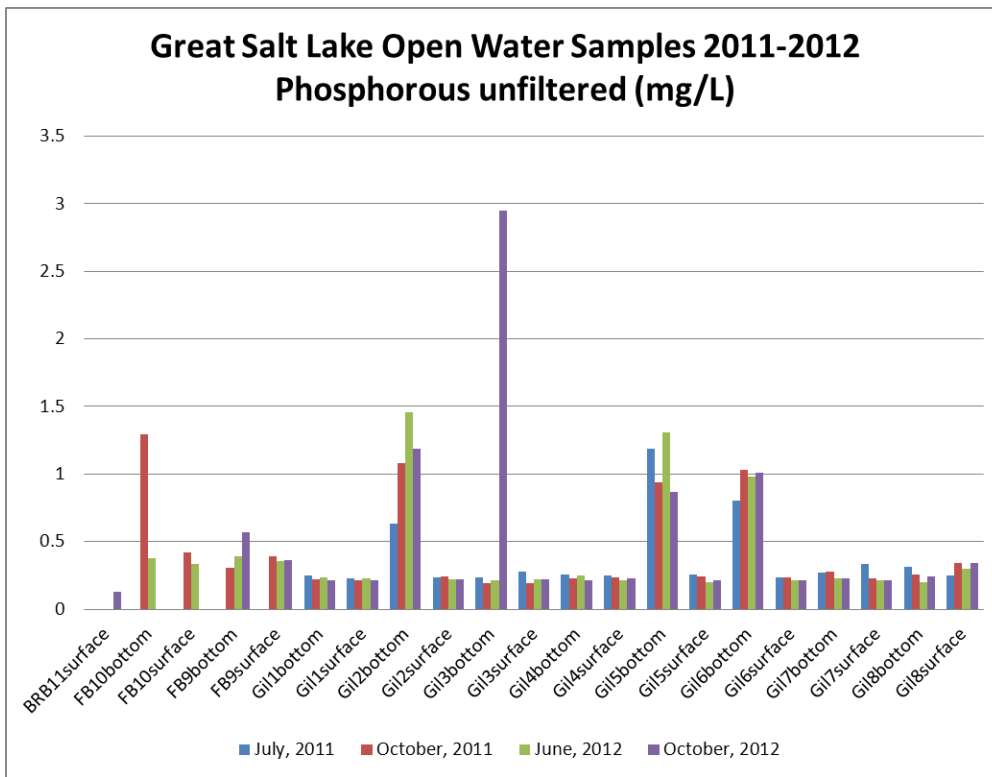


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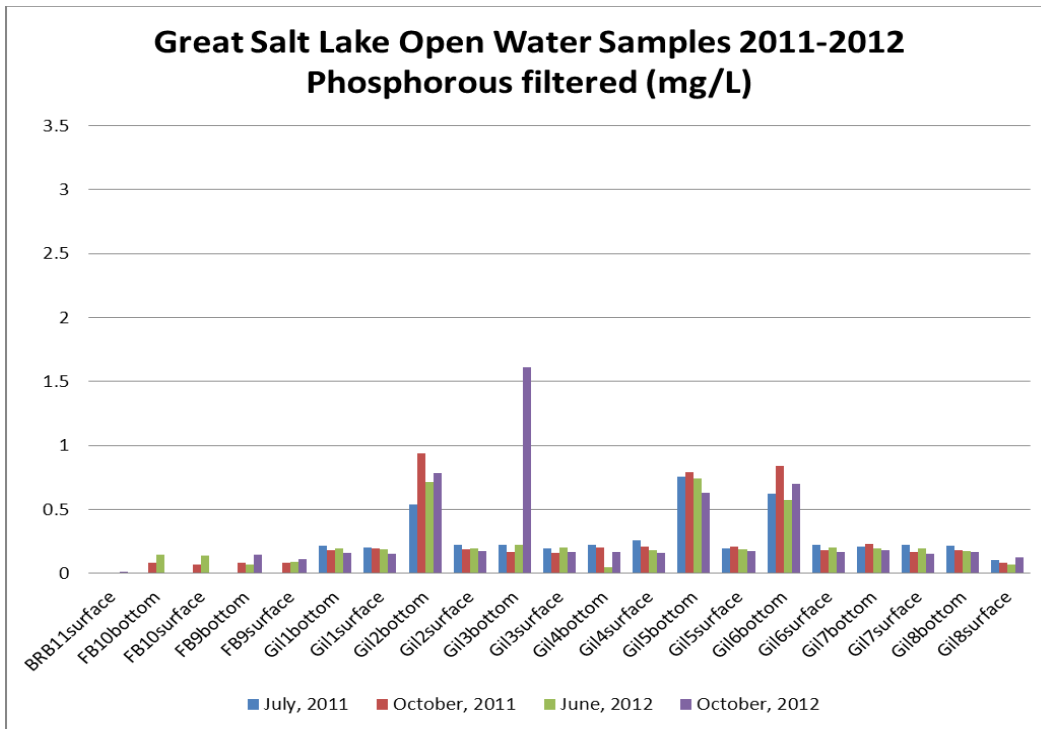


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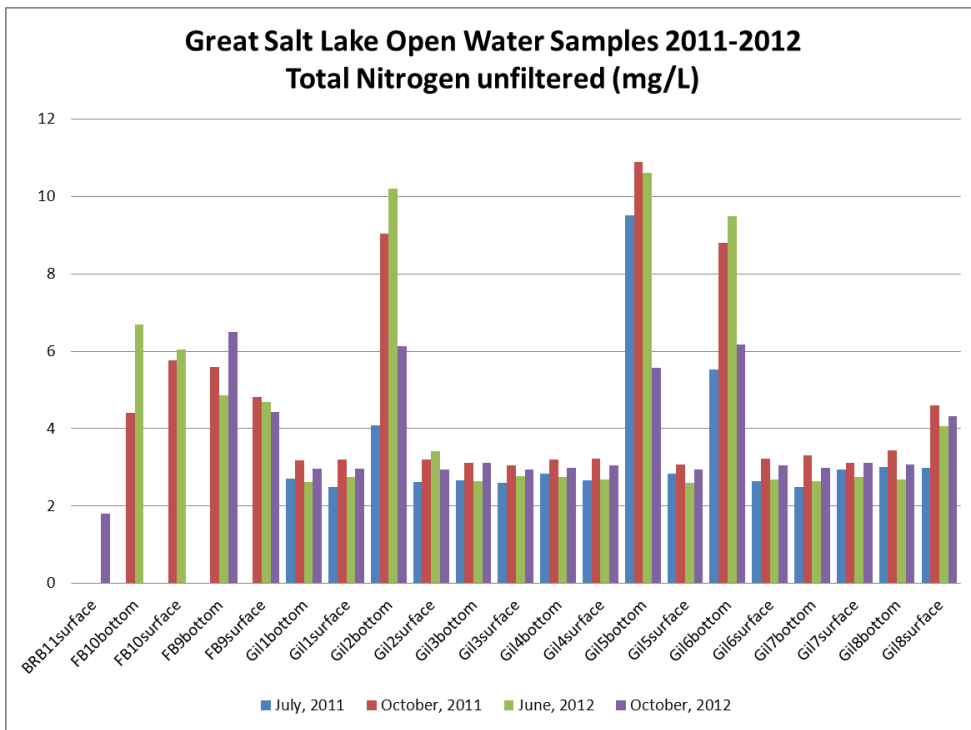


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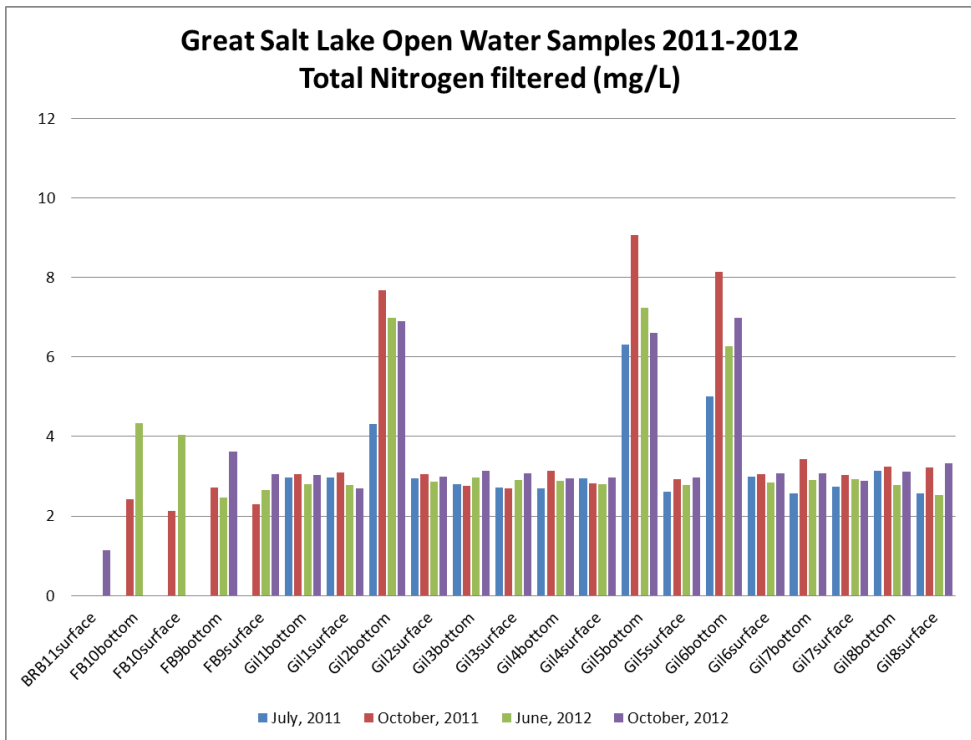


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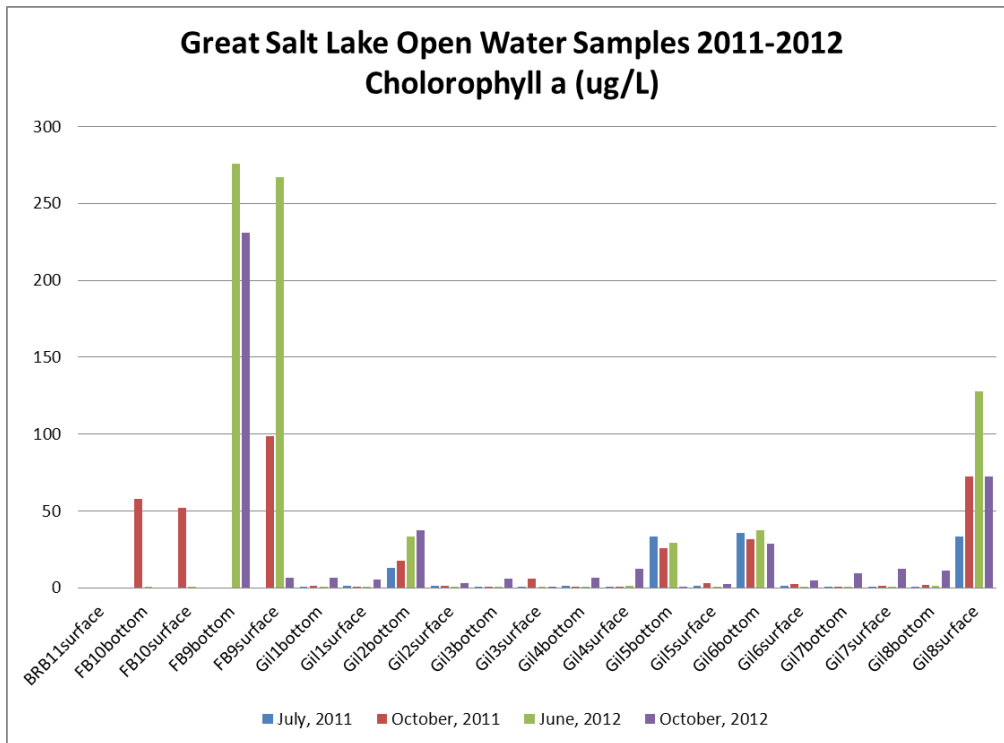


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TABLES

TABLE 1 METALS AND NUTRIENTS MEASURED IN WATER, BRINE SHRIMP AND AQUATIC DEPENDENT BIRD EGGS, RATIONALE FOR SELECTION AND COMPARISON CRITERIA

| Matrix | Analytes | Rationale for selection | Comparison Criteria |
|--------------|--|--|--|
| Water | Metals - total selenium, total and methyl-mercury, total arsenic, total copper, cadmium, lead, thallium Nutrients - total phosphorus, total nitrogen, ammonia, and chlorophyll-a Field Measurements – temperature, pH, dissolved oxygen, specific conductivity and depth | Direct measurement of media covered by the Clean Water Act for recreational and aquatic wildlife beneficial use support | Metals - EPA recommended numeric water quality chronic criteria for the protection of salt water aquatic wildlife and Utah fresh water numeric water quality standards |
| Brine Shrimp | Total selenium, total and methyl-mercury, total arsenic, total copper, cadmium, lead, and thallium, | Indicator of attainment of aquatic wildlife beneficial use as the food chain of avian species | Ever's Dietary Risk Ranges for total mercury. Dietary risk ranges for the rest of the metals will be compiled in the future |
| Bird Eggs | Total selenium and total mercury | Indicator of attainment of aquatic wildlife beneficial use that includes shorebirds and reflects the potential for biomagnification and/or bioaccumulation due to time spent foraging at GSL | Gilbert Bay selenium numeric water quality standard Ever's Egg tissue Risk Ranges for total mercury. |

TABLE 2 2011-2012 MEASUREMENTS OF WATER, BRINE SHRIMP AND SHOREBIRD EGGS

| Date | Bay | Matrix | Metals | Nutrients | Field Measurements |
|--------------|--|----------------|---------------------|-------------------------------|-------------------------------|
| June/2010 | Gilbert Bay (Saltair) | Shorebird eggs | X (THg and Se only) | NA | NA |
| June/2011 | Gilbert (Bridger Bay, Antelope Island) | Shorebird eggs | X (THg and Se only) | NA | NA |
| | Farmington Bay (Farmington Bay Waterfowl Management Area) | Shorebird eggs | X (THg and Se only) | NA | NA |
| July/2011 | Gilbert | Water | X | X | X |
| | Gilbert | Brine shrimp | X | NA | NA |
| | Farmington | Water | X | Not sampled ² | Not sampled ² |
| | Bear River ¹ | Water | Not sampled | Not sampled | Not sampled |
| October/2011 | Gilbert | Brine shrimp | X | X | X |
| | Farmington | Water | X | X | X |
| | Bear River | Water | X | Not sampled | |
| June/2012 | Gilbert Bay (Antelope Island Causeway and Ogden Bay Waterfowl Management Area) | Shorebird eggs | X (THg and Se only) | NA | NA |
| June/2012 | Gilbert | Water | X | X | X |
| | Gilbert | Brine shrimp | X | NA | NA |
| | Farmington | Water | X | X | X |
| | Bear River ³ | Water | Not sampled | Not sampled | Not sampled |
| October/2012 | Gilbert | Water | X | X | X |
| | Gilbert | Brine shrimp | X | | |
| | Farmington | Water | X | FB10 Not sampled ⁴ | FB09 Not sampled ⁵ |
| | Bear River | Water | X | | |

Appendix 1 Figures and Tables

Notes:

NA – Not applicable

1. Not sampled due to high velocities under the GSL Minerals bridge. Moved location further north.
2. Salinity and dissolved oxygen not sampled due to probe calibration issues. Only pH and temperature recorded.
3. Dry, no water
4. Nutrients not sampled at site FB10
5. Probe malfunction at site FB9

TABLE 3 GREAT SALT LAKE BASELINE SAMPLING SITES INCLUDING TARGET BAY, UDWQ SITE NAME, CORRESPONDING USGS SITE NAME AND TARGETED MEDIA

| UDWQ Sample Points | Target Bay and UDWQ Site Name | Coordinates | USGS NWIS Site Name and Description | Matrix/ Depth of Sample |
|---------------------------|--------------------------------------|---|---|---|
| 1 | Gilbert Bay Gil1 | Latitude 40°46'07", Longitude 112°19'38" | USGS 404607112193801 GSL 4069, 8 Miles West Of Saltair Marina | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 2 | Gilbert Bay Gil2 | Latitude 40°53'56", Longitude 112°20'56" | USGS 405356112205601 GSL 3510, 6 Miles West Of Antelope Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 3 | Gilbert Bay Gil3 | Latitude 41°02'23", Longitude 112°30'19" | USGS 410323112301901 GSL 2820, 2 Miles East Of Carrington Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 4 | Gilbert Bay Gil4 | Latitude 41°04'22", Longitude 112°20'00" | USGS 410422112200001 GSL 2767, 4 Miles West Of North Tip Of Antelope Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 5 | Gilbert Bay Gil5 | Latitude 41°06'44", Longitude 112°38'26" | USGS 410644112382601 GSL 2565, Northwest Of Hat Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 6 | Gilbert Bay Gil6 | Latitude 41°06'37", Longitude 112°27'04" | USGS 410637112270401 N1018 6 Miles Southwest Of Fremont Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 7 | Gilbert Bay Gil7 | Latitude 41°11'16", Longitude 112°24'44" | USGS 411116112244401 GSL 2267, 1 Mile Northwest Of Fremont Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 8 | Gilbert Bay/ Farmington Bay Gil8 | Latitude 41°04'52", Longitude 112°13'51" | USGS 410401112134801 GSL Farmington Bay Outflow At Causeway Bridge | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom Brine Shrimp |
| 9 | Farmington Bay FB9 | Latitude 41°02'24.36", Longitude 112°09'51.12" | USGS 410224112095101 Farmington Bay, 1.4 Miles East, 3.5 Miles South of Farmington Bay marina | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom |
| 10 | Farmington Bay FB10 | Latitude 41°01'53", Longitude | USGS 410153112082301 GSL 2963, Farmington Bay 4 Miles Southeast Of Antelope Island | Water Sample - 0.2m from surface Water Sample – 0.5m from bottom |

| | | | | |
|----|----------------------|---|--|----------------------------------|
| | | 112°08'23" | Marina | |
| 11 | Bear River Bay BRB11 | Latitude 41 17.340, Longitude 112 22.006 | USGS 10010060 North of Great Salt Lake Minerals Bridge | Water Sample - 0.2m from surface |

TABLE 4 PERCENT SALINITY OF OPEN WATER SITES PER SITE PER DATE

| Great Salt Lake Open Water Sites | Percent Salinity | | | |
|---|------------------|---------------|-------------|---------------|
| | July, 2011 | October, 2011 | June, 2012 | October, 2012 |
| BRB11surface | NA | NA | NA | NA |
| FB10bottom | NA | 1.7 | 6.6 | NA |
| FB10surface | NA | 1.6 | 6.6 | NA |
| FB9bottom | NA | 2.4 | 5.2 | 5.6 |
| FB9surface | NA | 1.7 | 5.1 | 4.5 |
| Gil1bottom | 11.3 | 11.7 | 11.3 | 13.3 |
| Gil1surface | 11.2 | 11.6 | 11.2 | 13.3 |
| Gil2bottom | 12.9 | 17.4 | 17.5 | 19.1 |
| Gil2surface | 11.3 | 11.6 | 11.3 | 13.3 |
| Gil3bottom | 11.3 | 11.5 | 11.4 | 13.3 |
| Gil3surface | 11.0 | 11.4 | 11.3 | 13.3 |
| Gil4bottom | 11.2 | 11.7 | 11.3 | 13.3 |
| Gil4surface | 10.8 | 11.2 | 11.1 | 12.8 |
| Gil5bottom | 18.6 | 20.4 | 21.0 | 22.5 |
| Gil5surface | 11.0 | 11.2 | 11.5 | 13.4 |
| Gil6bottom | 13.2 | 16.8 | 18.7 | 19.7 |
| Gil6surface | 11.2 | 11.6 | 11.3 | 13.3 |
| Gil7bottom | 11.1 | 11.4 | 11.4 | 13.2 |
| Gil7surface | 10.2 | 11.6 | 11.4 | 12.6 |
| Gil8bottom | 11.2 | 11.3 | 11.2 | 13.1 |
| Gil8surface | 5.1 | 3.3 | 5.0 | 5.5 |
| Average Farmington Bay Salinity | NA | 1.9 | 5.9 | 5.1 |
| Average Gilbert Bay Salinity | 11.4 | 12.2 | 12.4 | 14.1 |
| Average Gilbert Bay Surface Salinity | 10.2 | 10.4 | 10.5 | 12.2 |
| Average Gilbert Bay Bottom Salinity | 12.6 | 14.0 | 14.2 | 15.9 |
| Note: NA – Not available or applicable | | | | |

TABLE 5 TEMPERATURE IN DEGREES CELSIUS OF OPEN WATER SITES PER SITE PER DATE

| Great Salt Lake Open Water Sites | Temperature (Degrees Celsius) | | | |
|----------------------------------|-------------------------------|---------------|------------|---------------|
| | July, 2011 | October, 2011 | June, 2012 | October, 2012 |
| BRB11surface | NA | NA | NA | 11.98 |
| FB10bottom | NA | 8.44 | 26.40 | NA |
| FB10surface | NA | 10.02 | 27.60 | NA |
| FB9bottom | NA | 7.28 | 21.20 | 12.40 |
| FB9surface | NA | 8.23 | 22.80 | 11.70 |
| Gil1bottom | 24.70 | 12.00 | 19.70 | 12.80 |
| Gil1surface | 25.60 | 13.38 | 20.20 | 12.50 |
| Gil2bottom | 17.50 | 16.47 | 15.30 | 19.50 |
| Gil2surface | 26.40 | 12.68 | 20.90 | 12.70 |

Appendix 1 Figures and Tables

| | | | | |
|---|--------------|--------------|--------------|--------------|
| Gil3bottom | 25.30 | 12.64 | 19.10 | 12.80 |
| Gil3surface | 26.80 | 12.72 | 19.30 | 13.90 |
| Gil4bottom | 25.50 | 12.54 | NA | 12.80 |
| Gil4surface | 27.50 | 10.96 | 20.40 | 12.10 |
| Gil5bottom | 20.50 | 17.37 | 17.10 | 18.70 |
| Gil5surface | 25.50 | 11.40 | 19.00 | 12.80 |
| Gil6bottom | 20.70 | 15.07 | 17.70 | 19.00 |
| Gil6surface | 27.60 | 12.52 | 21.30 | 12.60 |
| Gil7bottom | 24.90 | 14.40 | 18.60 | 12.10 |
| Gil7surface | 25.70 | 13.20 | 18.60 | 11.70 |
| Gil8bottom | 26.10 | 10.67 | 19.70 | 12.80 |
| Gil8surface | 25.10 | 6.55 | 25.60 | 12.70 |
| Average Farmington Bay Temp | NA | 8.49 | 24.50 | 12.05 |
| Average Gilbert Bay Temp | 24.71 | 12.79 | 19.50 | 13.84 |
| Average Gilbert Bay Surface Brine Temp | 26.28 | 11.68 | 20.66 | 12.63 |
| Average Gilbert Bay Bottom Temp | 23.15 | 13.90 | 18.17 | 15.06 |
| Note: NA – Not available or applicable | | | | |

TABLE 6 PH OF OPEN WATER SITES PER SITE PER DATE

| Great Salt Lake Open Water Sites | pH | | | |
|----------------------------------|------------|---------------|------------|---------------|
| | July, 2011 | October, 2011 | June, 2012 | October, 2012 |
| BRB11surface | NA | NA | NA | 8.6 |
| FB10bottom | NA | 9.4 | 8.5 | NA |
| FB10surface | NA | 9.4 | 8.5 | NA |
| FB9bottom | NA | 9.2 | 9.2 | 9.0 |
| FB9surface | NA | 9.2 | 9.3 | 8.9 |
| Gil1bottom | 8.1 | 8.5 | 8.3 | 8.3 |
| Gil1surface | 8.0 | 8.4 | 8.3 | 8.2 |
| Gil2bottom | 8.0 | 7.8 | 7.8 | 7.4 |
| Gil2surface | 8.0 | 8.4 | 8.2 | 8.2 |
| Gil3bottom | 8.2 | 8.5 | 8.3 | 8.3 |
| Gil3surface | 8.1 | 8.5 | 8.3 | 8.2 |
| Gil4bottom | 8.1 | 8.2 | 8.1 | 8.3 |
| Gil4surface | 8.0 | 8.2 | 8.2 | 8.3 |
| Gil5bottom | 7.8 | 7.8 | 7.6 | 7.5 |
| Gil5surface | 8.2 | 8.5 | 8.2 | 8.2 |
| Gil6bottom | 8.0 | 7.8 | 7.8 | 7.5 |
| Gil6surface | 8.1 | 8.4 | 8.2 | 8.3 |
| Gil7bottom | 8.2 | 8.1 | 8.3 | 8.3 |
| Gil7surface | 8.2 | 8.2 | 8.3 | 8.4 |
| Gil8bottom | 8.0 | 8.3 | 8.3 | 8.3 |

| | | | | |
|---|------------|------------|------------|------------|
| Gil8surface | 8.6 | 9.3 | 8.8 | 9.1 |
| Average Farmington Bay pH | NA | 9.3 | 8.9 | 9.0 |
| Average Gilbert Bay pH | 8.1 | 8.3 | 8.2 | 8.2 |
| Average Gilbert Bay Surface pH | 8.2 | 8.5 | 8.3 | 8.4 |
| Average Gilbert Bay Bottom pH | 8.1 | 8.1 | 8.1 | 8.0 |
| Note: NA – Not available or applicable | | | | |

TABLE 7 DISSOLVED OXYGEN OF OPEN WATER SITES PER SITE PER DATE

| Great Salt Lake Open Water Sites | Dissolved Oxygen (milligrams/liter) | | | |
|---|-------------------------------------|---------------|-------------|---------------|
| | July, 2011 | October, 2011 | June, 2012 | October, 2012 |
| BRB11 surface | NA | NA | NA | NA |
| FB10bottom | NA | 7.94 | 3.40 | NA |
| FB10surface | NA | 6.75 | 5.70 | NA |
| FB9bottom | NA | 7.71 | 1.00 | NA |
| FB9surface | NA | 7.01 | 2.10 | NA |
| Gil1bottom | 4.40 | 9.44 | 7.00 | 8.10 |
| Gil1surface | 7.40 | 8.17 | 7.50 | 10.10 |
| Gil2bottom | 0.00 | 1.50 | 0.10 | 0.00 |
| Gil2surface | 5.70 | 8.28 | 6.90 | 9.50 |
| Gil3bottom | 6.60 | 8.90 | 7.10 | 7.00 |
| Gil3surface | 6.40 | 9.68 | 6.80 | 9.10 |
| Gil4bottom | 9.10 | 9.50 | NA | 8.30 |
| Gil4surface | 7.30 | 8.36 | 7.30 | 8.30 |
| Gil5bottom | 1.30 | 0.00 | NA | 0.00 |
| Gil5surface | 5.60 | 9.10 | NA | 9.00 |
| Gil6bottom | 2.10 | 0.00 | NA | 0.00 |
| Gil6surface | 5.70 | 9.13 | NA | 9.20 |
| Gil7bottom | 3.50 | 4.27 | NA | 5.30 |
| Gil7surface | 4.90 | 9.46 | NA | 5.40 |
| Gil8bottom | 5.30 | 6.95 | NA | 7.10 |
| Gil8surface | 8.70 | 6.20 | NA | 9.10 |
| Average Farmington Bay DO | NA | 7.35 | 3.05 | NA |
| Average Gilbert Bay DO | 5.25 | 6.81 | 6.10 | 6.59 |
| Average Gilbert Bay Surface DO | 6.46 | 8.55 | 7.13 | 8.71 |
| Average Gilbert Bay Bottom DO | 4.04 | 5.07 | 4.73 | 4.48 |
| Note: NA – Not available or applicable | | | | |

TABLE 8

| Analyte | Freshwater | | | Saltwater | | |
|---------|------------|-----------|-------------------------|-----------|-----------|-------------------------|
| | total | dissolved | Conversion ¹ | total | dissolved | Conversion ¹ |
| | | | | | | |

Appendix 1 Figures and Tables

| | | | | | | |
|---|--------|------|--|-------|------|-------|
| Arsenic (ug/L) | 150 | 150 | 1 | 36 | 36 | 1 |
| Cadmium ² (ug/L) | 0.76 | 0.64 | $e^{0.7409(\ln(\text{hardness})-4.719)}$ | 8.846 | 8.8 | 0.994 |
| Copper ² (ug/L) | 30.5 | 29.3 | $e^{0.845(\ln(\text{hardness})-1.702)}$ | TBT | 3.1 | 0.83 |
| Total Mercury (ng/L) | 0.9081 | 0.77 | 0.85 | 1.106 | 0.94 | 0.85 |
| Methylmercury (ng/L) | NA | NA | NA | NA | NA | NA |
| Lead ² (ug/L) | 18.6 | 10.9 | $e^{1.273(\ln(\text{hardness})-4.705)}$ | | 8.1 | 0.951 |
| Selenium (ug/L) | 5 | 4.6 | | TBT | 71 | 0.998 |
| Notes: | | | | | | |
| 1. Based on total recoverable metal | | | | | | |
| 2. Hardness dependent criteria. 400 mg/L hardness used. Used equations to convert dissolved metals standard to total recoverable metals | | | | | | |
| 3. NA – Not available or applicable | | | | | | |

TABLE 9 DESCRIPTIVE STATISTICS OF METALS CONCENTRATIONS AT ALL GILBERT BAY SITES OVER ALL DEPTHS IN 2011 AND 2012

| All Gilbert Bay Sites (Gil 1 – Gil8), at all depths over 2011 and 2012 | | | | | | | |
|---|---------|---------|---------|--------------------|-------|-----------------------------|----------------------------|
| Analyte | Average | Minimum | Maximum | Standard Deviation | Count | Freshwater Aquatic Criteria | Saltwater Aquatic Criteria |
| Arsenic (ug/L) | 77.852 | 27.900 | 157.000 | 25.760 | 64 | 150 | 36 |
| Cadmium (ug/L) | 0.046 | 0.010 | 0.280 | 0.065 | 64 | 0.76 | 8.8 |
| Copper(ug/L) | 2.553 | 0.175 | 15.000 | 2.742 | 64 | 30.5 | 3.1 |
| Total Mercury (ng/L) | 9.866 | 1.150 | 47.300 | 13.541 | 57 | 12 | 940 |
| Methyl mercury (ng/L) | 4.156 | 0.150 | 29.300 | 7.996 | 57 | 2.8 ¹ | NA |
| Lead (ug/L) | 2.117 | 0.439 | 13.400 | 2.538 | 64 | 18.6 | 8.1 |
| Selenium (ug/L) | 0.379 | 0.197 | 0.776 | 0.113 | 64 | 4.6 | 71 |
| Thallium (ug/L) | 0.038 | 0.010 | 0.113 | 0.015 | 64 | 0.03 ² | 17 ² |
| Notes: | | | | | | | |
| 1: LANL, 2009 Tier II value for protection of aquatic life communities | | | | | | | |
| 2: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. 2000. http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol2.pdf | | | | | | | |
| 3. NA – Not available or applicable | | | | | | | |

TABLE 10 DESCRIPTIVE STATISTICS OF METALS CONCENTRATIONS AT ALL GILBERT BAY SITES IN THE SURFACE WATER SAMPLES IN 2011 AND 2012

| All Gilbert Bay Sites (Gil 1 – Gil8), surface water samples (0.2 meters from the surface) over 2011 and 2012 | | | | | | | |
|--|---------|---------|---------|--------------------|-------|-----------------------------|----------------------------|
| Analyte | Average | Minimum | Maximum | Standard Deviation | Count | Freshwater Aquatic Criteria | Saltwater Aquatic Criteria |
| Arsenic (ug/L) | 67.063 | 27.900 | 100.000 | 20.783 | 32 | 150 | 36 |
| Cadmium (ug/L) | 0.020 | 0.010 | 0.046 | 0.013 | 32 | 0.76 | 8.8 |
| Copper(ug/L) | 1.825 | 0.880 | 3.750 | 0.602 | 32 | 30.5 | 3.1 |

| | | | | | | | |
|---|-------|-------|--------|-------|----|-------------------|-----------------|
| Total Mercury (ng/L) | 3.562 | 1.230 | 10.300 | 2.108 | 31 | 12 | 940 |
| Methyl mercury (ng/L) | 0.813 | 0.150 | 2.880 | 0.575 | 31 | 2.8 ¹ | |
| Lead (ug/L) | 1.084 | 0.439 | 1.490 | 0.232 | 32 | 18.6 | 8.1 |
| Selenium (ug/L) | 0.362 | 0.197 | 0.756 | 0.106 | 32 | 4.6 | 71 |
| Thallium (ug/L) | 0.032 | 0.010 | 0.042 | 0.008 | 32 | 0.03 ² | 17 ² |
| Notes: | | | | | | | |
| 1: LANL, 2009 Tier II value for protection of aquatic life communities | | | | | | | |
| 2: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. 2000. http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol2.pdf | | | | | | | |
| 3. NA – Not available or applicable | | | | | | | |

TABLE 11 DESCRIPTIVE STATISTICS OF METALS CONCENTRATIONS OF GILBERT BAY IN THE DEEP BRINE LAYER SITES IN 2011 AND 2012

| Deep Brine Layer Samples from Gil2bottom, Gil5bottom and Gil6bottom over 2011 and 2012 | | | | | | | |
|---|---------|---------|---------|--------------------|-------|-----------------------------|----------------------------|
| Analyte | Average | Minimum | Maximum | Standard Deviation | Count | Freshwater Aquatic Criteria | Saltwater Aquatic Criteria |
| Arsenic (ug/L) | 113.367 | 85.100 | 157.000 | 19.555 | 12 | 150 | 36 |
| Cadmium (ug/L) | 0.155 | 0.060 | 0.280 | 0.084 | 12 | 0.76 | 8.8 |
| Copper(ug/L) | 5.621 | 0.175 | 15.000 | 5.353 | 12 | 30.5 | 3.1 |
| Total Mercury (ng/L) | 38.900 | 26.400 | 47.300 | 8.186 | 9 | 12 | 940 |
| Methyl mercury (ng/L) | 21.223 | 8.710 | 29.300 | 7.392 | 9 | 2.8 ¹ | |
| Lead (ug/L) | 6.474 | 2.280 | 13.400 | 3.344 | 12 | 18.6 | 8.1 |
| Selenium (ug/L) | 0.488 | 0.348 | 0.776 | 0.142 | 12 | 4.6 | 71 |
| Thallium (ug/L) | 0.056 | 0.023 | 0.113 | 0.026 | 12 | 0.03 ² | 17 ² |
| Notes: | | | | | | | |
| 1: LANL, 2009 Tier II value for protection of aquatic life communities | | | | | | | |
| 2: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. 2000. http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol2.pdf | | | | | | | |
| 3. NA – Not available or applicable | | | | | | | |

TABLE 12 DESCRIPTIVE STATISTICS OF METALS IN BRINE SHRIMP TISSUE IN GILBERT BAY OVER 2011 AND 2012

| Analyte (expressed as wet weight) | Average | Minimum | Maximum | Standard Deviation | Count | Avian Dietary Effects Levels |
|-----------------------------------|---------|---------|---------|--------------------|-------|---|
| Arsenic (mg/kg) | 1.398 | 0.097 | 4.580 | 1.226 | 32 | TBD |
| Cadmium (mg/kg) | 0.024 | 0.006 | 0.066 | 0.018 | 32 | TBD |
| Copper(mg/kg) | 1.040 | 0.150 | 2.560 | 0.670 | 32 | TBD |
| Total Mercury (mg/kg) | 0.027 | 0.001 | 0.086 | 0.023 | 32 | Low Risk in Diet: < 0.05 mg/kg ww Moderate Risk in Diet:0.05-0.15 mg/kg ww High Risk in Diet:0.15–0.3mg/kg ww Extra High Risk in Diet: >0.3 mg/kg ww |
| Lead (mg/kg) | 0.155 | 0.011 | 0.630 | 0.192 | 32 | TBD |
| Selenium (mg/kg) | 0.181 | 0.040 | 0.460 | 0.128 | 32 | TBD |
| Thallium (mg/kg) | 0.005 | 0.001 | 0.021 | 0.005 | 32 | TBD |

Appendix 1 Figures and Tables

Notes:

1. Effect on Common Loons (Evers et al, 2004)
2. TBD – To be determined

TABLE 13 DESCRIPTIVE STATISTICS OF SELENIUM IN BIRD EGG TISSUE (MG/KG DRY WEIGHT) COMPARED TO THE SELENIUM NUMERIC STANDARD

| Date/Location Sampled | Geomean | Minimum | Maximum | Standard Deviation | Count | Gilbert Bay Selenium Numeric Standard ¹ |
|---|---------|---------|---------|--------------------|-------|--|
| 07/27/2010 at Saltair | 1.32 | 3.5 | 6 | 0.77 | 13 | 12.5 mg/kg dry weight |
| 06/02/2011 at Bridger Bay, Antelope Island | 1.56 | 1.38 | 1.84 | 0.19 | 5 | |
| 06/22/2011 at Farmington Bay Waterfowl Management Area ² | 2.54 | 2.28 | 2.83 | 0.21 | 5 | |
| 06/11/2012 at Ogden Bay Waterfowl Management Area | 1.46 | 1.13 | 2.03 | 0.33 | 9 | |
| 06/20/2012 at Antelope Island Causeway | 1.51 | 1.21 | 2.84 | 0.48 | 10 | |

Notes:

1. Utah Administrative Code R317-2-14
2. The selenium numeric water quality standard was established for Gilbert Bay. For Farmington Bay, the standard is used as a benchmark of avian risk

TABLE 14 DESCRIPTIVE STATISTICS OF MERCURY IN BIRD EGG TISSUE (MG/KG WET WEIGHT) COMPARED TO EVERS RISK RANGES

| Date/Location Sampled | Mean | Minimum | Maximum | Standard Deviation | Count | Evers Egg Tissue Risk Ranges ¹ |
|--|------|---------|---------|--------------------|-------|---|
| 06/02/2011 at Bridger Bay, Antelope Island | 0.23 | 0.15 | 0.33 | 0.07 | 5 | Low risk in eggs: 0 – 0.5 Hg mg/kg ww Moderate risk in eggs: 0.5 – 1.3 Hg mg/kg ww High risk in eggs: 1.3 -2.0 Hg mg/kg ww Extreme High Risk in eggs: >2.0 Hg mg/kg ww |
| 06/22/2011 at Farmington Bay Waterfowl Management Area | 0.34 | 0.21 | 0.42 | 0.08 | 5 | |
| 06/11/2012 at Ogden Bay Waterfowl Management Area | 0.12 | 0.05 | 0.24 | 0.06 | 8 | |
| 06/20/2012 at Antelope Island Causeway | 0.15 | 0.04 | 0.38 | 0.11 | 10 | |

Notes:

1. Effect on Common Loons (Evers et al, 2004)

TABLE 15 DESCRIPTIVE STATISTICS OF METALS CONCENTRATIONS AT THE BEAR RIVER BAY SITE OVER 2011 AND 2012

| Bear River Bay Site BRB11, at all depths over 2011 and 2012 | | | | | | | |
|---|---------|---------|---------|--------------------|-------|-----------------------------|----------------------------|
| Analyte | Average | Minimum | Maximum | Standard Deviation | Count | Freshwater Aquatic Criteria | Saltwater Aquatic Criteria |
| Arsenic (ug/L) | 15.700 | 13.100 | 18.300 | 3.677 | 2 | 150 | 36 |
| Cadmium (ug/L) | 0.035 | 0.020 | 0.051 | 0.021 | 2 | 0.76 | 8.8 |
| Copper(ug/L) | 1.209 | 0.368 | 2.050 | 1.189 | 2 | 30.5 | 3.1 |
| Total Mercury (ng/L) | 2.565 | 1.930 | 3.200 | 0.898 | 2 | 12 | 940 |
| Methyl mercury (ng/L) | 0.685 | 0.499 | 0.870 | 0.262 | 2 | 2.8 ¹ | NA |
| Lead (ug/L) | 0.170 | 0.148 | 0.192 | 0.031 | 2 | 18.6 | 8.1 |
| Selenium (ug/L) | 0.380 | 0.192 | 0.567 | 0.265 | 2 | 4.6 | 71 |
| Thallium (ug/L) | 0.015 | 0.013 | 0.017 | 0.003 | 2 | 0.03 ² | 17 ² |

Notes:
 1: LANL, 2009 Tier II value for protection of aquatic life communities
 2: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. 2000. <http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol2.pdf>
 3. NA – Not available or applicable

TABLE 16 DESCRIPTIVE STATISTICS OF METALS CONCENTRATIONS AT ALL FARMINGTON BAY SITES OVER ALL DEPTHS IN 2011 AND 2012

| All Farmington Bay Sites (FB9 and FB10), at all depths over 2011 and 2012 | | | | | | | |
|---|---------|---------|---------|--------------------|-------|-----------------------------|----------------------------|
| Analyte | Average | Minimum | Maximum | Standard Deviation | Count | Freshwater Aquatic Criteria | Saltwater Aquatic Criteria |
| Arsenic (ug/L) | 32.431 | 18.400 | 48.200 | 8.780 | 16 | 150 | 36 |
| Cadmium (ug/L) | 0.015 | 0.006 | 0.025 | 0.007 | 16 | 0.76 | 8.8 |
| Copper(ug/L) | 1.734 | 0.467 | 5.400 | 1.229 | 16 | 30.5 | 3.1 |
| Total Mercury (ng/L) | 4.590 | 2.250 | 13.400 | 2.532 | 16 | 12 | 940 |
| Methyl-mercury (ng/L) | 0.829 | 0.251 | 1.370 | 0.383 | 15 | 2.8 ¹ | |
| Lead (ug/L) | 0.726 | 0.133 | 1.550 | 0.446 | 16 | 18.6 | 8.1 |
| Selenium (ug/L) | 0.414 | 0.235 | 0.608 | 0.112 | 16 | 4.6 | 71 |
| Thallium (ug/L) | 0.009 | 0.003 | 0.010 | 0.002 | 16 | 0.03 ² | 17 ² |

Notes:
 1: LANL, 2009 Tier II value for protection of aquatic life communities
 2: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. 2000. <http://www.environment.gov.au/water/publications/quality/pubs/nwqms-guidelines-4-vol2.pdf>
 3. NA – Not available or applicable

TABLE 17 DESCRIPTIVE STATISTICS OF NUTRIENT CONCENTRATIONS AT ALL GILBERT BAY SITES OVER ALL DEPTHS DURING 2011 AND 2012

| All Gilbert Bay Sites (Gil 1 – Gil8), at all depths over 2011 and 2012 | | | | | |
|--|---------|---------|---------|--------------------|-------|
| Nutrients | Average | Minimum | Maximum | Standard Deviation | Count |
| Phosphorous - unfiltered (mg/L) | 0.431 | 0.189 | 2.95 | 0.460 | 64 |
| Phosphorous - filtered (mg/L) | 0.305 | 0.048 | 1.610 | 0.275 | 64 |

Appendix 1 Figures and Tables

| | | | | | |
|------------------------------------|--------|-------|--------|--------|----|
| Total Nitrogen - unfiltered (mg/L) | 3.935 | 2.490 | 10.900 | 2.230 | 64 |
| Total Nitrogen - filtered (mg/L) | 3.652 | 2.53 | 9.07 | 1.621 | 64 |
| Chlorophyll a (ug/L) | 11.780 | 0.004 | 128 | 21.876 | 64 |

TABLE 18 DESCRIPTIVE STATISTICS OF NUTRIENT CONCENTRATIONS AT ALL GILBERT BAY SITES IN SURFACE WATER SAMPLES DURING 2011 AND 2012

| All Gilbert Bay Sites surface water samples (Gil 1 – Gil8) over 2011 and 2012 | | | | | |
|--|----------------|----------------|----------------|---------------------------|--------------|
| Nutrients | Average | Minimum | Maximum | Standard Deviation | Count |
| Phosphorous - unfiltered (mg/L) | 0.239 | 0.189 | 0.342 | 0.039 | 32 |
| Phosphorous - filtered (mg/L) | 0.179 | 0.070 | 0.259 | 0.039 | 32 |
| Total Nitrogen - unfiltered (mg/L) | 3.045 | 2.500 | 4.600 | 0.479 | 32 |
| Total Nitrogen - filtered (mg/L) | 2.900 | 2.530 | 3.330 | 0.181 | 32 |
| Chlorophyll a (ug/L) | 11.740 | 0.004 | 128.000 | 27.855 | 32 |

TABLE 19 DESCRIPTIVE STATISTICS OF NUTRIENT CONCENTRATIONS AT ALL GILBERT BAY SITES IN THE DEEP BRINE DURING 2011 AND 2012

| All Gilbert Bay Sites bottom water samples (Gil 1 – Gil8) over 2011 and 2012 | | | | | |
|---|----------------|----------------|----------------|---------------------------|--------------|
| Nutrients | Average | Minimum | Maximum | Standard Deviation | Count |
| Phosphorous - unfiltered (mg/L) | 1.041 | 0.632 | 1.460 | 0.226 | 12 |
| Phosphorous - filtered (mg/L) | 0.719 | 0.536 | 0.940 | 0.115 | 12 |
| Total Nitrogen - unfiltered (mg/L) | 8.002 | 4.090 | 10.900 | 2.343 | 12 |
| Total Nitrogen - filtered (mg/L) | 6.793 | 4.310 | 9.070 | 1.279 | 12 |
| Chlorophyll a (ug/L) | 43.297 | 0.025 | 134.000 | 36.175 | 15 |

TABLE 20 DESCRIPTIVE STATISTICS OF NUTRIENT CONCENTRATIONS AT ALL FARMINGTON BAY SITES OVER ALL DEPTHS DURING 2011 AND 2012

| All Farmington Bay Sites (FB9 and FB10), at all depths over 2011 and 2012 | | | | | |
|--|----------------|----------------|----------------|---------------------------|--------------|
| Nutrients | Average | Minimum | Maximum | Standard Deviation | Count |
| Phosphorous - unfiltered (mg/L) | 0.481 | 0.309 | 1.29 | 0.293 | 10 |
| Phosphorous - filtered (mg/L) | 0.102 | 0.071 | 0.147 | 0.0304 | 10 |
| Total Nitrogen - unfiltered (mg/L) | 5.375 | 4.41 | 6.69 | 0.852 | 10 |
| Total Nitrogen - filtered (mg/L) | 2.972 | 2.12 | 4.34 | 0.771 | 10 |
| Chlorophyll a (ug/L) | 109.882 | 0.114 | 276 | 116.145 | 9 |