Muskoka Lakes Association Water Quality Initiative:

Summary Report of the 2005 Monitoring Program

including instructions for accessing data via the Internet

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Introduction

The Muskoka Lakes Association (MLA) water quality initiative uses two separate, yet complimentary, methods of reporting on the quality of surface waters in our lakes. These methods reflect the two complimentary *functions* of the initiative: monitoring and research. These functions are differentiated by how the data is used, and therefore, reported.

2005 marks the fifth year of the MLA water quality initiative, a program that has grown and evolved in order to meet the emerging needs of the community. Changes are now more subtle as the program has become mature. Since reporting mechanisms that are effective in communicating program results to the public and to interested scientists have been developed, 2005 reports are very similar to those of previous years.

Most readers will be mainly interested in the results of the monitoring function of the program. The monitoring function is an annual report of the results of a variety of parameters measured at various locations around the lakes that are part of the MLA program. The results of the monitoring function will indicate how the water quality in a particular location differs from water quality in other areas, and how water quality in a particular area varies through time (from season to season). Through monitoring and analysis of the results, we can recommend remedial measures for locations with impaired water quality or with water quality that is worsening over time. “Hot spots” can be identified, neighbours may be warned of any concerns to public health or the local ecosystem, and the appropriate government authorities can be notified of potential sources of contamination.

Due to the scope of information available and the importance of effectively disseminating it, these results are made available in electronic format to the public via the MLA website (a paper copy of these results would fill several hundred pages). The following short report summarizes the main findings of the monitoring function, and offers a detailed explanation of how to fully access the wealth of information in geo-referenced format via the MLA website.

Advanced readers will wish to read the results of the research function of the program. A traditional paper report outlining these results as well as the scientific theory, method, and quality assurance techniques of the program is available either in PDF format from the MLA website or from the MLA office in Port Carling.

Summary of Results

The following is a basic summary of the results observed in the water quality initiative, focussing on 2005 results within the context of observations from previous years. The report shows how water quality in each area studied compares with water quality objectives and with water quality observed in all other areas studied. The report also shows how water quality parameters have changed between 2002 and 2005. Full explanations of the significance of each parameter and descriptions of the sampling protocol used are referenced in the 2005 Annual Report.

When comparing water quality parameters, it is important to note that the conditions in various lakes and rivers differ drastically. Small, slow-moving, connective rivers like the Indian River and the Joseph River are not unlike the large lakes that they join (and in fact have been blasted and dredged to change their inherent characteristics). In comparison, rivers like the Hoc Roc River and Shadow River are more traditional, natural water courses that drain large catchment areas. These rivers are expected to have higher concentrations of contaminants, as they collect runoff from large areas and concentrate it in a small area.

Conditions between lakes in Muskoka tend to be more comparable. Nearly all lakes in Muskoka are naturally oligotrophic, which means 'nutrient-poor.' This condition arises from the fact that the lake is carved out of granite, which erodes slowly and contains few nutrients. An increase in biological productivity in these lakes (represented here by total phosphorus concentration, but also observed through the growth of algae and other plants) is typically unhealthy. Brandy Lake, which is not naturally oligotrophic, is the single exception in the water quality initiative. Brandy Lake is classified as a dystrophic lake, which means it has more dissolved organic carbon and total phosphorus regardless of human impacts. High total phosphorus in this case in not considered unhealthy.

E.Coli

What it is: Organism indicating contamination by enteric bacteria originating in human and animal waste products. Can cause gastrointestinal disease if ingested.

Safe Recreational Water Objective:

- Less than 100 counts/100mL (Provincial standard)
- Less than 10 counts/100mL (MLA safe water objective)

Figure 1 shows *Escherichia Coli* (*E.Coli*) results from 2005. Average values shown on the figure are calculated geometric means. The dotted red line represents the MLA Safe Water Objective, first described in Section 5.3 of the 2002 Annual Report (the MLA has set higher water quality objectives than the Province of Ontario to reflect the typically excellent water quality in Muskoka's lakes). Two areas exceeded the MLA Safe Water Objective on average in 2005 (Muskoka Sands-19.4, and the Muskoka River-15.6). This should not be interpreted to mean that the water quality in these general areas is unsafe for recreational purposes (swimming etc.) as the Ontario Ministry of Health's standard for safe recreational water is 100 counts/100mL (10 times as high as the MLA objective).

The observed counts of *E.Coli* on the Muskoka River remained virtually unchanged from 2004. Since the river traverses a large watershed and passes through several towns and small cities before being monitored in the lower reaches of the Muskoka River, it is very difficult to identify any specific sources of bacteria.

Site MSN-4

The high counts at the Muskoka Sands area can be attributed to very high readings at site MSN-4, on the Hoc Roc River. The average reading at this site was 146.5 counts/100mL, the first time the MLA program has observed a site on average higher than the Provincial Government's safe water standard. If high readings continue in the spring of 2006, investigation should be made as to the source of bacterial contaminants. It is important to note that the prime purpose of site MSN-4 is to monitor total phosphorus loading from the Taboo golf course; swimming is not expected in this marshy, riverine area. All other sites and areas were measured at well below the MLA Safe Water Objective.

Figure 2 shows the four-year average (geometric mean) of *E.Coli* readings. All lakes had a long-term average of below five *E.Coli* counts/100mL, which is very low. As noted previously, both the Hoc Roc River and Shadow River drain large catchment areas, and essentially concentrate contaminants from a wide area. As *E.Coli* can indicate human faecal contamination, it is prudent for Shadow and Hoc Roc River residents to be particularly cognizant of any potential sources of human waste, such as malfunctioning septic facilities, and report them to the MLA or the appropriate authorities.

Four-year trends for *E.Coli* readings are shown in Figure 3. *E.Coli* readings at most of the areas are steady, however small increases over time are observed at Windermere, Minett, and the Indian River, and a spike in *E.Coli* level was observed at Muskoka Sands in 2005 as previously mentioned. This does not indicate an immediate threat to public health (as goverment-determined thresholds have not been exceeded) but should resources be available, or should *E.Coli* levels continue to rise, an investigation into the source of pollution should be undertaken.

Total Coliform

What it is: Bacteria organism that could indicate contamination by enteric bacteria originating in human and animal waste products, but also originating in other sources not related to human health.

Safe Recreational Water Objective:

- Less than 1000 counts/100mL (former Provincial standard)
- Less than 100 counts/100mL (MLA safe water objective)

Average (geometric mean) total coliform in every area studied in 2005 is shown in Figure 4. A dramatic (more than three-fold) increase in the observed counts of total coliform were observed in 2005 over 2004, with approximately half (sixteen) of the areas exceeding the MLA Safe Water Objective on average (a phenomenon that had only occurred four times between 2002 and 2004). This increase in total coliform counts is most likely due to the higher than normal water temperatures that were also observed this year. Keeping in mind that total coliform are found in various natural processes, this increase alone has no implication for human health, but is indicative of the affects of temperature on the ecosystem.

Average (geometric mean) total coliform observed over the four year period of the program is shown in Figure 5. The figure shows that results are approximately ten times greater than average *E.Coli* measurements. Both Clear

Figure 1 - Average *E.Coli* observed in 2005

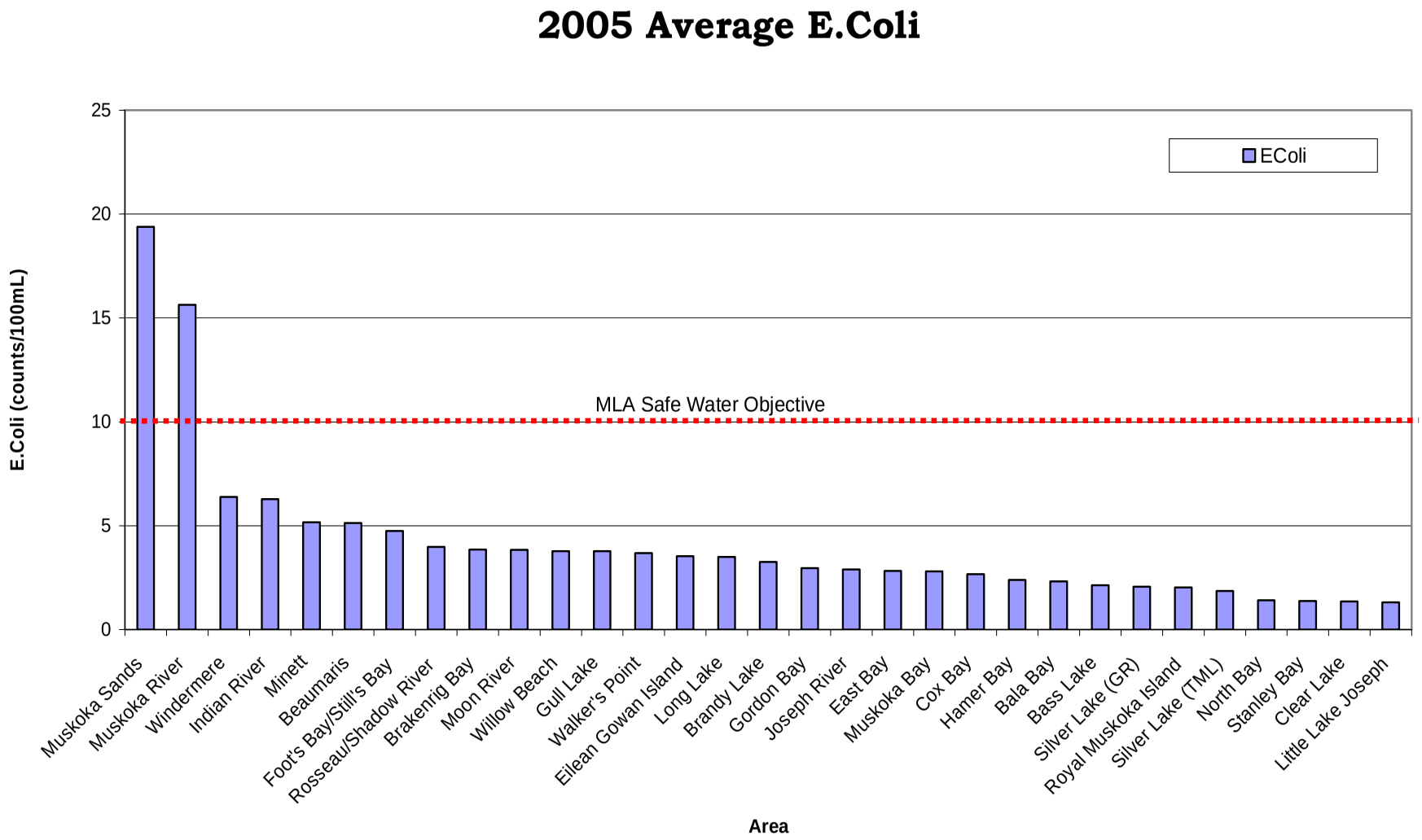


Figure 2 - Average *E.Coli* observed in 2002-2005

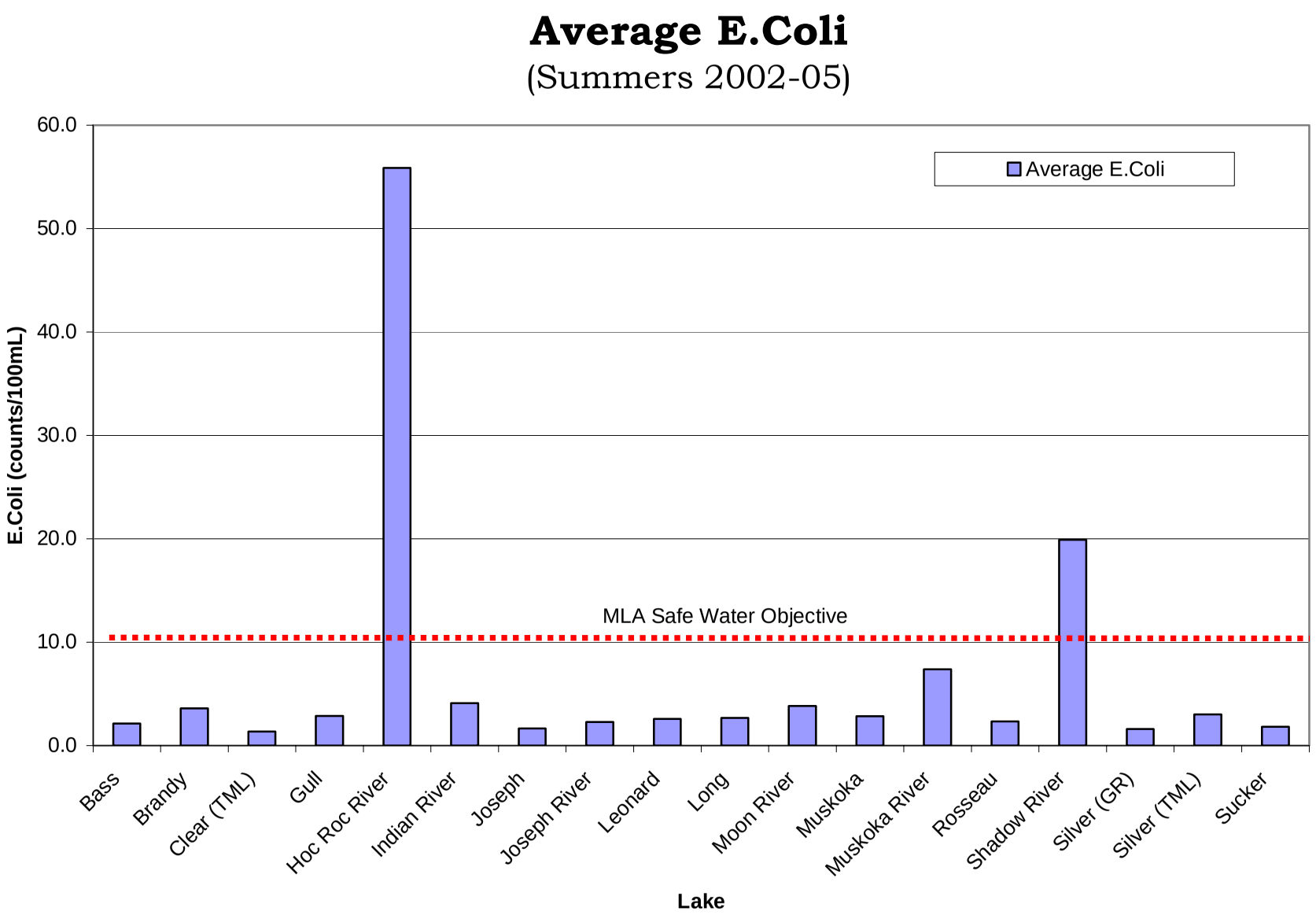
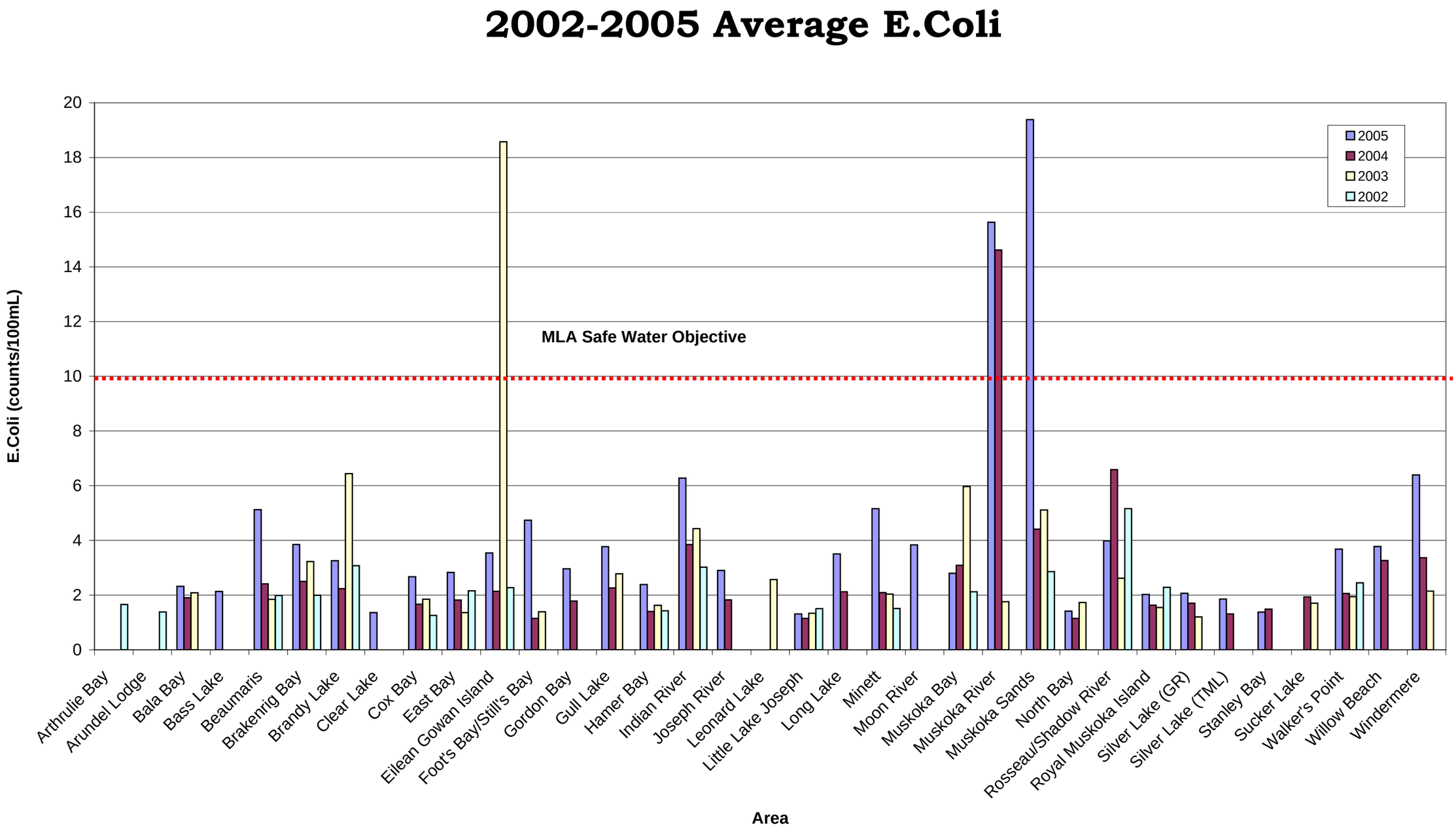


Figure 3 - Comparison of average E.Coli observed in 2002-2005



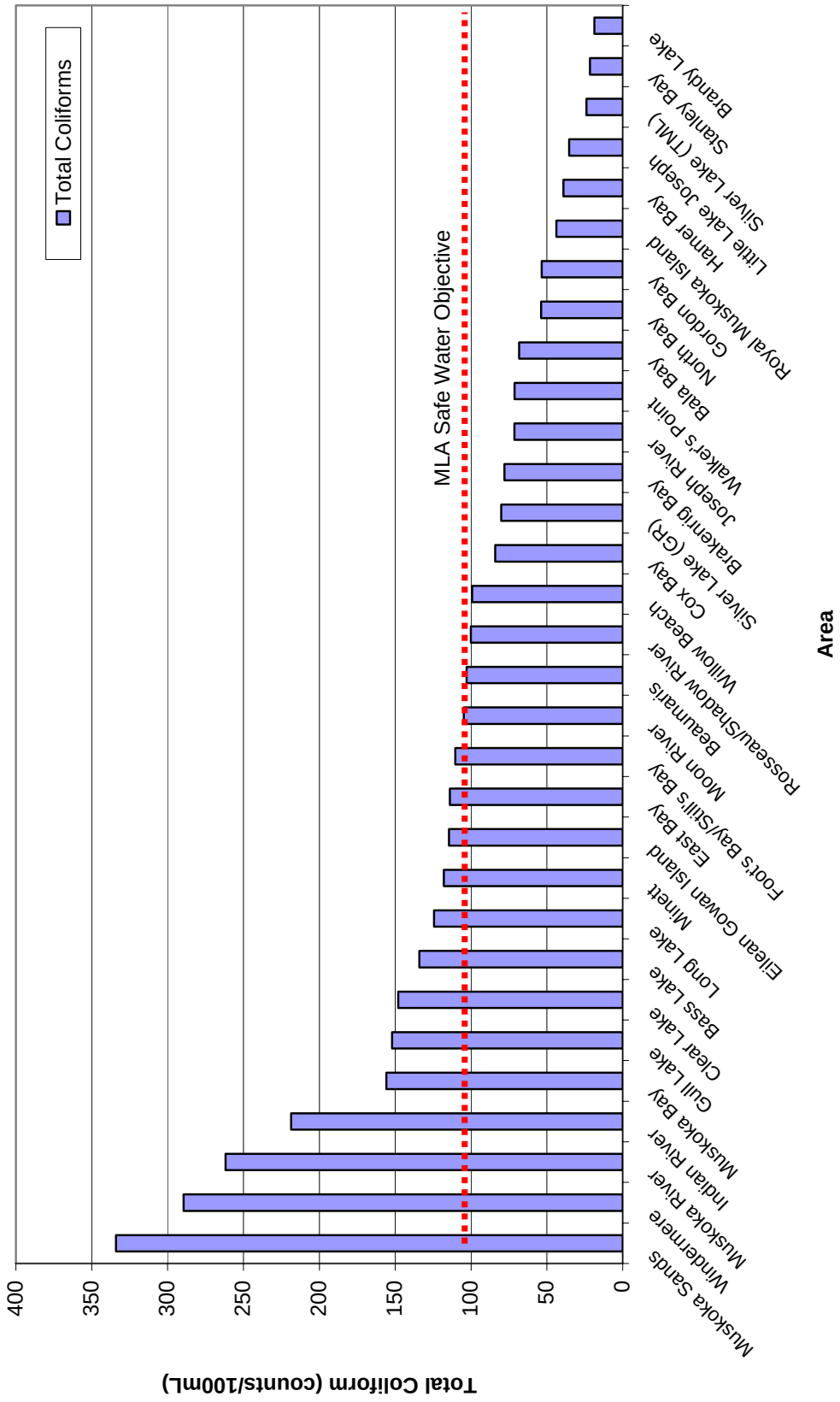


Figure 4 – Average Total Coliform observed in 2005

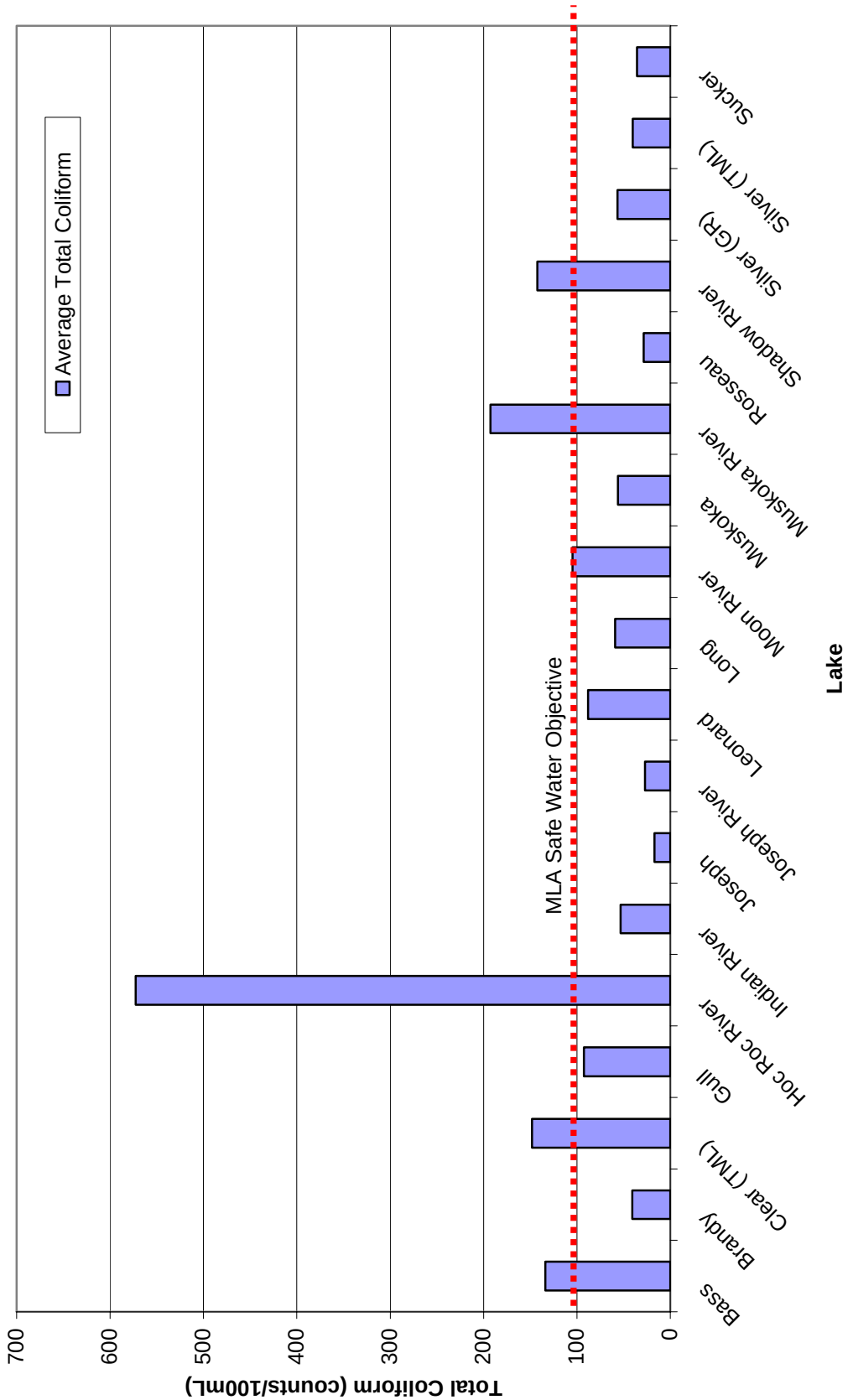
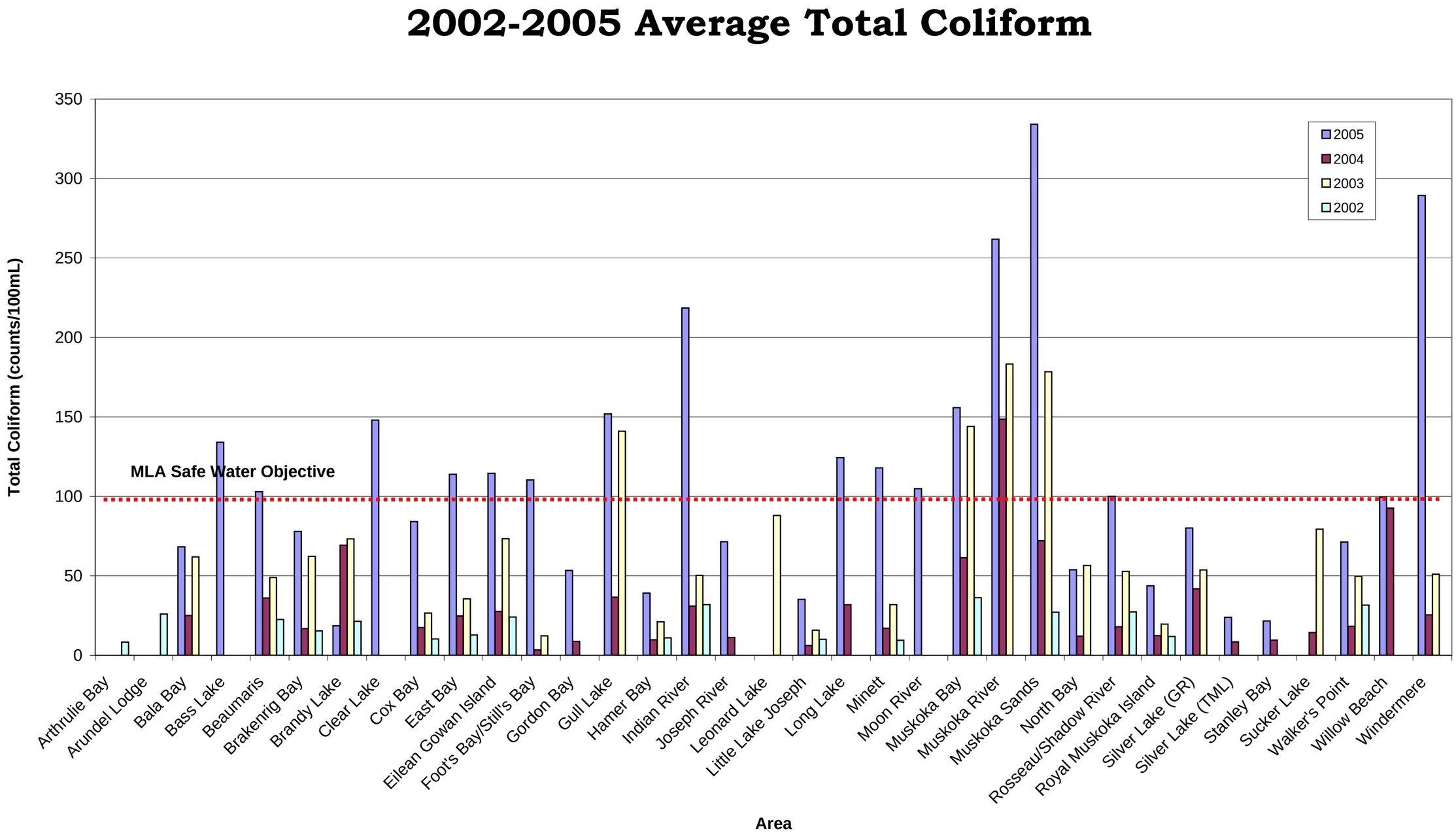


Figure 5 – Average Total Coliform observed in 2002-2005

Figure 6 - Comparison of average Total Coliform observed in 2002-2005



Lake and Bass Lake have high long-term average coliform, however it is noted that the "long-term average" for these lakes is based solely on 2005 measurements, and 2005 showed very high total coliform compared to previous years. Total coliform levels should be closely monitored throughout 2006 in all lakes and rivers including Bass Lake and Clear Lake. If climatic factors return to more typical levels, bacteria levels should diminish. If they remain high, further investigation is warranted. Again, the Hoc Roc and Shadow Rivers are high in coliform. The Muskoka River is also high in total coliform, again most likely because its catchment is an enormous area including a variety of land uses.

Figure 6 further illustrates the dramatic increase in total coliform over previous years. This increase should only be of concern if total coliform levels do not return to normal in the spring of 2006.

Total Phosphorus

What it is: Nutrient required for biological growth, typically the limiting nutrient in freshwater ecosystems. Phosphorus loading can be caused by human development, and usually brings algae blooms and unwanted plant growth to Muskoka's oligotrophic lakes, detrimentally affecting all parts of the ecosystem.

Water Quality Objective:

- Less than 10μg/L for naturally oligotrophic lakes

Figure 7 shows average total phosphorus concentration in each area where this parameter was measured in 2005. Averages shown are arithmetic means. These average values are slightly lower than in 2004, and in most cases approximately equal to the four-year observed average. Most Precambrian Shield lakes should have low nutrient levels (in the oligotrophic range). Most of the areas monitored by the MLA initiative do fall in this range, with a few in the lower mesotrophic range (see Figure 7). Brandy Lake is the one exception to this, as it is not a nutrient-poor lake. Rather than having a substrate of rock, Brandy Lake sits on peaty soil that is rich in nutrients and dissolved organic carbon. The high levels of total phosphorus (just over 30 μg/L) is not unhealthy in the case of this particular lake, and is consistent with readings from other years (Figure 9).

Figure 8 summarizes total phosphorus results for the program between 2002 and 2005. The four-year average phosphorus level reported here gives a very good picture of the true trophic status of lakes, due to the large number of samples averaged. All lakes are oligotrophic except Brandy Lake as previously

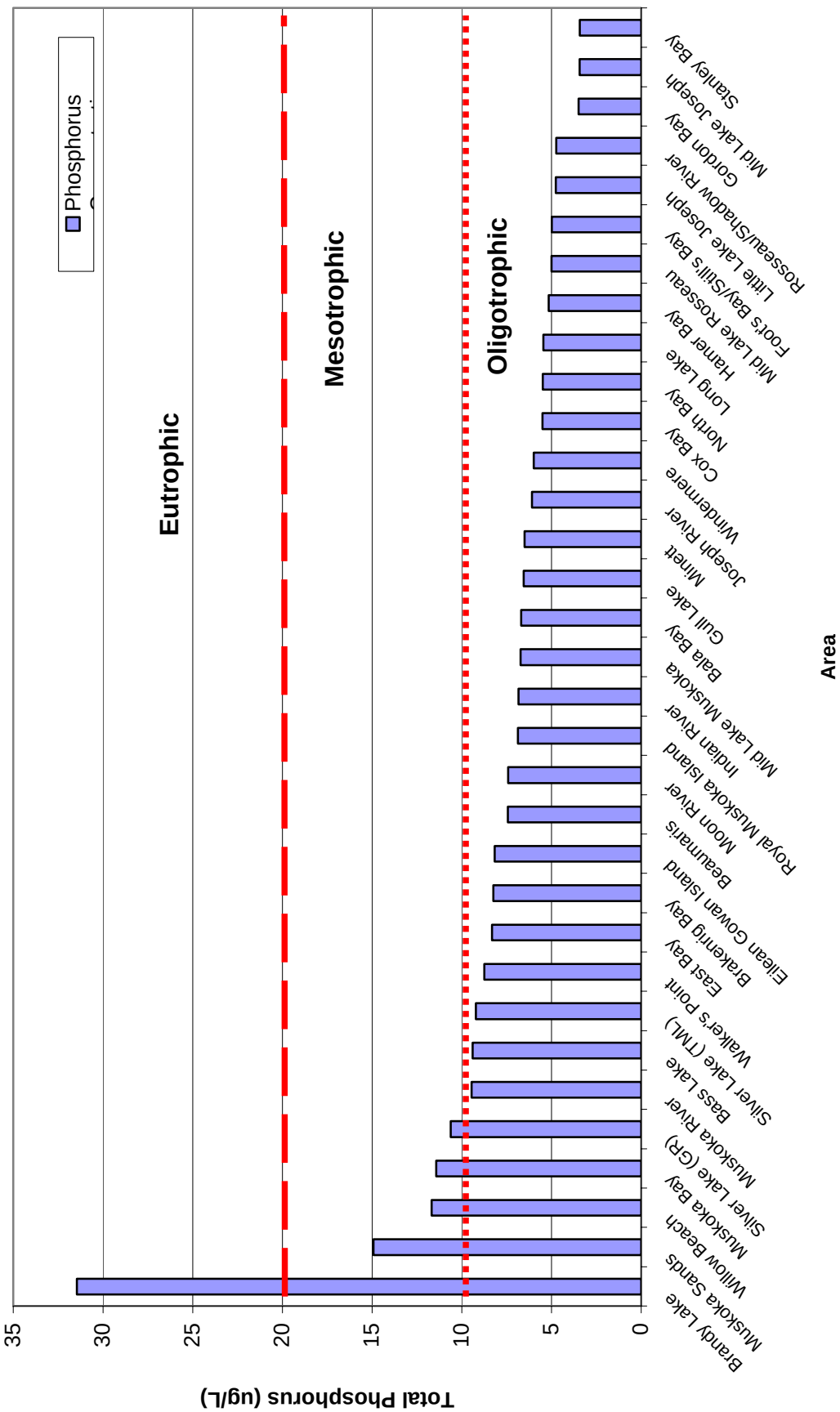


Figure 7 - Average Total Phosphorus observed in 2005

Figure 8 - Average Total Phosphorus observed in 2002-2005

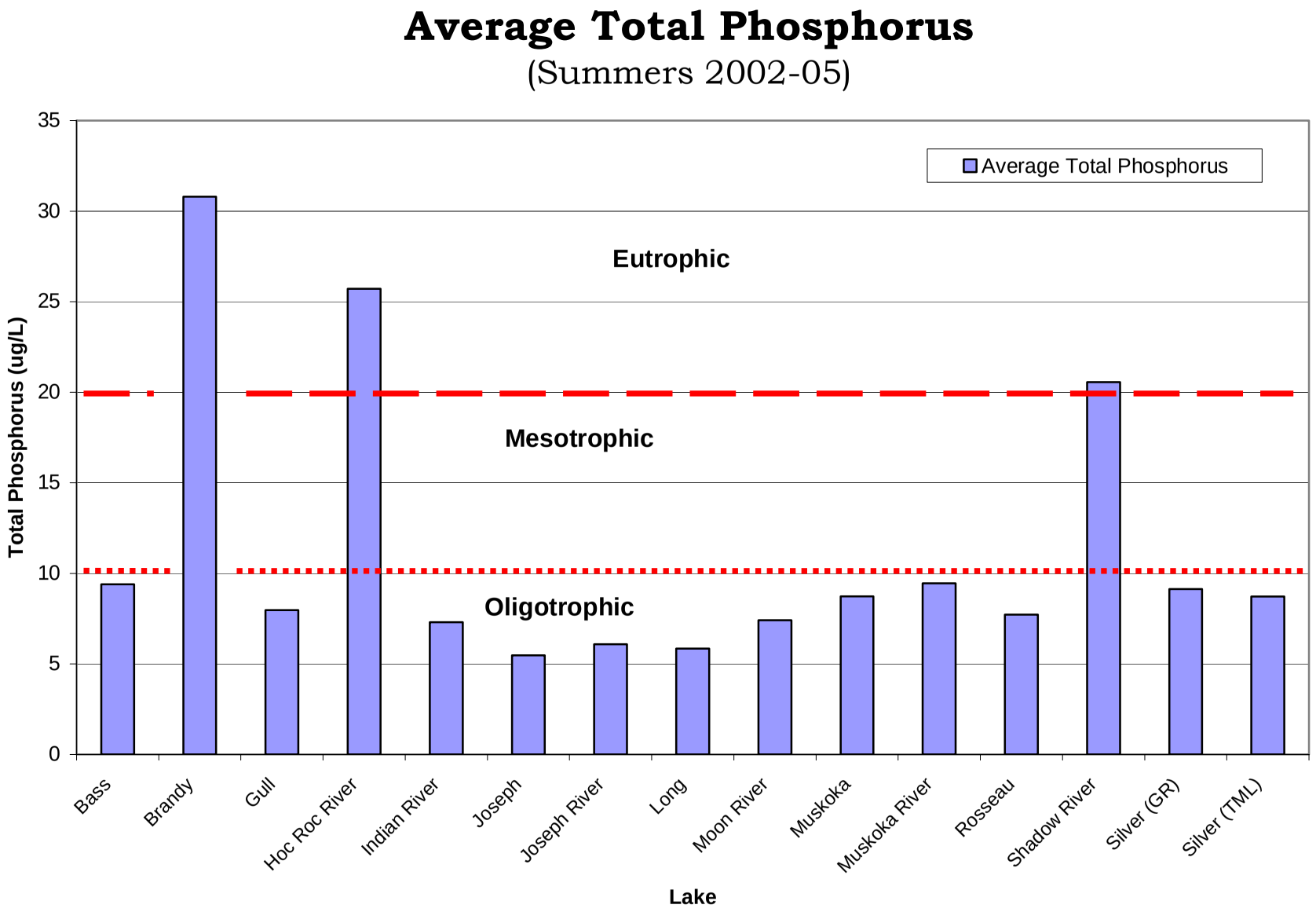
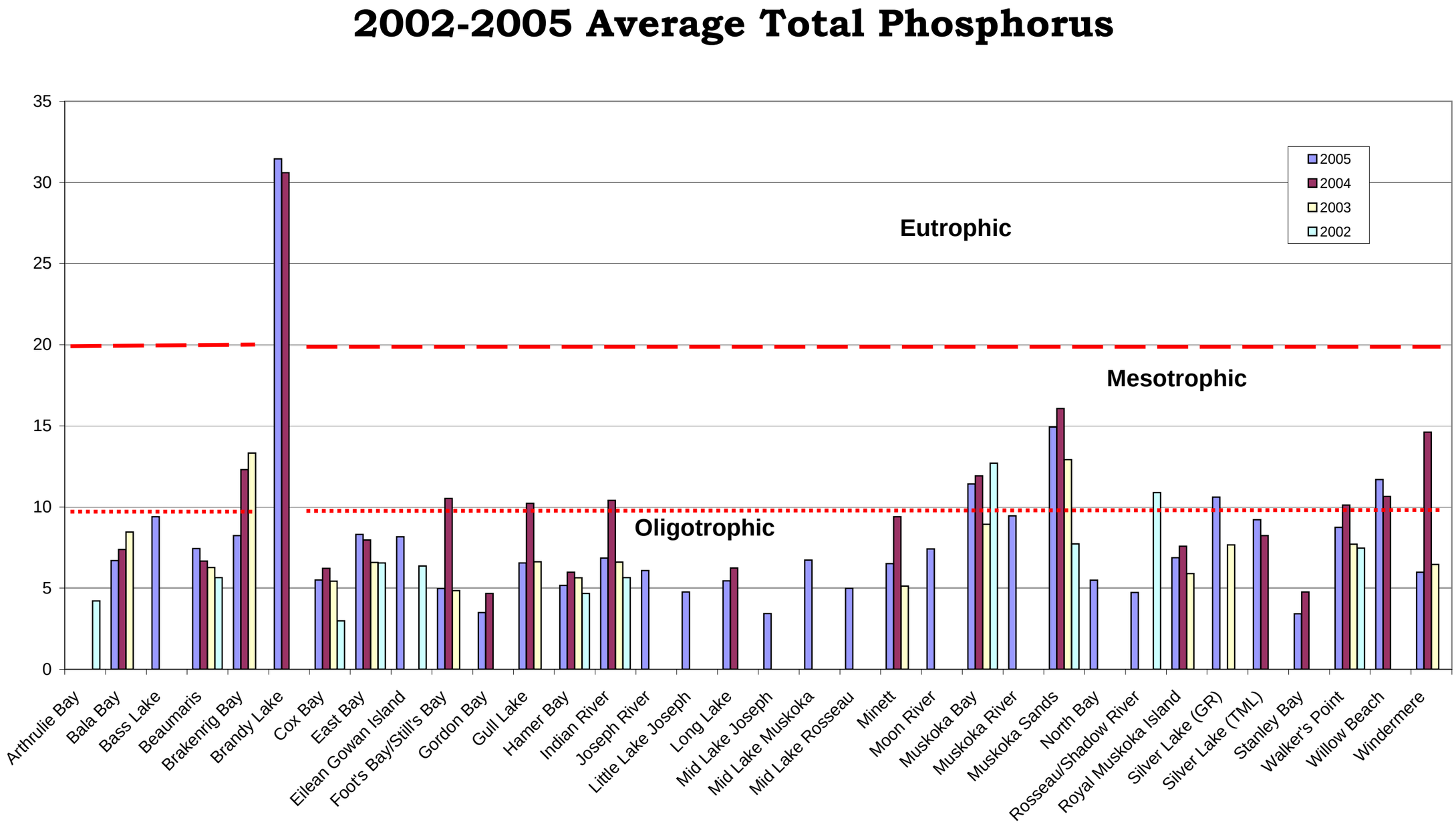


Figure 9 - Comparison of average Total Phosphorus observed in 2002-2005



discussed. The rivers monitored are also high in total phosphorus, which is normal in most natural river systems. Figure 9 shows how average total phosphorus has changed over these four years. This figure shows that in many cases, the average total phosphorus concentration is steady or decreasing over time. Exceptions to this include Beaumaris, Muskoka Sands and Walker's Point. If these areas continue to see an increase in total phosphorus concentration, remedial action may be warranted.

Total phosphorus measurements were extended to mid-lake sites in 2005. This was to facilitate a comparison between measurements using the MLA protocol and those measured using the District of Muskoka's Spring Turnover Phosphorus protocol. A full analysis of this research is found in the 2005 Annual Report.

Turbidity

What it is: Measurement of water clarity, mostly of concern for aesthetic purposes, but can have a significant impact on in-home water purification systems that use ultra-violet light to kill bacteria.

Water Quality Objective:

- None

Average turbidity is shown in Figure 10 (2005 arithmetic means), Figure 11 (four-year arithmetic mean, by lake) and 12 (four-year trend). While there is no water quality objective associated with turbidity, clearer water is usually considered to be aesthetically more pleasing and implies a healthy oligotrophic aquatic ecosystem. For reference, keep in mind that a commercially available bottle of drinking water (such as Aquafina) has a turbidity of approximately 0.3 NTU and normal black tea has a turbidity of approximately 25 NTU.Figure 12 shows that in most cases, water clarity has been relatively consistent since 2002. Brandy Lake had low turbidity in 2004 since the cooler temperatures prevented the typical late summer algal bloom.

Temperature

Average (arithmetic mean) temperature recorded at all sites in 2005 is shown in Figure 13. Average temperatures ranged from 20.5 degrees Celsius (at Foot's Bay) to 25 degrees Celsius (at Clear Lake). There are no objectives for water temperature, and temperature has no effect on human health. However, water temperature can effect ecosystem productivity and other parameters, as seen in 2005 total coliform observations.

Figure 10 - Average Turbidity observed in 2005

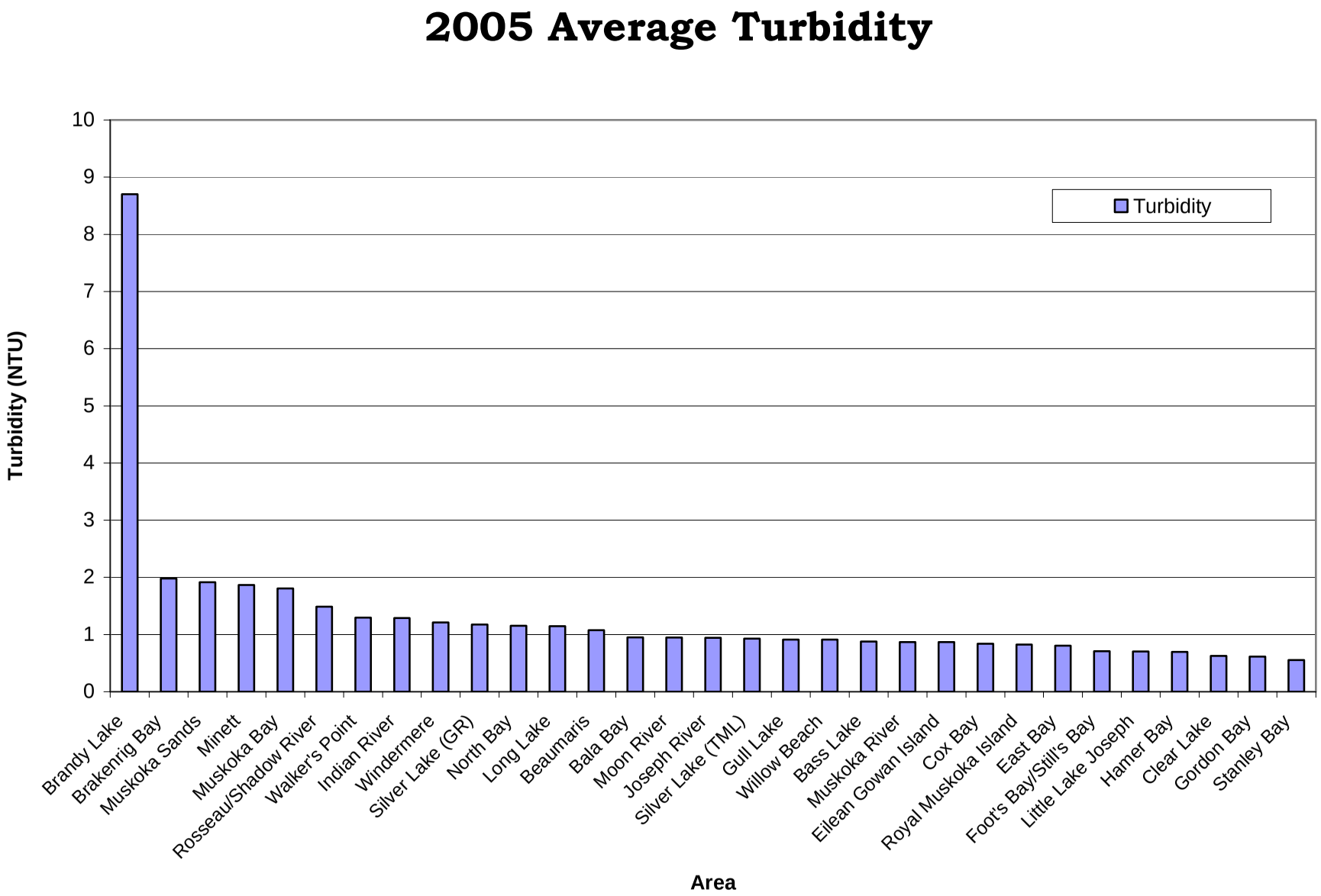


Figure 11 - Average Turbidity observed in 2002-2005

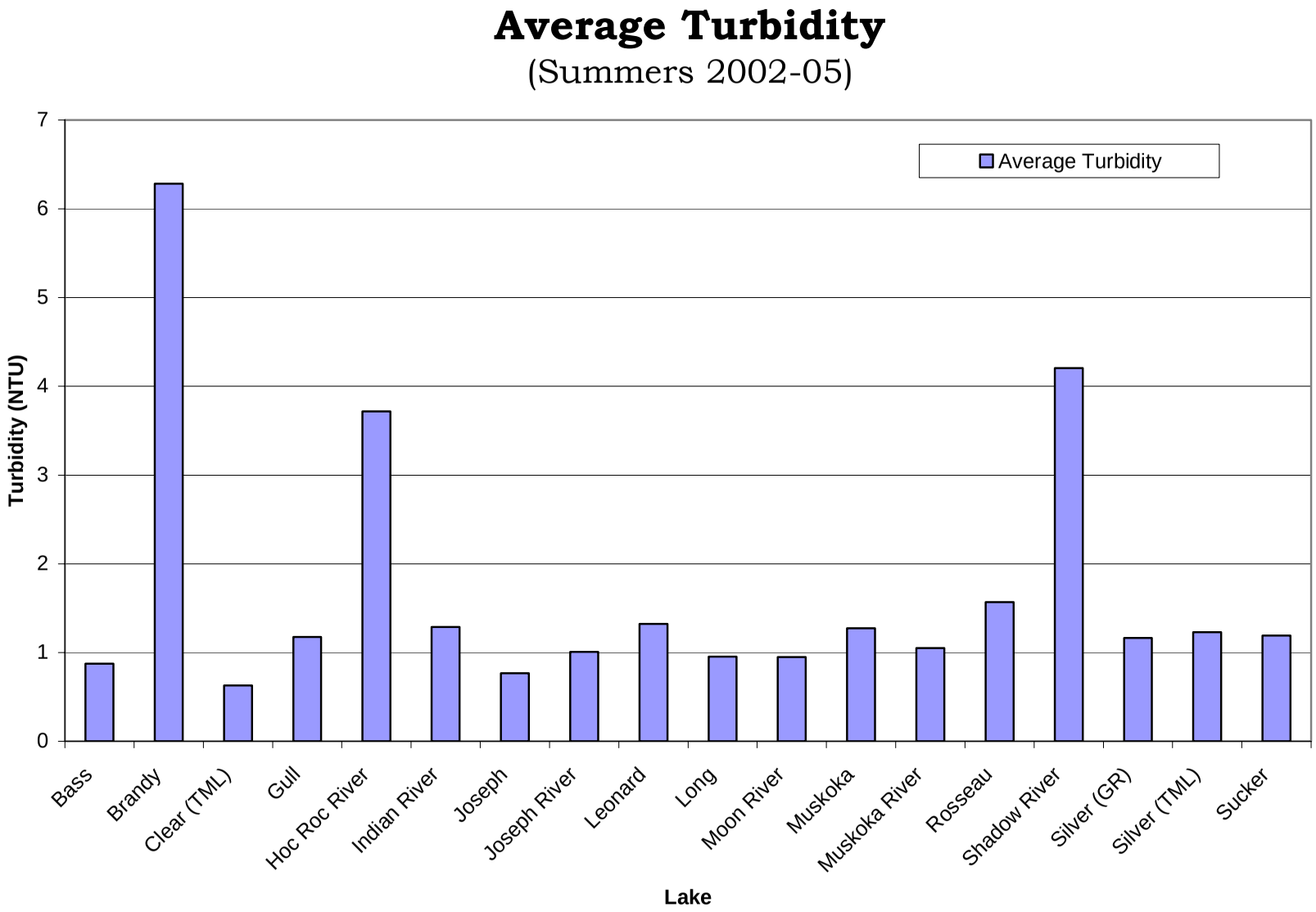


Figure 12 - Comparison of average Turbidity observed in 2002-2005

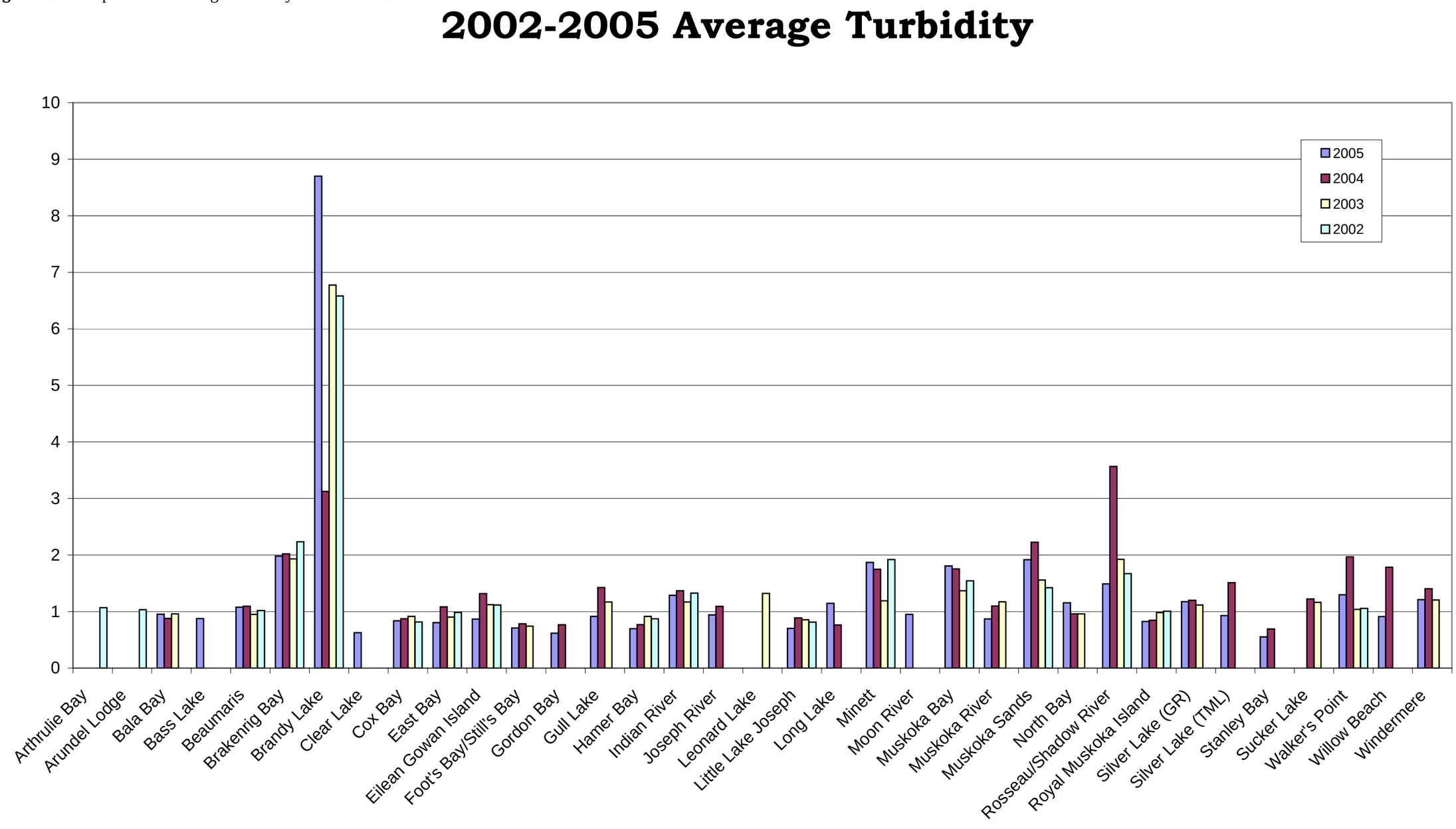


Figure 13 - Average Temperature observed in 2005

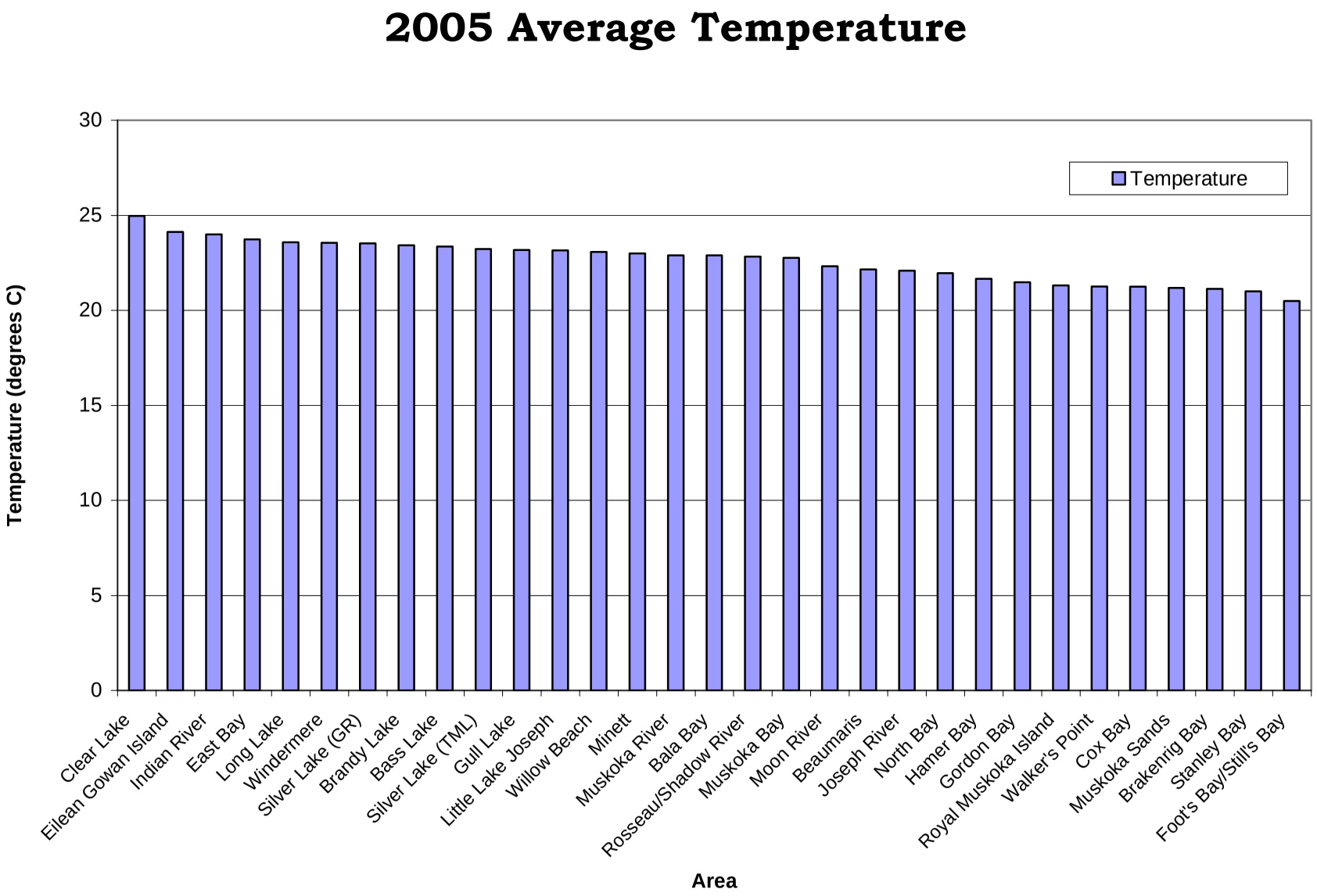


Figure 14 - Average Temperature observed in 2002-2005

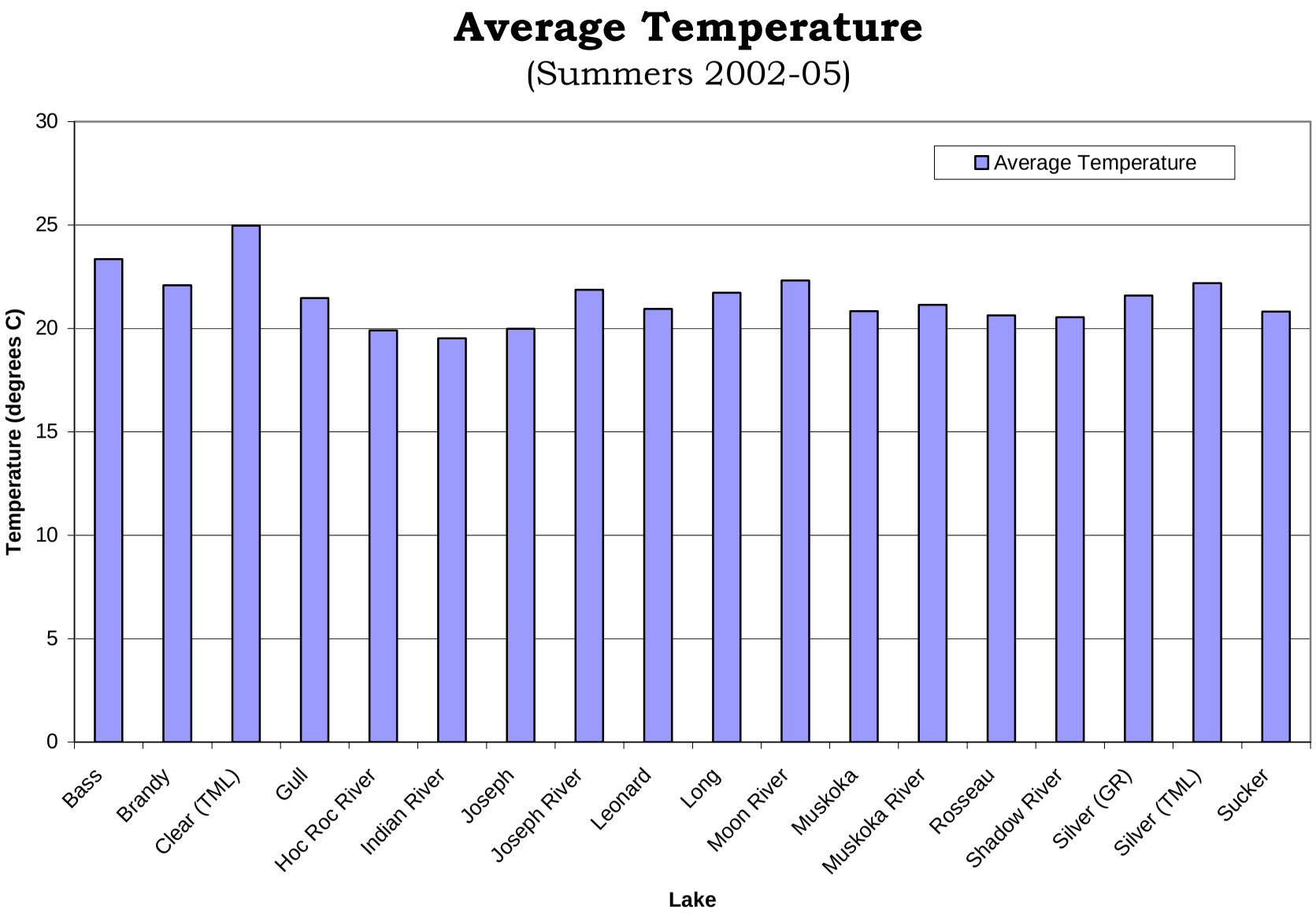


Figure 15 - Comparison of average Temperature observed in 2002-2005

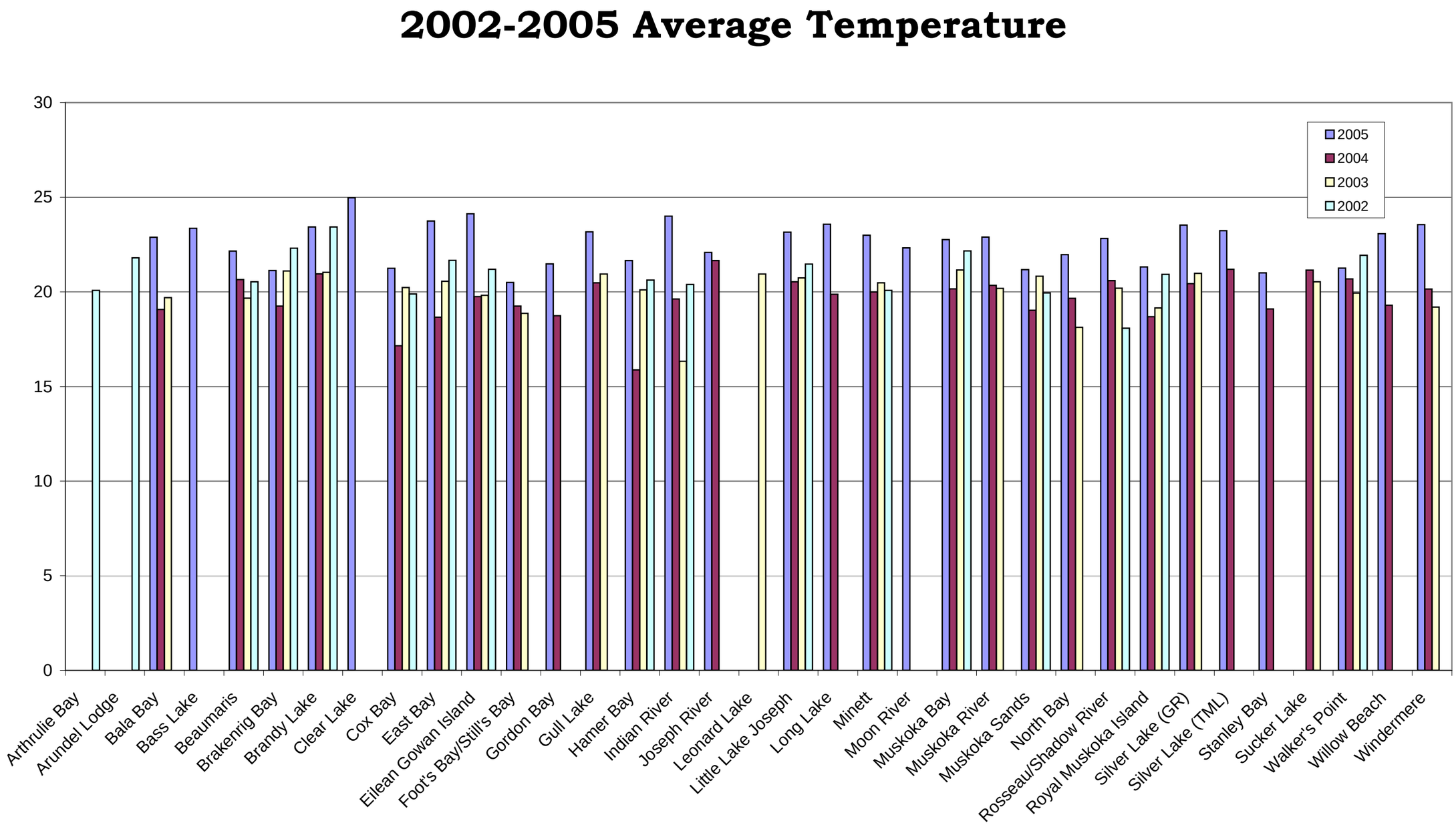


Figure 14 shows the long-term average temperature for each water body (since 2002). Note that the two highest readings, Clear Lake and Bass Lake, were only measured in 2005 when all temperatures were high, which makes their average temperature appear higher than other water bodies that have been part of the MLA initiative for a longer period.

The four-year trend in temperature is shown in Figure 15. The trends show that temperature increased by at least two degrees Celsius between 2004 and 2005 in nearly every area. The average increase in water temperature was 2.9 degrees Celsius between 2004 and 2005 and 1.6 degrees Celsius between 2002 (the next warmest year monitored) and 2005.

Conclusions

A review of program results show that between 2002 and 2004, bacteria levels (both *E.Coli* and total coliform) were typically well below the objectives set by the MLA. In 2005, total coliform levels exceeded the MLA Safe Water Objective in 16 areas, but *E.Coli* counts remained typically low. The increase in total coliform, which is an indication of bacteria presence but does not have implications for human health, is possibly due to the high water temperatures observed throughout the region. Note that these bacteria levels are still well below the safe water standard set by the Province of Ontario at all sites except Site MSN-4 where *E.Coli* averaged higher than is considered safe for recreational usage of water. In most areas therefore, it remains highly unlikely that a recreational user of these areas would become stricken with a bacteriological infection. Site MSN-4 is monitored primarily to determine phosphorus loading, and therefore does not pose a great risk to the swimming public. However, if *E.Coli* counts remain high during the first few sample periods in 2006, further study and remediation efforts should be undertaken.

Total phosphorus results show that most lakes in the area are oligotrophic, with the exception of Brandy Lake with its high levels of dissolved organic carbon. The rivers measured also have higher phosphorus levels than the oligotrophic lakes. Turbidity also shows consistent results, with less clear water found in Brandy Lake, areas of Lake Rosseau and Silver Lake.

There are important differences in water quality between one area and another on the same lake. Results from specific areas and sites show that some areas

tend to have higher readings for all parameters. These include the Muskoka Sands area, the Windermere area and the Willow Beach area.. Likewise, specific areas consistently return the lowest readings across all parameters. These areas include Little Lake Joseph, Stanley Bay, Gordon Bay and Hamer Bay.

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Using the Website

Detailed results from all sites monitored are accessible in an interactive web-based application. To access the water quality initiative's online results, visit the MLA's website at http://www.mla.on.ca and click "Water Quality" on the main menu. Detailed background information including a glossary and references can be accessed by clicking on "About this Site". A more detailed step-by-step tutorial on using the website to access data is also available on this page

Reports dating back to 2001 can be downloaded directly from the main water quality page. To get results using the interactive web-based tool, you will need to use Internet Explorer 6.0 or later, and download the Scalable Vector Graphics plug-in from Adobe (http://www.adobe.com/svg/viewer/install, or by following the link on the main water quality page). Updates may support the use of other browsers. The most up-to-date system requirements will be listed on the main page.

The results can be directly accessed by following the "Get Results" link. Once you click on this link, you are prompted to agree with a disclaimer that the MLA has written to protect itself against any liability arising from the use of the results of the Water Quality Initiative. The use of this disclaimer allows the MLA to share its results with anyone who is interested in them. Once you agree to the disclaimer, you will have full access to all of the data from the Water Quality Initiative.

Searching

Example: View 2005 Brackenrig Bay results.

1. Select "Brackenrig Bay" from the *Location Name* drop down menu.
2. Select "2005" from the *Starting Year* drop down menu
3. Select "2005" from the *Ending Year* drop down menu
4. Click the "Search" button

You may now search for the results that you are specifically interested in. The first step is to select the time and place that the data was collected. You can then graph your selected results in a variety of ways to help you understand them. Keep in mind that neither bacteria nor total phosphorus are measured at all of the sites in the program, and that all sites have not been included in all years, so there may be some data gaps.

You may choose to search the data geographically, temporally or both. The temporal boundaries (the years of data you are interested in) can be defined using the drop-down menus entitled “Starting Year” and “Ending Year.” Information for both of these years and all of the years in between will be displayed. If you don’t select any years, results from all years will be displayed.

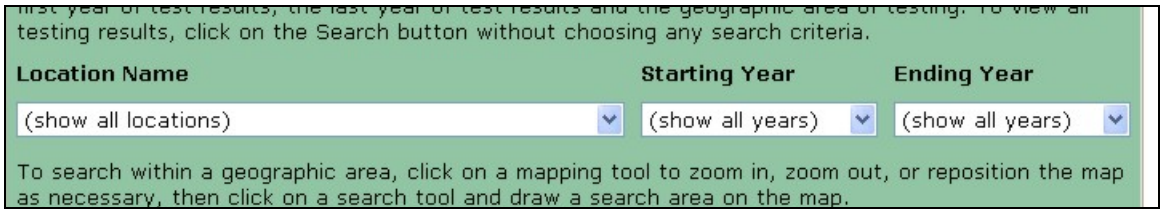

Figure A

Geographic boundaries of your search can be defined in two different ways. If you are only interested in data from one area, know that data exists for that area and know the name of the area you can select the area name from the drop-down menu called “Location Name” (see Figure A). If you would rather find the area on the map, you can do so by pointing at the area you are interested in. To do this, you will need to follow the following easy steps:

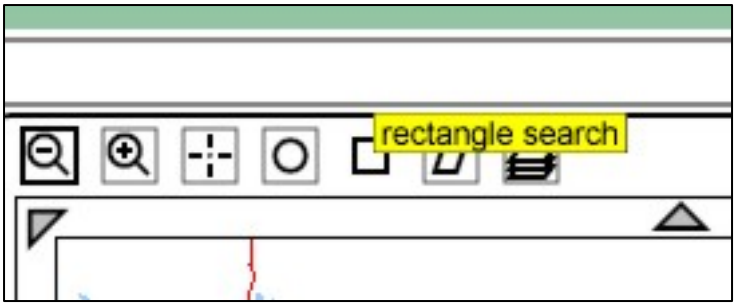

Figure B

1. Select one of the search tools in the map window. The search tools are identified when you use the mouse to move the pointer on top of one of the tools (see Figure B).
    - “Radius search” allows you to search a circular area on the map
    - “Rectangle search” allows you to search a rectangular area on the map
    - “Polygon search” allows you to search an irregular shaped area on the map – this allows for detailed searches, but you will need to define each corner of the polygon to search results in
2. After selecting the search tool you want to use, click on the map and drag the mouse until the shaded area includes the area you are interested in. If you make a mistake, simply start again. The old shaded area will disappear and the new one will appear.

Example: View all results in South Lake Muskoka.

1. Select the *zoom in* tool.
2. Click on the map near Gravenhurst.
3. Select the *radius search* tool
4. Click on the centre of the Lake Muskoka basin and drag the mouse until the shaded area encompasses all of South Lake Muskoka
5. Click on the "Search" button

3. If you need to see a more detailed map, use the zoom in tool in the map window to zoom in to a specific area. If you need to zoom out, switch to the zoom out tool and go back a step. When the map is showing enough detail for you to select the area you are interested in, switch to one of the search tools and make your boundary selection.

If you do not select a geographic location, information for all locations will be displayed.

After you have set both the parameters for your search (geographic, temporal or both) click on the "Search" button below the map to display the results that match your search criteria. If no data matches your criteria, or you wish to display different data, click on the "Get Results" link to restart the search process.

Viewing the Information

Sorting

Once the data you are interested in viewing is displayed on the screen, you can view it in a variety of ways. You can sort the data by any of the columns listed by clicking on the small, unshaded triangles next to the column heading (one triangle sorts the records in ascending order, the other sorts in descending order).

Example: Compare total phosphorus concentration at site BAL-0 between 2003 and 2005.

1. Search for all results from Bala Bay (as in preceding examples).
2. Click on upward facing triangle beside *Site Code* to list all BAL-0 results at the top of the display list.
3. Check the checkboxes beside BAL-0 2003, BAL-0 2004 and BAL-0 2005.
4. Go to the command line at the bottom of the display list.
5. Select "total phosphorus" in the first drop down menu, and "year" in the second drop down menu.
6. Click the "Graph" button. The graph shows three bars, so you can see how the concentration has changed over time.

Displaying sites on the map

Some or all of the sites in the display list can be shown on the map. Multiple sites can be selected from this list by

checking the checkbox to the right side of each site you wish to show. If you wish to select all of the sites in the display list, click the "Select All" link at the bottom of the display list. To display, click on the "Show selected sites on map" link. The map, set to a scale appropriate for the area you have selected, will appear showing a yellow dot indicating the location of each site selected. The site code (corresponding to the record in the display list) for each site appears when you point to the dot with the mouse pointer. Clicking on a dot shows photographs of the site.

Graphing

You may wish to graph the results. Check the checkbox to the right of each record in the display list you wish to graph. At the bottom of the display list, use the drop down menus to complete the command: "Graph [parameter] by [sort method]." Click the "Graph" button to display the results as requested.

Example: Compare how levels of *E.Coli* differed at all Hamer Bay sites in 2005.

1. Search for all results from Hamer Bay in 2005 (as in preceding examples).
2. Click on the "Select All" link at the bottom of the display list to check all of the checkboxes shown.
3. Go to the command line at the bottom of the display list.
4. Select "*E.Coli*" in the first drop down menu, and "location" in the second drop down menu.
5. Click the "Graph" button. The graph shows five bars (one for each site), so you can see how the concentration differed within the bay.

Completing this statement allows you to create a graph that shows any of the parameters measured (*E.Coli*, total coliform, total phosphorus, turbidity or temperature) sorted by year, location, or value. Clicking on a bar of the graph shows a map and photographs of the site. If a question mark appears on the graph, you can point to it to show a note that will help you interpret the data.