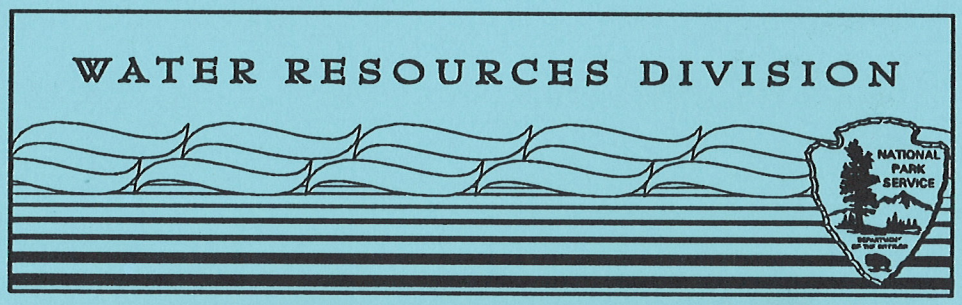
BACTERIA WATER QUALITY DATA ANALYSIS AND INTERPRETATION

GLEN CANYON NATIONAL RECREATION AREA

Barry A. Long and Rebecca A. Smith

Technical Report NPS/NRWRD/NRTR-95/46



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Bacteria Water Quality Data Analysis and Interpretation Glen Canyon National Recreation Area

Barry A. Long[1] and Rebecca A. Smith[2]

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EXECUTIVE SUMMARY

Since 1988, Glen Canyon National Recreation Area has been monitoring bacteria levels in Lake Powell to assess potential impacts from recreational bathing and boating. Due to high bacteria levels, advisory notices were posted at several beaches during the last few years. The park requested that the Water Resources Division analyze and interpret the bacteria data, and help them develop a way to measure acute levels of bacteria contamination in time to warn recreational users.

Fecal coliform bacteria was the primary parameter sampled, and average colony counts ranged from a high of 1,412 colony forming units per 100 milliliters (cfu/100 mL) to a low of zero. One duplicate sample collected from Hobi Cat Beach in 1991 contained 1,840 cfu/100 mL. Seventy-five violations of state of Utah water quality standards occurred at 18 sites in the park between 1988 and 1993. Seven violations occurred at six sites in Hansen Creek, Moqui Canyon, and Stanton Creek during 1991. Sixty-seven violations occurred at 13 sites in Davis Gulch, Farley Canyon, Forgotten Canyon, Hite Marina, Llewellyn Gulch, Moqui Canyon, Oak Canyon, and Upper Bullfrog Bay during 1992. One violation occurred at Hobi Cat Beach during 1993. The water quality standard is a geometric mean calculation of 200 cfu/100 mL from five or more samples in a 30-day period. Some sites did not post violations because they were sampled too infrequently to calculate valid geometric means. More frequent sampling at fewer sites may provide better data to assess compliance with water quality standards, warn users of potential health risks, and strengthen the validity of management decisions related to posting warnings or closing beaches.

The results of these analyses indicated that bacteria contamination may be a concern at certain beaches, but correlations between high bacteria counts and visitor use patterns or lake levels were not significant. The lack of standardized visitor use indices probably contributed to the weak statistical relationship. Annual or seasonal lake levels may have influenced bacteria dilution; however, the lack of sufficient seasonal lake level and bacteria data prevented further analyses to test these hypotheses. Accumulated visitor use during the week prior to sampling may be a better indicator than use on the day of sampling. Lake level adjustments coupled with rainfall indices may provide better inputs for early warning models than visitor use, especially in areas where visitor management is logistically difficult.

INTRODUCTION

Glen Canyon National Recreation Area (GLCA) has been monitoring bacteria levels in shoreline waters of Lake Powell to assess impacts from recreational bathing and boating since 1988. The Water Resources Division (WRD) contributed to the development of the GLCA bacteria monitoring program via recommendations made in a report titled *Water quality alternatives for the Glen Canyon National Recreation Area Water Resources Management Plan* (Flora and Wood 1986) and the park's *Water Resources Management Plan* (Wood and Kimball 1987). Recent data have shown an increase in bacteria levels at some beaches during the current drought. It is speculated that this trend may have resulted from less bacteria dilution at lower lake levels and/or changing recreational use patterns. GLCA posted advisory notices at several beaches during the last couple of years due to exceedences of the Utah primary-contact recreation (swimming), and Arizona full body-contact, water quality standard for fecal coliform bacteria of 200 colony forming units per 100 milliliters (cfu/100 mL). In 1991, high bacteria counts resulted in the closure of five beaches: Hansen Creek, Stanton Creek, Hobi Cat Beach, Moqui Canyon, and Farley Canyon. Eight canyons were posted with no swimming signs in 1992: Moqui Canyon, Farley Canyon, Government Housing, Llewellyn Gulch, Oak Canyon, Upper Bullfrog Bay, Hite Marina, and Forgotten Canyon. Subsequently, Llewellyn Gulch was posted as closed due to bacterial contamination. Llewellyn Gulch remained closed to public access until May, 1994. In 1993 and 1994, coliform counts were low and no new advisories or beach closures occurred. Water levels in Lake Powell rose over 50 feet in response to spring runoff during 1993.

In response to these data and increasing concerns regarding interpretation of the results by park management, staff, and the public, the park requested that WRD analyze and interpret the bacteria data collected between 1988 and 1993, and help them develop a way to measure acute levels of bacterial contamination in time to warn recreational users. The purpose of this paper is twofold: (1) to present a clear and concise explanation of what we know, and (2) to recommend changes in field, laboratory, and data management procedures which result in the most effective and efficient use of this information in making management decisions.

BACKGROUND

Previous and Ongoing Studies

Initial investigations into the bacterial water quality at popular swimming areas in Lake Powell were conducted by Walther (1971), Kidd (1975), and Cudney (1977). All three studies concluded that though the water was unsuitable for drinking, water quality standards generally were met for primary and secondary contact recreation. A later study (Fitzgerald et al. 1985) in-part, corroborated these results, but found elevated bacteria levels at certain locations. Related studies conducted by Brickler and Tunnicliff (1980), Tunnicliff and Brickler (1984), and Doyle et al. (1985) on riverine environments within and adjacent to GLCA, came to similar conclusions regarding bacterial water quality. In addition, these studies pointed out that resuspension of sediments could pose potential water quality hazards

because of suspected accumulations of bacteria in river bed sediments. Some researchers believed that these results should also be applied to resuspension of lake bed sediments.

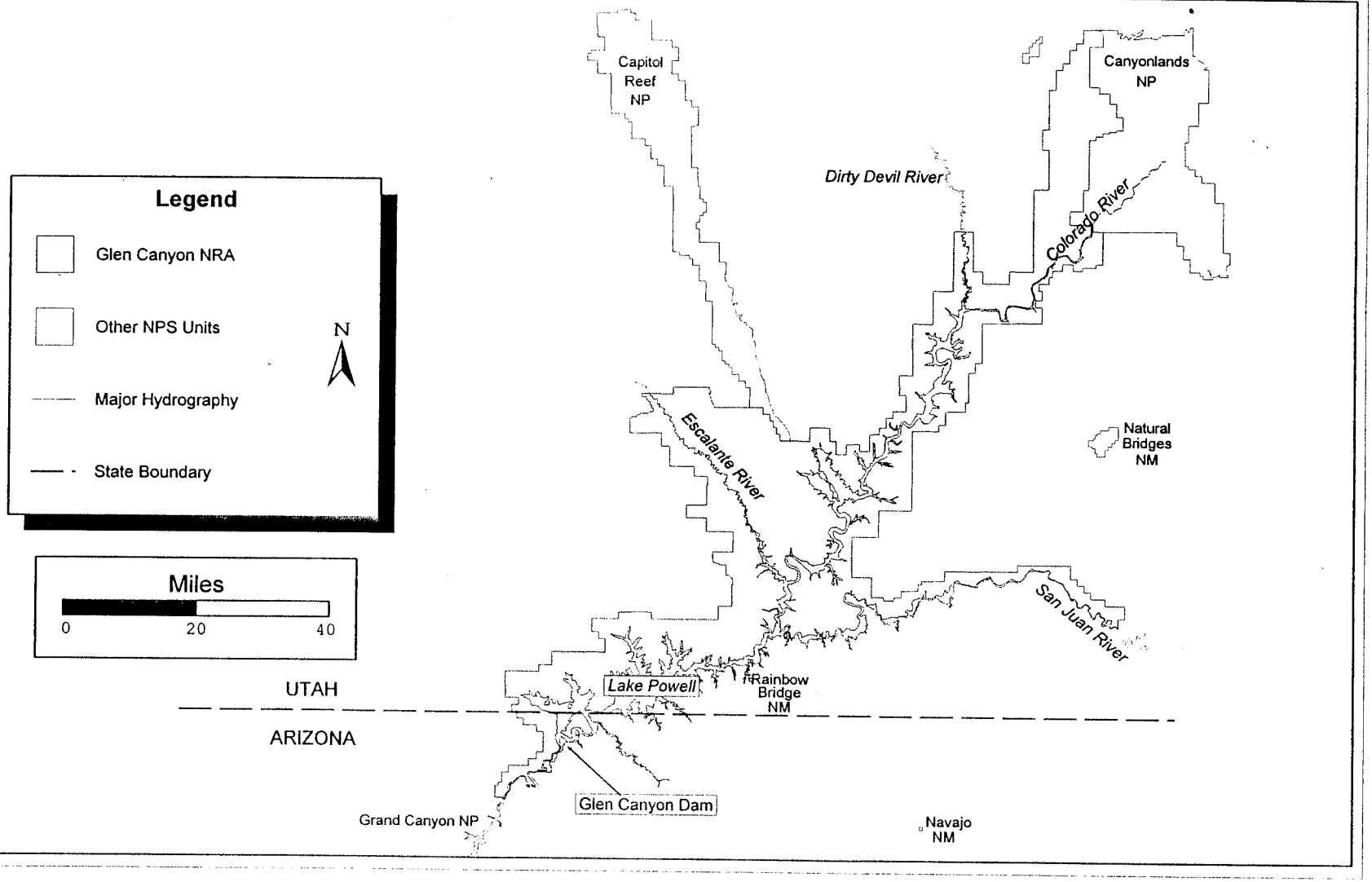
By 1988, although the water quality of Lake Powell was reported to be generally very good, a combination of increased recreational use, concerns for visitor safety, and recommendations by water resources professionals (Flora and Wood 1986; Wood and Kimball 1987) prompted GLCA to implement a routine bacterial water quality monitoring program at primary swimming beaches and marina areas. In the beginning, park staff collected water samples, and filtered and incubated the samples without the aid of a laboratory in the park. Often, samples were analyzed after they had exceeded their holding times. During this time the Utah Department of Health, state of Arizona, and Coconino County laboratories assisted the park by analyzing samples and recommending needed equipment. In 1991 and 1992, GLCA established bacteria water laboratories at downlake and uplake locations in the park, respectively. These laboratories became certified by the Utah Department of Health in 1994.

Study Area Description

GLCA was established in 1972, primarily to provide for public outdoor recreation use and enjoyment of Lake Powell. Lake Powell, created by Glen Canyon Dam in 1963, is the major water feature of GLCA (Figure 1). The major sources of inflow to Lake Powell include the Colorado River, San Juan River, Dirty Devil River, and Escalante River. The total drainage area above Glen Canyon Dam is approximately 112,000 square miles (mi^2). At a maximum pool of 1,128 meters (m) (3,700 feet) (ft) in elevation, Lake Powell covers a surface area of 660 square kilometers (km^2) (255 mi^2), stores a volume of 33 billion cubic meters (m^3)(27 million acre feet) of water, and has over 3,000 km (1,900 mi) of shoreline. Lately, the normal pool of Lake Powell has ranged between 1,103 - 1,118 m (3,620 - 3,670 ft), with a storage volume as low as 16 billion m^3 (13 million acre-feet [ac-ft]) in February, 1993, during a recent drought. Lake Powell is characterized as a warm monomictic lake, mixing once a year during winter, with advective circulation due to density differences between spring and winter inflows. Typically, the waters of Lake Powell are moderately saline and low in nutrients.

GLCA receives an average of six to seven inches of precipitation per year; however, the Colorado River drains some areas which receive considerably more annual precipitation. Spring snowmelt and summer thunderstorms are the primary sources of natural hydrologic adjustments in Lake Powell and its contributing rivers. Irrigation withdrawals and dam operations upstream, and the operation of Glen Canyon Dam, are the primary sources of artificial level adjustments in Lake Powell. In 1993, GLCA had 3.58 million visitors, and 4 million were expected in 1994.

Figure 1. Glen Canyon National Recreation Area



METHODOLOGY

Field Sampling

The majority of sampling sites on Lake Powell were selected because they had a history of high visitor use and/or high fecal coliform counts in the past (Figures 2, 3 and 4). Also, some sites which sustain little historical use, and have expected low counts were chosen as control sites. Forty-two sites were sampled in 1988, 46 sites in 1989, 49 sites in 1990, 63 sites in 1991, 44 sites in 1992, and 52 sites in 1993. A list of site identification codes and site names is included in Appendix A. Prior to 1992, sampling occurred only during the peak visitation period from May through September. Beginning in the winter of 1992-1993, sampling was done year round at sites which showed high counts during the summer of 1992. In 1992 and 1993, samples were collected once every two weeks, and immediately following holiday weekends at most sites. Some sites were only sampled once a month. When a sample had greater than or equal to 200 cfu/100 mL, the site was resampled until the samples dropped below 200 cfu/100 mL.

Samples were collected by boat where the water depth was four feet (Miller and Pinnock 1991; Tinkler 1992; Tinkler 1993). Beginning in 1993, a Van Dorn water sampler was used to collect water four inches below the water surface. Subsamples of 50 mL and 100 mL were extracted from this larger sample and put in plastic bottles which had been sterilized for 15 minutes at a temperature of 270°F. Sampling bottles and equipment were sterilized up to two weeks prior to sampling. Sampling date, sampling time, weather, air temperature, water temperature, location use, location condition, lake elevation, and turbidity were recorded on data sheets.

Sample Handling

Once the water samples were put in sterilized plastic bottles, they were packed on ice (Miller and Pinnock 1991; Tinkler 1992; Tinkler 1993). When all the samples were collected in one area, the samples were transported by boat and plane to one of the two laboratories in GLCA. Through 1991, there was only one laboratory which was housed in the Wahweap maintenance area. In 1992, an additional laboratory was established at Hite, and in 1993 this laboratory was moved to Bullfrog. In 1993, samples from 32 downlake sites were analyzed at the Wahweap laboratory and samples from 20 uplake sites were analyzed at the Bullfrog laboratory. Samples were transported to the laboratories as quickly as possible so that they could be analyzed as close as possible to the six-hour time-limit recommended by *Standard methods for the examination of water and wastewater* (APHA 1985) in order to avoid "unpredictable changes". The establishment of the second laboratory at Bullfrog greatly assisted in enabling the samples to be analyzed within six hours after collection. In 1993, the time each sample was processed was recorded on the data sheet. This new procedure permitted monitoring the elapsed time between sample collection and analysis in order to check the validity of the fecal coliform results.

Figure 2. Glen Canyon National Recreation Area - South

Water Quality Sampling Sites

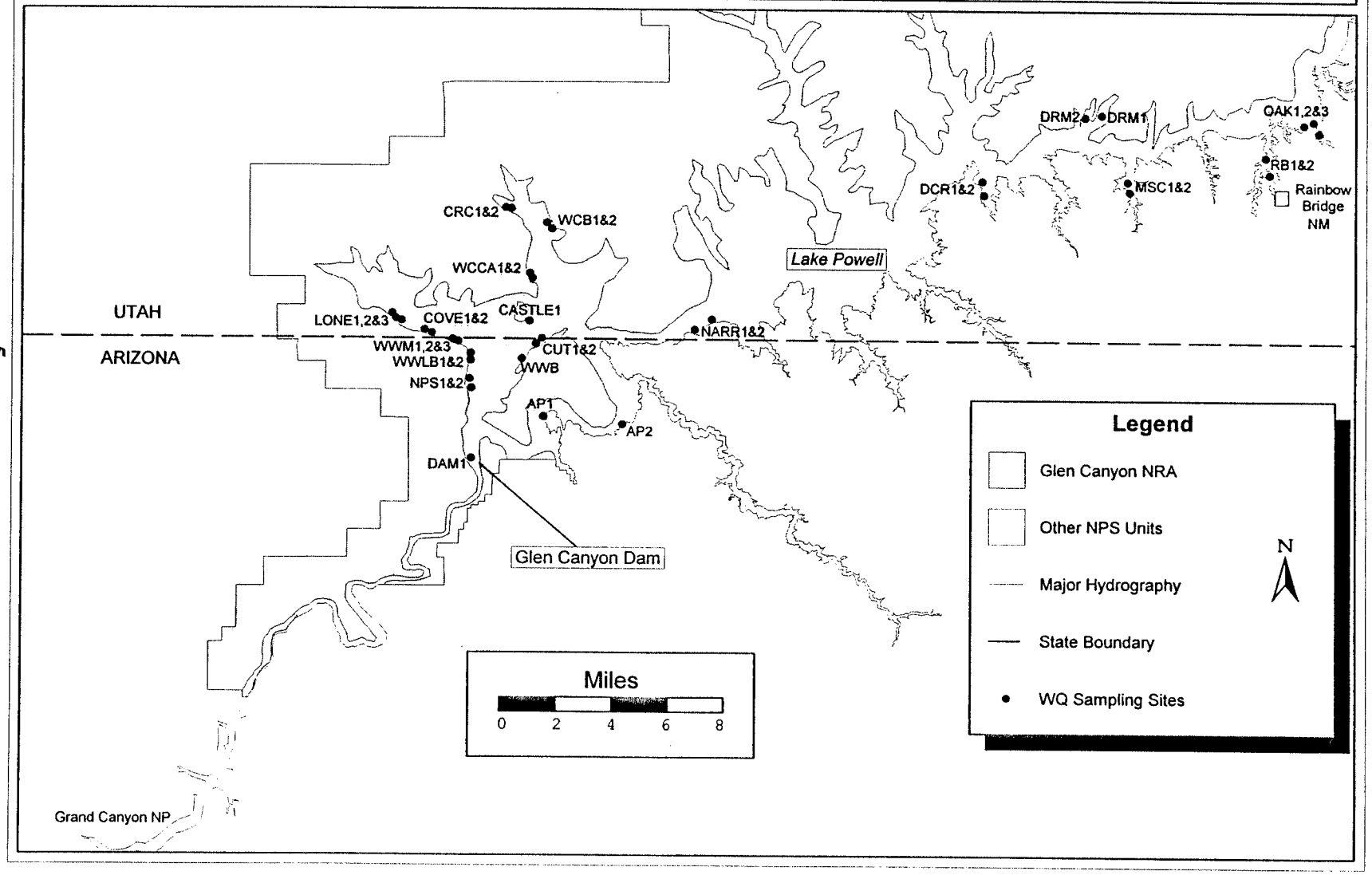


Figure 3. Glen Canyon National Recreation Area - Middle

Water Quality Sampling Sites

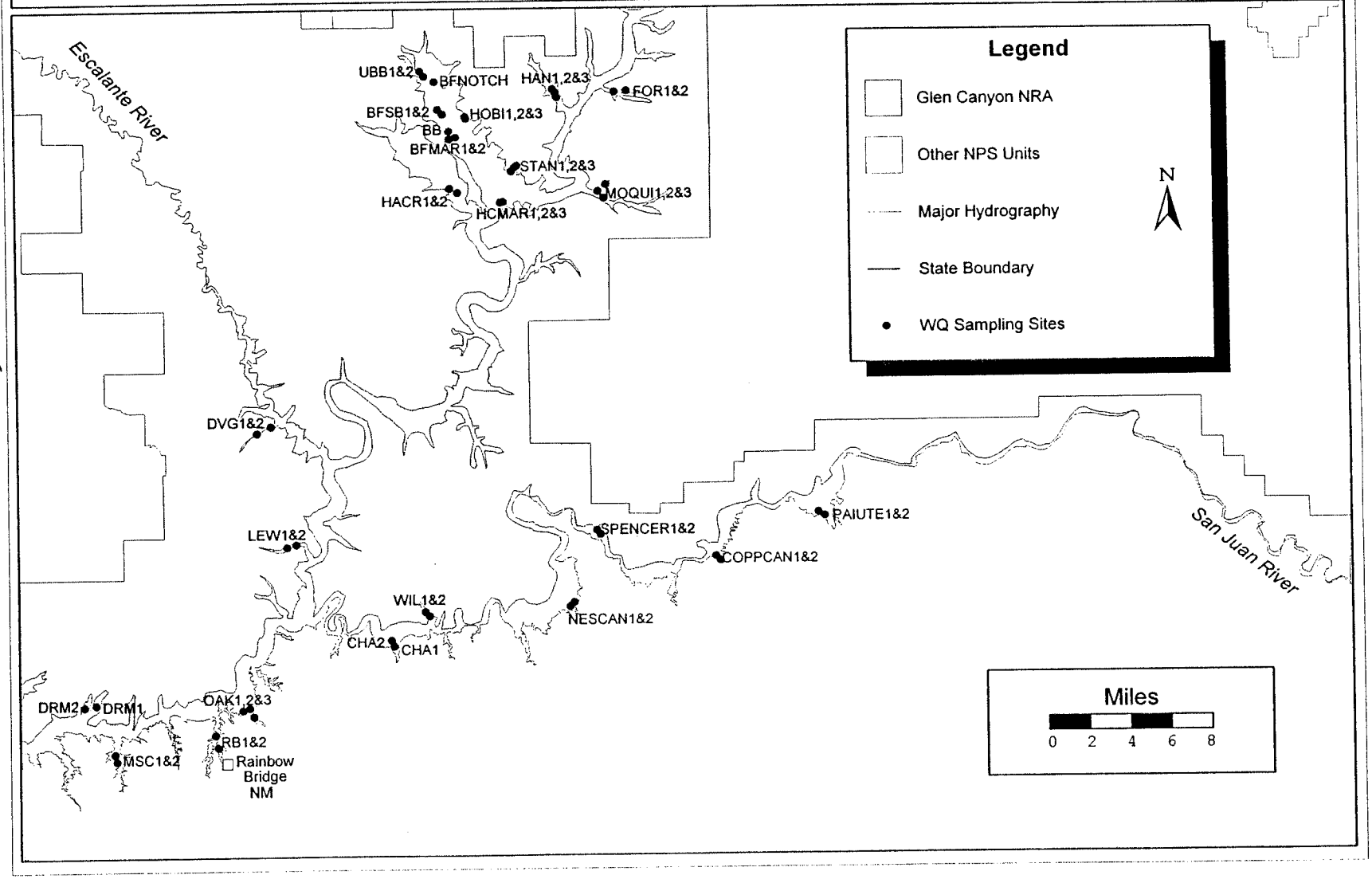
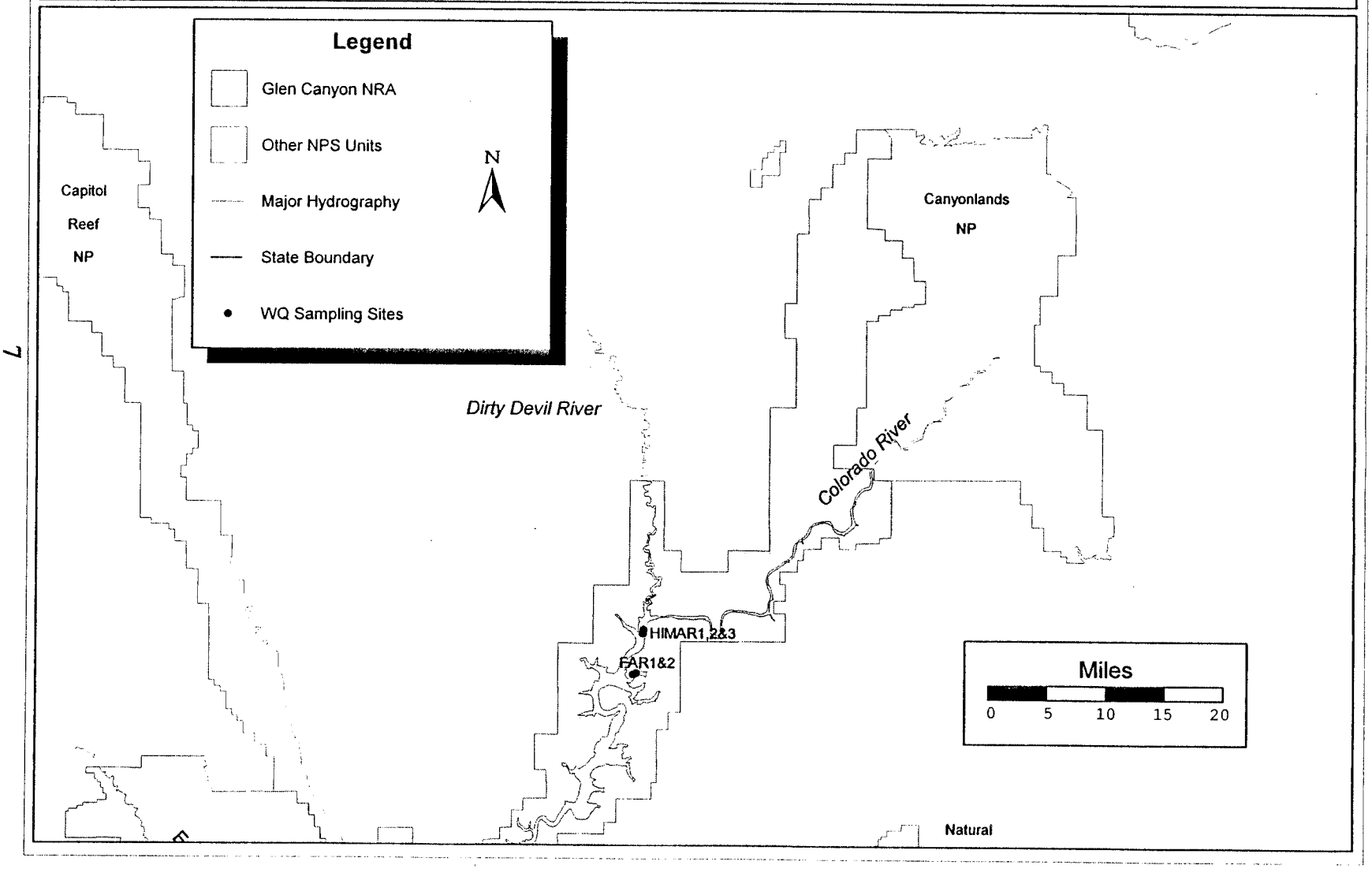


Figure 4. Glen Canyon National Recreation Area - North

Water Quality Sampling Sites



Laboratory Analysis

The Membrane Filter (MF) technique was used to analyze water samples for fecal coliform (Miller and Pinnock 1991; Tinkler 1992; Tinkler 1993). These analyses were conducted in accordance with the procedures in *Standard methods* (APHA 1985). A detailed description of the laboratory procedures used by GLCA is given in *Water laboratory quality control program, Glen Canyon National Recreation Area* (Tinkler et al. 1993).

In 1988 and 1989, water samples were tested for fecal streptococci as well as fecal coliform. The fecal coliform/fecal streptococci ratio was used to determine whether the source of the contamination was human or animal. Analysis for fecal streptococci was discontinued in 1990 because: (1) fecal streptococci counts were relatively low, (2) most sites were thought to be contaminated by human sources, and (3) there is no regulatory standard for fecal streptococci.

Data Management

All water quality sampling data were entered by GLCA into separate database files for each year in DBASE III+ software format. In order to conduct statistical analyses for the entire period of record, the six separate files were merged into a single file named ARCHIVE.DBF using DBASE IV software. This merged file contained the following information: site identification code, sampling date, sampling time, time sample was filtered in the laboratory, site name, weather, air temperature, wind, clarity of the water, choppiness of the water, number of boats, number of vehicles, number of people, site usage, number of sanitary stations, condition of the site, water elevation, water temperature, turbidity, fecal coliform count, fecal streptococci count, and fecal coliform/fecal streptococci ratio. Not all of these parameters were recorded for all years. Several changes were made to the data in this merged file. Field lengths and names were standardized prior to appending each file. Site identification codes were standardized (some of these codes had changed over the years as different people performed the sampling and laboratory analyses from year-to-year). Site names were added to the file. Since DBASE III+ and IV replaced blank numeric fields with zeros, it was impossible to distinguish missing data from actual zeros. Consequently, all zeros known to be missing data were replaced with -9s. Since -9 cannot be a real value for most parameters, it should be clear that these represent missing data. Several data entry errors were corrected by checking suspect values against the data sheets, and the database was sorted by site identification code and date. Lastly, data values reported as "too numerous to count" (TNTC) were changed to 1,000 cfu/100 mL for statistical purposes.

Once the data in the merged file had been corrected and standardized, two analysis files (ANALYSIS.DBF and ANALGEOM.DBF) were created from the ARCHIVE.DBF file. Fecal coliform counts in ANALYSIS.DBF were averaged when more than one sample was collected in a single day. Field names in this file were shortened to eight characters and some descriptive fields were deleted. This file was used for the summary statistics and

correlation analysis, and to generate box-and-whiskers plots. ANALGEOM.DBF contained only the following three fields: site identification code, date, and fecal coliform count. Duplicate fecal coliform values were included in this data set, and a text version of the file was used in the geometric mean analysis. Descriptions of text, graphic, program, and database files which were used in the report are included in Appendix B. Detailed file structures for all database files are contained in Appendix C.

In addition, all data included in the ARCHIVE.DBF file were uploaded into the Environmental Protection Agency's national database STORET. Stations in STORET were created for each site and all data labeled with STORET parameter codes (see file structures in Appendix C) were entered into the database. Data from this database are available to all federal and state agencies. Other information related to the STORET database, and data that reside in STORET, can be found in the *Baseline water quality data inventory and analysis report for Glen Canyon NRA* (National Park Service 1994).

Summary statistics were performed on the fecal coliform data (ANALYSIS.DBF with duplicates averaged) in order to determine the following annual and period-of-record statistics: mean, standard deviation, 10th percentile, 25th percentile, median, 75th percentile, 90th percentile, minimum, and maximum (Appendix E). These statistics were calculated using the Proc Univariate procedure in SAS software, version 6.03. A Pearson correlation matrix and regression plots (Appendix F) were produced by SYSTAT software, version 5.03.

Annual box-and-whiskers plots (Appendix E) were produced by SigmaPlot software, version 1.02a. For the box-and-whiskers plots, the solid horizontal lines within the box represented the median value of the data group. The dashed horizontal line represents the mean value. The bounds of the box represents the 25th and 75th percentiles of the data values. The whiskers display the range of data values which fall within the 10th and 90th percentiles. Data values outside the 10th and 90th percentiles are plotted as solid dots. In order for a site to generate a annual box-and-whisker plot, it must have had a minimum of two years of data containing three or more values per annum. In addition, SigmaPlot requires a minimum of three values to compute the 25th and 75th percentiles, five values to compute the 10th percentile, and six values to compute the 90th percentile.

Geometric mean tables and time series graphs (Appendix G) were generated using a geometric mean program developed by Dean Tucker of WRD. This program averaged duplicate fecal coliform samples and calculated a geometric mean using the formula:

> **Geometric Mean = antilog [1/n (log sample 1 + log sample 2 + log sample 3 + log sample 4 + ... log sample n)], where n is the number of sample observations**

The criterion used for calculating a valid geometric mean was greater-than or equal to five samples in a 30-day period. Data values that met this criterion are represented by box

symbols on the geometric mean graphs and values that didn't meet this criterion are represented by plus symbols. Geometric mean values were compared with the Utah and Arizona state water quality standards for fecal coliform of 200 cfu/100 mL (state of Utah 1994; state of Arizona 1992). Fecal coliform standard tables are included in Appendix H for use designations that apply to Lake Powell, in each state.

RESULTS

Summary Statistics

Fecal Coliform Bacteria—Fecal coliform results were highly variable, typical of bacteria data. Average colony counts ranged from a high of 1,412 cfu/100 mL to a low of zero (or "none detected"). One duplicate sample collected from Hobi Cat Beach in 1991 contained 1,840 cfu/100 mL. Average colony counts greater-than or equal to 1,000 cfu/100 mL were measured at several beaches during 1988-1993, including: Antelope Point Beach, Bullfrog Marina, Cha Canyon, Dangling Rope Marina, Davis Gulch, Farley Canyon, Hansen Creek, Hite Marina, Hobi Cat Beach, Llewellyn Gulch, Lone Rock, Moqui Canyon, Mountain Sheep Canyon, Government Housing, Oak Canyon, Rainbow Bridge, Stanton Creek, Upper Bullfrog Bay, and Wilson Creek. The highest median colony counts were from samples collected at Bullfrog Marina #2, Cha Canyon #1, Davis Gulch #1, Forgotten Gulch #1, Hansen Creek #1, #2 and #3, Hobi Cat Beach #1, Llewellyn Gulch #1 and #2, Lone Rock #2, Moqui Canyon #1, Oak Canyon #1, Rainbow Bridge #1, Stanton Creek #2, and Wahweap Marina #1 and #2. The lowest median colony counts were from samples collected in Copper Canyon, The Narrows, Neskahi Canyon, Paiute Farms, and Spencer Camp. No fecal coliform colonies were detected in 408 out of 2,420 averaged samples (17%). Summary statistical tables and annual box-and-whisker plots for each site are presented in Appendix E. It is interesting to note that, in general, higher maximum values were measured in 1991, and higher median values were measured in 1992. This phenomenon may be the result of actual bacteria fluctuations due to natural and/or human caused events, or possibly sample handling problems.

Fecal Streptococci Bacteria—Fecal streptococci colony counts were relatively low during 1988 and 1989, possibly due to mortality of the colonies and/or minor contributions of bacterial contamination by animal sources. Again, colony counts ranged from a high of over 1,000 cfu/100 mL to a low of zero (Appendix E). Median values were highest in Cha Canyon, Copper Canyon, Farley Canyon, Hite Marina, Lone Rock, Moqui Canyon, Neskahi Canyon, Paiute Farms, Spencer Camp, and Warm Creek Cattle Area. No fecal streptococci colonies were detected in 250 out of 384 samples (65%). Since the park discontinued sampling for fecal streptococci after only two years of sampling, which resulted in few samples to analyze, no further analyses were conducted or conclusions made on these data.

Fecal Coliform/Fecal Streptococci (FC/FS) Ratio—FC/FS ratios were calculated for the data collected in 1988 and 1989 (Appendix E). Based on this analysis, FC/FS ratios consistently were less than 0.7 during 1988, which indicated contamination from animal sources (APHA 1985). In 1989, FC/FS ratios varied from 0.001 to 73.0, which indicated contamination

from a mixture of animal and human sources. However, the FC/FS ratios in Appendix E are biased because no ratios were calculated when either value was zero.

Fecal Coliform Geometric Mean Standards Analysis

The geometric mean standards analysis identified 75 violations of state of Utah water quality standards for fecal coliform bacteria at 18 sites (Appendix G). Seven violations occurred at six sites in Hansen Creek, Moqui Canyon, and Stanton Creek during 1991. Sixty-seven violations (89% of the total) occurred at 13 sites in Davis Gulch, Farley Canyon, Forgotten Canyon, Hite Marina, Llewellyn Gulch, Moqui Canyon, Oak Canyon, and Upper Bullfrog Bay during 1992. Geometric means from Llewellyn Gulch exceeded the standard of 200 cfu/100 mL, seventeen times during 1992. One violation occurred at Hobi Cat Beach during 1993. One hundred and seventy-seven geometric means were calculated which met the criterion of five samples within 30 days. The geometric means ranged in value from a high of 531 cfu/100 mL at Hansen Creek #2 to a low of 12 cfu/100 mL at Wahweap Lodge Beach #2. Obviously, a significant factor in this analysis was the number of samples collected within a 30-day period. Some sites with potential exceedences of water quality standards did not post violations because they were sampled too infrequently.

Fecal Coliform Correlation Analysis

The correlation analysis produced a Pearson correlation matrix, a matrix of probabilities, and a frequency table which compared relationships between the variables: air temperature, number of boats, number of vehicles, number of people, site usage, water elevation, water temperature, turbidity, and average fecal coliform count (Appendix F). None of the correlations with fecal coliform were statistically significant; therefore, no conclusions were drawn regarding factors which may explain bacteria fluctuations at these sites, or model and predict potential concern levels using visitor use or other environmental variables. Additional data for environmental and visitor-use parameters would be required to make these determinations.

DISCUSSION AND RECOMMENDATIONS

Significance of Water Quality Indicators

Fecal coliform bacteria was the primary parameter sampled to assess the sanitary conditions of shoreline recreational bathing and boating waters in GLCA. Fecal streptococci bacteria were sampled during 1988 and 1989, but not thereafter due to the reasons previously stated. In addition, fecal coliform/fecal streptococci ratios were calculated; however, their significance in determining potential sources of contamination has been questioned because of potential sample pH, salinity, and fecal streptococci total count and survival capacity influences (U.S. Environmental Protection Agency 1978). For example, if fecal streptococci counts are less than 100 cfu/100 mL, ratios should not be applied. *Standard methods for the*

examination of water and wastewater (APHA 1989) recommends that FC/FS ratios should not be used as a means of differentiating between human and animal sources of pollution.

Recent guidelines have suggested that E. coli and enterococci be used instead of fecal coliform (U.S. Environmental Protection Agency 1986). E. coli and enterococci are better indicator species for pathogens in fresh and marine waters, and criteria have been established which eventually may be adopted by all states. WRD recommends that GLCA continue with fecal coliform monitoring until such time as the states of Utah and Arizona change their regulatory standards for bacteria water quality.

Water Quality Standards Compliance

The water quality standards evaluation proved valuable in assessing chronic bacteria problems at individual sites and regulatory compliance with state water quality standards. Based on this evaluation, it appears that the state of Utah 30-day geometric mean fecal coliform water quality standard was exceeded multiple times at Farley Canyon, Forgotten Canyon, Hansen Creek, Hite Marina, Llewellyn Gulch, Moqui Canyon, Stanton Creek, and Upper Bullfrog Bay. However, insufficient numbers of water samples were collected per annum at some sites with potential bacteria contamination problems to adequately assess compliance with water quality standards. For example, Cha Canyon summary statistical data (e.g. mean, median, percentiles, etc.) exhibited high bacteria levels, but did not meet the criterion used for calculating valid geometric means as specified by state water quality standards. Other sites exhibited high median coliform counts during individual years where few samples were collected.

If the primary objective of the bacteria monitoring program is to assess compliance with water quality standards to warn users of potential health risks, then WRD recommends that GLCA consider modifying their sampling program to collect a greater number of samples on a more frequent basis from a fewer number of high priority locations. This would allow the calculation of more geometric mean values to assess compliance with state standards, and strengthen the validity of management decisions related to posting warnings or closing beaches.

Characterization of Water Quality Trends

Summary statistical tables and annual box-and-whisker plots were used to assess water quality trends (Appendix E). Based on these results, it appears that fecal coliform bacterial contamination was widespread at several bathing beaches and marinas during 1991 and 1992, particularly during August of 1992. In 1993, bacteria levels were dramatically lower than the two previous years, which seems to coincide with a greater than 50-foot rise in the level of Lake Powell. However, park staff reported that some site locations change with varying lake levels, and trend results from those sites may be difficult to substantiate (Dodson, pers. com.).

No time series analyses were performed due to the lack of data required to report significant time trends. Also, seasonal analyses of these data were not performed due to low numbers or absence of data in two of the four hydrologic seasons used by WRD in the *Baseline water quality data inventory and analysis report for Glen Canyon NRA* (National Park Service 1994). WRD recommends that GLCA consider sampling during all hydrologic seasons, at varying intensities, to assess seasonal patterns in bacteria water quality.

Field Sampling and Laboratory Analysis Protocols

Field sampling, sample handling, and laboratory analysis procedures have improved significantly during the water quality monitoring effort from 1988 to 1993. Consequently, confidence in the accuracy of the fecal coliform counts has increased each year. A manual prepared in August 1993, titled *Water laboratory quality control program, Glen Canyon National Recreation Area*, is a good aid to ensure consistency in sampling and analysis methods among field staff, and between the two laboratories. The establishment of a second laboratory in the northern portion of the lake assisted in decreasing the time between sampling and analysis to within the six-hour limit recommended by *Standard methods* (APHA 1989), in most cases. Also, the hiring of water quality technicians in 1992 improved consistency in sampling dates and procedures.

Duplicate samples were collected at most sites during most years. Two sample volumes (50 mL and 100 mL) were filtered for each site. Occasionally, replicate samples of 25 mL and 50 mL were filtered at sites with elevated bacterial counts. Seven methods of quality assurance/quality control were used in the laboratory analyses (Tinkler et al. 1993). These were: (1) a positive control designed to show that the condition of the media and the water bath are conducive to the growth of *Escherichia coli*, (2) a negative control *Enterobacter aerogenes* which should show no growth at appropriate incubator temperature, (3) UV controls to determine if the UV sterilizer was working properly, (4) blank controls to ensure buffer sterility and lack of contamination, (5) a media control, (6) rinse controls, and (7) final rinse controls. All controls operated properly in 1993 with the exception of the positive control on September 7, 1993. In 1992, the blank and media controls worked properly, but the positive control failed on two dates (May 27, 1992, at the Hite laboratory, and July 15, 1992 at the Wahweap laboratory). The negative control failed 65 percent of the time at the Wahweap laboratory and 80 percent of the time at the Hite laboratory. The UV control failed 65 percent of the time at the Wahweap laboratory and 60 percent of the time at the Hite laboratory.

Several problems were noted in 1991. In regard to field sampling and sample handling, samples were taken at improper depths, propellers were allowed to stir up bottom sediments where samples were collected, sample bottles were not stored in adequate amounts of ice after the samples were collected, and samples were not returned to the laboratory in adequate time to keep the samples viable. Positive and negative controls consistently failed in the park laboratory. These controls were obtained from a state of Arizona laboratory in Flagstaff,

and checked there for viability. For an unknown reason, the controls did not work well in the park laboratory and failed to produce colonies of the proper color.

WRD recommends that the park continue to improve their laboratory procedures for data validation as detailed in the park manual. In addition, WRD recommends that expanded subsample dilutions (e.g., 1/10/100 mL, 1/50/100 mL, 0.1/1/10/100 mL, etc.) be extracted from future samples collected at historically contaminated sites to eliminate the 1,000 cfu/100 mL ceiling for plates which are "too numerous to count". Sample volumes for fecal coliform testing should yield approximately 20 to 60 colonies and not more than 200 colonies per filter (APHA 1989; Border et al. 1978). It is relatively easy to accurately measure bacteria colony counts of several thousand using dilution techniques.

Data Management Protocols

It is important to standardize the site identification codes and consistently use them from year to year so that all the data gathered from a site are attributed to the correct site. Data in the computer files should be checked at least once, preferably by a different person than the one who performed the data entry. This is an important step in insuring the accuracy of the data set before any analyses are preformed. When entering data into numeric fields, a substitute number such as -9 or -99, should be inputted for missing data to prevent blank records from being converted to zeros by DBASE III+. Also, it is helpful to sort or index the files by site identification code and date.

WRD recommends that GLCA use the files attached to this report and discard any older files of the same data. New files which are created can be appended to the master file, but will need to have the same database structure as the master file (Appendix C), and have -9s substituted for missing values before they are appended. Currently, WRD is developing a park-based Water Quality Data Management System software program for use on personal computers which is designed to assist parks in managing their water quality data in standardized formats. This user-friendly program should be available to parks in 1995.

CONCLUSIONS

GLCA is fortunate to have the support from management and staff to establish and maintain a long-term bacteria monitoring program in Lake Powell to ensure that recreational users and resources are safeguarded. Bacteria monitoring, with the objective to warn recreational users of unsafe conditions, is very difficult to accomplish; especially in sparsely populated areas where visitors are relatively unmanaged. Sampling, alone, doesn't necessarily predict when contamination levels may be high enough to impact human health and other natural resources, such as aquatic organisms and avian wildlife. The next step is perhaps the most difficult step, and poses the following two questions. (1) How can we identify ranges of measurable parameters which appear to relate to, or can be correlated with high, medium and low bacteria levels in different parts of the lake? Although water temperature, runoff, and dilution have an effect on bacteria levels, discharge of human waste by recreational users is

likely the primary source of bacteria in Lake Powell. Since bacteria levels are expected to be highest during heavy-use periods, park staff should schedule rigorous sampling during holiday weekends in the summer. (2) How do we use a series of these measurements to predict a corresponding response in bacteria levels early enough to post warnings or close beaches prior to the analyses of samples containing threatening bacteria levels? Automated sampling systems which are linked telemetrically to satellites or other relay stations may be the most practical solution for early warning devices. However, these types of platforms and sensors are very expensive and difficult to maintain. In addition, measured or predicted bacteria levels don't necessarily preclude erroneous conclusions regarding disease susceptibility without rigorous testing to statistically correlate bacteria counts with disease outbreaks from various pathogens.

The current database does not provide sufficient data to make these types of predictions with any confidence. Several of the parameters which were measured, such as visitor use and lake level, may offer information which could help the park infer that bacteria contamination may be a concern at certain beaches at certain times. However, none of the parameters were strongly correlated with bacteria counts. The lack of standardized visitor use indices and sufficient seasonal lake level and bacteria data probably contributed to the weak statistical relationships. More frequent sampling of these parameters is required to provide sufficient data for statistical comparisons. In addition, more emphasis on standardization of these indices and measurements in association with bacteria monitoring during various recreational use periods, hydrologic seasons, and periods of lake level adjustments is needed before predictive models can be developed to assist those making management decisions. Accumulated visitor use during the week prior to sampling may be a better indicator than use on the day of sampling. Lake level adjustments coupled with rainfall indices may provide better inputs for early warning models than visitor use, especially in areas where visitor management is logistically difficult. Lastly, the successful implementation of a program which achieves these objectives may require additional trained staff and resources at the park level.

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APPENDICES

Appendix A

Site Identification Codes and Site Names

The following table provides the site names corresponding to the site identification codes used in this report.

List of Site IDs and Site Names for GLCA Water Quality Sampling Locations	
SITE ID	**SITE NAME**
AP1	Antelope Point Beach
AP2	Antelope Point Intake
BB	Bullfrog Bay
BFMAR1, BFMAR2	Bullfrog Marina
BFNOTCH	Bullfrog
BFSB1, BFSB2	Bullfrog
CASTLE1	Castle Rock
CHA1, CHA2	Cha Canyon
COPPCAN1, COPPCAN2	Copper Canyon
COVE1, COVE2	The Coves
CRC1, CRC2	Crosby Canyon
CUT1, CUT2	The Cut
DAM1	The Dam
DCR1, DCR2	Dungeon Creek
DRM1, DRM2	Dangling Rope Marina
DVG1, DVG2	Davis Gulch
FAR1, FAR2	Farley Canyon
FOR1, FOR2	Forgotten Canyon
HACR1, HACR2	Halls Creek Bay
HAN1, HAN2, HAN3	Hansen Creek
HCMAR1, HCMAR2	Halls Crossing Marina
HIMAR1, HIMAR2, HIMAR3	Hite Marina
HOBI1, HOBI2, HOBI3	Hobi Cat Beach

List of Site IDs and Site Names for GLCA Water Quality Sampling Locations	
SITE ID	**SITE NAME**
LEW1, LEW2	Llewellyn Gulch
LONE1	Lone Rock Beach North
LONE2	Lone Rock Beach Middle
LONE3	Lone Rock Beach South
MOQUI1, MOQUI2, MOQUI3	Moqui Canyon
MSC1, MSC2	Mt. Sheep Canyon
NARR1, NARR2	The Narrows
NESCAN1, NESCAN2	Neskahi Canyon
NPS1, NPS2	Government Housing
OAK1, OAK2, OAK3	Oak Canyon
PAIUTE1, PAIUTE2	Paiute Farms
RB1, RB2	Rainbow Bridge
SPENCER1, SPENCER2	Spencer Camp
STAN1, STAN2, STAN3	Stanton Creek
UBB1, UBB2	Upper Bullfrog Bay
WCB1, WCB2	Warm Creek Beach
WCCA1, WCCA2	Warm Creek Cattle Area
WIL1, WIL2	Wilson Creek
WWB	Wahweap Bay
WWLB1, WWLB2	Wahweap Lodge Beach
WWM1, WWM2, WWM3	Wahweap Marina

Appendix B

Computer Files Transmitted With

Water Quality Data Analysis Report

The three computer disks accompanying this report include seven compressed (ZIP) files containing digital copies of all the tables, figures, and other materials used to produce this report. To decompress these files, you must use the commonly available shareware program PKUNZIP. The command to type at the DOS prompt is:

PKUNZIP -E *COMPRESS.ZIP FILENAME.EXT*

where COMPRESS.ZIP is the name of one of the seven compressed (ZIP) files listed below and FILENAME.EXT is the name of the file you wish to extract. If you want to decompress all of the files in COMPRESS.ZIP, simply omit the FILENAME.EXT. To simply obtain a listing of all the files compressed into a particular ZIP file, type the following:

PKUNZIP -V *COMPRESS.ZIP* | MORE

where COMPRESS.ZIP is the name of one of the seven compressed (ZIP) files listed below. Once you see the file you wish to obtain, substitute this file name for FILENAME.EXT in the first command line to extract and decompress this particular file.

The following seven compressed (ZIP) files are included on the disks accompanying this report:

(1) GLCADATA.ZIP

This compressed file contains three DBASE III+ and one ASCII file containing all data received from GLCA. Detailed database structures for each of the DBASE III+ files are found in Appendix C. In the DBASE III+ files, missing data are represented by -9s. The files compressed into this file include:

(a) ARCHIVE.DBF - All data for each site for the period from May 1988 to January 1994.

(b) ANALYSIS.DBF - This file is a subset of the data contained in ARCHIVE.DBF. It contains the data used in the SAS statistical analysis. Fecal coliform results from samples taken on the same day were averaged, field names were shortened to 8 characters, and some fields unnecessary for the statistical analysis were deleted.

(c) ANALGEOM.DBF - This file is also a subset of the data contained in ARCHIVE.DBF. It contains only three fields - site id, date, and colcount. Duplicate samples were not averaged.

(d) ANALGEOM.TXT - This is the same file as ANALGEOM.DBF, but in ASCII text format, and is the file that was run through the geometric mean program.

(2) GLCAPRGM.ZIP

This compressed file contains two executable files written in BASIC and ASSEMBLY language that were used by WRD to compute geometric means and generate plots. The programs are not finished products and do not have documentation or support. These files include:

(a) GEOMEAN.EXE - Program which computes geometric means of input data.

(b) PLOTTHEM.EXE - Program which prints plots generated by the geometric mean program.

(3) GLCAMAP.ZIP

This compressed file contains the four maps which appear in this report (Figures 1-4). These files are in Windows Clipboard (CLP) format which can be imported and/or edited in most Windows-based word processors and graphics packages. The files included in this compressed file are named FIGURE_1.CLP, FIGURE_2.CLP, FIGURE_3.CLP, and FIGURE_4.CLP.

(4) GLCABOX.ZIP

This compressed file contains all of the box-and-whiskers plots which appear in this report. These files are in Windows Clipboard (CLP) format which can be imported and/or edited in most Windows-based word processors and graphics packages. The names of the files included in this compressed file combine the site identification codes for the two sites whose plots appear in the file. For example, AP1AP2.CLP is the file containing the box-and-whiskers plots for sites AP1 and AP2. Some of the site identification codes were abbreviated when they were more than four characters long.

(5) GLCAGEOM.ZIP

This compressed file contains all of the geometric mean plots which appear in this report. These files are in Computer Graphic Metafile (CGM) format which can be imported and/or edited in most word processors and graphics packages, including WordPerfect. The names of the files included in this compressed file have the prefix GEOM followed by two numbers indicating the sites whose plots appear in the file. For example, GEOM0102.CGM is the file containing the geometric mean plots for sites AP1 and AP2. The files are numbered in alphabetical order by site identification code. Sites with insufficient data do not have geometric mean plots.

(6) GLCAREG.ZIP

This compressed file contains the linear regression plots associated with the Pearson correlations. These files are in Windows Metafile (WMF) format which can be imported and/or edited in most Windows-based word processing and graphics

packages. These files include:

(a) REGE&T.WMF - Linear regression plots of average fecal coliform versus water surface elevation and turbidity.

(b) REGW&A.WMF - Linear regression plots of average fecal coliform versus water temperature and air temperature.

(7) GLCAREPT.ZIP

This compressed file contains all narrative portions of this report in WordPerfect Version 5.1 format files. These files include:

(a) GLCAREP.WP - Report text.

(b) AP_ABCD.WP - Appendices A, B, C, and D.

(c) AP_EFC.WP - Fecal coliform summary statistics table contained in Appendix E.

(d) AP_EFS.WP - Fecal streptococci summary statistics table contained in Appendix E.

(e) AP_EFCFS.WP - Fecal coliform/fecal streptococci ratio table contained in Appendix E.

(f) AP_F.WP - Pearson correlation matrix contained in Appendix F.

(g) AP_G.WP - Geometric mean table contained in Appendix G.

(h) AP_H.WP - Appendix H.

Appendix C

Water Quality Database File Structures

The following table provides the DBASE III+ database field structure for all the water quality data contained in ARCHIVE.DBF. These data will allow parks or other interested parties to replicate the statistical analyses and graphics contained in this report; perform more sophisticated analyses; or to establish a baseline park water quality database. Values equalling -9 in the database represent missing data.

ARCHIVE.DBF				
Field Name	**Field Type**	**Width/ # Decimal places**	**Parameter STORET No.**	**Field Description**
SITE_ID	Character	8		Identification code for sample location
DATE	Date	8		Date sample taken [mm/dd/yy]
TIME	Numeric	4		Time sample taken [hhmm]
TIMEPROC	Numeric	4		Time sample processed in lab [hhmm]
SITE_NAME	Character	25		Name of sample location
WEATHER	Character	6		Weather conditions at time of sampling
AIRTEMP	Numeric	3	00020	Temperature, air: °F
WIND	Numeric	2		Wind speed at time of sampling
CLARITY	Logical	1		Water clear or turbid
CHOPPY	Logical	1		Water choppy or not
BOATS	Numeric	3		Number of boats at time of sampling
VEHICLES	Numeric	3		Number of vehicles at time of sampling
PEOPLE	Numeric	3		Number of people at time of sampling
USE	Numeric	2		Number indicating degree of use at sample site

ARCHIVE.DBF				
Field Name	**Field Type**	**Width/ # Decimal places**	**Parameter STORET No.**	**Field Description**
SANIST	Numeric	3		Sanitation present or absent on boats
CONDITIONS	Character	80		Other conditions related to sampling
ELEVATION	Numeric	7/2	50040	Elevation of water to MSL: feet
WATERTEMP	Numeric	2	00010	Temperature, water: °C
TURBIDITY	Numeric	4	82078	Turbidity, field: Nephelometric Turbidity Units (NTU)
COLCOUNT	Numeric	4	31616	Fecal Coliform, M-FC BROTH, 0.45 mm filter: cfu/100 mL
ST_REMARK1	Character	1		STORET remark codes for Fecal Coliform data
FSCOUNT	Numeric	4	31673	Fecal Streptococci, MF, AGAR at 35 °C: cfu/100 mL
ST_REMARK2	Character	1		STORET remark codes for Fecal Streptococci data
FCFSRATIO	Numeric	7/3	00111	Ratio of Fecal Coliform to Fecal Streptococci

The following table provides the DBASE III+ database field structure for ANALYSIS.DBF, the data file used for SAS analyses. These data will allow parks or other interested parties to replicate the statistical analyses and graphics contained in this report; perform more sophisticated analyses; or to establish a baseline park water quality database. Values equalling -9 in the database represent missing data.

ANALYSIS.DBF				
Field Name	**Field Type**	**Width/ # Decimal places**	**Parameter STORET No.**	**Field Description**
SITE_ID	Character	8		Identification code for sample location
DATE	Date	8		Date sample taken [mm/dd/yy]
TIME	Numeric	4		Time sample taken [hhmm]
AIRTEMP	Numeric	3	00020	Temperature, air: °F
WIND	Numeric	2		Wind speed at time of sampling
BOATS	Numeric	3		Number of boats at time of sampling
VEHICLES	Numeric	3		Number of vehicles at time of sampling
PEOPLE	Numeric	3		Number of people at time of sampling
USE	Numeric	2		Number indicating degree of use at sample site
SANIST	Numeric	3		Sanitation present or absent on boats
ELEV	Numeric	7/2	50040	Elevation of water to MSL: feet
H2OTEMP	Numeric	2	00010	Temperature, water: °C
TURBID	Numeric	4	82078	Turbidity, field: Nephelometric Turbidity Units (NTU)

ANALYSIS.DBF				
Field Name	**Field Type**	**Width/ # Decimal places**	**Parameter STORET No.**	**Field Description**
AVGFCOL	Numeric	4	31616	Fecal Coliform, M-FC BROTH, 0.45 mm filter: cfu/100 mL
REMARK1	Character	1		STORET remark codes for Fecal Coliform data
AVGFS	Numeric	4	31673	Fecal Streptococci, MF, AGAR at 35 °C: cfu/100 mL
REMARK2	Character	1		STORET remark codes for Fecal Streptococci data
AVGCSRAT	Numeric	7/3	00111	Ratio of Fecal Coliform to Fecal Streptococci

The following table provides the DBASE III+ database field structure for ANALGEOM.DBF, the data file used for the geometric mean analysis. These data will allow parks or other interested parties to replicate the geometric mean tables and plots contained in this report. The file ANALGEOM.TXT has the same field structure as ANALGEOM.DBF.

ANALGEOM.DBF				
Field Name	**Field Type**	**Width/ # Decimal places**	**Parameter STORET No.**	**Field Description**
SITE_ID	Character	8		Identification code for sample location
DATE	Date	8		Date sample taken [mm/dd/yy]
COLCOUNT	Numeric	4	31616	Fecal Coliform, M-FC BROTH, 0.45 mm filter: cfu/100 mL

Appendix D

STORET Remark Codes

The following is a list of STORET remark codes. These codes are found in the files ARCHIVE.DBF and ANALYSIS.DBF in the fields named ST_REMARK1 (or REMARK1) and ST_REMARK2 (or REMARK2).

STORET Remark Codes	
A	Value reported is the mean of two or more determinations
B	Results based upon colony counts outside the acceptable range
C	Value calculated
D	Indicates field measurement
E	Indicates extra samples taken at composite stations
F	In the case of species, F indicates female sex
G	Value reported is the maximum of two or more determinations
H	Value based on field kit determination; results may not be accurate
J	Estimated value; value not accurate
K	Actual value is known to be less than value given
L	Actual value is known to be greater than value given
M	Presence of material verified, negative value, or male sex
N	Presumptive evidence of presence of material
O	Sampled, but analysis lost or not performed
P	Too numerous to count
Q	Exceeded normal holding time
R	Significant rain in last 48 hours
S	Laboratory test
T	Value reported is less than criteria of detection
U	Indicates material was analyzed for but not detected, or undet. sex
V	Analyte was detected in sample and method blank
W	Value observed is less than lowest value reportable under "T" code
X	Value is quasi vertically-integrated sample
Y	Analysis of unpreserved sample
Z	Too many colonies were present; numeric value is filtration volume

Appendix E

Summary Statistics Tables

and Box and Whisker Plots

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
AP1	1988	4	5	7.5	0	1	2	9	16	0	16
AP1	1989	3	155	261.9	0	0	7	457	457	0	457
AP1	1990	7	7	6.9	0	1	5	15	18	0	18
AP1	1991	12	207	309.7	0	2	42	324	553	0	1000
AP1	1992	13	194	216.1	50	87	114	220	320	3	852
AP1	1993	6	96	165.2	0	1	24	105	424	0	424
AP1	1988-93	45	136	223.0	0	2	25	173	424	0	1000
AP2	1988	4	7	14.5	0	0	0	15	29	0	29
AP2	1989	3	0	0.0	0	0	0	0	0	0	0
AP2	1990	7	3	3.7	0	0	2	6	10	0	10
AP2	1991	12	109	228.0	1	1	15	111	189	0	806
AP2	1992	11	88	69.2	18	31	69	160	176	6	211
AP2	1993	5	212	441.2	0	2	3	54	1000	0	1000
AP2	1988-93	42	81	196.2	0	1	8	69	176	0	1000
BB	1992	10	71	71.8	0	1	68	116	174	0	206
BB	1993	9	41	100.2	0	0	1	7	304	0	304
BB	1992-93	19	57	85.3	0	0	1	106	206	0	304
BFMAR1	1991	10	175	302.0	5	17	80	148	639	1	1000
BFMAR1	1992	10	87	63.1	2	39	100	142	165	0	170
BFMAR1	1993	15	62	111.5	0	6	17	37	322	0	337
BFMAR1	1994	1	0	.	0	0	0	0	0	0	0
BFMAR1	1991-94	36	98	178.9	0	9	32	119	277	0	1000
BFMAR2	1991	10	186	302.2	6	25	54	223	638	3	1000
BFMAR2	1992	10	56	63.1	0	2	36	106	149	0	174
BFMAR2	1993	4	41	39.6	7	7	37	75	83	7	83
BFMAR2	1991-93	24	108	205.1	2	7	51	115	223	0	1000
BFNOTCH	1988	8	7	13.9	0	0	1	9	39	0	39
BFNOTCH	1989	6	0	0.0	0	0	0	0	0	0	0
BFNOTCH	1988-89	14	4	10.8	0	0	0	1	15	0	39
BFSB1	1988	8	6	8.0	0	2	4	6	25	0	25
BFSB1	1989	6	25	44.7	0	0	8	21	115	0	115
BFSB1	1988-89	14	14	30.0	0	1	4	13	25	0	115
BFSB2	1988	8	9	13.5	0	2	4	10	41	0	41

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
BFSB2	1989	6	34	75.3	0	2	4	8	188	0	188
BFSB2	1988-89	14	20	49.5	0	2	4	8	41	0	188
CASTLE1	1993	3	25	34.1	3	3	7	64	64	3	64
CHA1	1988	2	0	0.0	0	0	0	0	0	0	0
CHA1	1989	2	81	109.6	3	3	81	158	158	3	158
CHA1	1990	7	275	345.8	19	25	121	354	1000	19	1000
CHA1	1991	6	94	134.1	0	1	28	183	327	0	327
CHA1	1992	8	287	275.8	77	100	178	451	761	77	761
CHA1	1993	4	16	18.7	0	4	11	29	43	0	43
CHA1	1988-93	29	173	249.4	0	8	92	190	691	0	1000
CHA2	1988	2	0	0.0	0	0	0	0	0	0	0
CHA2	1989	2	8	9.2	1	1	8	14	14	1	14
CHA2	1990	8	396	436.6	20	25	212	839	1000	20	1000
CHA2	1991	7	41	56.0	0	0	3	82	143	0	143
CHA2	1992	2	185	104.7	111	111	185	259	259	111	259
CHA2	1988-92	21	183	316.0	0	1	27	143	678	0	1000
COPPCAN1	1988	2	0	0.0	0	0	0	0	0	0	0
COPPCAN1	1989	1	0	.	0	0	0	0	0	0	0
COPPCAN1	1988-89	3	0	0.0	0	0	0	0	0	0	0
COPPCAN2	1988	2	1	1.4	0	0	1	2	2	0	2
COPPCAN2	1989	1	0	.	0	0	0	0	0	0	0
COPPCAN2	1988-89	3	1	1.2	0	0	0	2	2	0	2
COVE1	1990	3	7	8.2	0	0	5	16	16	0	16
COVE2	1990	3	1	1.0	0	0	1	2	2	0	2
CRC1	1990	1	10	.	10	10	10	10	10	10	10
CRC2	1990	1	15	.	15	15	15	15	15	15	15
CUT1	1991	10	42	76.2	0	0	7	45	170	0	239
CUT1	1992	5	123	109.3	11	59	69	211	266	11	266
CUT1	1993	4	5	8.3	0	0	1	9	17	0	17
CUT1	1991-93	19	55	86.7	0	0	12	69	239	0	266
CUT2	1991	9	36	68.4	0	0	1	14	199	0	199
DAM1	1993	3	14	11.7	1	1	16	24	24	1	24
DCR1	1990	2	22	20.5	7	7	22	36	36	7	36

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
DCR1	1991	10	90	151.0	0	1	7	144	364	0	378
DCR1	1992	4	92	70.6	34	39	74	146	187	34	187
DCR1	1993	4	12	18.7	0	1	5	24	40	0	40
DCR1	1990-93	20	68	113.7	0	2	9	74	268	0	378
DCR2	1990	2	24	24.0	7	7	24	41	41	7	41
DCR2	1991	10	116	196.5	0	1	6	148	466	0	570
DCR2	1990-91	12	101	181.5	0	2	7	109	362	0	570
DRM1	1989	1	0	.	0	0	0	0	0	0	0
DRM1	1990	6	54	94.3	0	3	18	39	244	0	244
DRM1	1991	9	126	328.5	0	3	6	48	1000	0	1000
DRM1	1992	10	64	36.1	14	46	63	78	117	7	121
DRM1	1993	9	6	10.8	0	0	1	7	33	0	33
DRM1	1989-93	35	61	170.6	0	1	11	53	112	0	1000
DRM2	1989	1	3	.	3	3	3	3	3	3	3
DRM2	1990	5	23	29.2	0	2	17	23	72	0	72
DRM2	1991	9	137	325.4	0	3	10	81	1000	0	1000
DRM2	1992	11	102	133.2	22	34	56	86	224	11	465
DRM2	1993	8	34	52.1	0	1	11	51	150	0	150
DRM2	1989-93	34	81	184.3	0	3	29	72	150	0	1000
DVG1	1988	4	7	8.4	0	2	4	12	19	0	19
DVG1	1989	5	11	23.3	0	0	1	3	53	0	53
DVG1	1990	6	137	231.7	8	26	50	80	607	8	607
DVG1	1991	8	239	356.7	0	15	49	394	1000	0	1000
DVG1	1992	16	149	89.6	38	80	151	193	278	0	328
DVG1	1993	11	61	119.3	0	0	14	57	122	0	404
DVG1	1988-93	50	118	186.3	0	3	49	154	303	0	1000
DVG2	1988	4	9	8.0	0	3	9	16	18	0	18
DVG2	1989	3	53	81.6	1	1	11	147	147	1	147
DVG2	1990	5	33	38.6	10	10	20	22	101	10	101
DVG2	1991	8	70	114.1	4	17	30	57	348	4	348
DVG2	1993	11	4	6.1	0	0	1	4	13	0	18
DVG2	1988-93	31	31	67.0	0	1	11	22	62	0	348
FAR1	1988	7	35	76.9	0	0	3	22	208	0	208

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
FAR1	1989	5	12	15.0	1	1	4	16	36	1	36
FAR1	1990	8	11	27.9	0	1	1	2	80	0	80
FAR1	1991	12	341	382.2	4	51	110	592	1000	1	1000
FAR1	1992	19	229	160.3	0	94	238	342	480	0	489
FAR1	1993	9	12	11.5	1	2	8	19	30	1	30
FAR1	1988-93	60	149	232.2	1	1	26	235	485	0	1000
FAR2	1988	7	1	1.1	0	0	1	1	3	0	3
FAR2	1989	6	19	29.0	0	1	6	25	75	0	75
FAR2	1990	8	16	13.6	2	5	15	26	40	2	40
FAR2	1991	12	392	452.2	8	37	167	755	1000	5	1304
FAR2	1992	19	197	174.8	0	23	174	313	498	0	542
FAR2	1993	8	10	14.3	0	1	3	17	38	0	38
FAR2	1988-93	60	146	263.9	0	2	24	188	483	0	1304
FOR1	1990	8	45	53.3	0	8	37	54	166	0	166
FOR1	1991	10	141	242.8	1	4	40	118	561	0	755
FOR1	1992	16	183	145.4	1	11	209	295	316	0	464
FOR1	1993	10	22	42.1	1	1	4	26	87	0	136
FOR1	1990-93	44	112	159.1	1	3	34	175	304	0	755
FOR2	1991	10	124	159.9	2	8	69	203	385	1	500
FOR2	1992	2	284	5.7	280	280	284	288	288	280	288
FOR2	1993	9	20	36.4	0	1	7	21	114	0	114
FOR2	1991-93	21	95	136.2	1	4	23	114	280	0	500
HACR1	1991	4	226	258.1	5	7	195	445	508	5	508
HACR2	1991	3	99	84.7	3	3	133	162	162	3	162
HAN1	1990	9	70	72.8	9	12	45	92	217	9	217
HAN1	1991	16	282	304.2	3	8	131	581	687	3	806
HAN1	1992	12	92	101.8	1	2	67	162	200	1	298
HAN1	1993	10	52	85.8	1	1	14	77	192	0	270
HAN1	1990-93	47	144	212.6	1	5	45	182	500	0	806
HAN2	1991	16	309	351.1	2	10	239	517	1000	2	1000
HAN3	1991	1	72	.	72	72	72	72	72	72	72
HCMAR1	1990	8	45	56.0	5	9	26	58	170	5	170
HCMAR1	1991	9	108	166.3	4	8	29	115	522	4	522

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
HCMAR1	1992	10	49	58.2	0	0	16	106	126	0	142
HCMAR1	1993	12	31	83.1	0	2	9	13	14	0	294
HCMAR1	1994	1	6	.	6	6	6	6	6	6	6
HCMAR1	1990-94	40	55	99.5	0	4	11	92	155	0	522
HCMAR2	1990	8	19	20.3	4	6	13	25	64	4	64
HCMAR2	1991	9	78	123.8	3	21	31	75	397	3	397
HCMAR2	1992	10	49	55.4	0	0	29	90	125	0	146
HCMAR2	1993	9	25	33.6	0	3	7	32	93	0	93
HCMAR2	1990-93	36	44	71.9	0	4	17	66	98	0	397
HIMAR1	1988	7	5	11.4	0	0	1	3	31	0	31
HIMAR1	1989	6	1	2.4	0	0	0	1	6	0	6
HIMAR1	1990	8	30	38.1	0	4	12	53	104	0	104
HIMAR1	1991	12	345	424.5	10	13	128	786	1000	1	1000
HIMAR1	1992	19	248	179.4	0	21	294	416	470	0	532
HIMAR1	1993	10	20	41.5	0	1	3	6	91	0	129
HIMAR1	1988-93	62	151	249.3	0	1	15	236	440	0	1000
HIMAR2	1988	8	23	55.6	0	0	2	11	160	0	160
HIMAR2	1989	6	11	9.5	1	3	8	22	23	1	23
HIMAR2	1990	8	34	32.6	0	11	21	57	95	0	95
HIMAR2	1991	13	297	379.8	10	16	60	596	1000	2	1000
HIMAR2	1992	19	213	180.5	0	16	234	340	496	0	592
HIMAR2	1993	5	23	33.1	1	4	10	19	81	1	81
HIMAR2	1988-93	59	145	232.8	0	4	22	234	496	0	1000
HIMAR3	1991	12	345	404.4	0	20	156	731	1000	0	1000
HOBI1	1990	5	19	18.3	0	9	14	27	47	0	47
HOBI1	1991	11	121	98.0	3	25	101	227	227	1	285
HOBI1	1992	12	72	67.3	6	17	58	111	178	1	202
HOBI1	1993	16	131	232.6	0	3	20	100	497	0	782
HOBI1	1994	1	0	.	0	0	0	0	0	0	0
HOBI1	1990-94	45	97	153.0	1	8	46	117	227	0	782
HOBI2	1990	5	23	23.4	6	8	15	25	63	6	63
HOBI2	1991	12	199	393.5	2	6	79	177	298	2	1412
HOBI2	1992	12	68	55.9	10	15	61	121	143	8	148

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
HOBI2	1993	15	80	148.1	0	0	11	118	367	0	482
HOBI2	1994	1	0	.	0	0	0	0	0	0	0
HOBI2	1990-94	45	101	224.8	0	8	20	116	232	0	1412
HOBI3	1991	11	84	128.5	2	5	15	103	199	1	424
LEW1	1990	5	283	408.6	19	53	115	228	1000	19	1000
LEW1	1991	6	105	250.8	0	0	4	7	617	0	617
LEW1	1992	21	272	299.7	26	95	185	278	833	0	1000
LEW1	1993	11	20	38.1	0	1	3	24	57	0	122
LEW1	1990-93	43	185	281.9	0	3	71	201	617	0	1000
LEW2	1990	4	435	456.0	5	69	367	801	1000	5	1000
LEW2	1991	6	76	176.9	0	0	6	7	437	0	437
LEW2	1992	21	299	319.4	31	123	200	266	1000	0	1000
LEW2	1993	11	2	2.8	0	0	2	5	6	0	8
LEW2	1990-93	42	202	303.1	0	3	84	228	602	0	1000
LONE1	1988	9	1	1.3	0	0	1	1	4	0	4
LONE1	1989	6	0	0.5	0	0	0	1	1	0	1
LONE1	1990	8	25	36.2	0	3	9	35	107	0	107
LONE1	1991	11	81	84.3	3	3	66	132	214	1	250
LONE1	1992	25	128	158.3	3	49	91	140	241	0	774
LONE1	1993	15	26	55.9	0	0	3	18	101	0	204
LONE1	1988-93	74	63	112.6	0	1	11	91	159	0	774
LONE2	1988	9	14	17.0	0	1	7	23	49	0	49
LONE2	1989	6	232	567.6	0	0	1	2	1391	0	1391
LONE2	1990	9	120	187.1	2	16	41	89	561	2	561
LONE2	1991	10	118	107.5	1	28	89	180	291	1	305
LONE2	1992	25	114	98.5	3	58	94	150	189	0	426
LONE2	1993	15	42	73.6	0	0	4	61	177	0	239
LONE2	1988-93	74	98	186.5	0	2	46	119	239	0	1391
LONE3	1988	9	5	3.7	0	1	4	8	10	0	10
LONE3	1989	6	15	33.3	0	0	2	5	83	0	83
LONE3	1990	9	18	31.2	0	2	6	15	98	0	98
LONE3	1991	10	178	298.8	4	8	96	180	605	4	1000
LONE3	1992	25	140	191.3	4	78	99	135	185	0	1000

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
LONE3	1993	14	52	156.6	0	0	2	13	79	0	591
LONE3	1988-93	73	86	179.5	0	2	13	98	180	0	1000
MOQUI1	1988	2	13	6.4	8	8	13	17	17	8	17
MOQUI1	1989	3	26	24.0	2	2	26	50	50	2	50
MOQUI1	1991	7	518	297.3	37	341	558	644	1000	37	1000
MOQUI1	1992	18	210	190.5	0	5	180	376	499	0	564
MOQUI1	1993	10	18	35.7	1	1	7	15	69	0	118
MOQUI1	1988-93	40	192	246.1	1	5	44	359	561	0	1000
MOQUI2	1988	2	48	29.0	27	27	48	68	68	27	68
MOQUI2	1989	3	42	38.3	1	1	47	77	77	1	77
MOQUI2	1991	7	439	337.3	27	121	315	800	846	27	846
MOQUI2	1992	19	156	159.3	0	0	152	298	350	0	512
MOQUI2	1993	10	5	8.0	0	0	1	7	19	0	25
MOQUI2	1988-93	41	154	223.4	0	1	27	264	350	0	846
MOQUI3	1988	2	12	8.5	6	6	12	18	18	6	18
MOQUI3	1989	3	10	7.9	4	4	7	19	19	4	19
MOQUI3	1988-89	5	11	7.1	4	6	7	18	19	4	19
MSC1	1988	9	2	4.5	0	0	0	2	14	0	14
MSC1	1989	6	0	0.4	0	0	0	0	1	0	1
MSC1	1990	4	29	31.8	0	9	21	49	74	0	74
MSC1	1991	8	47	89.8	0	2	6	51	262	0	262
MSC1	1992	11	162	280.2	49	54	62	114	164	40	1000
MSC1	1993	10	21	60.6	0	0	1	2	100	0	193
MSC1	1988-93	48	52	150.3	0	0	2	57	114	0	1000
MSC2	1988	9	10	18.0	0	0	3	10	56	0	56
MSC2	1989	6	1	1.2	0	0	1	2	3	0	3
MSC2	1990	3	18	5.5	13	13	18	24	24	13	24
MSC2	1991	8	23	36.6	0	2	9	29	107	0	107
MSC2	1992	11	254	371.4	56	59	74	179	1000	35	1000
MSC2	1993	10	2	3.1	0	0	0	1	7	0	10
MSC2	1988-93	47	67	203.1	0	0	4	56	107	0	1000
NARR1	1988	3	1	1.5	0	0	1	3	3	0	3
NARR1	1989	3	0	0.0	0	0	0	0	0	0	0

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
NARR1	1990	6	2	2.1	0	0	1	3	5	0	5
NARR1	1993	4	5	5.0	0	2	5	9	12	0	12
NARR1	1988-93	16	2	3.2	0	0	1	4	5	0	12
NARR2	1988	3	3	4.9	0	0	1	9	9	0	9
NARR2	1989	3	2	1.5	0	0	2	3	3	0	3
NARR2	1990	6	1	2.0	0	0	1	2	5	0	5
NARR2	1988-90	12	2	2.7	0	0	1	3	5	0	9
NESCAN1	1988	2	3	4.2	0	0	3	6	6	0	6
NESCAN1	1989	1	0	.	0	0	0	0	0	0	0
NESCAN1	1988-89	3	2	3.5	0	0	0	6	6	0	6
NESCAN2	1988	2	0	0.0	0	0	0	0	0	0	0
NESCAN2	1989	1	26	.	26	26	26	26	26	26	26
NESCAN2	1988-89	3	9	15.0	0	0	0	26	26	0	26
NPS1	1989	1	7	.	7	7	7	7	7	7	7
NPS1	1990	7	12	18.7	1	3	5	10	54	1	54
NPS1	1991	10	79	96.2	0	3	58	109	234	0	299
NPS1	1992	9	279	305.0	73	93	120	346	1000	73	1000
NPS1	1993	9	7	7.5	0	1	6	10	21	0	21
NPS1	1989-93	36	96	189.9	0	3	13	103	299	0	1000
NPS2	1989	1	1	.	1	1	1	1	1	1	1
NPS2	1990	6	7	6.2	2	3	6	7	19	2	19
NPS2	1991	10	44	74.5	1	2	11	39	173	0	232
NPS2	1989-91	17	28	59.2	1	2	5	19	113	0	232
OAK1	1988	3	66	73.9	12	12	35	150	150	12	150
OAK1	1989	4	18	23.0	0	1	11	35	49	0	49
OAK1	1990	7	93	75.6	15	36	68	127	242	15	242
OAK1	1991	9	97	198.2	0	1	39	51	617	0	617
OAK1	1992	15	148	245.4	0	46	54	84	706	0	780
OAK1	1993	11	2	1.8	0	0	2	3	4	0	5
OAK1	1988-93	49	82	168.4	0	2	36	68	172	0	780
OAK2	1988	3	1	1.0	0	0	1	2	2	0	2
OAK2	1989	3	24	42.1	0	0	0	73	73	0	73
OAK2	1990	6	79	126.6	6	7	15	104	325	6	325

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
OAK2	1991	9	107	162.8	0	5	11	142	437	0	437
OAK2	1992	15	181	268.7	0	42	89	164	603	0	1000
OAK2	1993	10	8	13.2	0	0	2	5	32	0	39
OAK2	1988-93	46	94	185.0	0	1	17	104	321	0	1000
OAK3	1988	3	1	0.0	1	1	1	1	1	1	1
OAK3	1989	4	0	0.5	0	0	0	1	1	0	1
OAK3	1990	6	46	79.3	3	6	12	38	206	3	206
OAK3	1991	9	47	79.8	0	2	5	52	233	0	233
OAK3	1988-91	22	32	66.4	0	1	3	12	118	0	233
PAIUTE1	1988	2	9	5.7	5	5	9	13	13	5	13
PAIUTE1	1989	2	3	4.2	0	0	3	6	6	0	6
PAIUTE1	1988-89	4	6	5.4	0	3	6	10	13	0	13
PAIUTE2	1988	2	6	2.8	4	4	6	8	8	4	8
PAIUTE2	1989	2	2	2.1	0	0	2	3	3	0	3
PAIUTE2	1988-89	4	4	3.3	0	2	4	6	8	0	8
RB1	1990	4	19	21.1	2	5	13	34	49	2	49
RB1	1991	8	16	19.8	0	1	3	38	42	0	42
RB1	1992	12	191	273.6	47	62	92	150	412	43	1000
RB1	1993	4	46	92.0	0	0	0	92	184	0	184
RB1	1990-93	28	96	197.0	0	2	43	92	184	0	1000
RB2	1990	3	36	24.8	7	7	50	50	50	7	50
RB2	1991	8	18	43.2	0	1	3	8	125	0	125
RB2	1990-91	11	23	38.7	0	1	5	50	50	0	125
SPENCER1	1988	2	1	0.7	0	0	1	1	1	0	1
SPENCER1	1989	1	0	.	0	0	0	0	0	0	0
SPENCER1	1988-89	3	0	0.6	0	0	0	1	1	0	1
SPENCER2	1988	2	0	0.0	0	0	0	0	0	0	0
SPENCER2	1989	1	1	.	1	1	1	1	1	1	1
SPENCER2	1988-89	3	0	0.6	0	0	0	1	1	0	1
STAN1	1990	9	123	326.0	0	5	10	23	991	0	991
STAN1	1991	14	303	374.4	9	26	105	670	1000	2	1000
STAN1	1992	13	129	102.6	0	15	174	204	218	0	294
STAN1	1993	16	106	254.0	0	1	10	76	353	0	1000

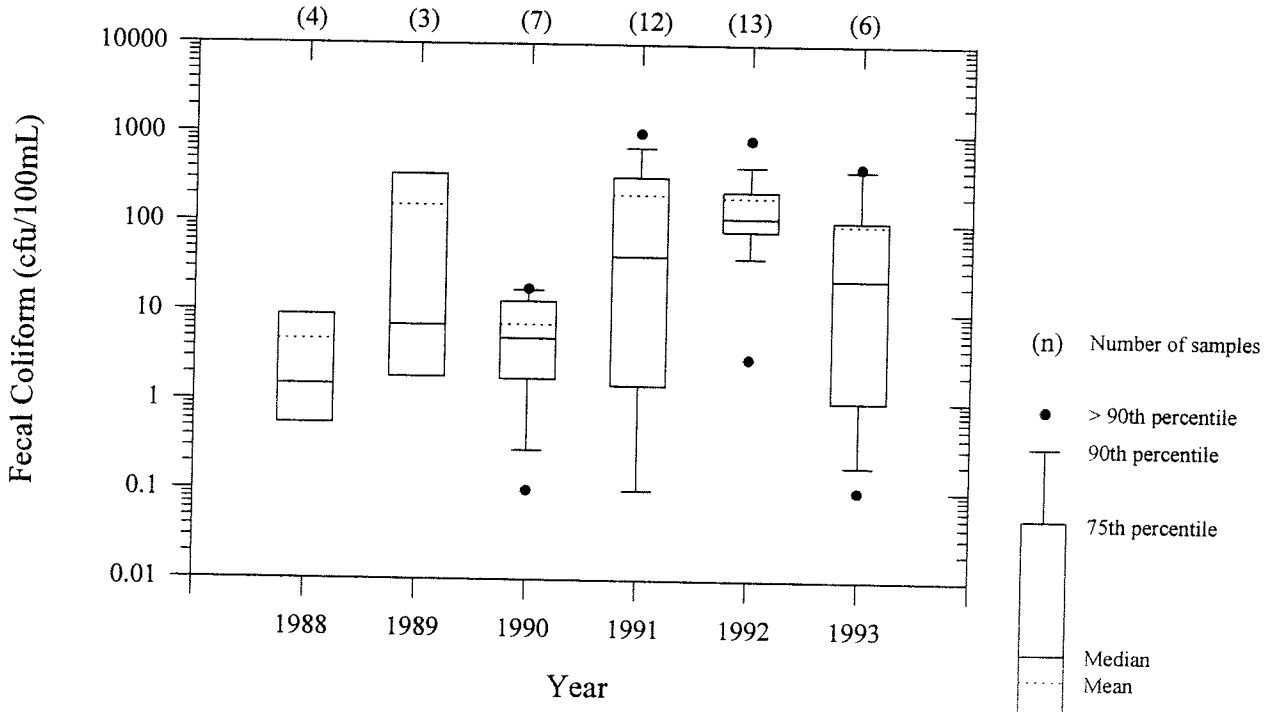
Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
STAN1	1994	1	1	.	1	1	1	1	1	1	1
STAN1	1990-94	53	165	282.5	0	5	27	202	670	0	1000
STAN2	1991	15	229	288.6	7	13	84	292	641	6	1000
STAN2	1992	13	84	72.3	1	6	79	147	163	0	184
STAN2	1993	16	114	266.3	0	1	9	70	497	0	1000
STAN2	1994	1	0	.	0	0	0	0	0	0	0
STAN2	1991-94	45	141	237.5	0	6	58	158	497	0	1000
STAN3	1991	1	500	.	500	500	500	500	500	500	500
UBB1	1988	8	7	8.0	0	1	5	11	23	0	23
UBB1	1989	6	4	7.4	0	0	1	5	19	0	19
UBB1	1990	9	68	161.5	0	5	6	20	496	0	496
UBB1	1991	11	218	389.9	1	5	39	177	1000	1	1000
UBB1	1992	19	180	146.9	0	9	200	280	398	0	458
UBB1	1993	15	30	106.8	0	0	1	5	12	0	416
UBB1	1988-93	68	102	202.9	0	1	7	130	364	0	1000
UBB2	1988	8	19	29.9	0	2	8	21	89	0	89
UBB2	1989	6	24	34.9	0	0	5	46	85	0	85
UBB2	1991	11	212	315.3	1	2	130	185	622	1	1000
UBB2	1992	18	165	146.5	3	15	155	254	363	2	524
UBB2	1993	15	66	119.3	0	1	5	136	237	0	412
UBB2	1994	1	1	.	1	1	1	1	1	1	1
UBB2	1988-94	59	112	180.5	0	2	23	160	292	0	1000
WCB1	1988	9	1	1.2	0	0	1	2	3	0	3
WCB1	1989	6	7	11.9	0	0	1	9	30	0	30
WCB1	1990	7	12	16.1	0	1	7	19	45	0	45
WCB1	1991	10	51	91.7	0	1	7	71	203	0	286
WCB1	1992	10	84	59.9	20	34	68	142	173	16	186
WCB1	1993	4	5	8.2	0	1	1	9	17	0	17
WCB1	1988-93	46	33	59.6	0	1	4	34	120	0	286
WCB2	1988	9	3	3.8	0	1	2	2	11	0	11
WCB2	1989	6	11	22.2	0	1	2	5	56	0	56
WCB2	1990	7	4	6.0	0	0	1	8	16	0	16
WCB2	1991	10	48	70.3	1	1	4	119	159	0	190

Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
WCB2	1992	10	91	55.9	18	50	92	140	166	0	178
WCB2	1993	4	13	24.2	0	1	1	25	49	0	49
WCB2	1988-93	46	34	54.1	0	1	2	50	128	0	190
WCCA1	1988	3	1	1.5	0	0	1	3	3	0	3
WCCA1	1989	3	0	0.0	0	0	0	0	0	0	0
WCCA1	1990	8	6	6.5	0	1	4	11	17	0	17
WCCA1	1991	10	156	219.6	1	1	35	268	539	0	577
WCCA1	1992	4	156	55.0	118	122	135	190	237	118	237
WCCA1	1993	4	5	8.3	0	0	1	9	17	0	17
WCCA1	1988-93	32	71	142.2	0	0	4	79	237	0	577
WCCA2	1988	3	0	0.0	0	0	0	0	0	0	0
WCCA2	1989	3	0	0.6	0	0	0	1	1	0	1
WCCA2	1990	7	7	5.9	0	2	6	10	17	0	17
WCCA2	1991	10	52	67.0	1	2	22	82	167	0	181
WCCA2	1988-91	23	25	49.4	0	0	3	17	82	0	181
WIL1	1990	6	215	390.1	5	8	52	172	1000	5	1000
WIL1	1991	7	92	186.9	0	0	2	135	500	0	500
WIL1	1992	5	221	206.4	42	104	147	249	565	42	565
WIL1	1993	4	8	6.3	0	4	9	13	15	0	15
WIL1	1990-93	22	139	248.2	0	3	16	147	500	0	1000
WIL2	1990	7	247	387.6	1	1	29	560	1000	1	1000
WIL2	1991	7	102	207.6	0	0	2	158	554	0	554
WIL2	1990-91	14	174	308.0	0	1	14	158	560	0	1000
WWB	1992	12	71	44.3	0	47	72	106	125	0	134
WWB	1993	7	5	11.1	0	0	1	4	30	0	30
WWB	1992-93	19	47	48.1	0	0	35	89	125	0	134
WWLB1	1988	9	1	2.2	0	0	0	1	5	0	5
WWLB1	1989	6	4	2.2	1	2	5	5	7	1	7
WWLB1	1990	8	7	6.0	1	2	7	10	19	1	19
WWLB1	1991	10	58	79.3	3	8	22	76	191	0	250
WWLB1	1992	13	75	52.7	2	43	71	125	140	0	145
WWLB1	1993	14	45	87.5	0	2	9	61	109	0	325
WWLB1	1988-93	60	38	63.6	0	2	8	57	128	0	325

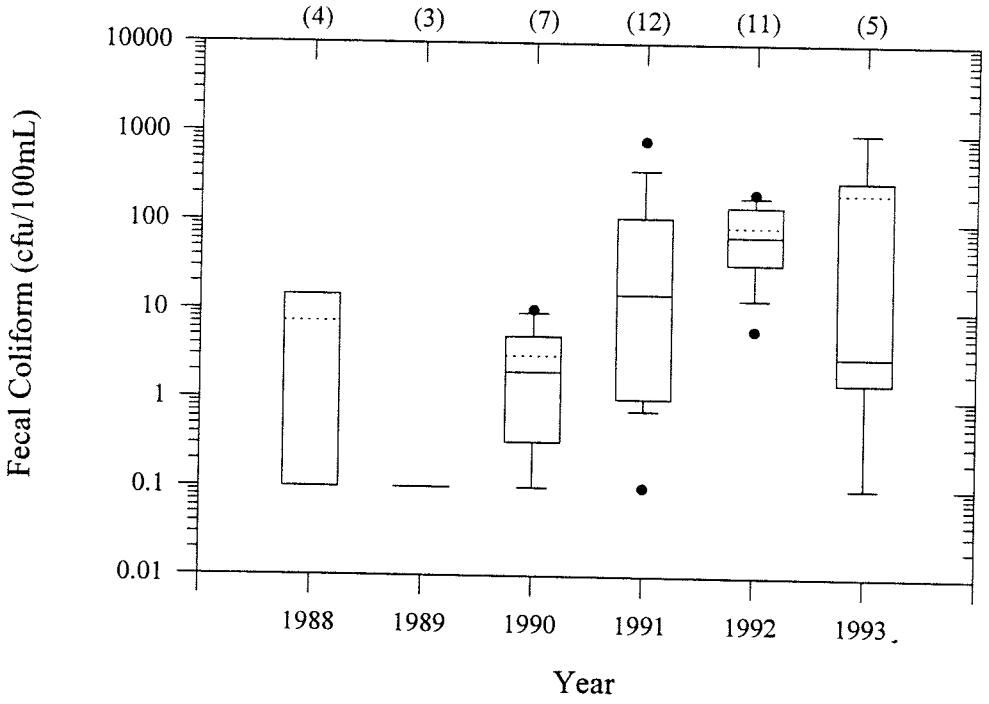
Summary Statistics for GLCA Fecal Coliform Data, May 1988 - Jan. 1994, with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
WWLB2	1988	9	16	41.9	0	1	2	4	128	0	128
WWLB2	1989	6	3	5.0	0	0	1	2	13	0	13
WWLB2	1990	8	4	4.9	0	0	3	8	13	0	13
WWLB2	1991	11	171	246.9	3	5	26	319	620	0	642
WWLB2	1992	13	83	78.3	1	11	72	135	148	0	267
WWLB2	1993	14	39	79.0	0	1	2	15	176	0	250
WWLB2	1988-93	61	61	128.4	0	1	4	61	169	0	642
WWM1	1991	9	83	114.2	4	19	29	106	367	4	367
WWM1	1992	11	127	71.2	58	78	107	188	198	21	270
WWM1	1993	10	12	15.5	1	1	5	21	39	0	43
WWM1	1991-93	30	76	88.5	2	8	39	107	193	0	367
WWM2	1991	9	157	120.0	2	86	125	255	379	2	379
WWM2	1992	12	107	46.2	44	96	109	133	155	6	179
WWM2	1993	13	86	124.5	2	4	14	166	239	0	374
WWM2	1991-93	34	112	103.3	3	14	105	155	255	0	379
WWM3	1991	9	55	92.0	1	10	28	34	295	1	295

Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Antelope Point Beach (AP1)



Antelope Point Intake (AP2)



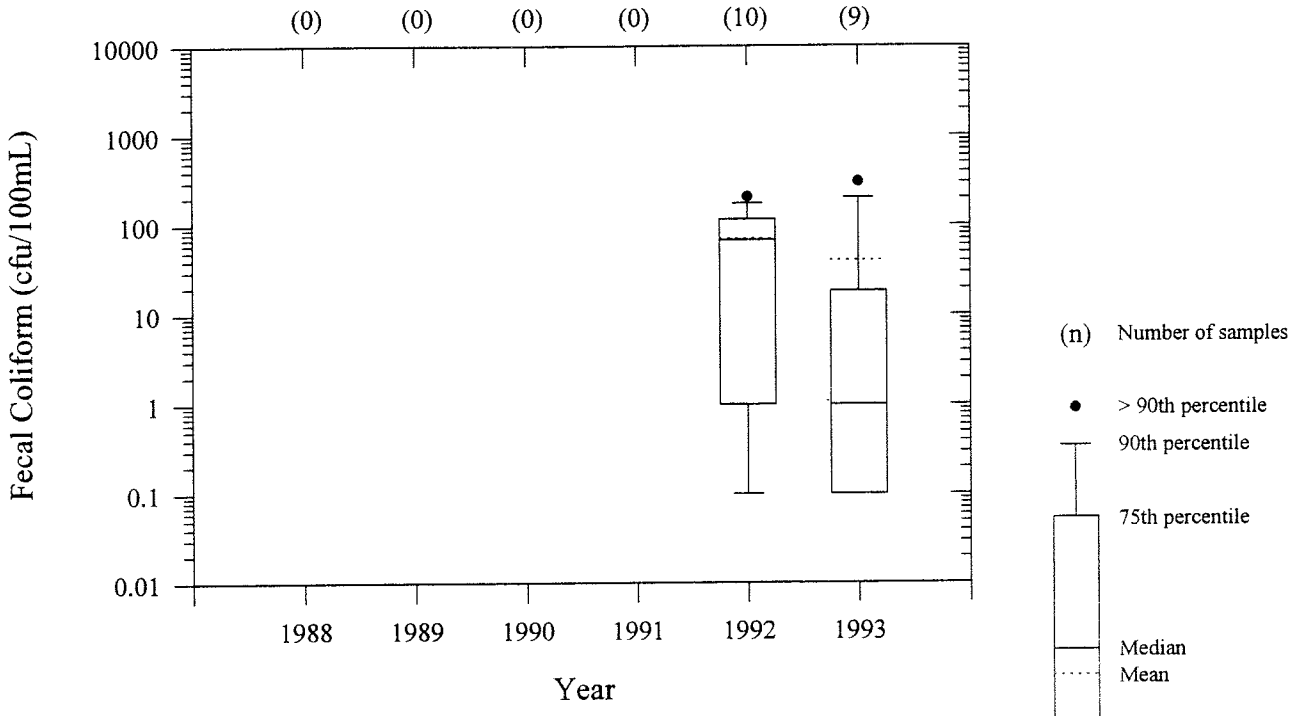
Values of 0.1 in the plots represent fecal coliform counts equal to zero

Values of 1000 in the plots represent fecal coliform counts too numerous to count

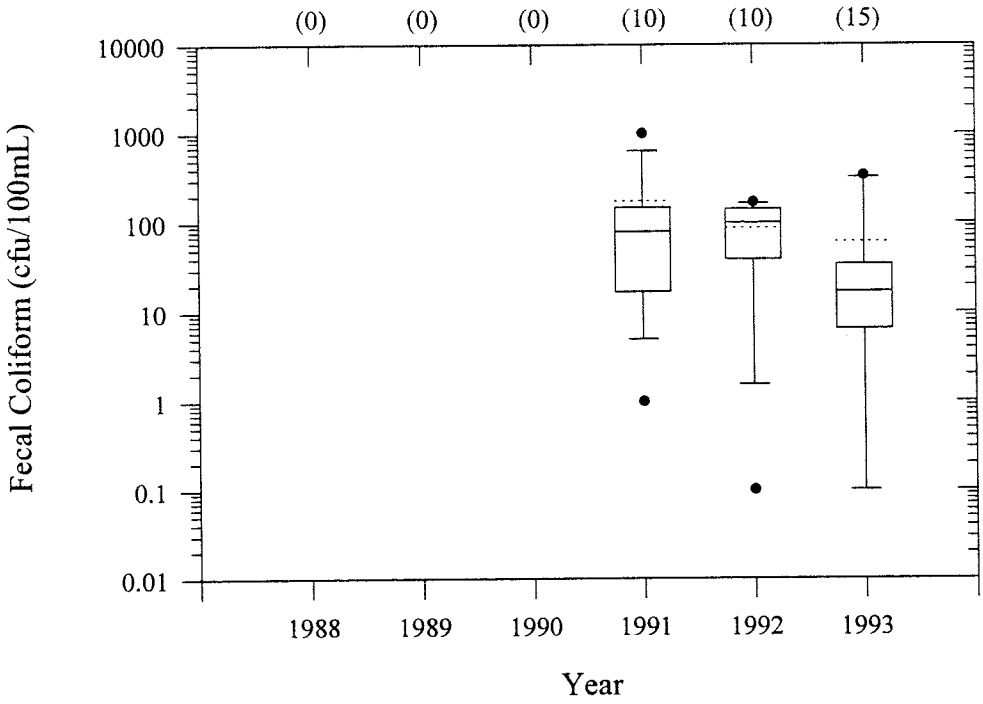
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Bullfrog Bay (BB)



Bullfrog Marina (BFMAR1)



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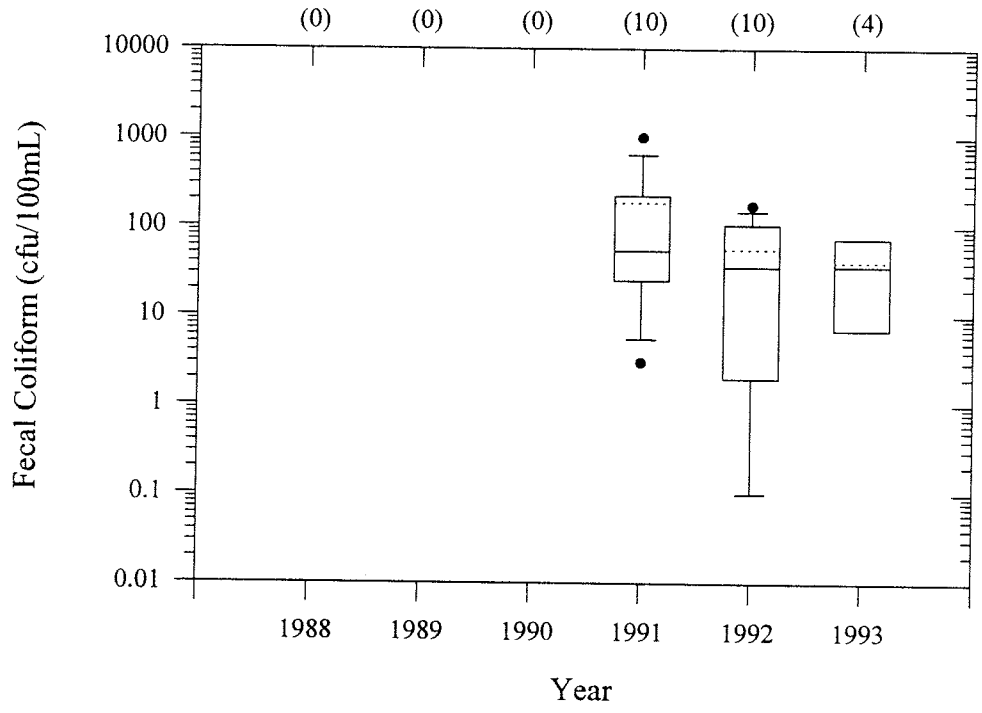
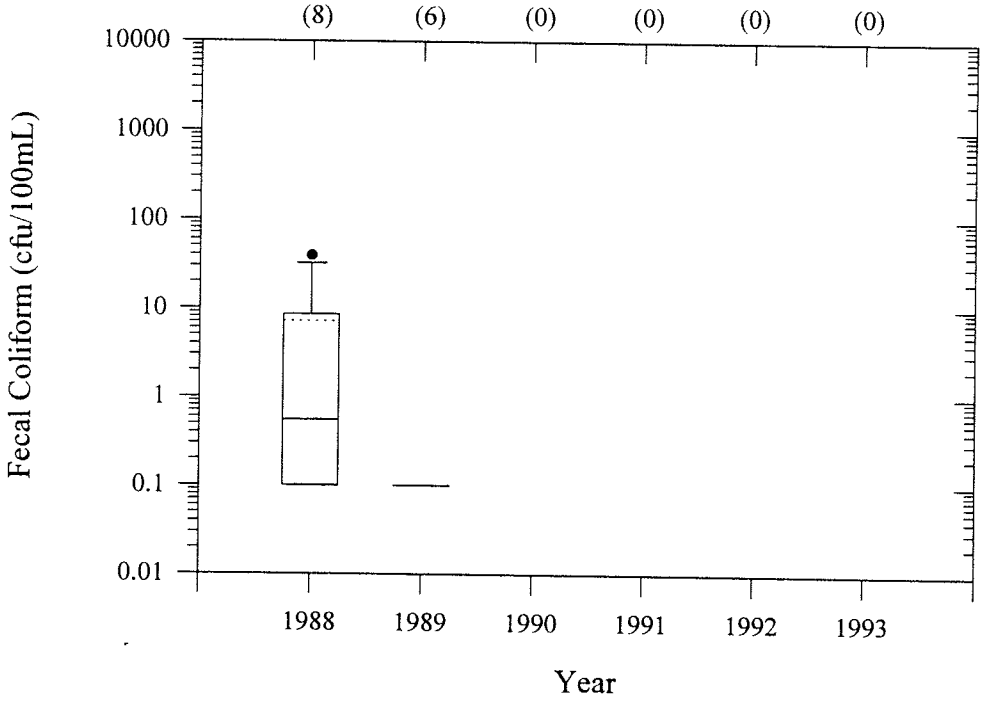
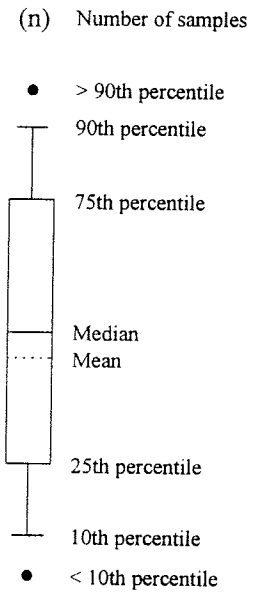
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Bullfrog Marina (BFMAR2)



Bullfrog (BFNOTCH)





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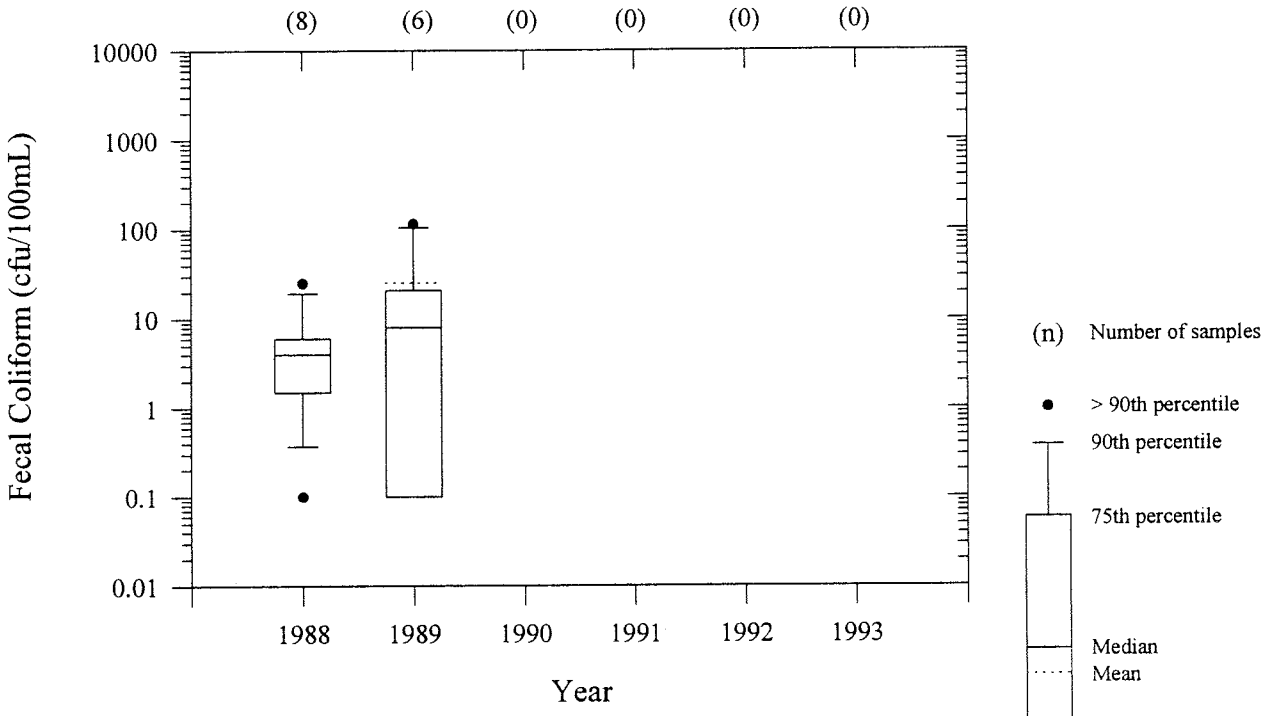
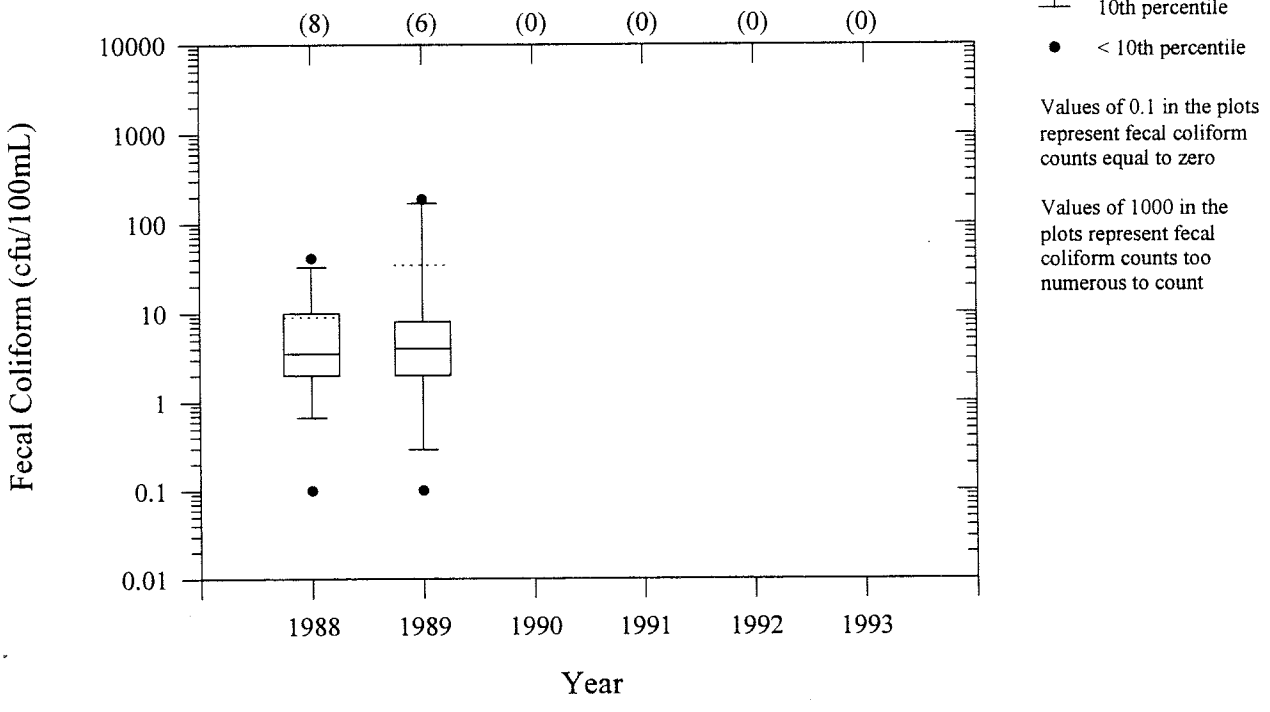
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Bullfrog (BFSB1)



Bullfrog (BFSB2)



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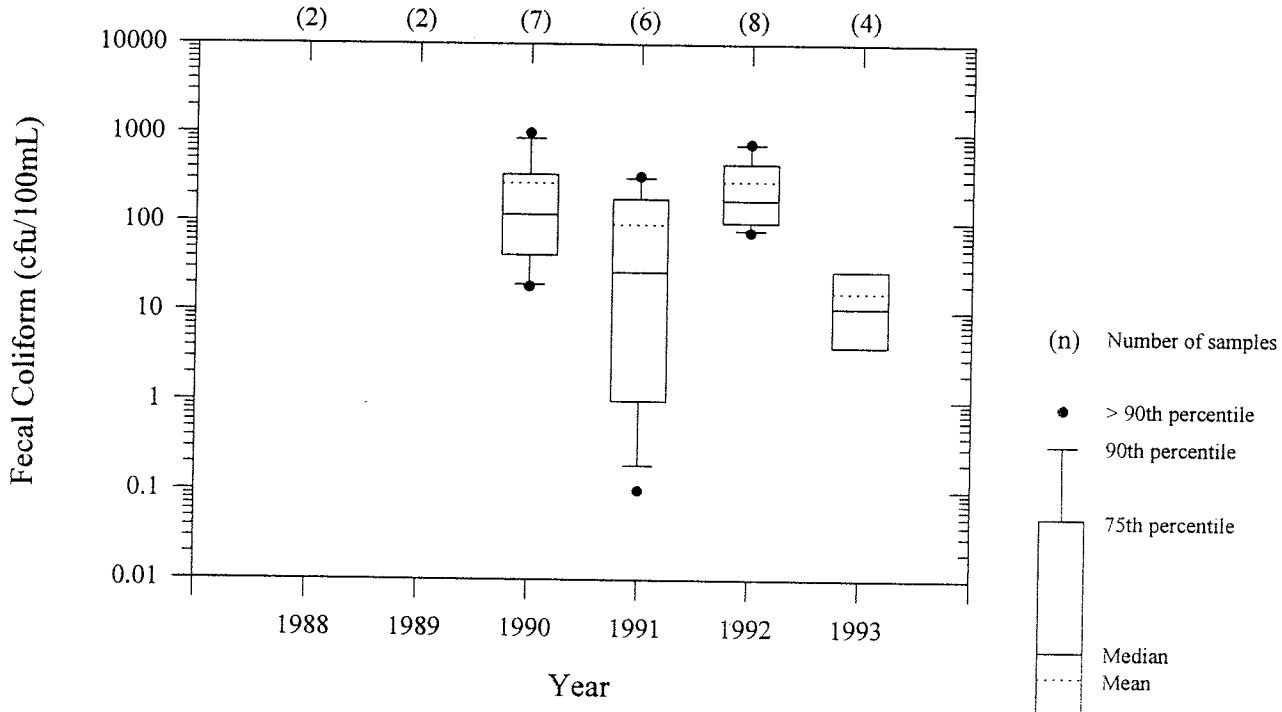
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Cha Canyon (CHA1)



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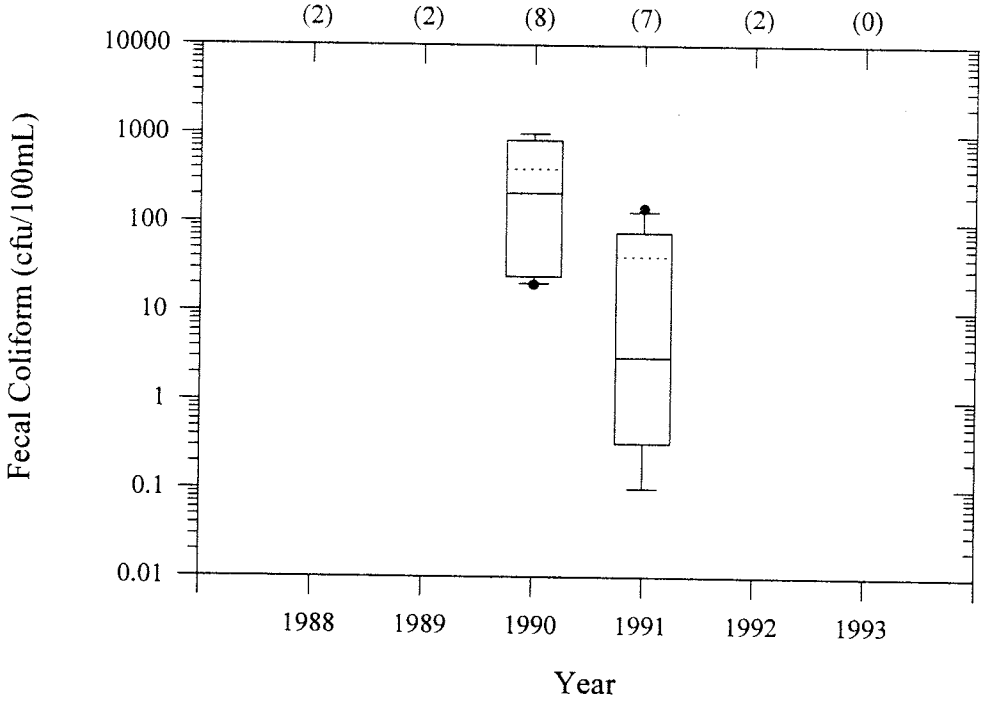
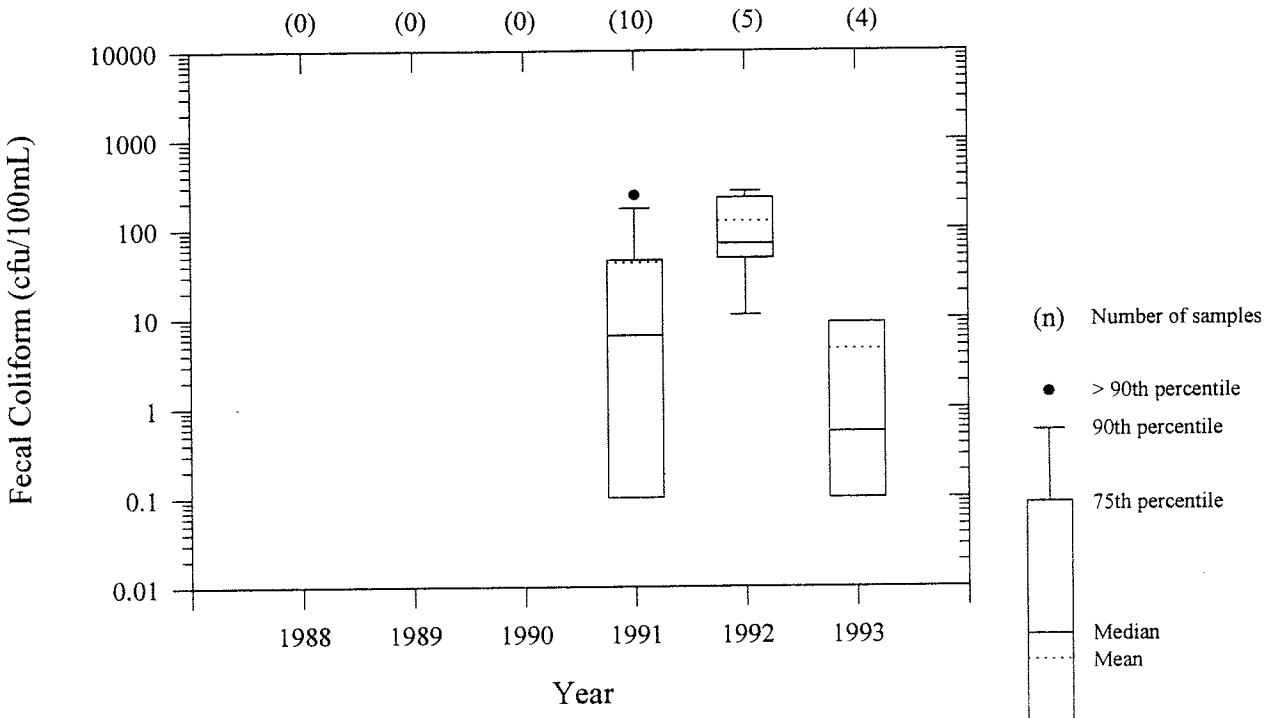
Cha Canyon (CHA2)



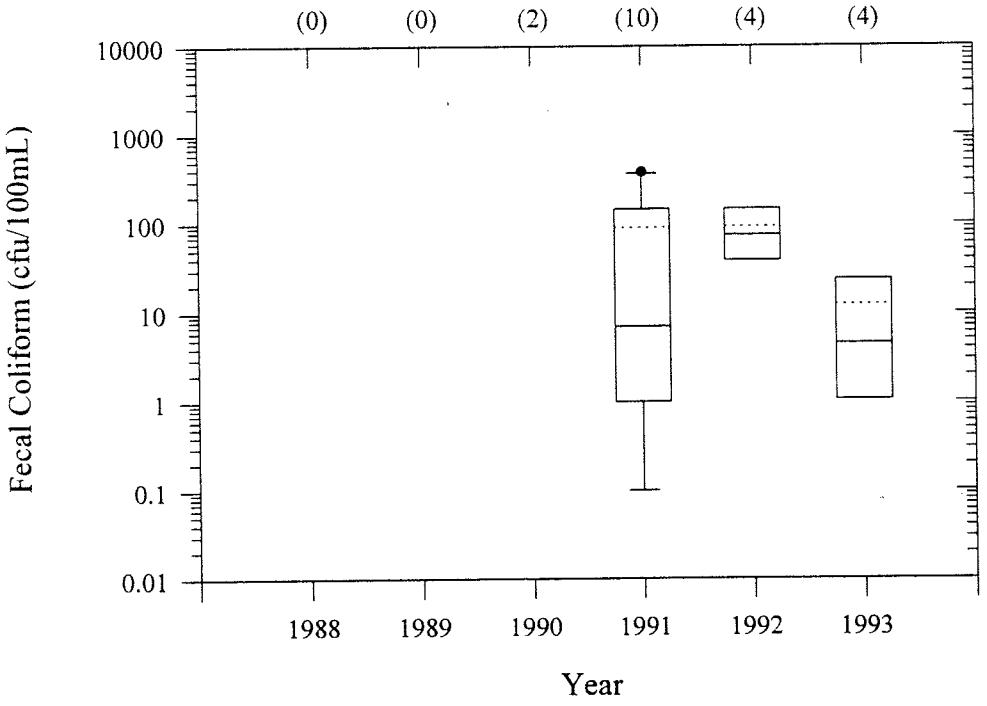
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

The Cut (CUT1)

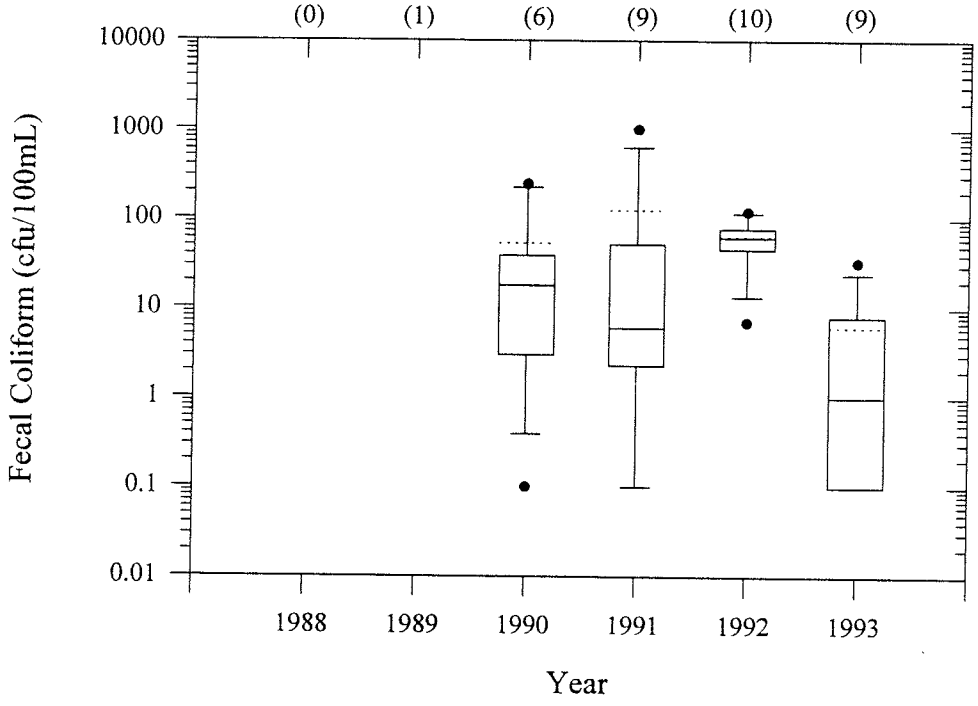


Dungeon Creek (DCR1)

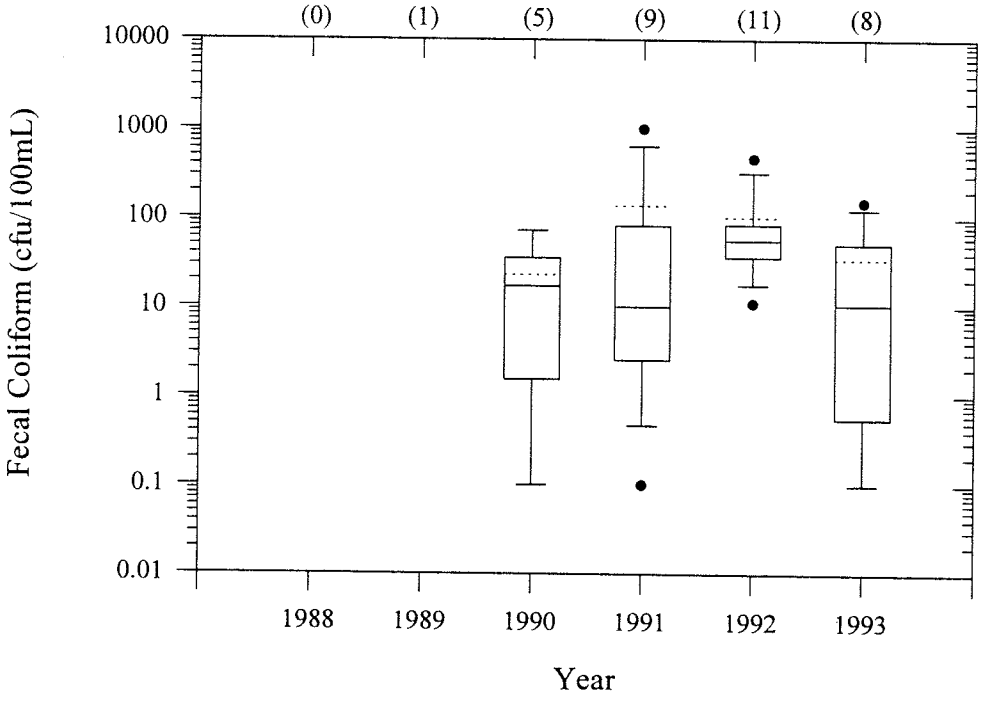


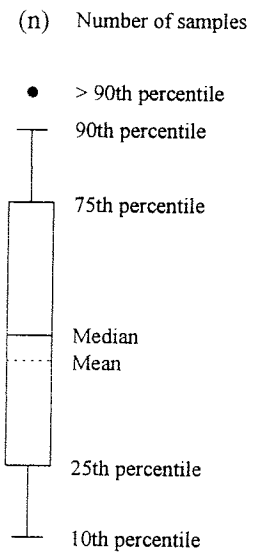
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Dangling Rope Marina (DRM1)



Dangling Rope Marina (DRM2)





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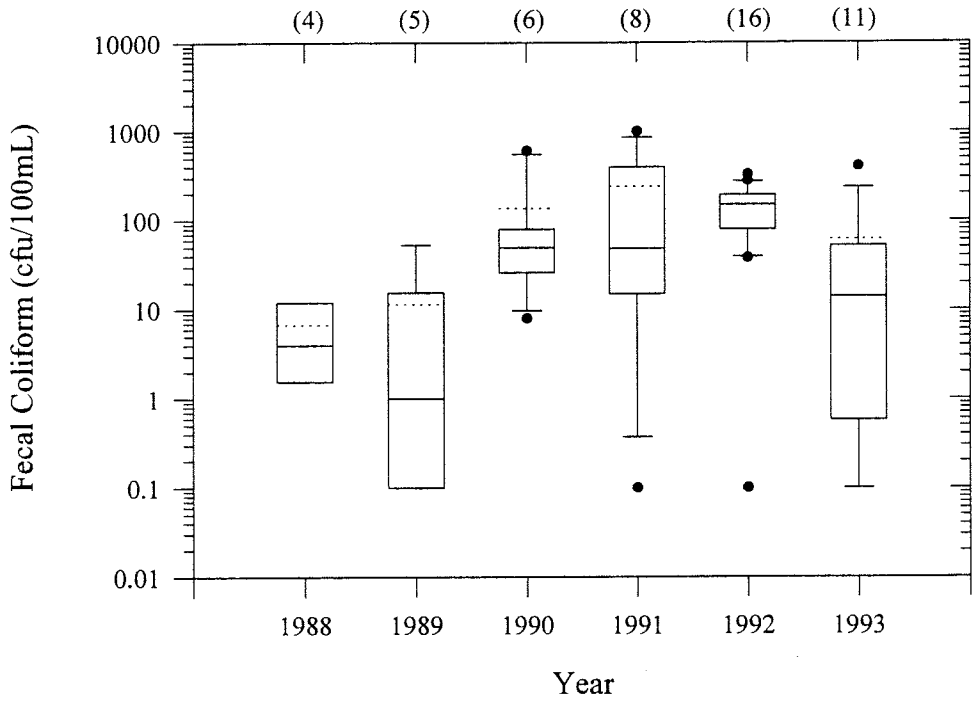
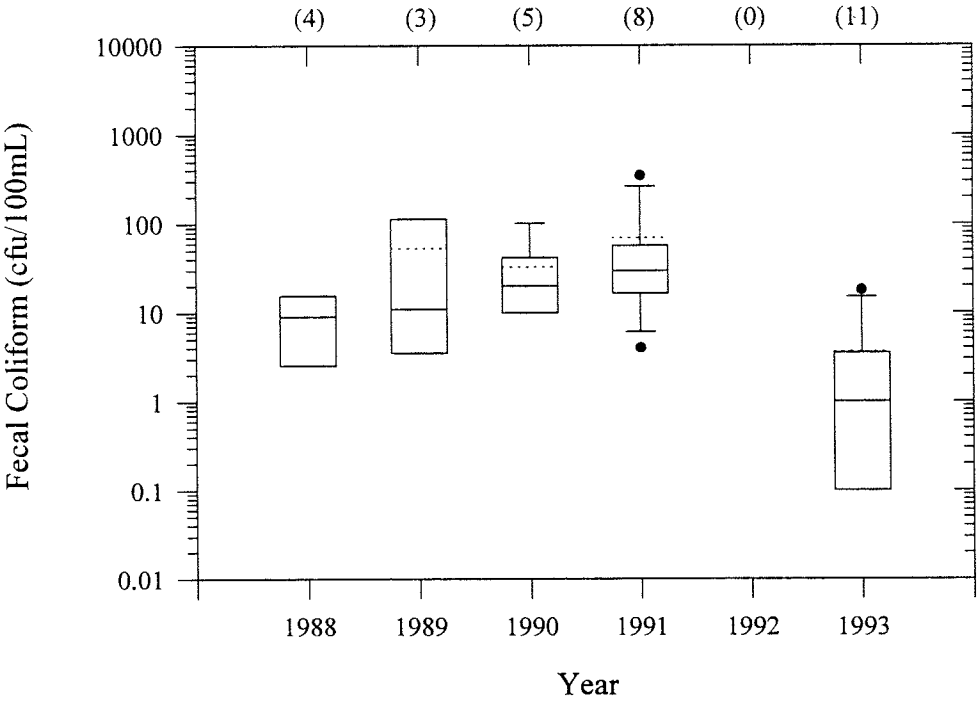
Annual Fecal Coliform by Site

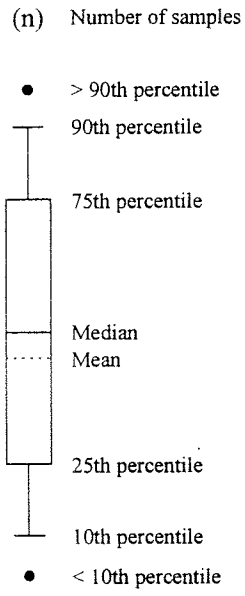
Glen Canyon National Recreation Area

Davis Gulch (DVG1)



Davis Gulch (DVG2)





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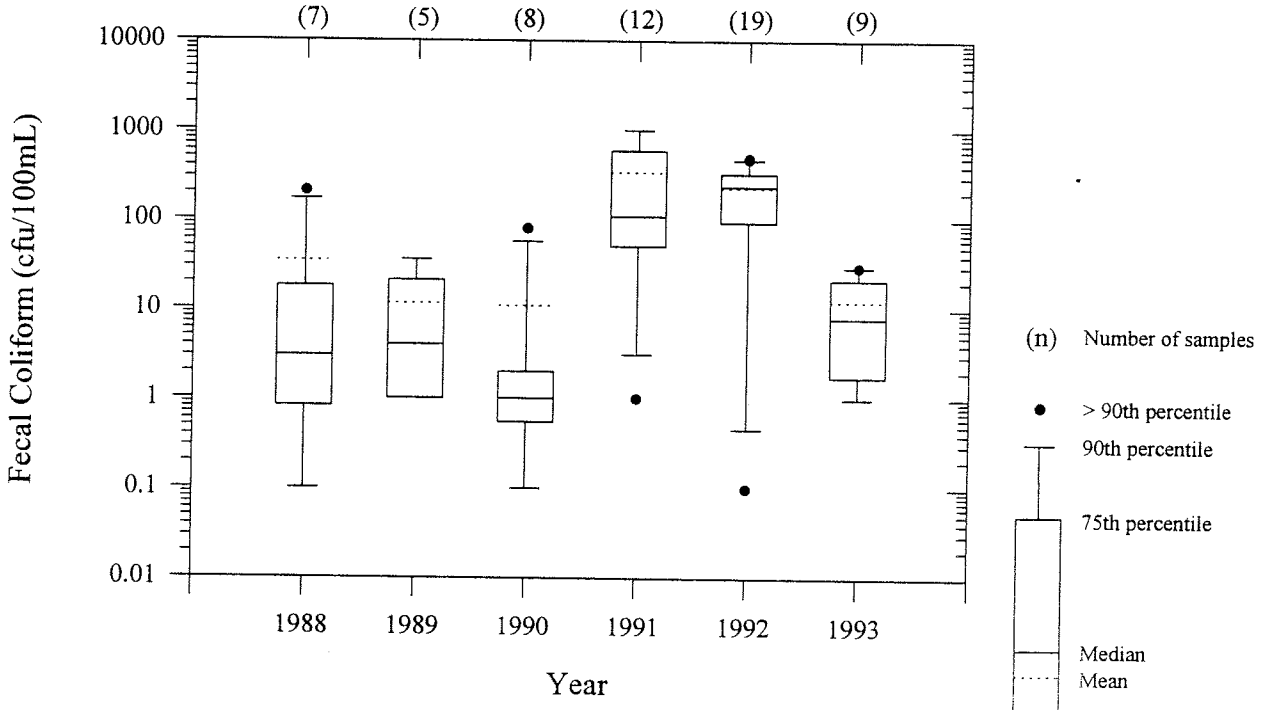
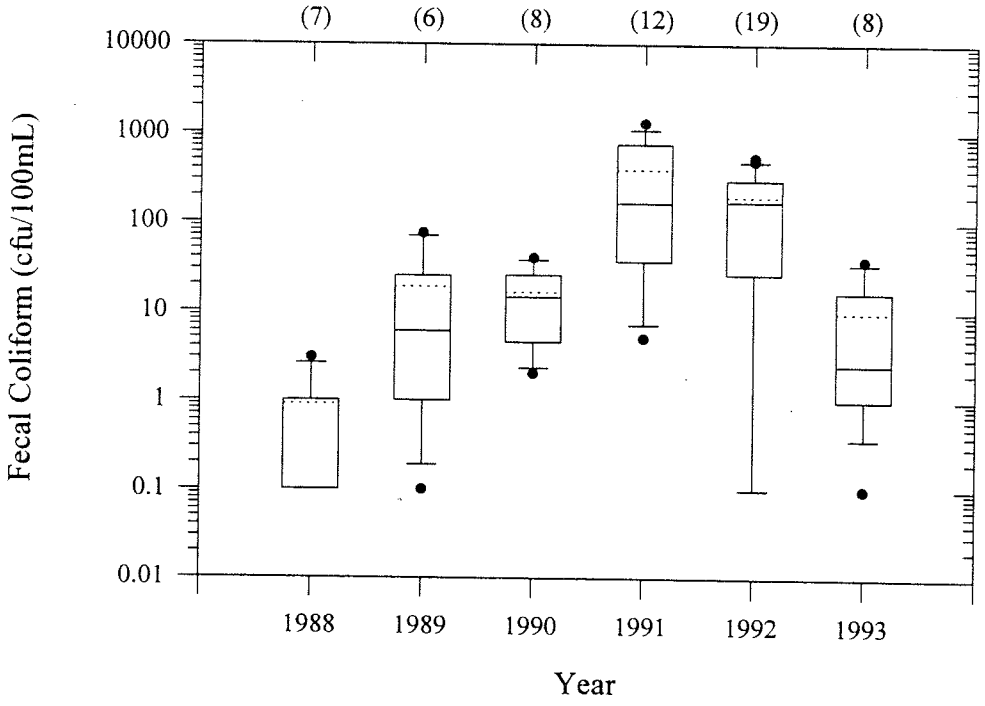
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Farley Canyon (FAR1)



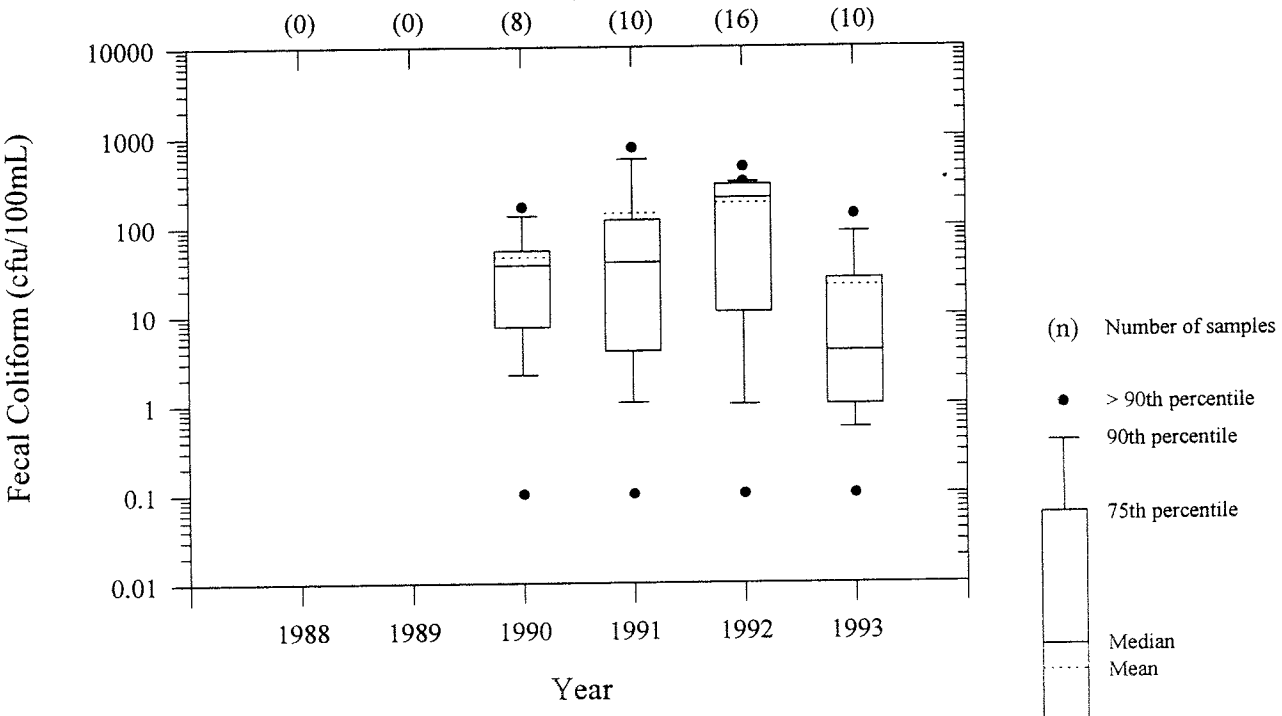
Farley Canyon (FAR2)



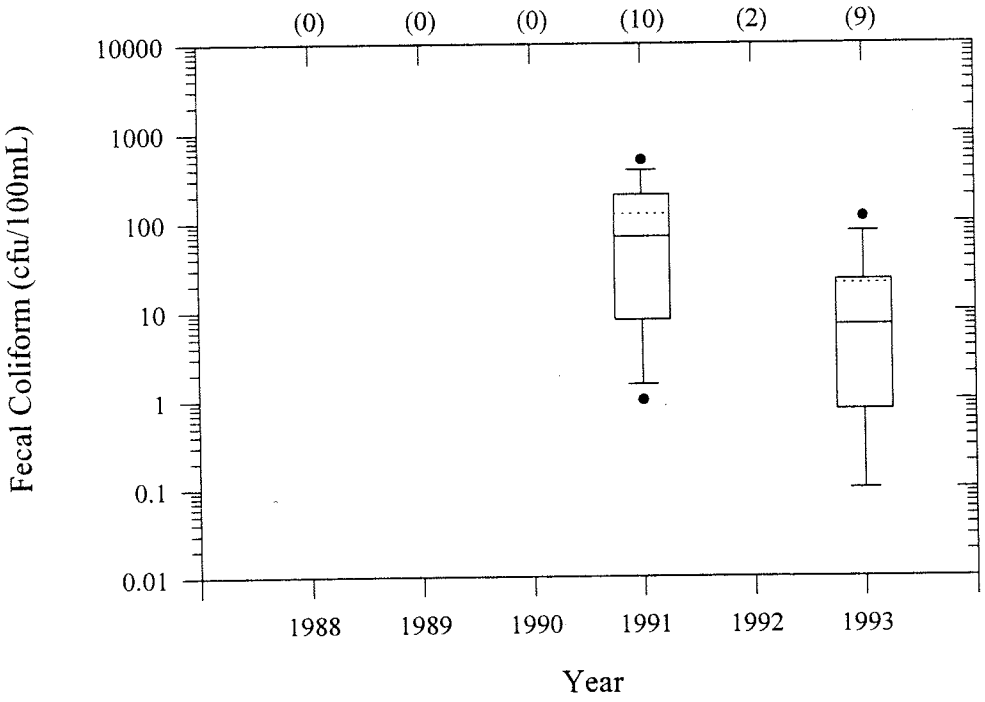
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Forgotten Canyon (FOR1)



Forgotten Canyon (FOR2)



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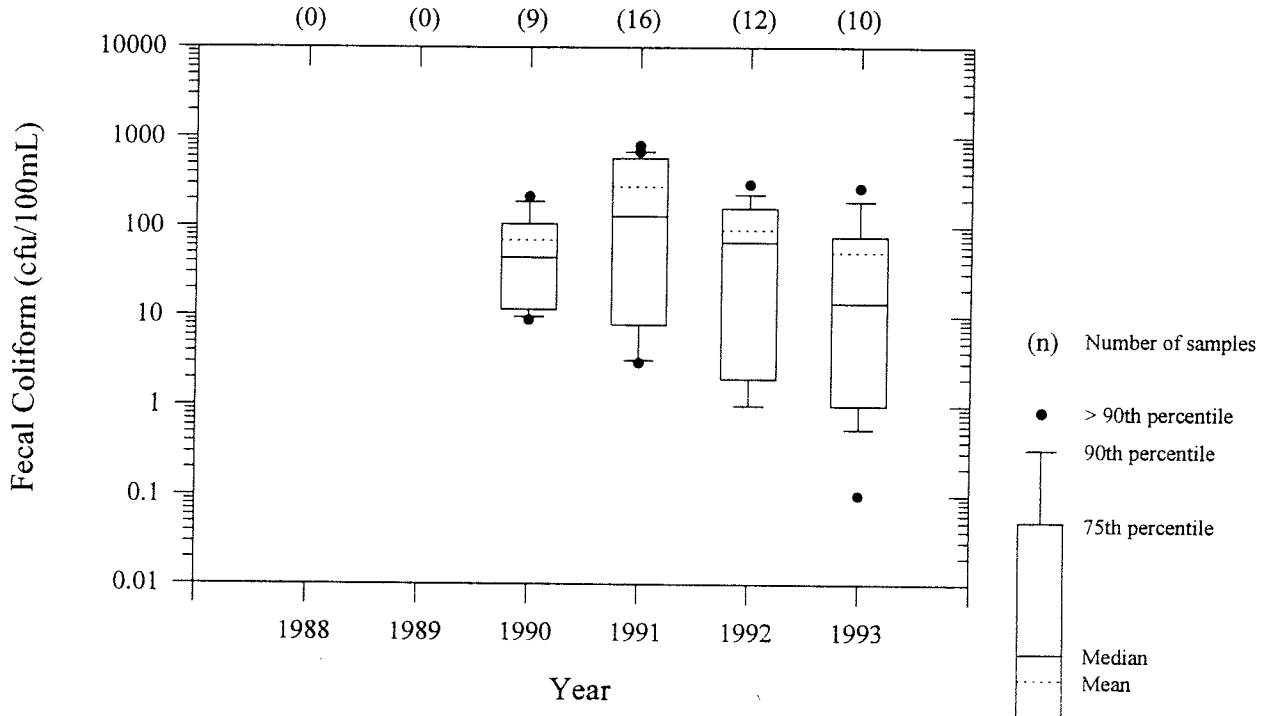
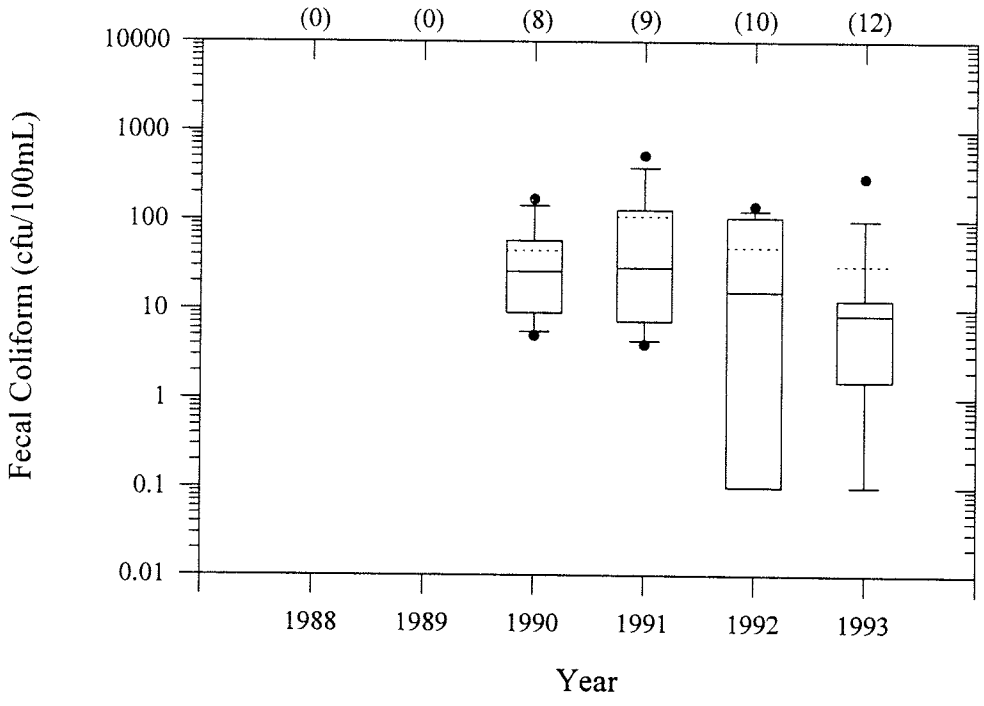
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Hansen Creek (HAN1)



Halls Crossing Marina (HCMAR1)



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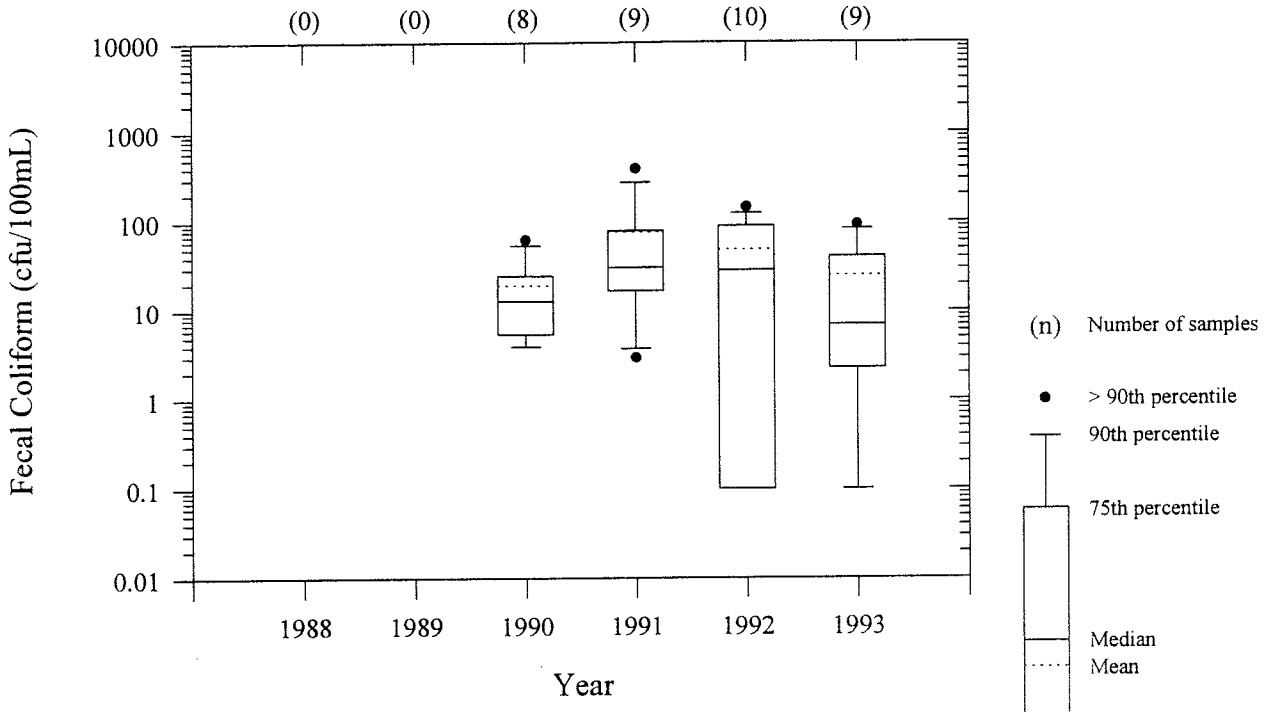
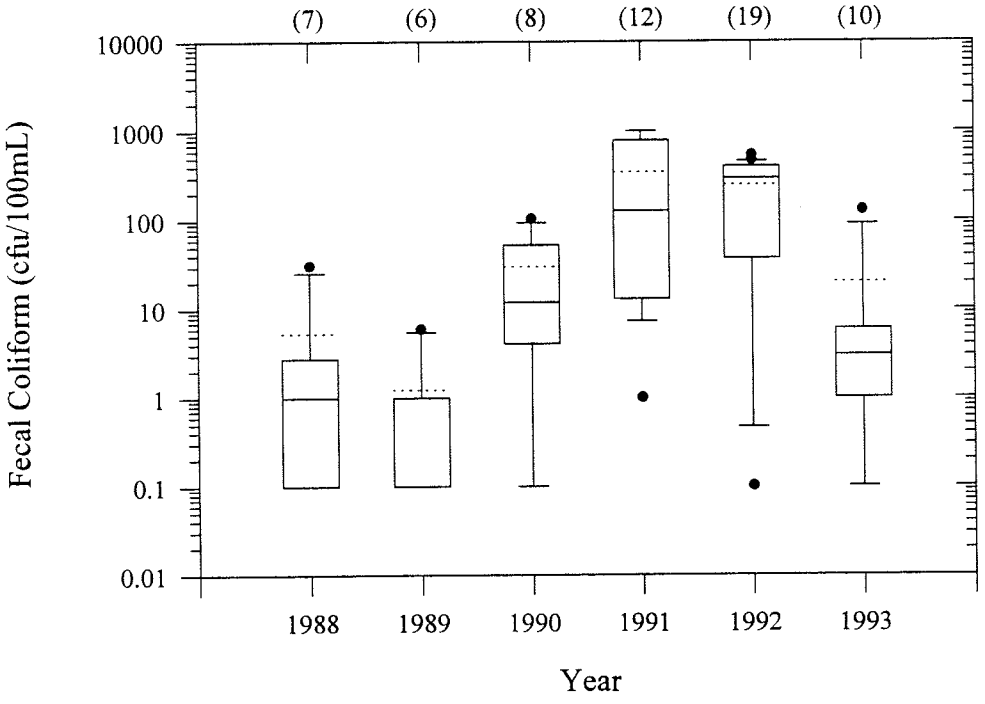
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Halls Crossing Marina (HCMAR2)

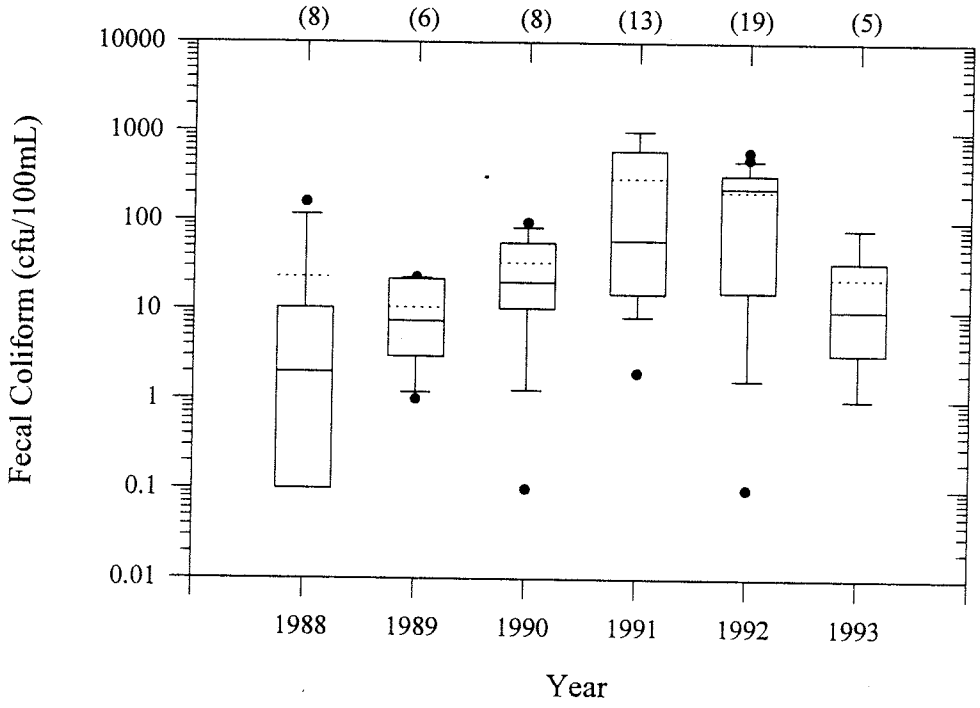


Hite Marina (HIMAR1)

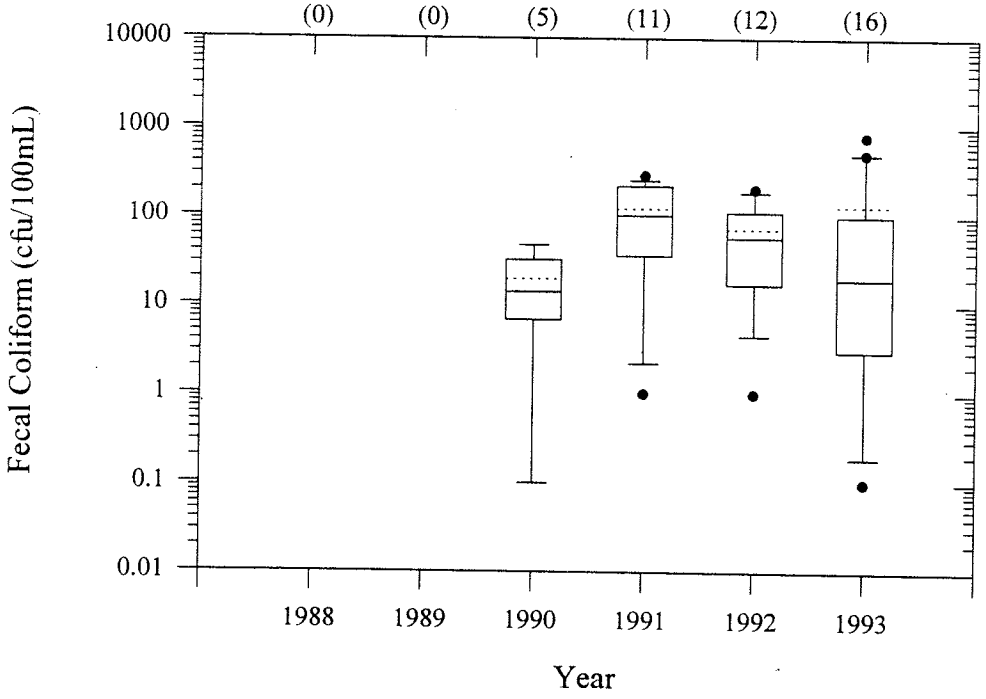


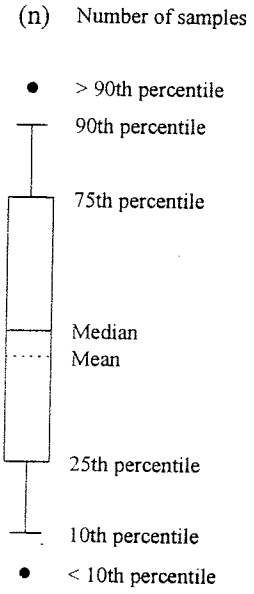
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Hite Marina (HIMAR2)



Hobi Cat Beach (HOBI1)





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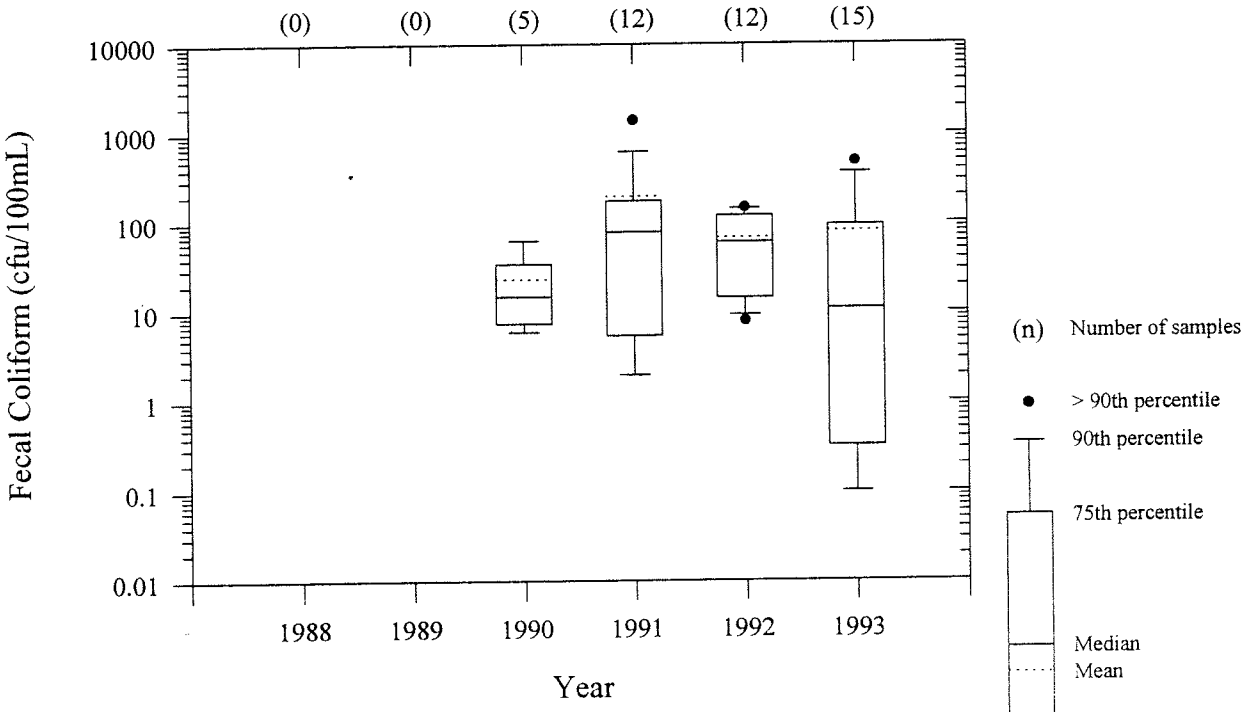
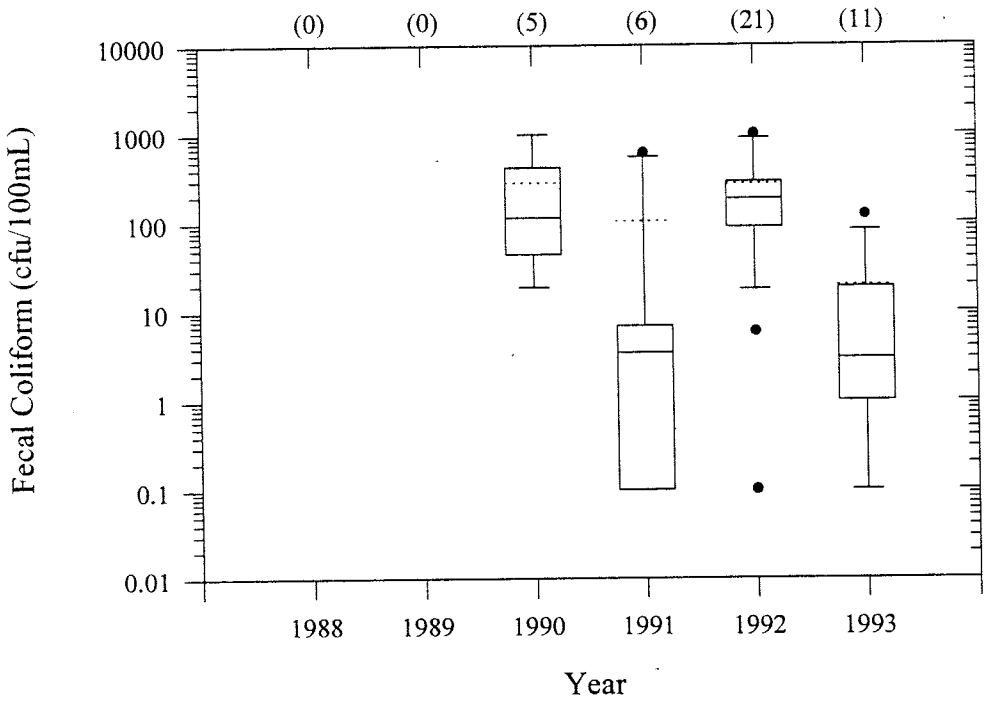
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Hobi Cat Beach (HOBI2)



Llewellyn Gulch (LEW1)



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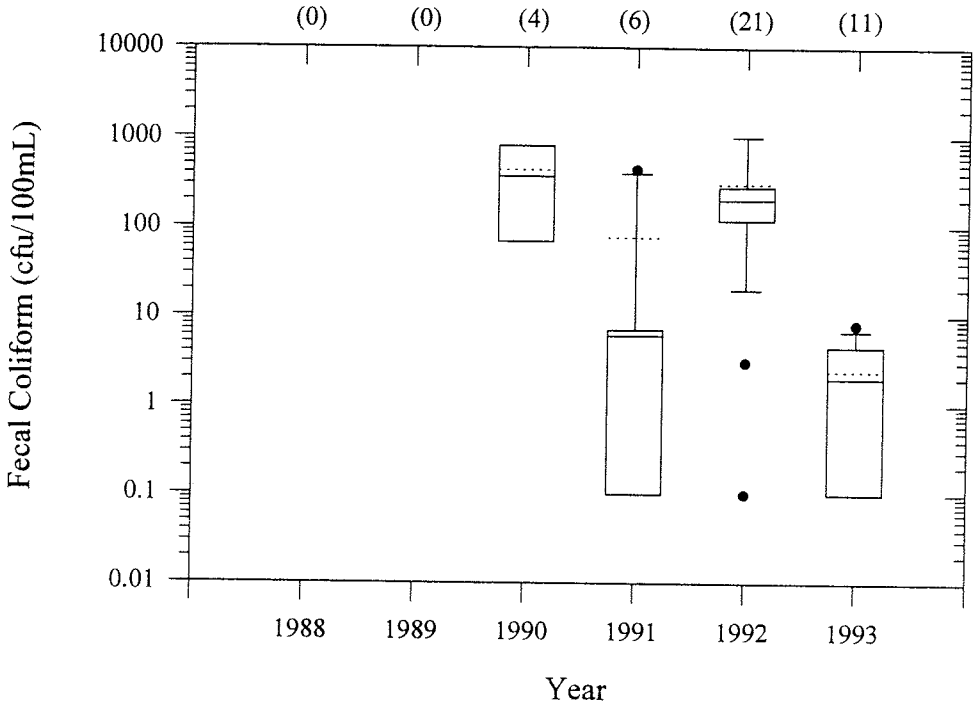
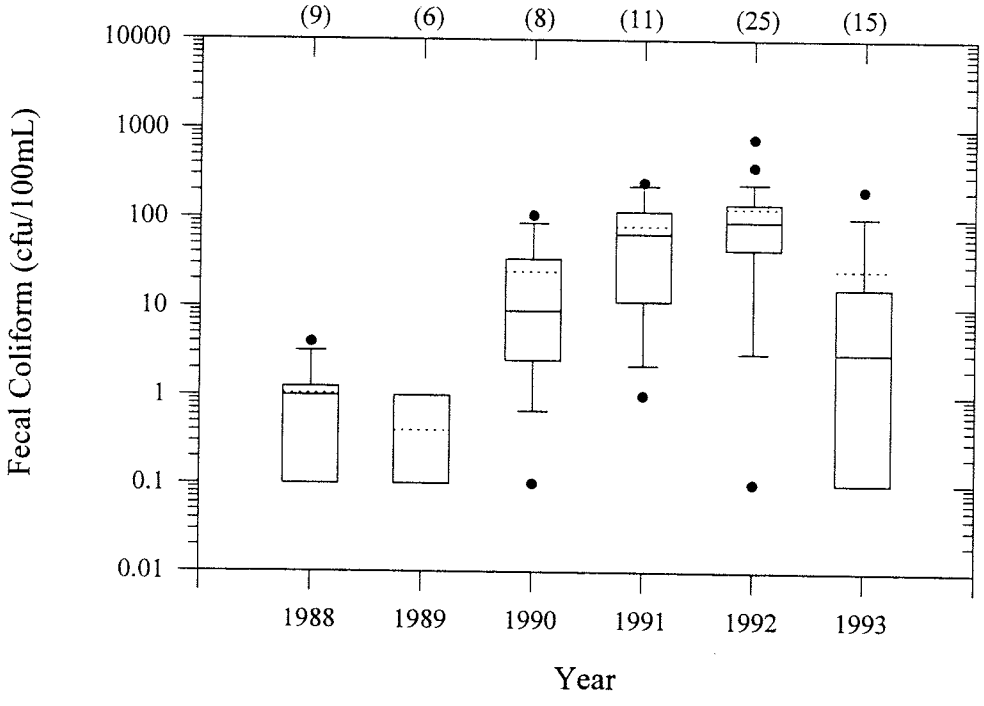
Annual Fecal Coliform by Site

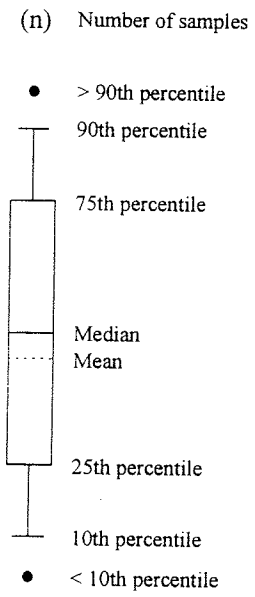
Glen Canyon National Recreation Area

Llewellyn Gulch (LEW2)



Lone Rock Beach (LONE1)





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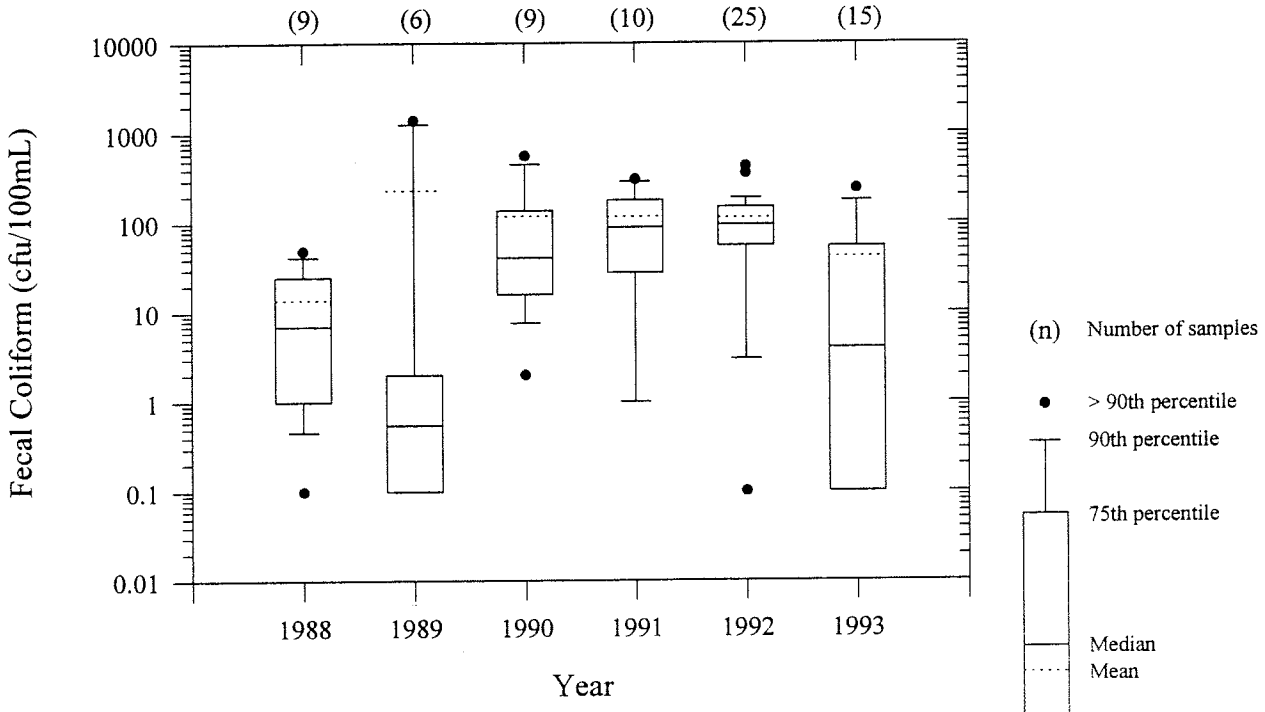
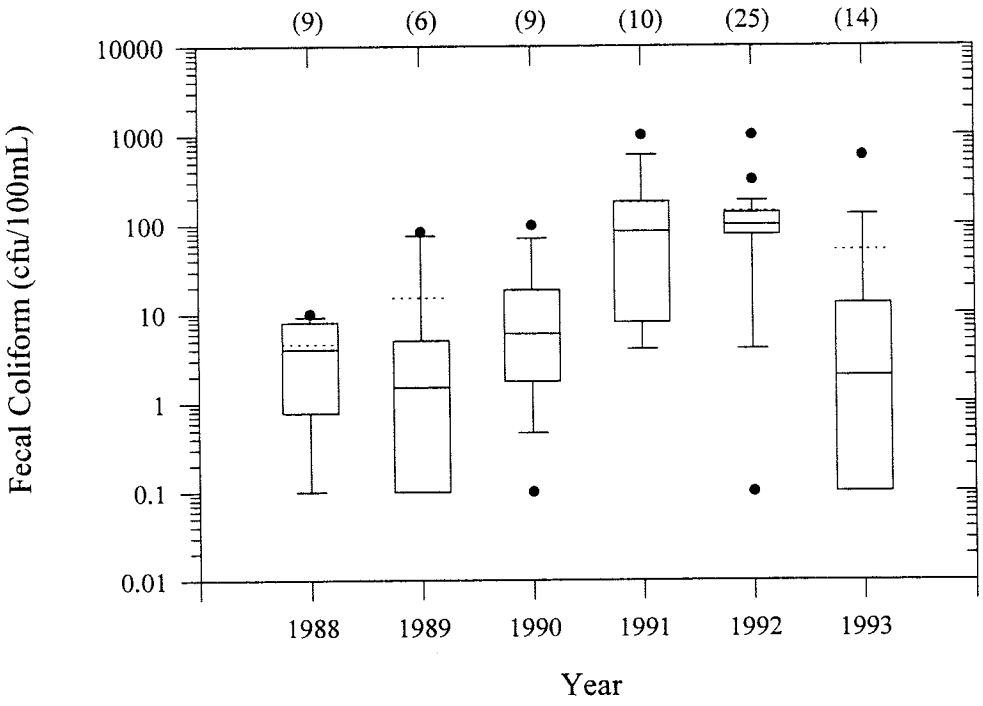
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Lone Rock Beach (LONE2)



Lone Rock Beach (LONE3)



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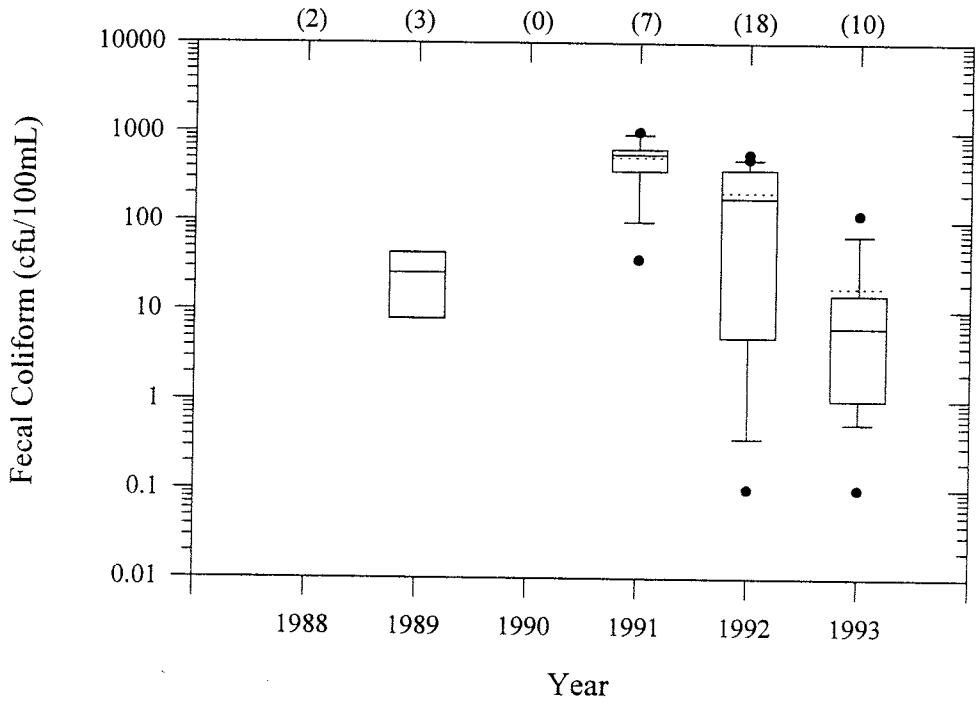
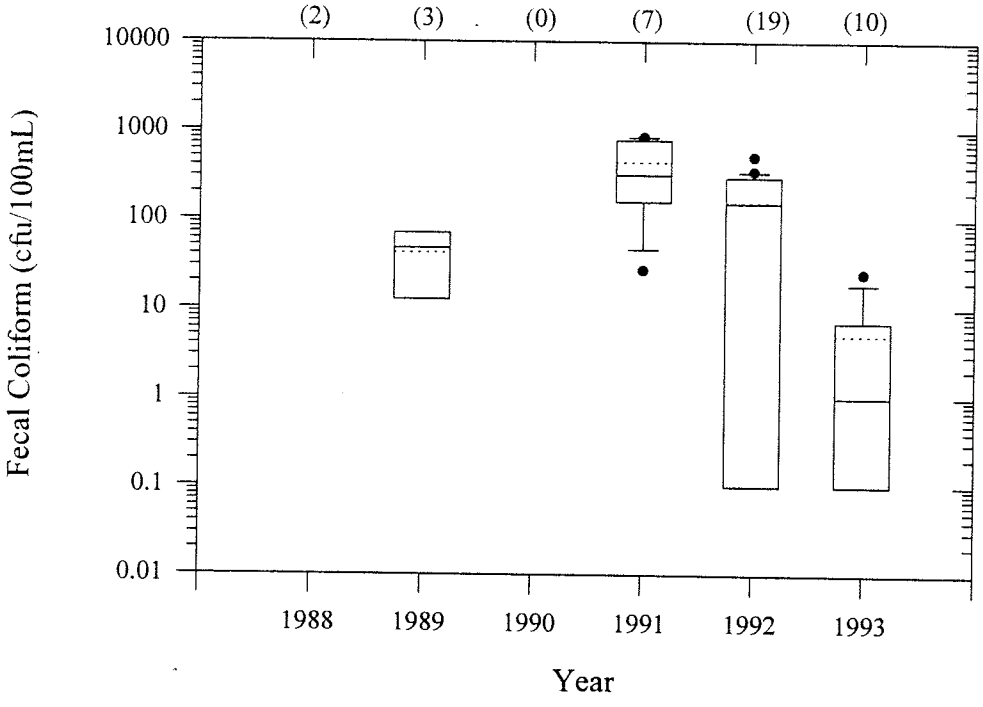
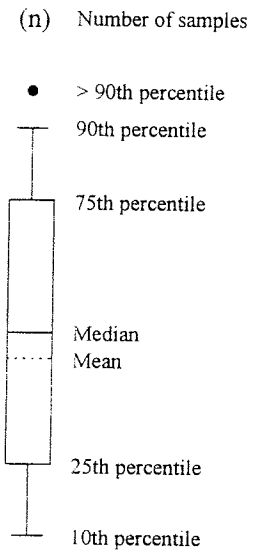
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Moqui Canyon (MOQUI1)



Moqui Canyon (MOQUI2)





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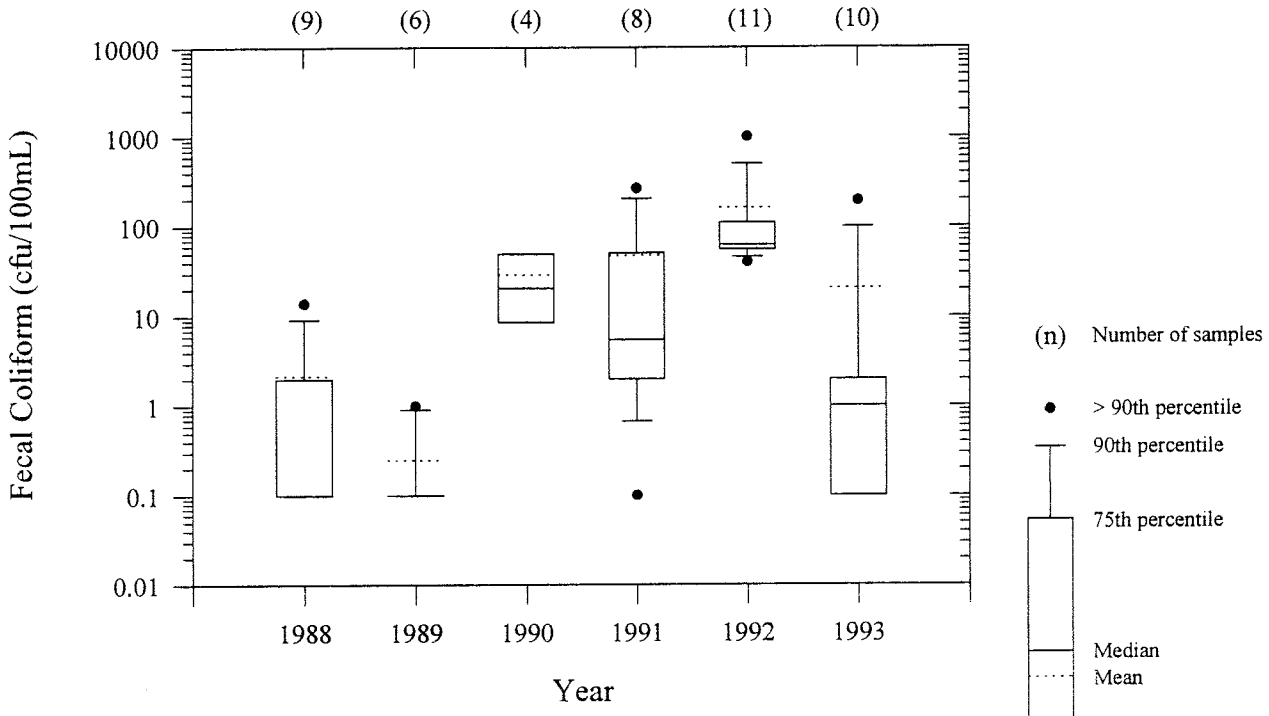
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Mt. Sheep Canyon (MSC1)



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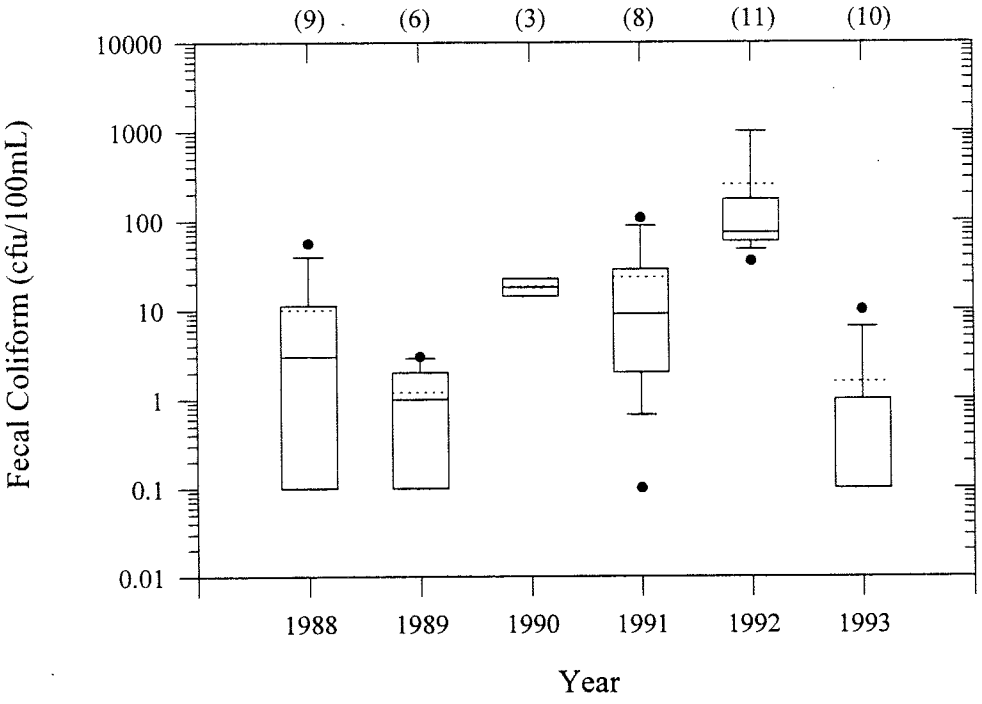
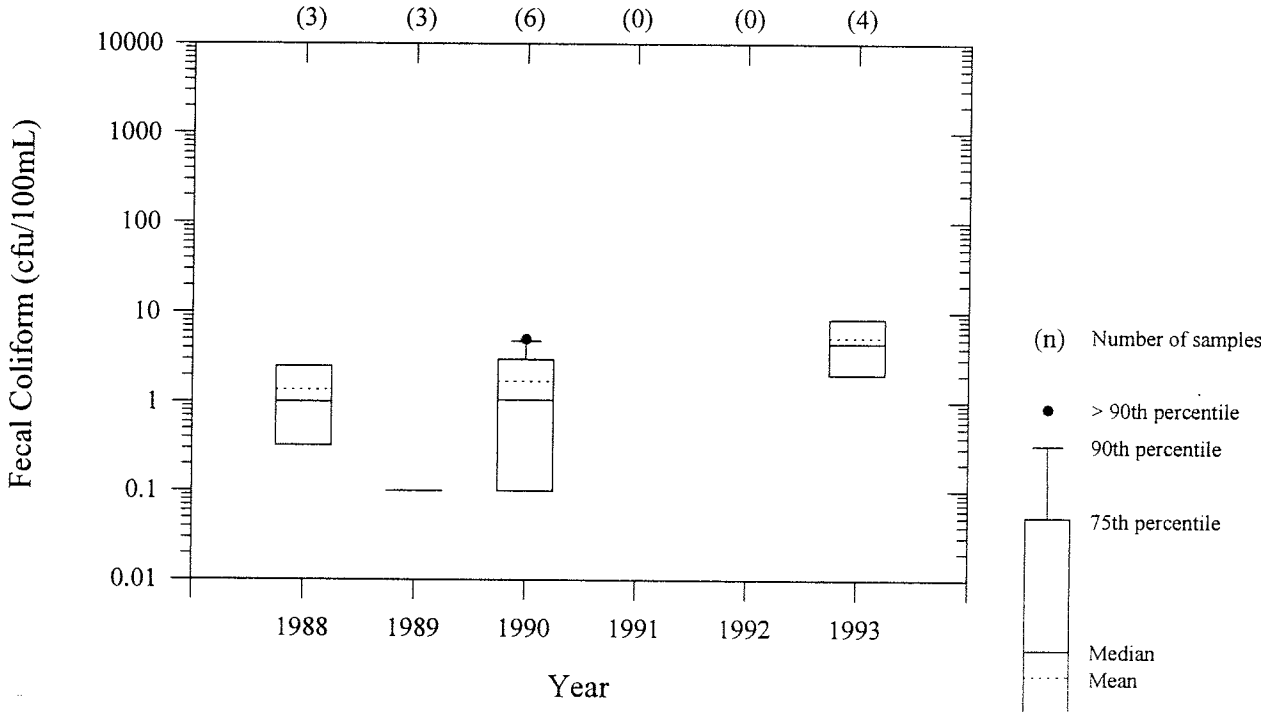
Mt. Sheep Canyon (MSC2)



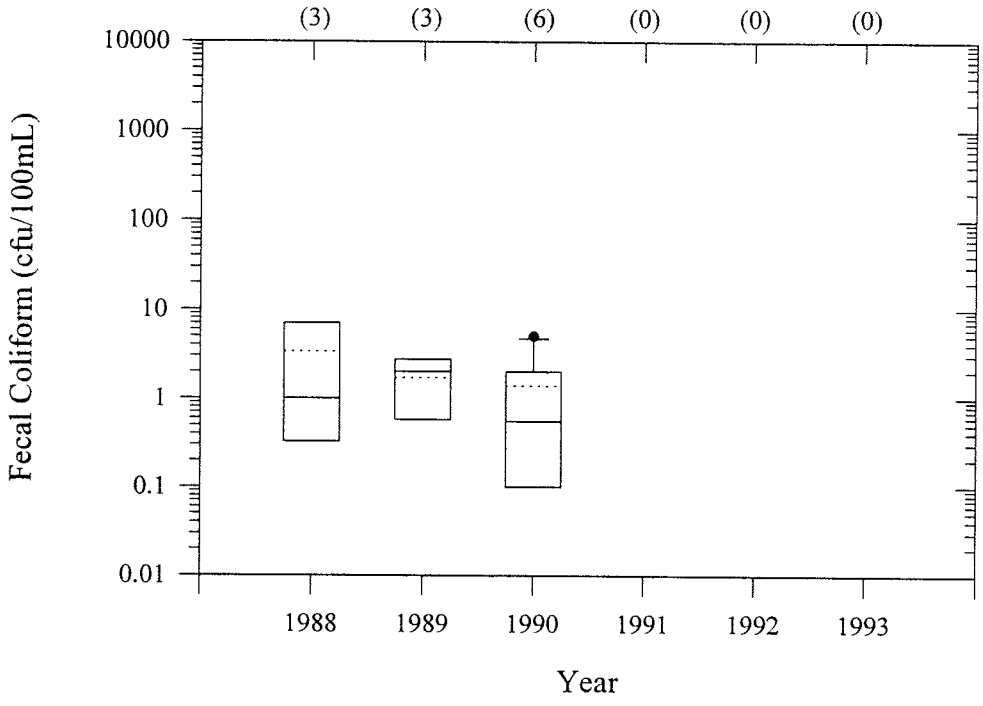
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

The Narrows (NARR1)



The Narrows (NARR2)



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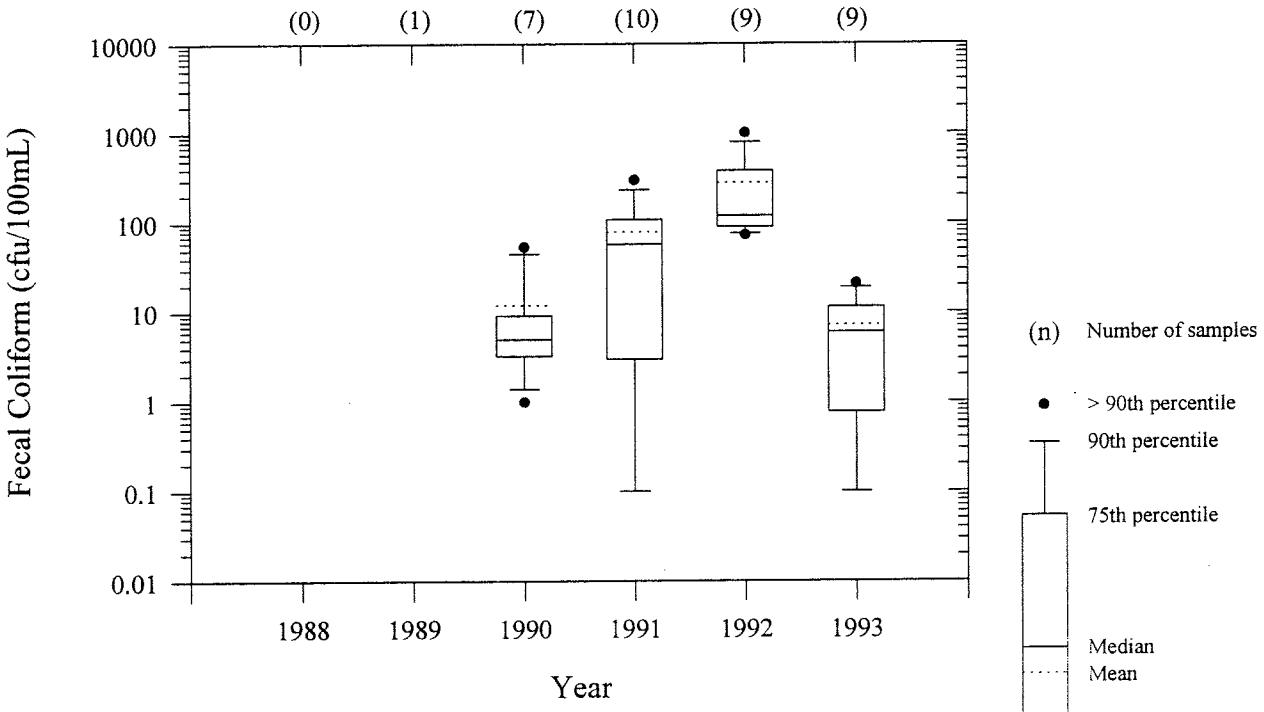
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

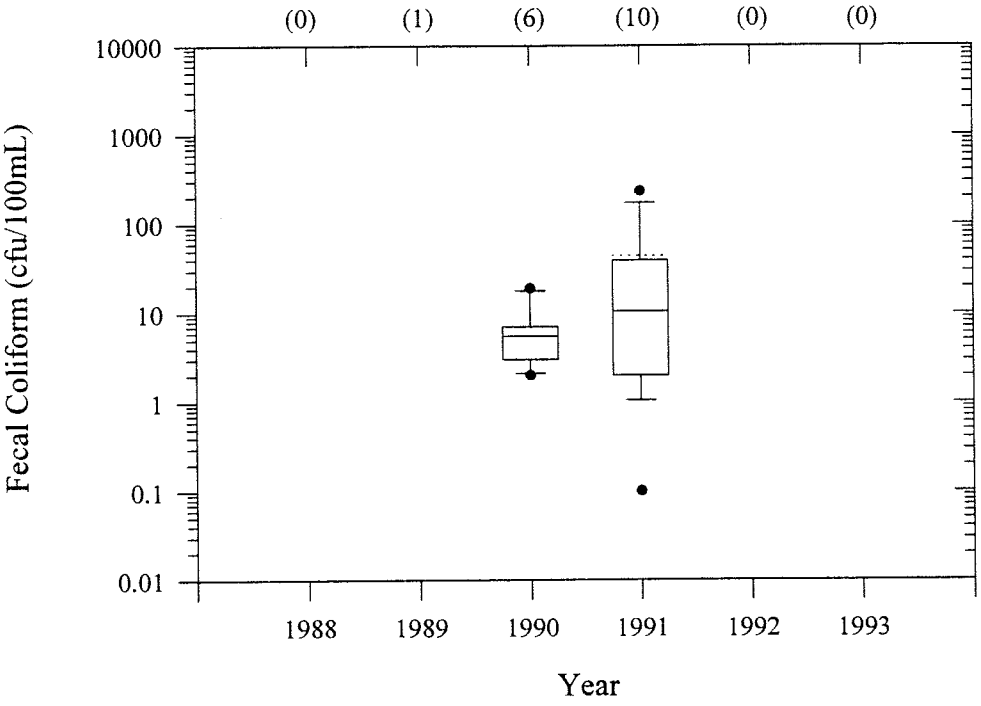
Government Housing (NPS1)



Values of 0.1 in the plots represent fecal coliform counts equal to zero

Values of 1000 in the plots represent fecal coliform counts too numerous to count

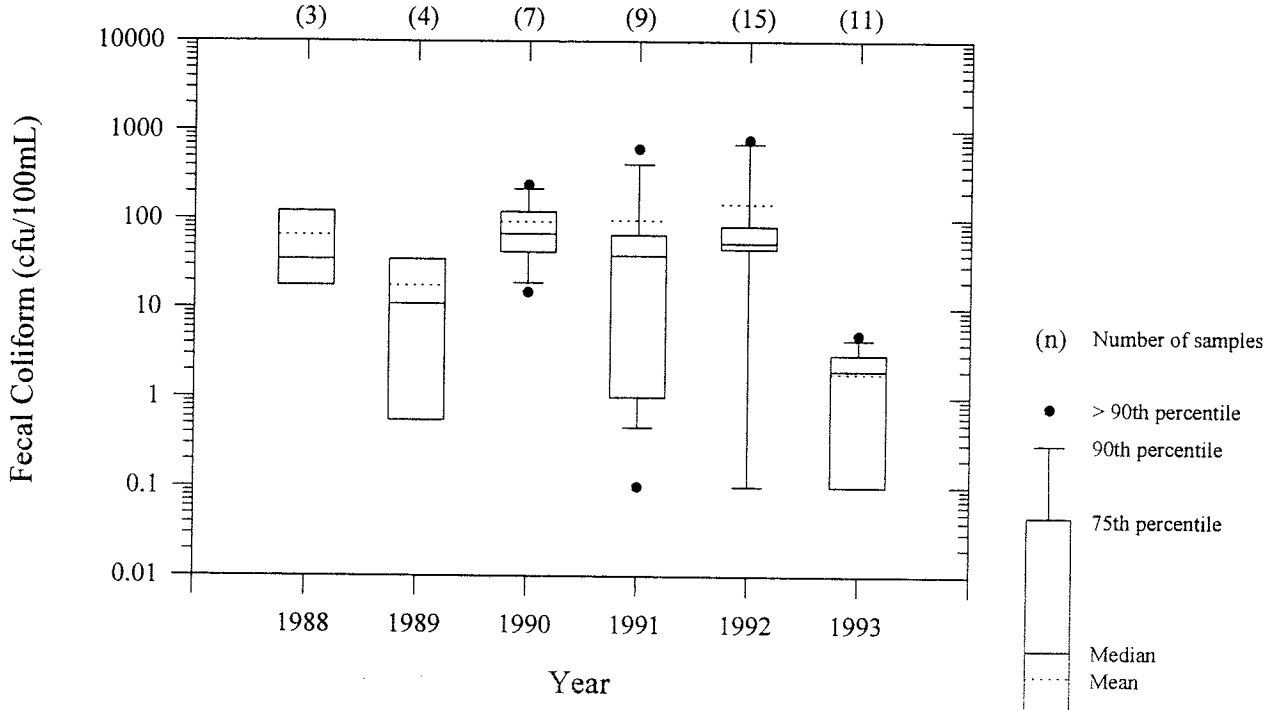
Government Housing (NPS2)



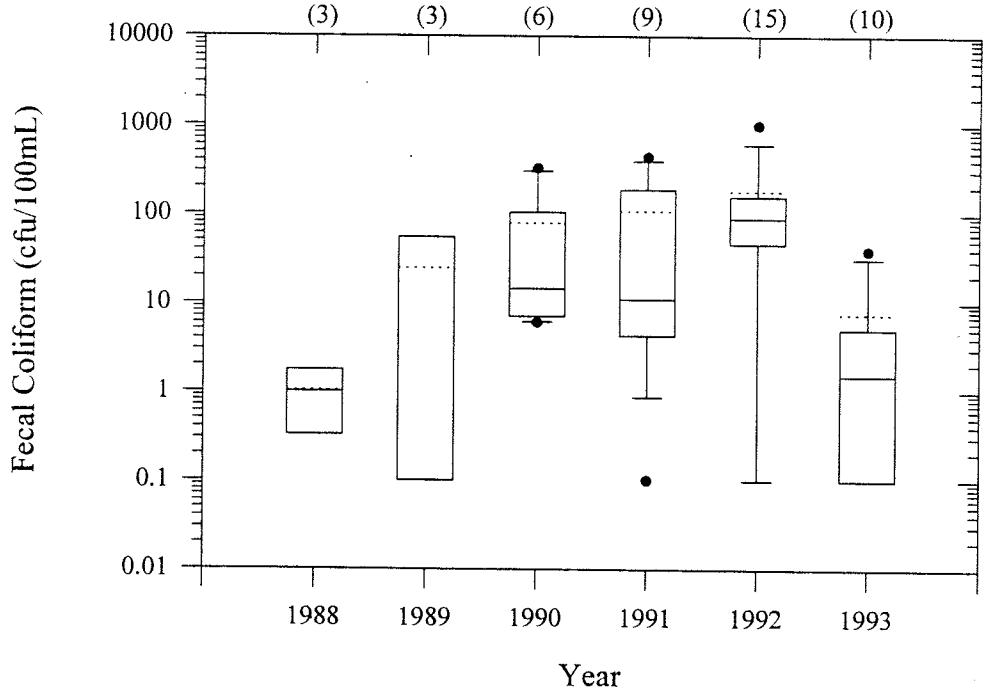
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Oak Canyon (OAK1)



Oak Canyon (OAK2)



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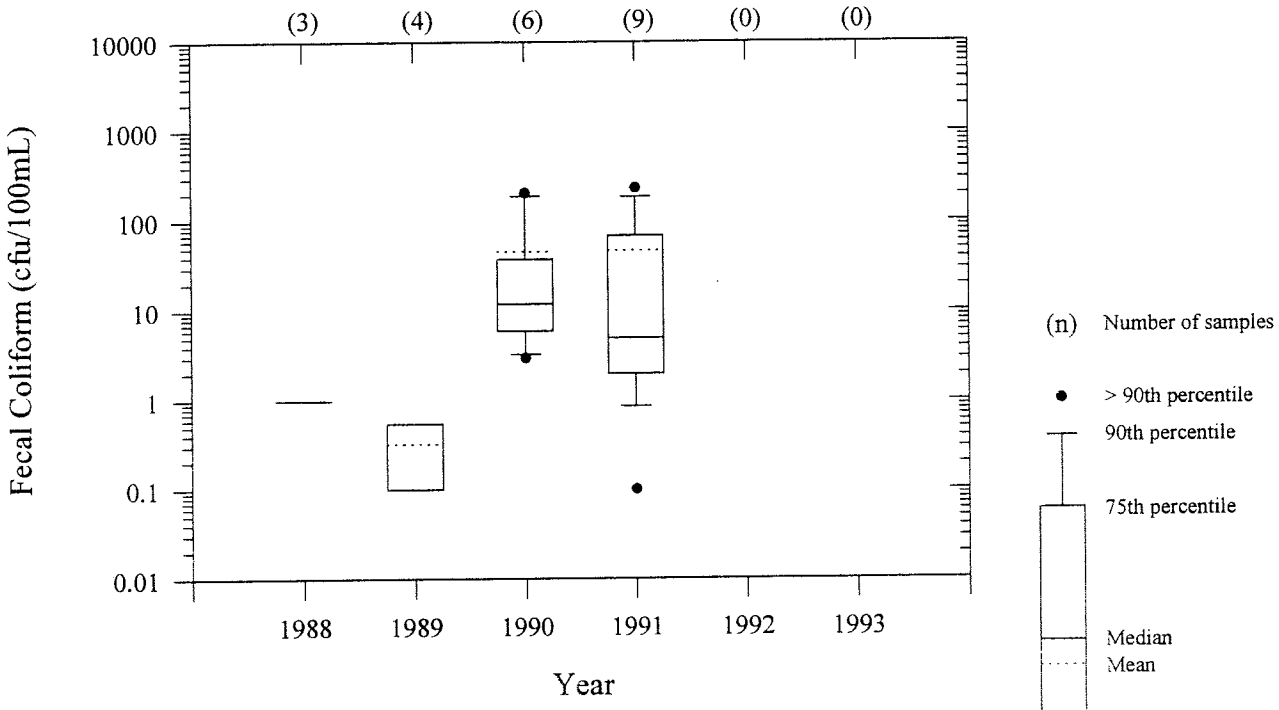
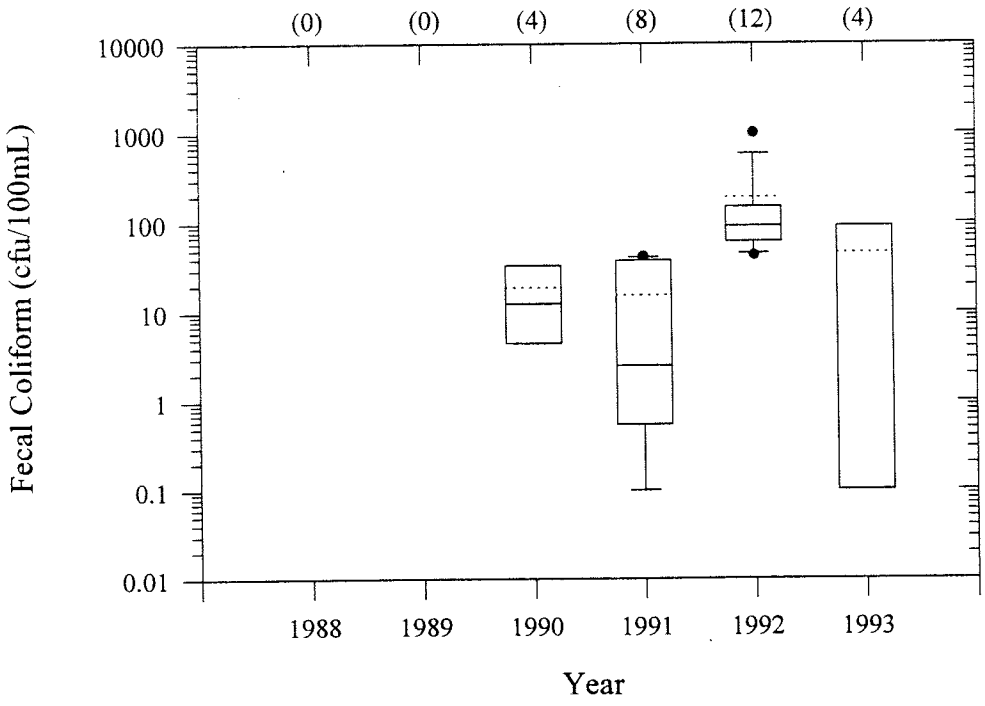
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Oak Canyon (OAK3)



Rainbow Bridge (RB1)



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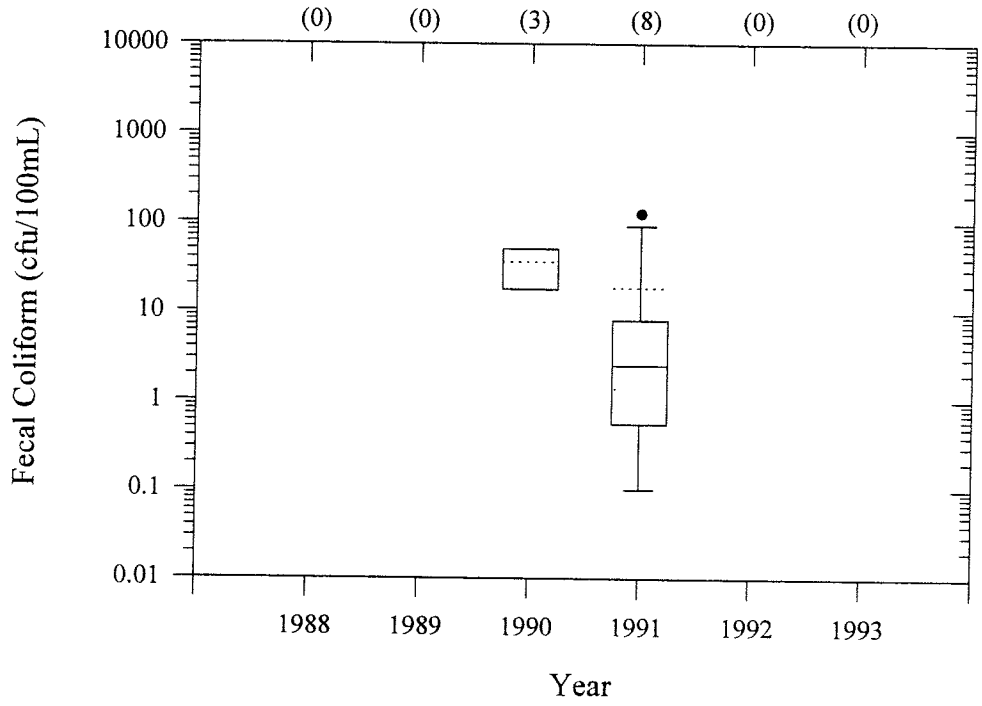
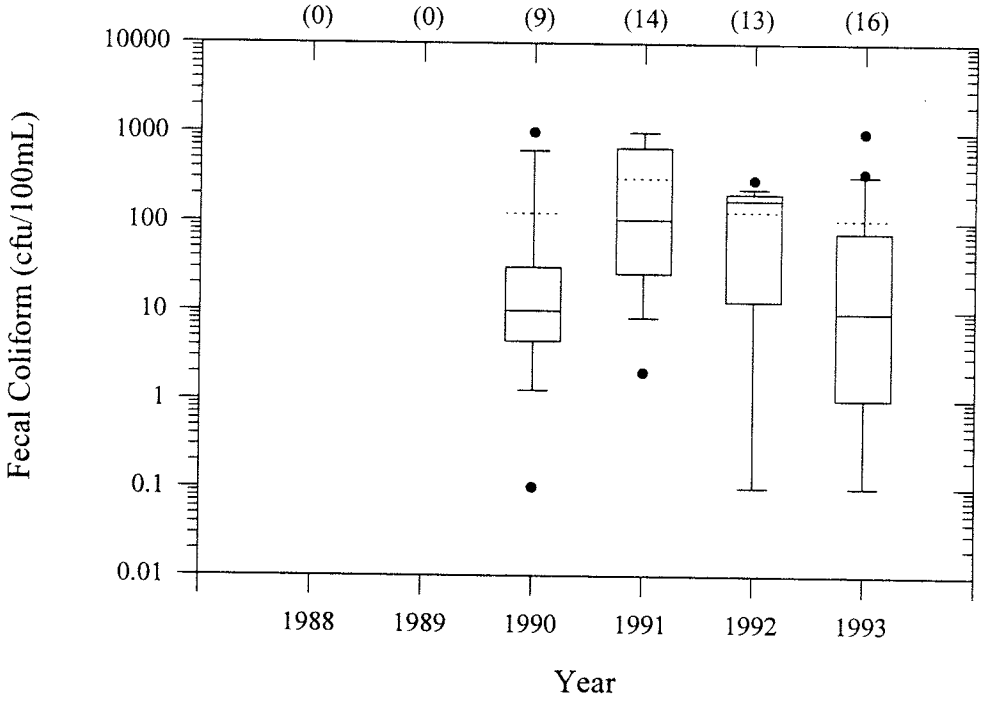
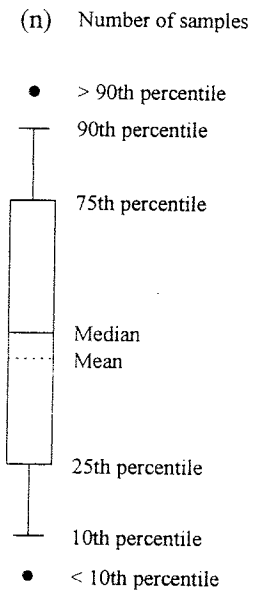
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Rainbow Bridge (RB2)



Stanton Creek (STAN1)





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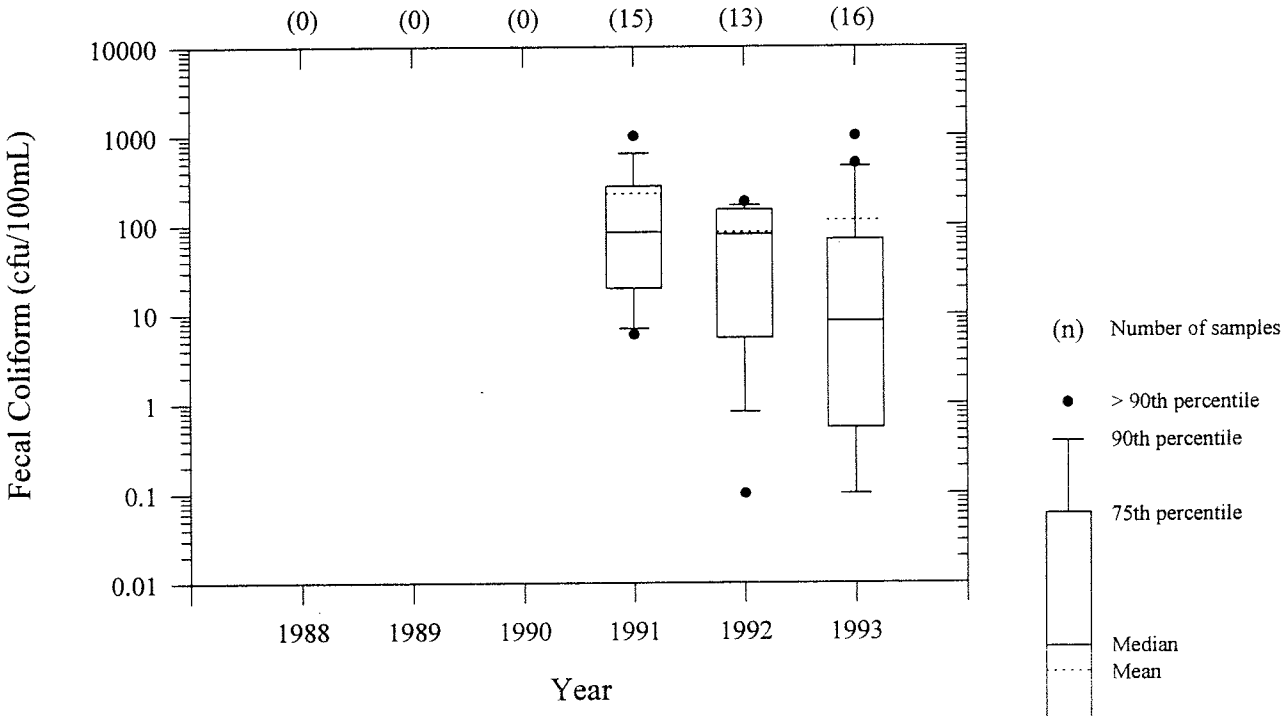
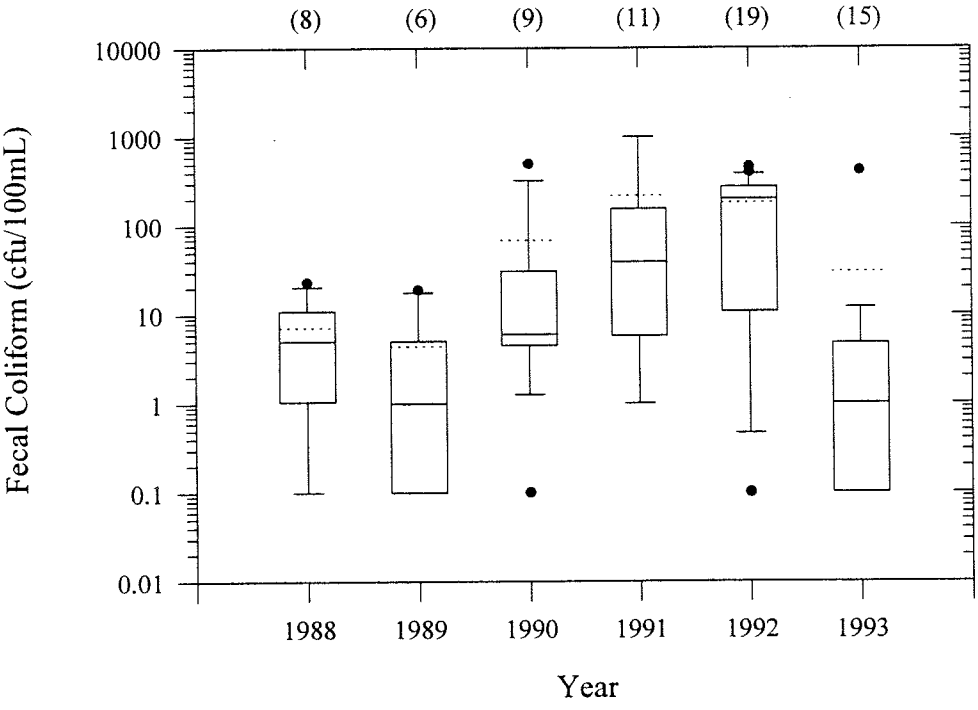
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Stanton Creek (STAN2)



Upper Bullfrog Bay (UBB1)



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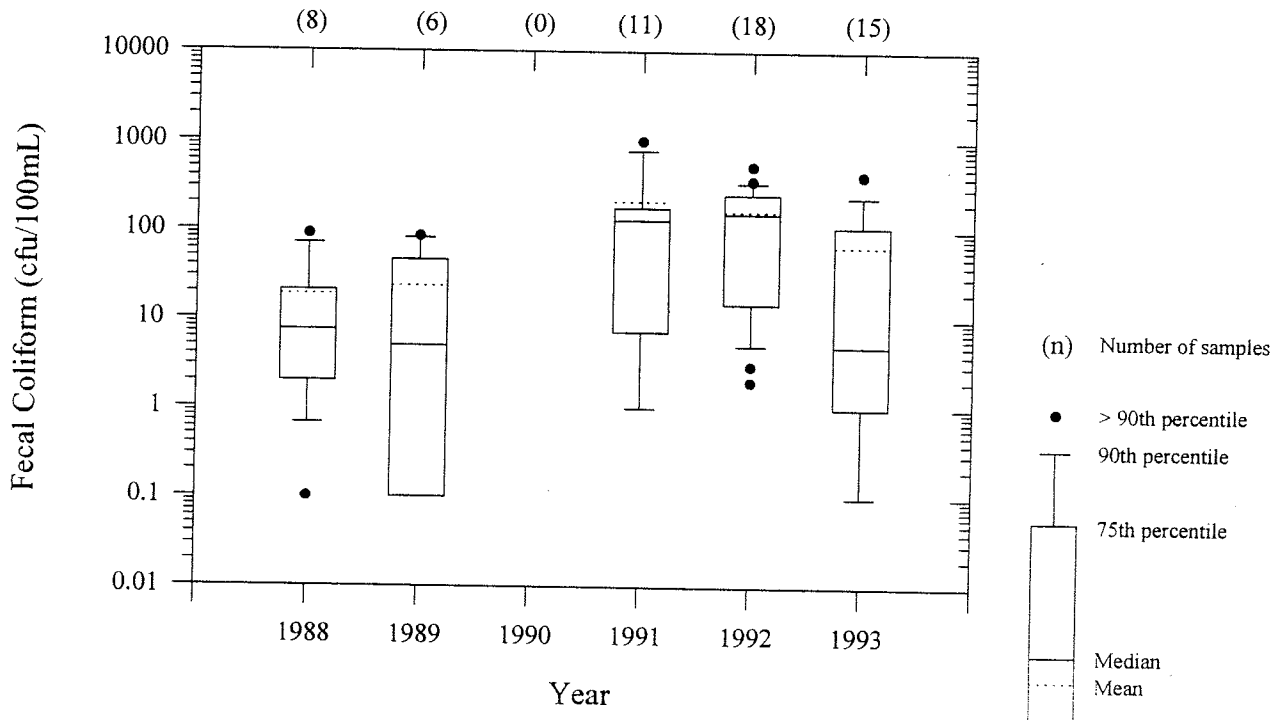
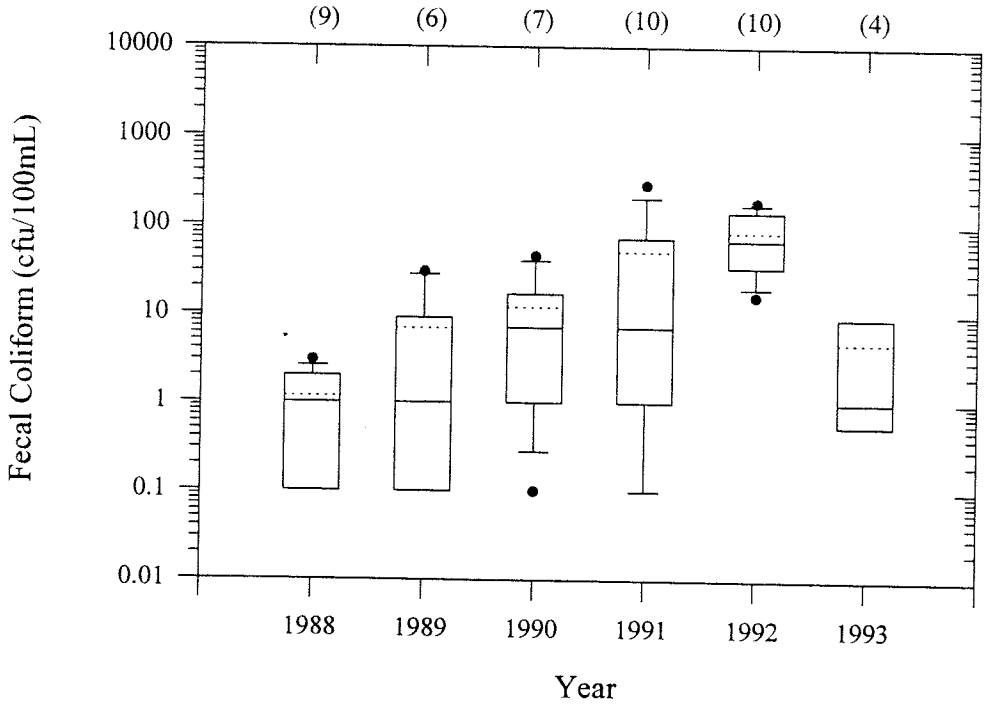
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Upper Bullfrog Bay (UBB2)



Warm Creek Beach (WCB1)



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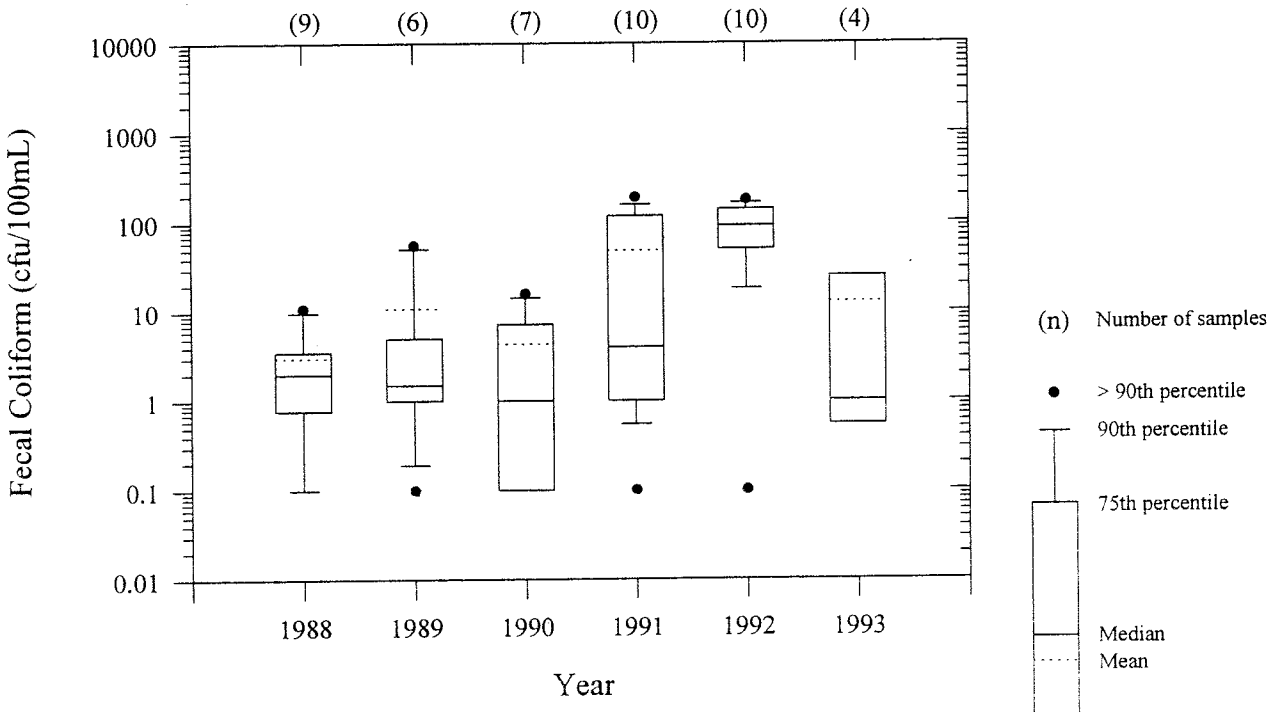
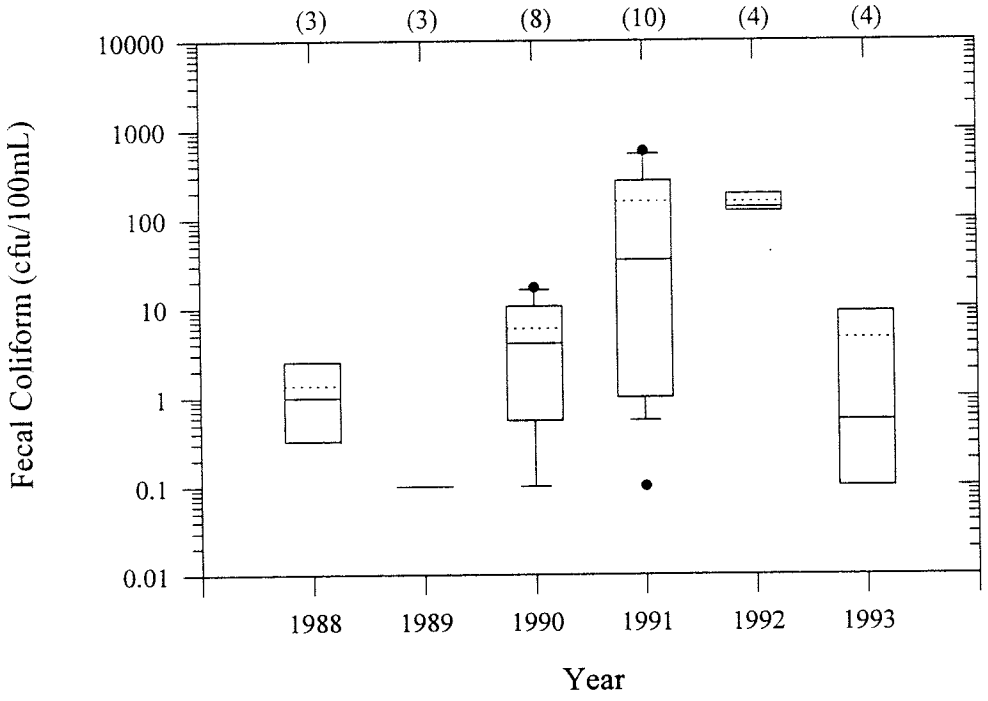
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Warm Creek Beach (WCB2)



Warm Creek Cattle Area (WCCA1)



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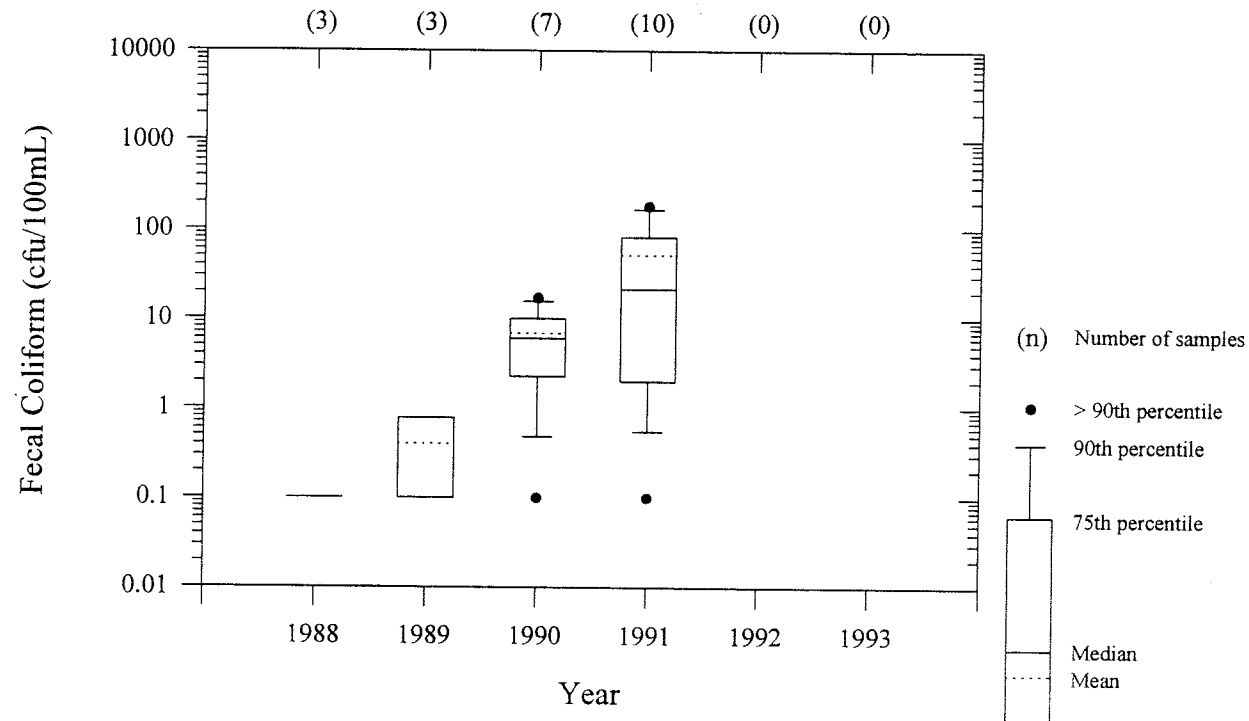
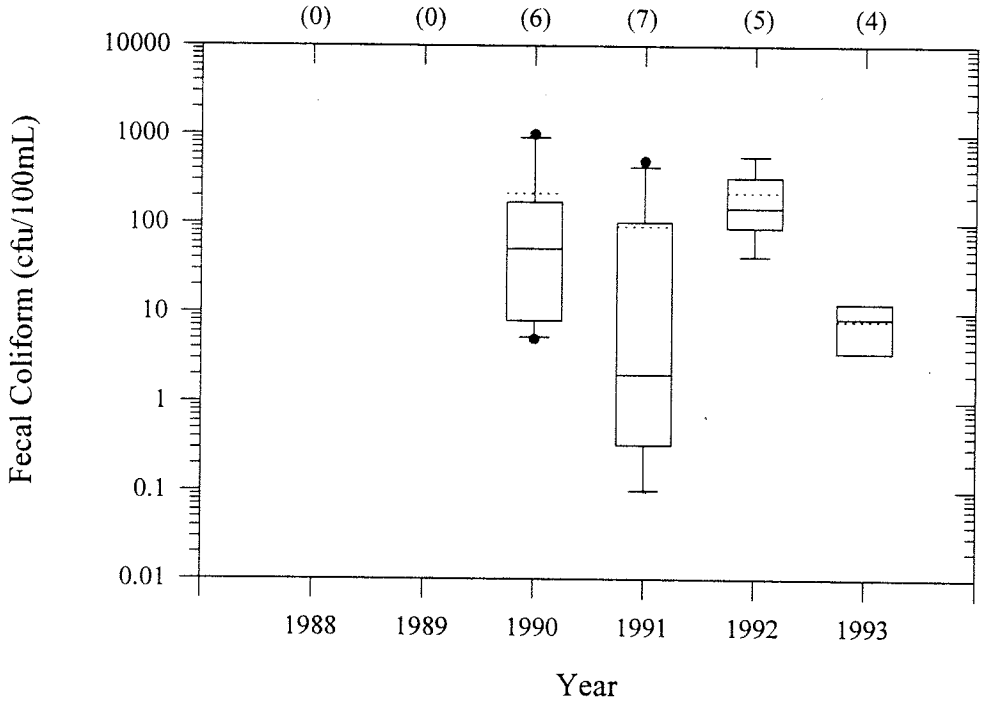
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Warm Creek Cattle Area (WCCA2)



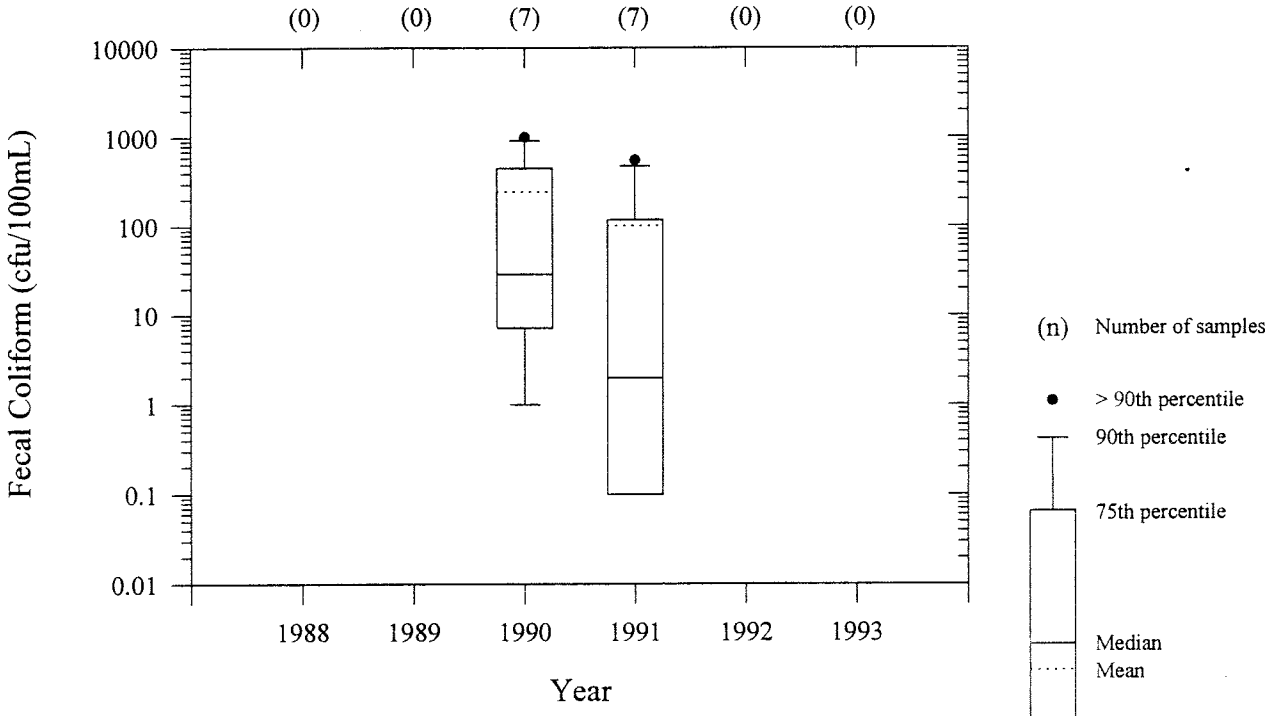
Wilson Creek (WIL1)



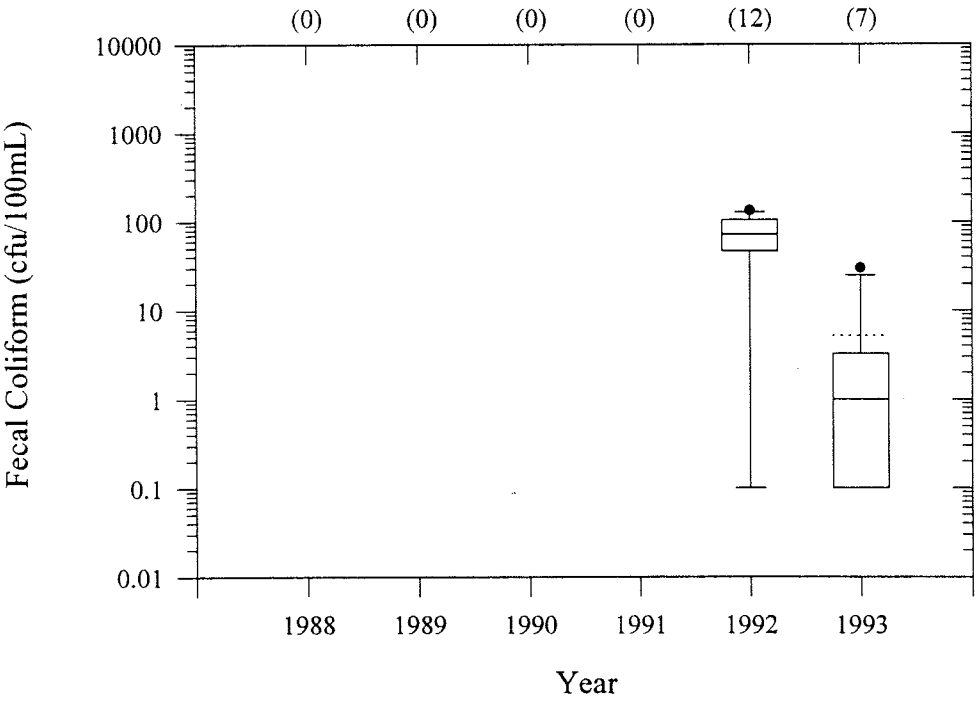
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Wilson Creek (WIL2)



Wahweap Bay (WWB)



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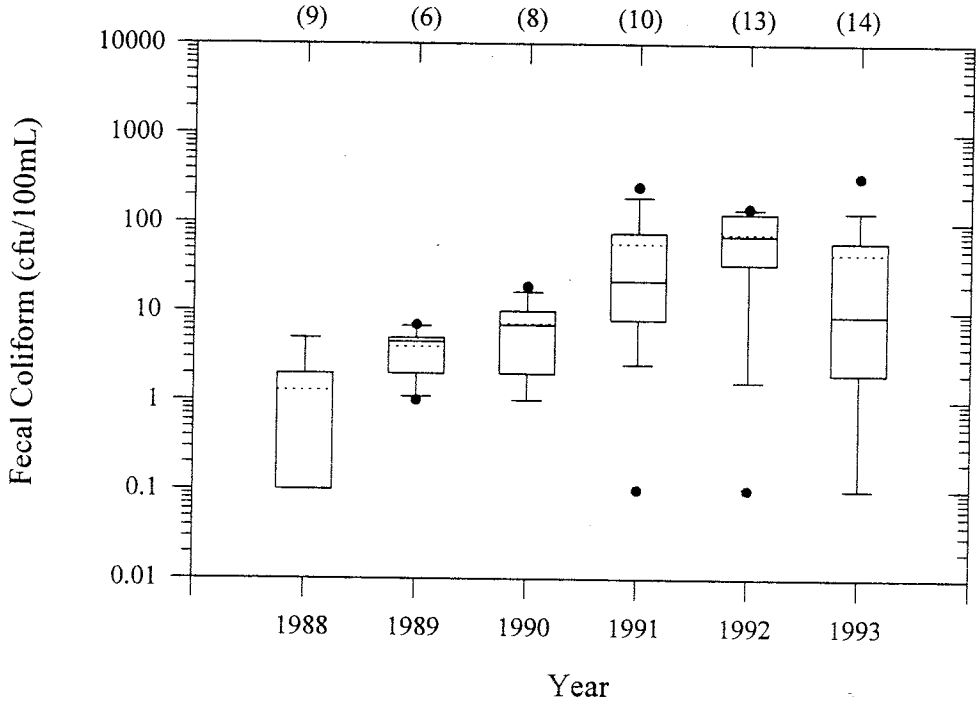
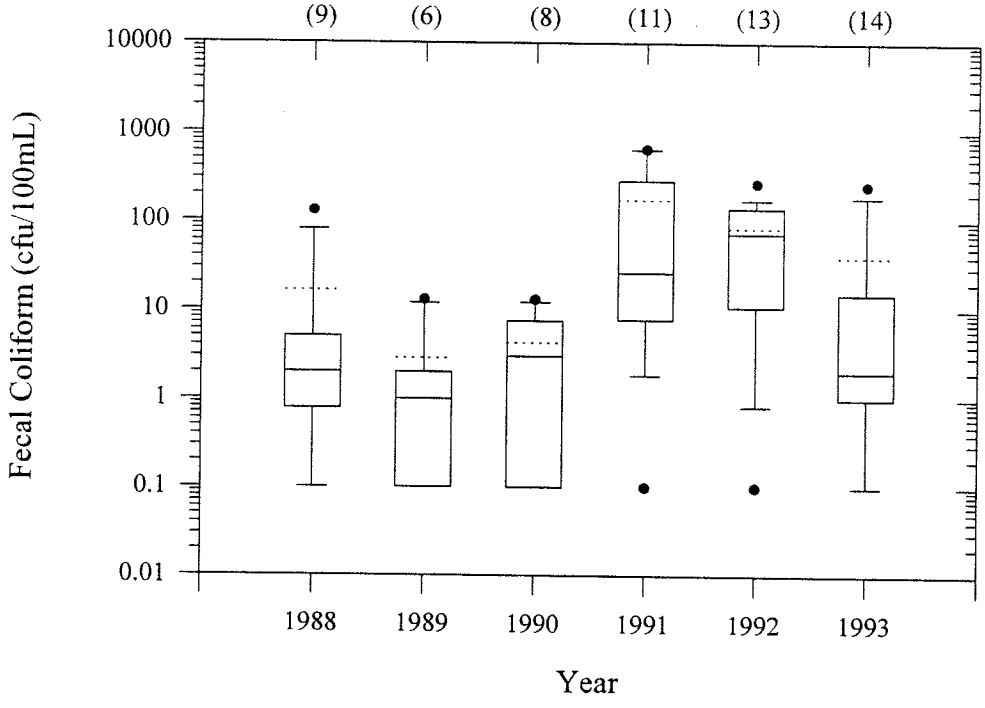
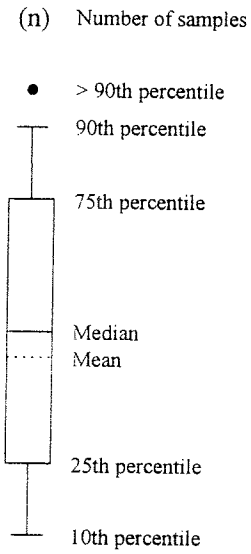
Annual Fecal Coliform by Site
Glen Canyon National Recreation Area

Wahweap Lodge Beach (WWLB1)



Wahweap Lodge Beach (WWLB2)





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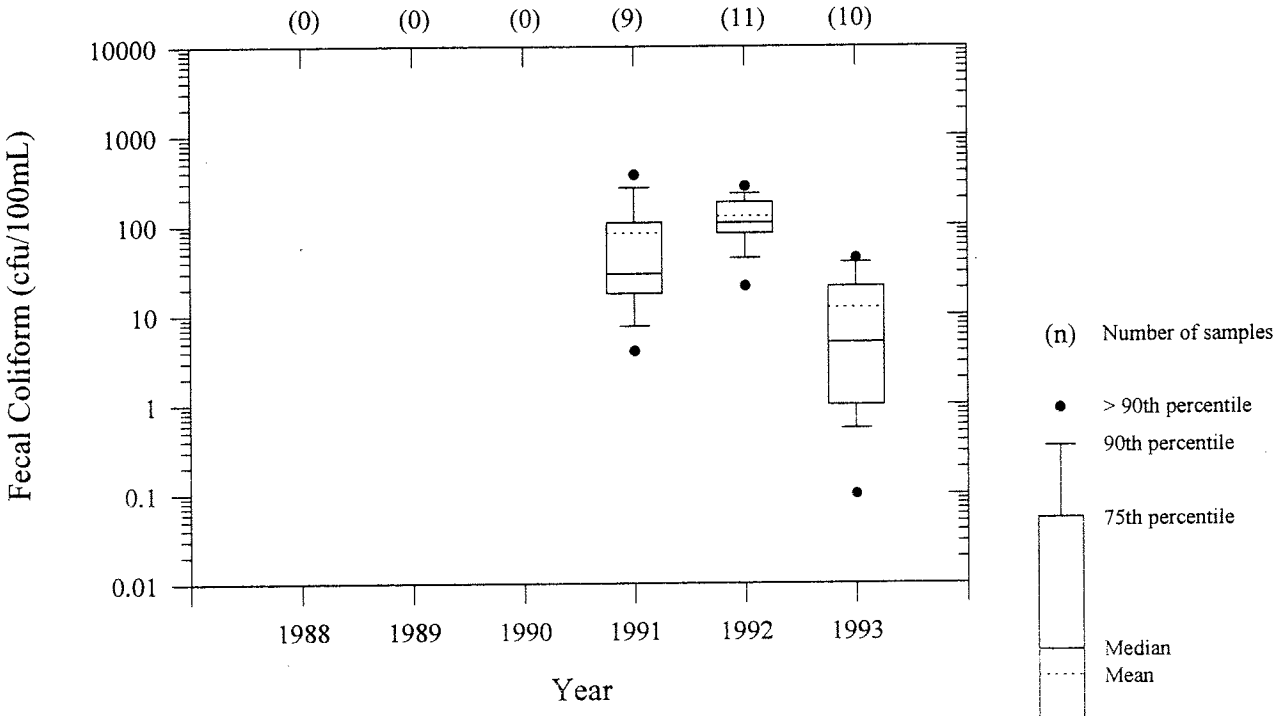
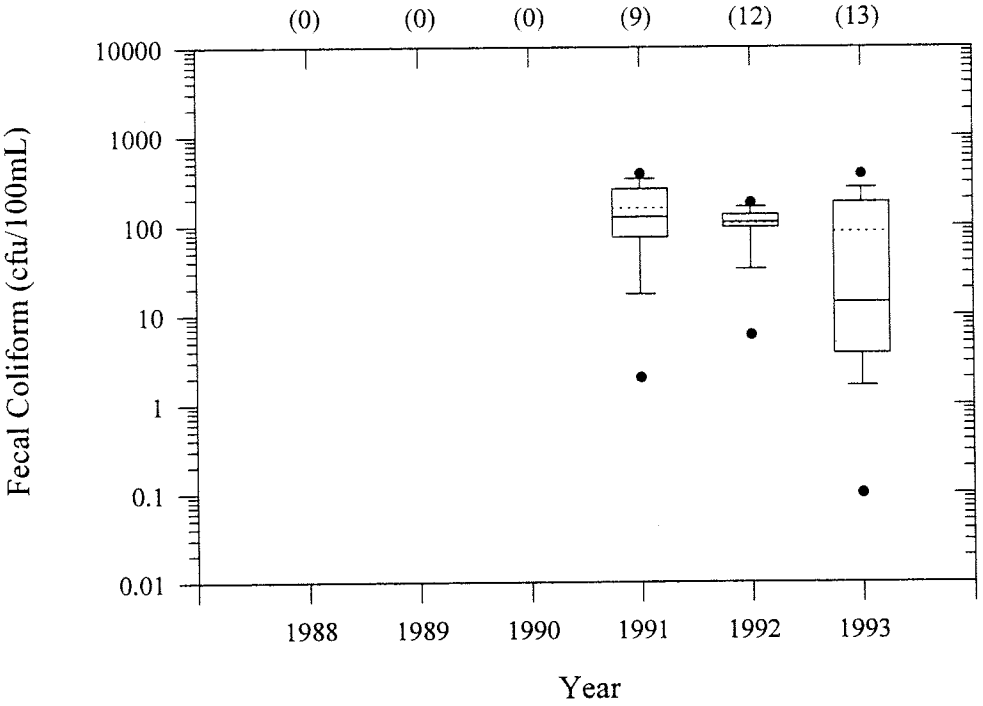
Annual Fecal Coliform by Site

Glen Canyon National Recreation Area

Wahweap Marina (WWM1)



Wahweap Marina (WWM2)



Summary Statistics for GLCA Fecal Streptococci Data, 1988-1989,with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
AP1	1988	4	4	7.0	0	0	0	7	14	0	14
AP1	1989	3	76	131.6	0	0	0	228	228	0	228
AP1	1988-89	7	35	85.5	0	0	0	14	228	0	228
AP2	1988	4	5	9.0	0	0	0	9	18	0	18
AP2	1989	3	2	4.0	0	0	0	7	7	0	7
AP2	1988-89	7	4	6.9	0	0	0	7	18	0	18
BFNOTCH	1988	8	67	162.2	0	0	4	29	466	0	466
BFNOTCH	1989	6	2	3.1	0	0	0.5	2	8	0	8
BFNOTCH	1988-89	14	39	123.6	0	0	1	8	48	0	466
BFSB1	1988	8	40	42.3	0	0	27	82	98	0	98
BFSB1	1989	6	35	80.1	0	0	2	6	198	0	198
BFSB1	1988-89	14	37	58.6	0	0	5	76	98	0	198
BFSB2	1988	8	77	104.3	0	0	36	125	296	0	296
BFSB2	1989	6	13	14.4	0	0	7.5	28	32	0	32
BFSB2	1988-89	14	50	83.9	0	0	15	56	154	0	296
CHA1	1988	2	833	236.2	666	666	833	1000	1000	666	1000
CHA1	1989	2	0	0.0	0	0	0	0	0	0	0
CHA1	1988-89	4	417	499.9	0	0	333	833	1000	0	1000
CHA2	1988	2	768	328.1	536	536	768	1000	1000	536	1000
CHA2	1989	2	0	0.0	0	0	0	0	0	0	0
CHA2	1988-89	4	384	482.2	0	0	268	768	1000	0	1000
COPPCAN1	1988	2	86	96.2	18	18	86	154	154	18	154
COPPCAN1	1989	1	0	.	0	0	0	0	0	0	0
COPPCAN1	1988-89	3	57	84.2	0	0	18	154	154	0	154
COPPCAN2	1988	2	59	58.0	18	18	59	100	100	18	100
COPPCAN2	1989	1	0	.	0	0	0	0	0	0	0
COPPCAN2	1988-89	3	39	53.3	0	0	18	100	100	0	100
DRM1	1989	1	0	.	0	0	0	0	0	0	0
DRM2	1989	1	1	.	1	1	1	1	1	1	1
DVG1	1988	4	43	33.7	8	17	38	68	86	8	86
DVG1	1989	5	1	3.1	0	0	0	0	7	0	7
DVG1	1988-89	9	20	30.0	0	0	7	26	86	0	86
DVG2	1988	4	34	20.5	4	21	42	47	48	4	48

Summary Statistics for GLCA Fecal Streptococci Data, 1988-1989,with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
DVG2	1989	3	1	1.2	0	0	0	2	2	0	2
DVG2	1988-89	7	20	23.0	0	0	4	46	48	0	48
FAR1	1988	7	65	105.4	0	0	0	90	286	0	286
FAR1	1989	5	35	44.3	0	2	22	42	108	0	108
FAR1	1988-89	12	53	83.8	0	0	12	86	108	0	286
FAR2	1988	7	110	149.4	0	0	36	320	328	0	328
FAR2	1989	7	107	127.9	0	0	59	172	359	0	359
FAR2	1988-89	13	97	125.3	0	0	36	122	320	0	328
HIMAR1	1988	7	162	370.5	0	0	8	70	1000	0	1000
HIMAR1	1989	6	0	0.0	0	0	0	0	0	0	0
HIMAR1	1988-89	13	87	275.2	0	0	0	8	70	0	1000
HIMAR2	1988	8	144	348.0	0	0	6	69	1000	0	1000
HIMAR2	1989	6	117	157.1	0	0	62	164	412	0	412
HIMAR2	1988-89	14	132	273.7	0	0	20	110	412	0	1000
LONE1	1988	9	89	147.5	0	0	14	68	374	0	374
LONE1	1989	6	3	4.3	0	0	0	6	10	0	10
LONE1	1988-89	15	54	119.8	0	0	4	24	316	0	374
LONE2	1988	9	133	169.9	0	0	8	334	366	0	366
LONE2	1989	6	31	52.6	0	4	7.5	31	136	0	136
LONE2	1988-89	15	92	142.0	0	0	8	136	356	0	366
LONE3	1988	9	136	174.1	0	0	56	202	510	0	510
LONE3	1989	6	88	147.3	0	2	32	80	383	0	383
LONE3	1988-89	15	117	160.2	0	0	35	202	383	0	510
MOQUI1	1988	2	36	50.9	0	0	36	72	72	0	72
MOQUI1	1989	3	15	13.1	0	0	21	24	24	0	24
MOQUI1	1988-89	5	23	29.4	0	0	21	24	72	0	72
MOQUI2	1988	2	59	83.4	0	0	59	118	118	0	118
MOQUI2	1989	3	37	44.4	0	0	24	86	86	0	86
MOQUI2	1988-89	5	46	53.6	0	0	24	86	118	0	118
MOQUI3	1988	2	27	38.2	0	0	27	54	54	0	54
MOQUI3	1989	3	28	29.1	0	0	26	58	58	0	58
MOQUI3	1988-89	5	28	28.0	0	0	26	54	58	0	58
MSC1	1988	9	12	15.4	0	0	0	22	40	0	40

Summary Statistics for GLCA Fecal Streptococci Data, 1988-1989,with Duplicates Averaged (cfu/100mL)											
SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
MSC1	1989	6	1	1.2	0	0	0	0	3	0	3
MSC1	1988-89	15	7	13.0	0	0	0	18	28	0	40
MSC2	1988	9	12	20.4	0	0	0	24	56	0	56
MSC2	1989	6	1	3.3	0	0	0	0	8	0	8
MSC2	1988-89	15	8	16.6	0	0	0	8	32	0	56
NARR1	1988	3	138	239.0	0	0	0	414	414	0	414
NARR1	1989	3	1	2.3	0	0	0	4	4	0	4
NARR1	1988-89	6	70	168.7	0	0	0	4	414	0	414
NARR2	1988	3	11	18.5	0	0	0	32	32	0	32
NARR2	1989	3	1	1.2	0	0	0	2	2	0	2
NARR2	1988-89	6	6	12.9	0	0	0	2	32	0	32
NESCAN1	1988	2	181	222.0	24	24	181	338	338	24	338
NESCAN1	1989	1	0	.	0	0	0	0	0	0	0
NESCAN1	1988-89	3	121	188.6	0	0	24	338	338	0	338
NESCAN2	1988	2	180	206.5	34	34	180	326	326	34	326
NESCAN2	1989	1	0	.	0	0	0	0	0	0	0
NESCAN2	1988-89	3	120	179.2	0	0	34	326	326	0	326
NPS1	1989	1	10	.	10	10	10	10	10	10	10
NPS2	1989	1	12	.	12	12	12	12	12	12	12
OAK1	1988	3	104	180.1	0	0	0	312	312	0	312
OAK1	1989	4	1	1.2	0	0	1	2	2	0	2
OAK1	1988-89	7	45	117.7	0	0	0	2	312	0	312
OAK2	1988	3	13	23.1	0	0	0	40	40	0	40
OAK2	1989	3	10	16.5	0	0	1	29	29	0	29
OAK2	1988-89	6	12	18.0	0	0	1	29	40	0	40
OAK3	1988	3	13	23.1	0	0	0	40	40	0	40
OAK3	1989	4	1	1.4	0	0	0.5	2	3	0	3
OAK3	1988-89	7	6	14.9	0	0	0	3	40	0	40
PAIUTE1	1988	2	553	632.9	105	105	552.5	1000	1000	105	1000
PAIUTE1	1989	2	0	0.0	0	0	0	0	0	0	0
PAIUTE1	1988-89	4	276	485.0	0	0	53	553	1000	0	1000
PAIUTE2	1988	2	533	660.4	66	66	533	1000	1000	66	1000
PAIUTE2	1989	2	0	0.0	0	0	0	0	0	0	0

Summary Statistics for GLCA Fecal Streptococci Data, 1988-1989,with Duplicates Averaged (cfu/100mL)

SITE	YEAR	COUNT	MEAN	ST DEV	P10	P25	MEDIAN	P75	P90	MIN	MAX
PAIUTE2	1988-89	4	267	490.0	0	0	33	533	1000	0	1000
SPENCER1	1988	2	39	21.2	24	24	39	54	54	24	54
SPENCER1	1989	1	0	.	0	0	0	0	0	0	0
SPENCER1	1988-89	3	26	27.1	0	0	24	54	54	0	54
SPENCER2	1988	2	44	8.5	38	38	44	50	50	38	50
SPENCER2	1989	1	0	.	0	0	0	0	0	0	0
SPENCER2	1988-89	3	29	26.1	0	0	38	50	50	0	50
UBB1	1988	8	62	149.2	0	0	6	27	430	0	430
UBB1	1989	6	1	1.0	0	0	0.5	2	2	0	2
UBB1	1988-89	14	36	113.9	0	0	2	10	30	0	430
UBB2	1988	8	39	61.6	0	0	10	57	178	0	178
UBB2	1989	6	14	24.8	0	0	0	23	61	0	61
UBB2	1988-89	14	28	49.5	0	0	1	46	68	0	178
WCB1	1988	9	84	161.2	0	0	2	16	424	0	424
WCB1	1989	6	4	5.3	0	0	1	7	13	0	13
WCB1	1988-89	15	52	128.5	0	0	2	13	302	0	424
WCB2	1988	10	56	115.2	0	0	5	16	261	0	346
WCB2	1989	6	7	13.0	0	0	1	7	33	0	33
WCB2	1988-89	15	40	95.8	0	0	2	16	176	0	346
WCCA1	1988	3	140	121.3	0	0	208	212	212	0	212
WCCA1	1989	3	6	10.4	0	0	0	18	18	0	18
WCCA1	1988-89	6	73	106.4	0	0	9	208	212	0	212
WCCA2	1988	3	51	66.2	0	0	28	126	126	0	126
WCCA2	1989	3	18	25.6	0	0	6	47	47	0	47
WCCA2	1988-89	6	35	48.5	0	0	17	47	126	0	126
WWLB1	1988	9	97	166.0	0	0	0	102	464	0	464
WWLB1	1989	6	5	7.1	0	0	0.5	9	17	0	17
WWLB1	1988-89	15	60	134.0	0	0	0	24	280	0	464
WWLB2	1988	9	255	355.7	0	0	18	498	1000	0	1000
WWLB2	1989	6	5	6.7	0	0	2.5	11	16	0	16
WWLB2	1988-89	15	155	297.1	0	0	4	236	540	0	1000

Fecal Coliform Fecal Streptococci Ratio Data for values > 0, 1988-1989				
SITE ID	DATE	FECAL COLIFORM	FECAL STREPTOCOCCI	FC/FS RATIO
AP1	15-Aug-88	1	14	0.071
AP1	14-Aug-89	457	228	2.004
BFNOTCH	15-Aug-88	1	8	0.125
BFSB1	01-Aug-88	2	12	0.167
BFSB1	15-Aug-88	25	98	0.255
BFSB1	29-Aug-88	6	88	0.068
BFSB1	06-Sep-88	6	76	0.079
BFSB1	17-Jul-89	21	6	3.500
BFSB1	14-Aug-89	115	198	0.581
BFSB2	01-Aug-88	4	296	0.014
BFSB2	15-Aug-88	7	16	0.438
BFSB2	29-Aug-88	2	96	0.021
BFSB2	06-Sep-88	3	154	0.019
BFSB2	17-Jul-89	5	28	0.179
BFSB2	14-Aug-89	188	32	5.875
BFSB2	11-Sep-89	2	13	0.154
COPPCAN2	14-Sep-88	2	100	0.020
DRM2	14-Aug-89	3	1	3.000
DVG1	01-Aug-88	19	86	0.221
DVG1	29-Aug-88	5	26	0.192
DVG1	06-Sep-88	3	50	0.060
DVG2	01-Aug-88	18	46	0.391
DVG2	29-Aug-88	13	38	0.342
DVG2	06-Sep-88	5	48	0.104
DVG2	28-Aug-89	1	2	0.500
FAR1	15-Aug-88	3	90	0.033
FAR1	29-Aug-88	3	82	0.037
FAR1	06-Sep-88	208	286	0.727
FAR1	05-Jul-89	36	108	0.333
FAR1	17-Jul-89	16	2	8.000
FAR1	14-Aug-89	4	42	0.095
FAR1	28-Aug-89	1	22	0.045

Fecal Coliform Fecal Streptococci Ratio Data for values > 0, 1988-1989				
SITE ID	DATE	FECAL COLIFORM	FECAL STREPTOCOCCI	FC/FS RATIO
FAR2	01-Aug-88	1	320	0.003
FAR2	06-Sep-88	3	328	0.009
FAR2	05-Jul-89	25	122	0.205
FAR2	14-Aug-89	4	36	0.111
FAR2	28-Aug-89	8	59	0.136
HIMAR1	15-Aug-88	2	8	0.250
HIMAR1	06-Sep-88	1	1000	0.001
HIMAR2	15-Aug-88	1	110	0.009
HIMAR2	06-Sep-88	3	1000	0.003
HIMAR2	05-Jul-89	7	164	0.043
HIMAR2	14-Aug-89	22	412	0.053
HIMAR2	28-Aug-89	23	82	0.280
HIMAR2	11-Sep-89	3	42	0.071
LONE1	01-Aug-88	1	68	0.015
LONE1	15-Aug-88	1	14	0.071
LONE1	29-Aug-88	1	316	0.003
LONE1	11-Sep-89	1	10	0.100
LONE2	05-Jul-88	23	8	2.875
LONE2	01-Aug-88	49	366	0.134
LONE2	15-Aug-88	1	334	0.003
LONE2	29-Aug-88	3	356	0.008
LONE2	06-Sep-88	10	136	0.074
LONE2	17-Jul-89	1	4	0.250
LONE2	31-Jul-89	1391	136	10.228
LONE2	14-Aug-89	2	7	0.286
LONE3	05-Jul-88	10	24	0.417
LONE3	01-Aug-88	1	290	0.003
LONE3	15-Aug-88	8	510	0.016
LONE3	29-Aug-88	4	202	0.020
LONE3	06-Sep-88	6	146	0.041
LONE3	17-Jul-89	1	2	0.500
LONE3	31-Jul-89	83	383	0.217

Fecal Coliform Fecal Streptococci Ratio Data for values > 0, 1988-1989				
SITE ID	DATE	FECAL COLIFORM	FECAL STREPTOCOCCI	FC/FS RATIO
LONE3	14-Aug-89	5	80	0.063
LONE3	11-Sep-89	2	35	0.057
MOQUI1	15-Aug-88	8	72	0.111
MOQUI1	14-Aug-89	50	24	2.083
MOQUI1	11-Sep-89	2	21	0.095
MOQUI2	15-Aug-88	27	118	0.229
MOQUI2	14-Aug-89	77	86	0.895
MOQUI2	11-Sep-89	1	24	0.042
MOQUI3	15-Aug-88	18	54	0.333
MOQUI3	14-Aug-89	19	58	0.328
MOQUI3	11-Sep-89	4	26	0.154
MSC1	15-Aug-88	2	22	0.091
MSC1	29-Aug-88	14	18	0.778
MSC1	06-Sep-88	1	40	0.025
MSC2	01-Aug-88	10	32	0.313
MSC2	15-Aug-88	15	24	0.625
MSC2	29-Aug-88	4	56	0.071
MSC2	11-Sep-89	1	8	0.125
NARR1	29-Aug-88	1	414	0.002
NARR2	29-Aug-88	1	32	0.031
NARR2	28-Aug-89	3	2	1.500
NESCAN1	26-Sep-88	6	338	0.018
NPS1	14-Aug-89	7	10	0.700
NPS2	14-Aug-89	1	12	0.083
OAK1	15-Aug-88	150	312	0.481
OAK1	14-Aug-89	49	2	24.500
OAK2	14-Aug-89	73	1	73.000
OAK3	15-Aug-88	1	40	0.025
OAK3	14-Aug-89	1	3	0.333
PAIUTE1	14-Sep-88	13	1000	0.013
PAIUTE1	26-Sep-88	5	105	0.048
PAIUTE2	14-Sep-88	8	1000	0.008

Fecal Coliform Fecal Streptococci Ratio Data for values > 0, 1988-1989				
SITE ID	DATE	FECAL COLIFORM	FECAL STREPTOCOCCI	FC/FS RATIO
PAIUTE2	26-Sep-88	4	66	0.061
SPENCER1	26-Sep-88	1	24	0.042
UBB1	01-Aug-88	7	430	0.016
UBB1	15-Aug-88	14	30	0.467
UBB1	29-Aug-88	2	10	0.200
UBB1	17-Jul-89	19	2	9.500
UBB1	14-Aug-89	5	1	5.000
UBB2	01-Aug-88	2	178	0.011
UBB2	15-Aug-88	2	68	0.029
UBB2	29-Aug-88	14	18	0.778
UBB2	06-Sep-88	3	46	0.065
UBB2	14-Aug-89	85	61	1.393
WCB1	01-Aug-88	3	302	0.010
WCB1	15-Aug-88	2	424	0.005
WCB1	29-Aug-88	1	16	0.063
WCB1	06-Sep-88	2	12	0.167
WCB1	14-Aug-89	9	13	0.692
WCB1	28-Aug-89	1	7	0.143
WCB2	05-Jul-88	2	8	0.250
WCB2	01-Aug-88	8	346	0.023
WCB2	15-Aug-88	1	16	0.063
WCB2	29-Aug-88	2	10	0.200
WCB2	06-Sep-88	11	176	0.063
WCB2	14-Aug-89	56	33	1.697
WCB2	28-Aug-89	2	7	0.286
WCB2	11-Sep-89	1	2	0.500
WCCA1	29-Aug-88	1	208	0.005
WCCA2	28-Aug-89	1	47	0.021
WWLB1	06-Sep-88	1	102	0.010
WWLB1	14-Aug-89	5	17	0.294
WWLB1	28-Aug-89	1	1	1.000
WWLB1	11-Sep-89	7	9	0.778

Fecal Coliform Fecal Streptococci Ratio Data for values > 0, 1988-1989				
SITE ID	DATE	FECAL COLIFORM	FECAL STREPTOCOCCI	FC/FS RATIO
WWLB2	01-Aug-88	128	1000	0.128
WWLB2	15-Aug-88	1	540	0.002
WWLB2	29-Aug-88	4	236	0.017
WWLB2	06-Sep-88	2	498	0.004
WWLB2	14-Aug-89	13	16	0.813
WWLB2	28-Aug-89	1	1	1.000

Appendix F

Pearson Correlation Table

and Regression Plots

PEARSON CORRELATION MATRIX

	AIRTEMP	BOATS	VEHICLES	PEOPLE	USE
AIRTEMP	1.000				
BOATS	0.143	1.000			
VEHICLES	0.088	0.779	1.000		
PEOPLE	0.136	0.718	0.834	1.000	
USE	0.245	.	.	.	1.000
ELEV	0.196	0.030	0.032	0.052	0.079
H2OTEMP	0.786	0.154	0.220	0.273	0.186
TURBID	-0.243	0.317	0.238	0.251	-0.075
AVGFCOL	0.197	-0.050	-0.106	-0.065	0.208

	ELEV	H2OTEMP	TURBID	AVGFCOL
ELEV	1.000			
H2OTEMP	0.072	1.000		
TURBID	-0.730	-0.085	1.000	
AVGFCOL	-0.293	0.211	0.129	1.000

ERROR
CORRELATION MATRIX IS NOT POSITIVE DEFINITE.
INDIVIDUAL SIGNIFICANCE TESTS ARE SUSPECT.
ERROR
INSUFFICIENT DEGREES OF FREEDOM FOR GLOBAL SIGNIFICANCE TEST.
INDIVIDUAL SIGNIFICANCE TESTS ARE SUSPECT.

MATRIX OF PROBABILITIES

	AIRTEMP	BOATS	VEHICLES	PEOPLE	USE
AIRTEMP	0.000				
BOATS	0.002	0.000			
VEHICLES	0.058	0.000	0.000		
PEOPLE	0.003	0.000	0.000	0.000	
USE	0.000	.	.	.	0.000
ELEV	0.000	0.515	0.485	0.256	0.084
H2OTEMP	0.000	0.001	0.000	0.000	0.000
TURBID	0.000	0.000	0.010	0.005	0.105
AVGFCOL	0.000	0.271	0.021	0.158	0.000

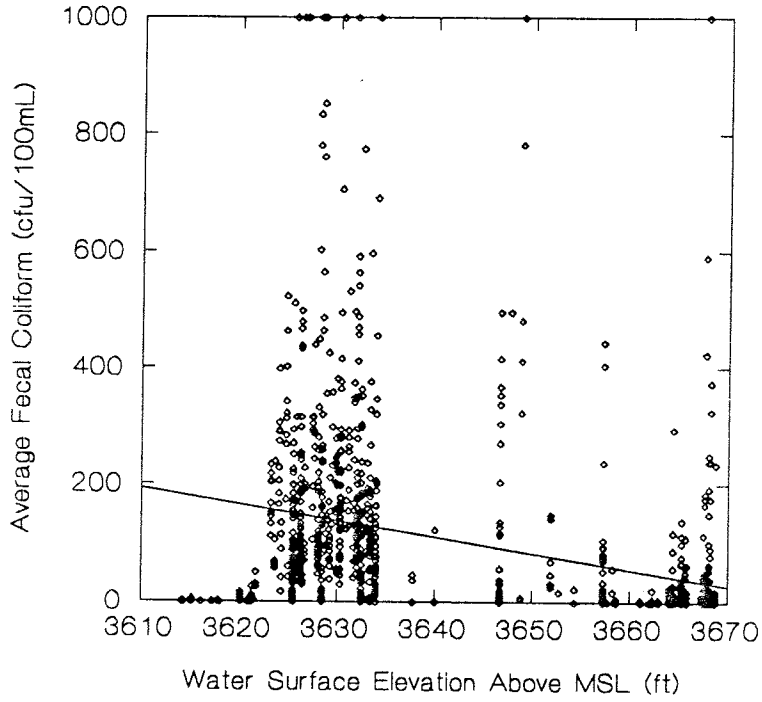
	ELEV	H2OTEMP	TURBID	AVGFCOL
ELEV	0.000			
H2OTEMP	0.017	0.000		
TURBID	0.000	0.028	0.000	
AVGFCOL	0.000	0.000	0.001	0.000

FREQUENCY TABLE

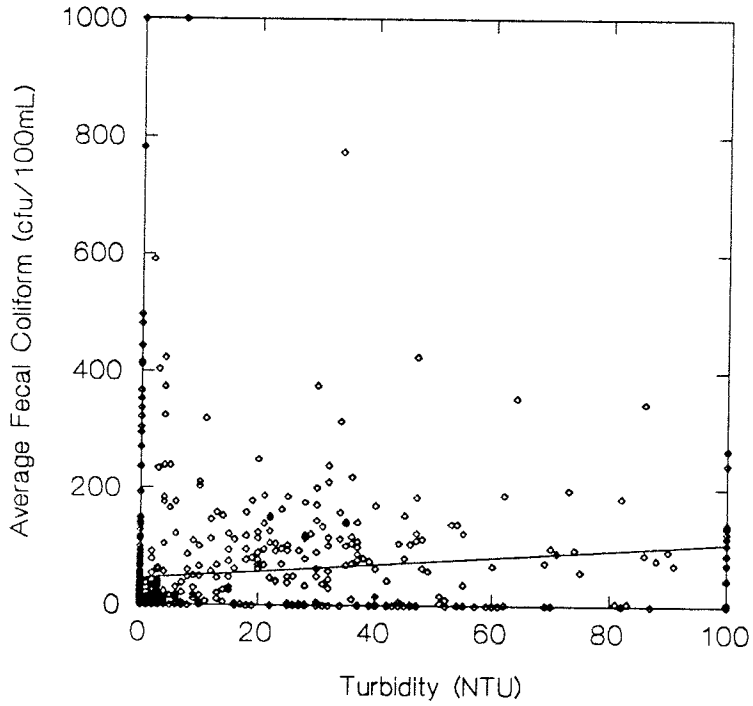
	AIRTEMP	BOATS	VEHICLES	PEOPLE	USE
AIRTEMP	1121				
BOATS	474	479			
VEHICLES	465	467	470		
PEOPLE	475	466	465	480	
USE	464	0	0	0	474
ELEV	1120	476	467	477	474
H2OTEMP	1096	470	461	471	460
TURBID	680	118	116	125	474
AVGFCOL	1121	479	470	480	474

	ELEV	H2OTEMP	TURBID	AVGFCOL
ELEV	1133			
H2OTEMP	1107	1110		
TURBID	690	671	690	
AVGFCOL	1133	1110	690	2420

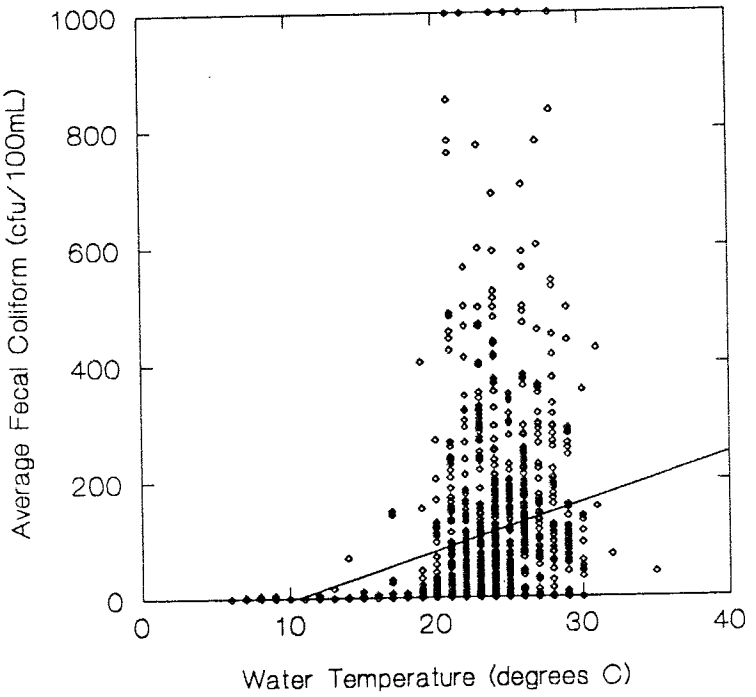
Average Fecal Coliform vs Water Surface Elevation



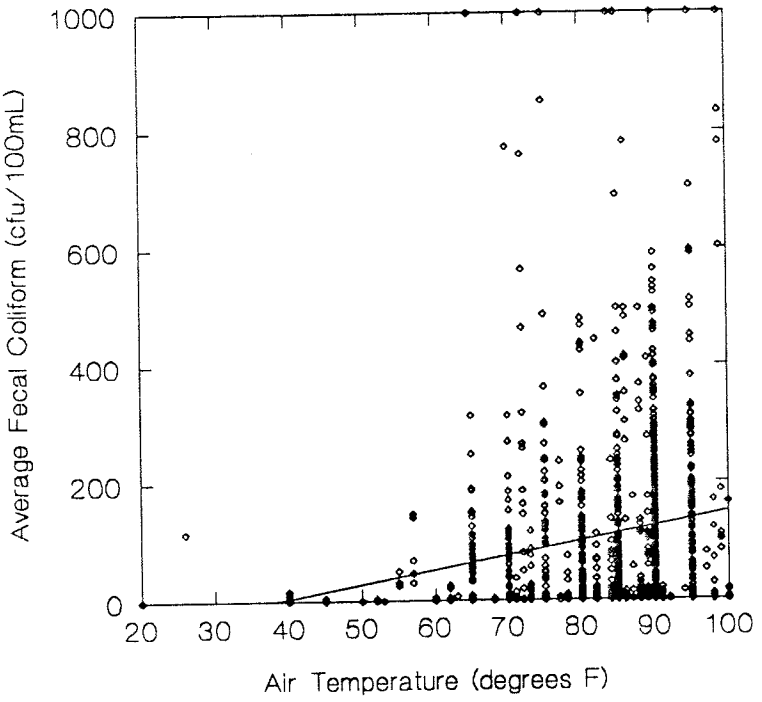
Average Fecal Coliform vs Turbidity



Average Fecal Coliform vs Water Temperature



Average Fecal Coliform vs Air Temperature



Appendix G

Geometric Mean Tables

and Time Series Plots

30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
AP1	05-26-92 - 06-24-92	30	197.7	
BFMAR1	06-10-91 - 07-08-91	29	89.8	
BFMAR1	06-24-91 - 07-22-91	29	59.8	
BFMAR1	05-24-93 - 06-14-93	22	71.6	
BFMAR1	06-01-93 - 06-28-93	28	87.3	
BFMAR2	06-10-91 - 07-08-91	29	97.2	
BFMAR2	06-24-91 - 07-22-91	29	58.8	
DVG1	07-20-92 - 08-17-92	29	180.6	
DVG1	08-03-92 - 08-26-92	24	211.6	Yes
DVG1	08-05-92 - 08-31-92	27	180.9	
DVG1	08-10-92 - 09-08-92	30	164.2	
FAR1	07-06-92 - 08-03-92	29	106.5	
FAR1	07-20-92 - 08-07-92	19	316.6	Yes
FAR1	07-22-92 - 08-17-92	27	311.4	Yes
FAR1	07-27-92 - 08-19-92	24	295.9	Yes
FAR1	08-03-92 - 08-31-92	29	333.5	Yes
FAR1	08-17-92 - 09-14-92	29	344.3	Yes
FAR1	08-31-92 - 09-28-92	29	291.2	Yes
FAR2	07-06-92 - 08-03-92	29	109.7	
FAR2	07-20-92 - 08-07-92	19	291.3	Yes
FAR2	07-22-92 - 08-17-92	27	264.1	Yes
FAR2	07-27-92 - 08-19-92	24	232.6	Yes
FAR2	08-03-92 - 08-31-92	29	268.6	Yes
FAR2	08-17-92 - 09-14-92	29	295.0	Yes
FAR2	08-31-92 - 09-28-92	29	238.6	Yes
FOR1	07-20-92 - 08-17-92	29	229.4	Yes
FOR1	07-27-92 - 08-20-92	25	232.4	Yes
FOR1	08-03-92 - 08-31-92	29	276.3	Yes
FOR1	08-17-92 - 09-14-92	29	325.8	Yes
FOR1	08-31-92 - 09-28-92	29	256.7	Yes
HAN1	05-28-91 - 06-26-91	30	179.2	

30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
HAN1	06-10-91 - 07-01-91	22	277.4	Yes
HAN1	06-12-91 - 07-08-91	27	93.7	
HAN1	06-24-91 - 07-22-91	29	41.2	
HAN1	08-19-91 - 09-16-91	29	154.9	
HAN2	05-28-91 - 06-26-91	30	153.3	
HAN2	06-10-91 - 07-01-91	22	531.1	Yes
HAN2	06-12-91 - 07-08-91	27	214.7	Yes
HAN2	06-24-91 - 07-22-91	29	116.9	
HAN2	08-19-91 - 09-16-91	29	172.3	
HIMAR1	08-19-91 - 09-16-91	29	164.5	
HIMAR1	07-06-92 - 08-03-92	29	129.3	
HIMAR1	07-20-92 - 08-07-92	19	404.2	Yes
HIMAR1	07-22-92 - 08-17-92	27	338.6	Yes
HIMAR1	07-27-92 - 08-19-92	24	354.9	Yes
HIMAR1	08-03-92 - 08-31-92	29	341.4	Yes
HIMAR1	08-17-92 - 09-14-92	29	315.4	Yes
HIMAR1	08-31-92 - 09-28-92	29	300.2	Yes
HIMAR2	08-19-91 - 09-16-91	29	188.2	
HIMAR2	07-06-92 - 08-03-92	29	163.4	
HIMAR2	07-20-92 - 08-07-92	19	401.5	Yes
HIMAR2	07-22-92 - 08-17-92	27	340.1	Yes
HIMAR2	07-27-92 - 08-19-92	24	318.2	Yes
HIMAR2	08-03-92 - 08-31-92	29	344.5	Yes
HIMAR2	08-17-92 - 09-14-92	29	270.6	Yes
HIMAR2	08-31-92 - 09-28-92	29	245.7	Yes
HOBI1	05-24-93 - 06-14-93	22	257.3	Yes
HOBI1	06-01-93 - 06-15-93	15	119.6	
HOBI1	06-03-93 - 06-29-93	27	75.9	
HOBI2	06-10-91 - 07-08-91	29	68.7	
HOBI2	05-24-93 - 06-09-93	17	57.0	
HOBI2	06-01-93 - 06-14-93	14	57.0	

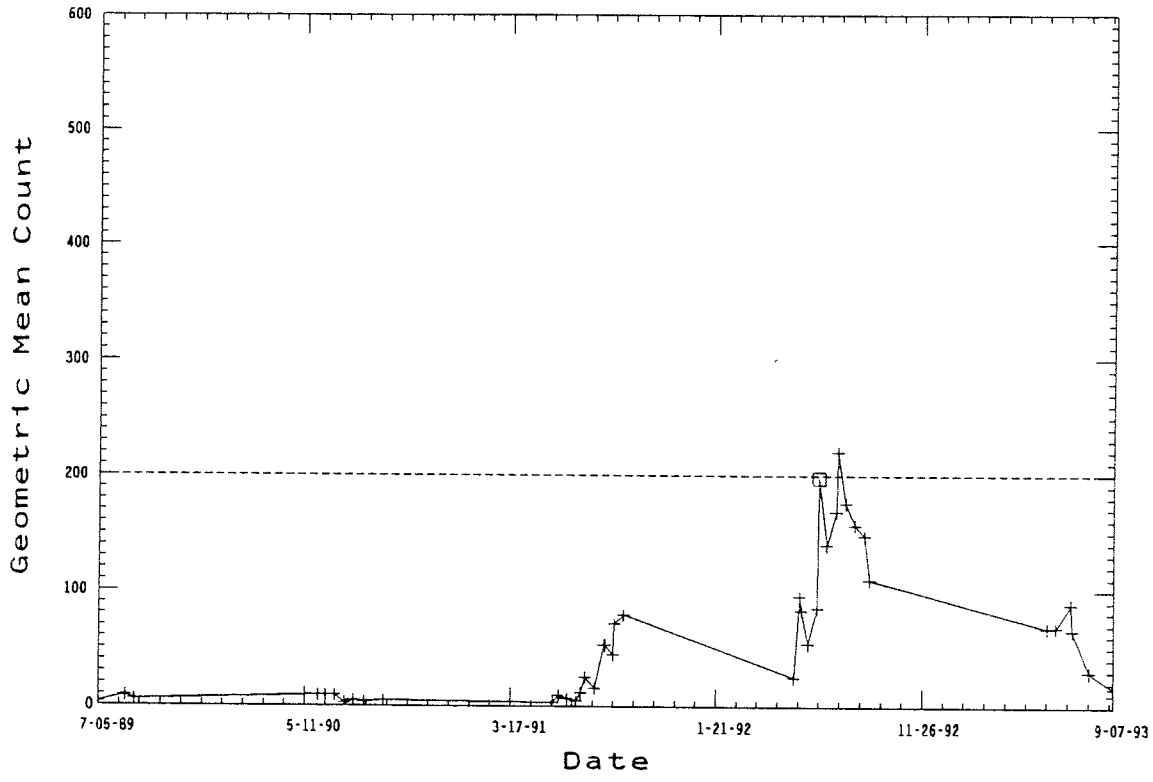
30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
HOBI2	06-03-93 - 06-29-93	27	28.3	
HOBI3	06-10-91 - 07-08-91	29	39.9	
LEW1	05-26-92 - 06-24-92	30	252.7	Yes
LEW1	06-22-92 - 07-20-92	29	277.9	Yes
LEW1	06-24-92 - 07-22-92	29	191.6	
LEW1	07-06-92 - 08-03-92	29	267.4	Yes
LEW1	07-08-92 - 08-05-92	29	307.4	Yes
LEW1	07-20-92 - 08-10-92	22	259.3	Yes
LEW1	07-22-92 - 08-17-92	27	323.0	Yes
LEW1	08-03-92 - 08-26-92	24	339.8	Yes
LEW1	08-05-92 - 08-31-92	27	171.8	
LEW1	08-10-92 - 09-08-92	30	148.6	
LEW2	05-26-92 - 06-24-92	30	251.3	Yes
LEW2	06-22-92 - 07-20-92	29	346.0	Yes
LEW2	06-24-92 - 07-22-92	29	346.0	Yes
LEW2	07-06-92 - 08-03-92	29	324.0	Yes
LEW2	07-08-92 - 08-05-92	29	265.6	Yes
LEW2	07-20-92 - 08-10-92	22	233.1	Yes
LEW2	07-22-92 - 08-17-92	27	330.0	Yes
LEW2	08-03-92 - 08-26-92	24	245.5	Yes
LEW2	08-05-92 - 08-31-92	27	287.1	Yes
LEW2	08-10-92 - 09-08-92	30	286.6	Yes
LONE1	06-10-91 - 07-08-91	29	52.3	
LONE1	06-22-92 - 07-20-92	29	126.3	
LONE1	07-06-92 - 07-21-92	16	167.6	
LONE1	07-08-92 - 07-29-92	22	143.3	
LONE1	07-13-92 - 08-03-92	22	124.3	
LONE1	07-20-92 - 08-11-92	23	122.4	
LONE1	07-21-92 - 08-12-92	23	119.3	
LONE1	07-29-92 - 08-17-92	20	124.8	
LONE1	08-03-92 - 08-26-92	24	104.6	

30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
LONE1	08-11-92 - 08-27-92	17	86.4	
LONE1	08-12-92 - 08-31-92	20	70.0	
LONE1	08-17-92 - 09-03-92	18	66.7	
LONE1	08-26-92 - 09-08-92	14	63.2	
LONE1	08-27-92 - 09-17-92	22	66.2	
LONE1	08-31-92 - 09-24-92	25	78.3	
LONE2	06-22-92 - 07-20-92	29	101.1	
LONE2	07-06-92 - 07-21-92	16	95.7	
LONE2	07-08-92 - 07-29-92	22	95.7	
LONE2	07-13-92 - 08-03-92	22	91.3	
LONE2	07-20-92 - 08-11-92	23	112.1	
LONE2	07-21-92 - 08-12-92	23	152.6	
LONE2	07-29-92 - 08-17-92	20	173.8	
LONE2	08-03-92 - 08-26-92	24	162.3	
LONE2	08-11-92 - 08-27-92	17	186.6	
LONE2	08-12-92 - 08-31-92	20	151.5	
LONE2	08-17-92 - 09-03-92	18	130.9	
LONE2	08-26-92 - 09-08-92	14	113.9	
LONE2	08-27-92 - 09-17-92	22	120.2	
LONE2	08-31-92 - 09-24-92	25	94.9	
LONE2	07-08-93 - 08-04-93	28	45.1	
LONE3	06-22-92 - 07-20-92	29	129.7	
LONE3	07-06-92 - 07-21-92	16	124.5	
LONE3	07-08-92 - 07-29-92	22	115.1	
LONE3	07-13-92 - 08-03-92	22	103.4	
LONE3	07-20-92 - 08-11-92	23	106.1	
LONE3	07-21-92 - 08-12-92	23	110.6	
LONE3	07-29-92 - 08-17-92	20	99.5	
LONE3	08-03-92 - 08-26-92	24	95.0	
LONE3	08-11-92 - 08-27-92	17	82.2	
LONE3	08-12-92 - 08-31-92	20	76.0	

30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
LONE3	08-17-92 - 09-03-92	18	96.4	
LONE3	08-26-92 - 09-08-92	14	114.2	
LONE3	08-27-92 - 09-17-92	22	121.5	
LONE3	08-31-92 - 09-24-92	25	150.8	
LONE3	07-08-93 - 08-04-93	28	27.7	
MOQUI1	08-19-91 - 09-16-91	29	323.4	Yes
MOQUI1	07-20-92 - 08-17-92	29	255.5	Yes
MOQUI1	07-27-92 - 08-20-92	25	224.3	Yes
MOQUI1	08-03-92 - 08-31-92	29	283.8	Yes
MOQUI1	08-17-92 - 09-14-92	29	282.0	Yes
MOQUI1	08-31-92 - 09-28-92	29	275.4	Yes
MOQUI2	08-19-91 - 09-16-91	29	332.2	Yes
MOQUI2	07-20-92 - 08-17-92	29	212.3	Yes
MOQUI2	07-27-92 - 08-20-92	25	207.8	Yes
MOQUI2	08-03-92 - 08-31-92	29	227.3	Yes
MOQUI2	08-17-92 - 09-14-92	29	312.8	Yes
MOQUI2	08-31-92 - 09-28-92	29	275.8	Yes
OAK1	08-03-92 - 08-31-92	29	158.0	
OAK2	08-03-92 - 08-31-92	29	223.1	Yes
STAN1	06-10-91 - 07-08-91	29	201.3	Yes
STAN1	06-01-93 - 06-14-93	14	65.9	
STAN1	06-03-93 - 06-28-93	26	48.6	
STAN2	06-10-91 - 07-08-91	29	148.6	
STAN2	08-05-91 - 08-22-91	18	199.6	
STAN2	08-07-91 - 09-04-91	29	251.7	Yes
STAN2	08-19-91 - 09-16-91	29	164.9	
STAN2	06-01-93 - 06-28-93	28	194.0	
UBB1	06-10-91 - 07-08-91	29	150.1	
UBB1	06-24-91 - 07-22-91	29	53.3	
UBB1	07-06-92 - 08-03-92	29	105.2	
UBB1	07-15-92 - 08-06-92	23	316.4	Yes

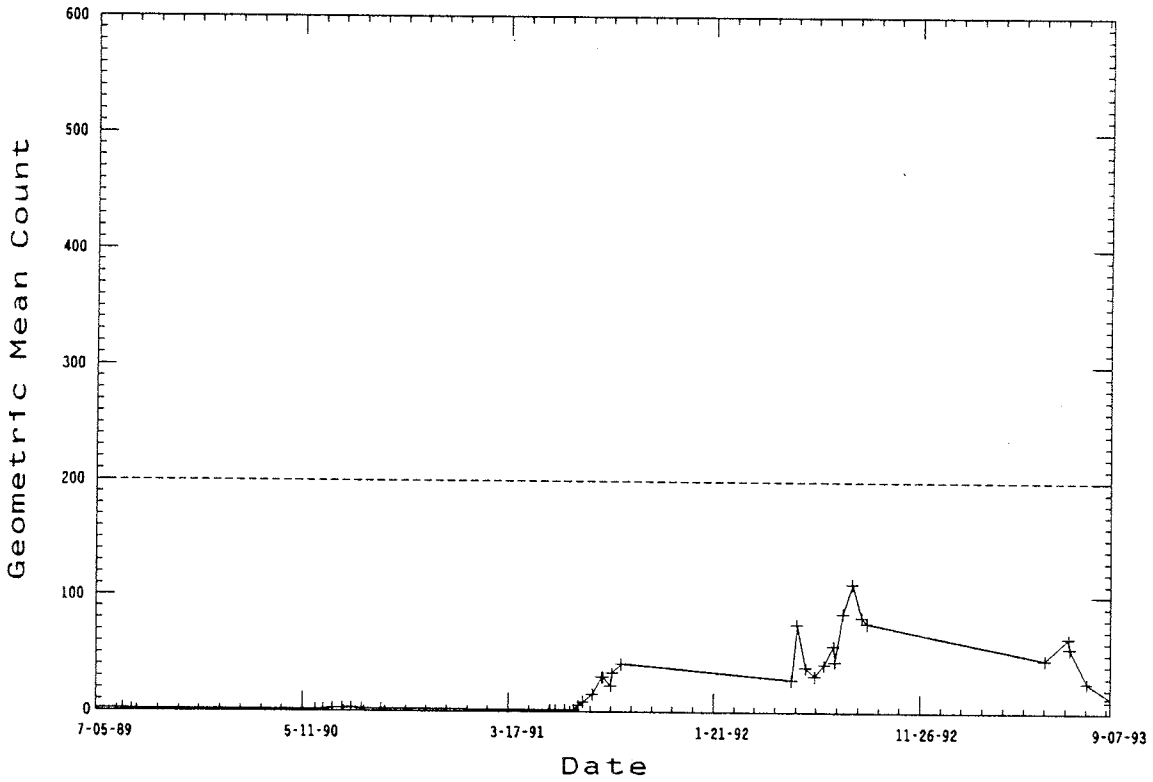
30-Day Geometric Mean Computations for GLCA Fecal Coliform Data				
Number of Values = 5; Period \ 30 Days; Utah Standard = 200 cfu/100mL				
SITE	**START DATE - END DATE**	**PERIOD (DAYS)**	**GEOMETRIC MEAN**	**EXCEEDS STANDARD**
UBB1	07-20-92 - 08-17-92	29	311.6	Yes
UBB1	07-27-92 - 08-20-92	25	252.5	Yes
UBB1	08-03-92 - 08-31-92	29	249.7	Yes
UBB1	08-17-92 - 09-14-92	29	206.7	Yes
UBB1	08-31-92 - 09-28-92	29	232.8	Yes
UBB2	06-10-91 - 07-08-91	29	80.7	
UBB2	06-24-91 - 07-22-91	29	29.9	
UBB2	08-03-92 - 08-31-92	29	205.9	Yes
UBB2	08-17-92 - 09-14-92	29	241.1	Yes
UBB2	08-31-92 - 09-28-92	29	247.4	Yes
UBB2	06-01-93 - 06-28-93	28	141.5	
WWLB1	06-14-93 - 07-11-93	28	75.6	
WWLB1	06-29-93 - 07-19-93	21	48.2	
WWLB1	07-08-93 - 08-02-93	26	29.9	
WWLB2	06-14-93 - 07-11-93	28	41.7	
WWLB2	06-29-93 - 07-19-93	21	20.9	
WWLB2	07-08-93 - 08-02-93	26	12.1	
WWM2	05-18-92 - 06-08-92	22	51.0	
WWM2	06-14-93 - 07-11-93	28	38.1	
WWM2	06-29-93 - 07-19-93	21	98.8	
WWM2	07-08-93 - 07-20-93	13	78.7	
WWM2	07-09-93 - 08-02-93	25	73.1	

Running Geometric Mean of AP1 Over 1525 Days



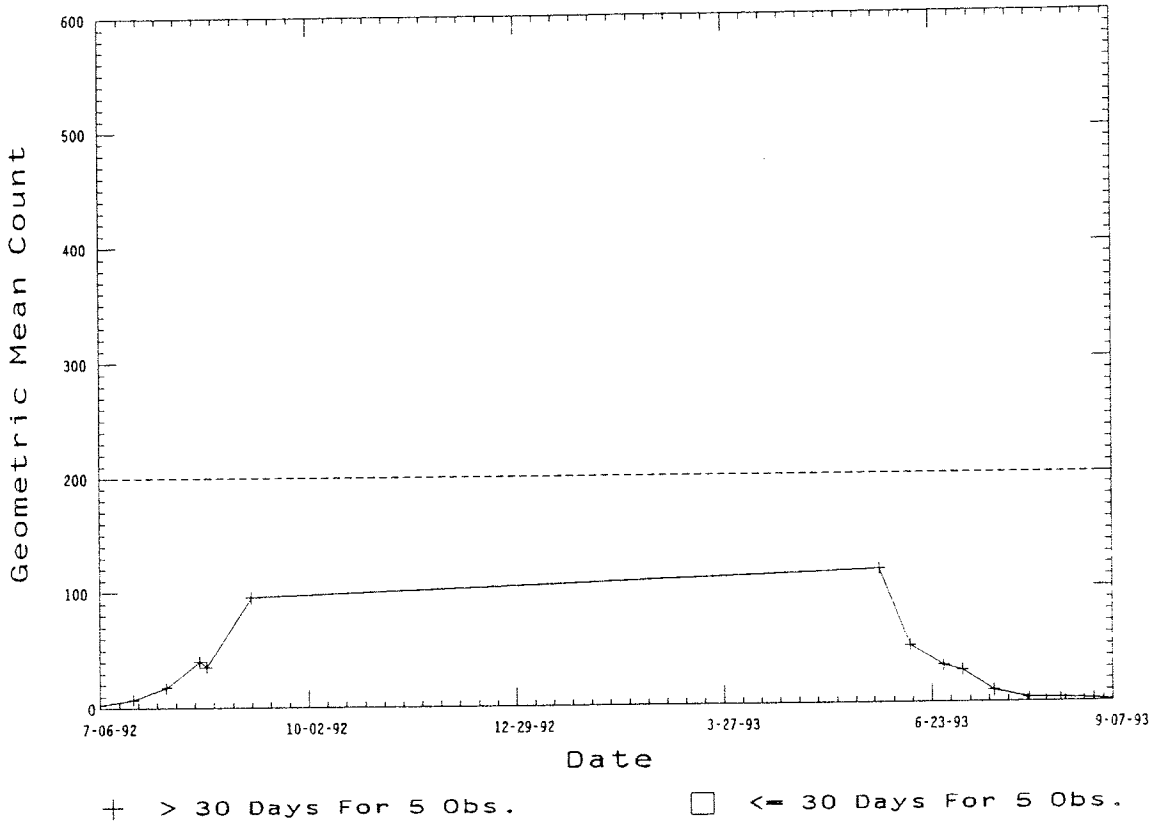
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of AP2 Over 1525 Days

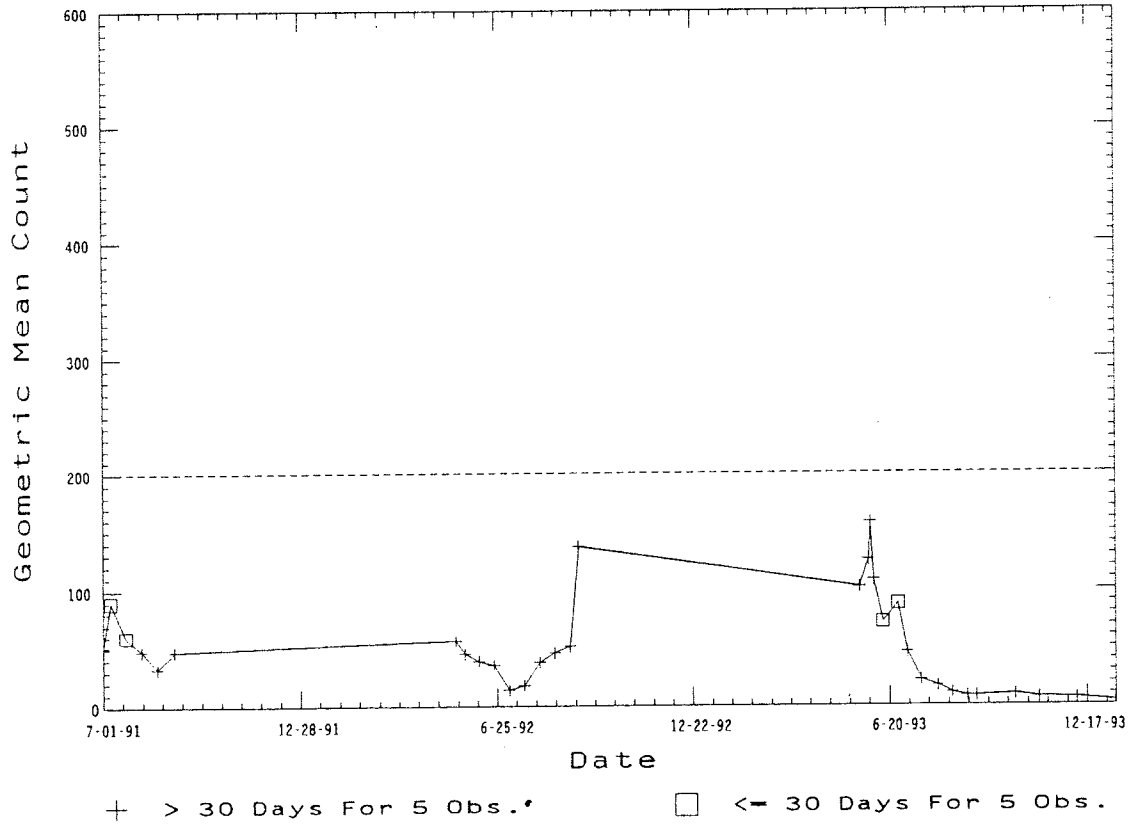


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

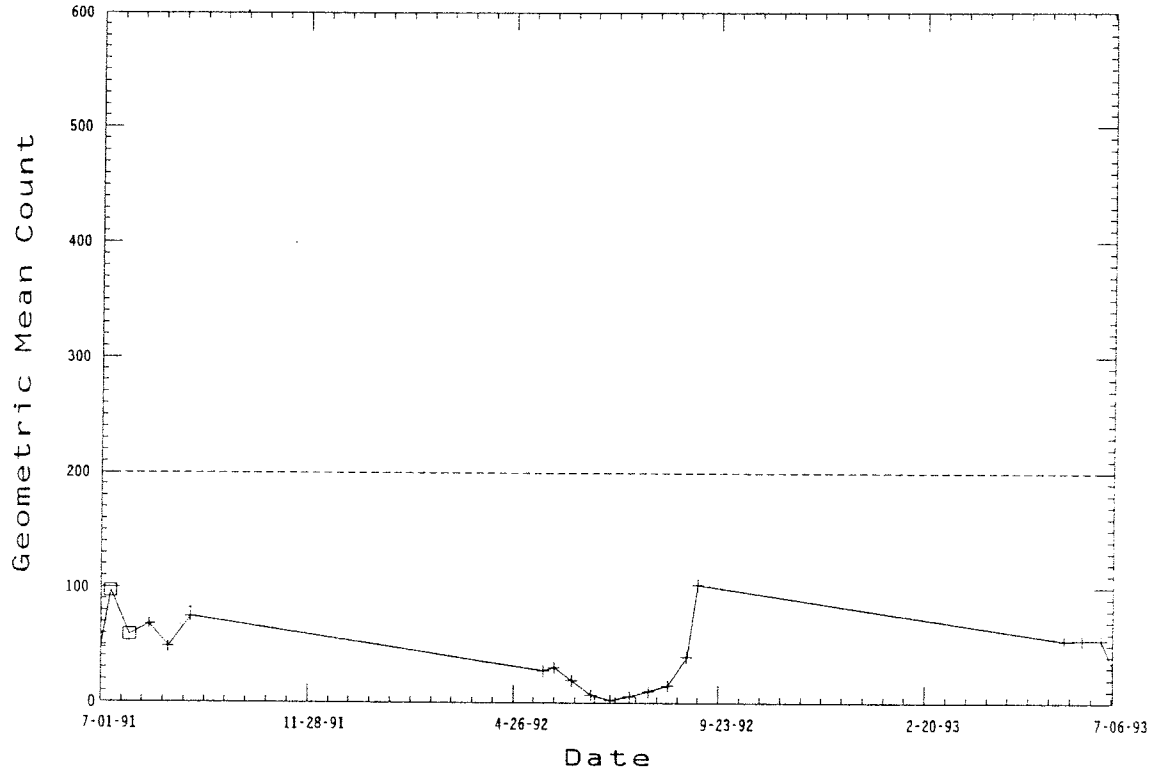
Running Geometric Mean of BB Over 428 Days



Running Geometric Mean of BFMAR1 Over 926 Days

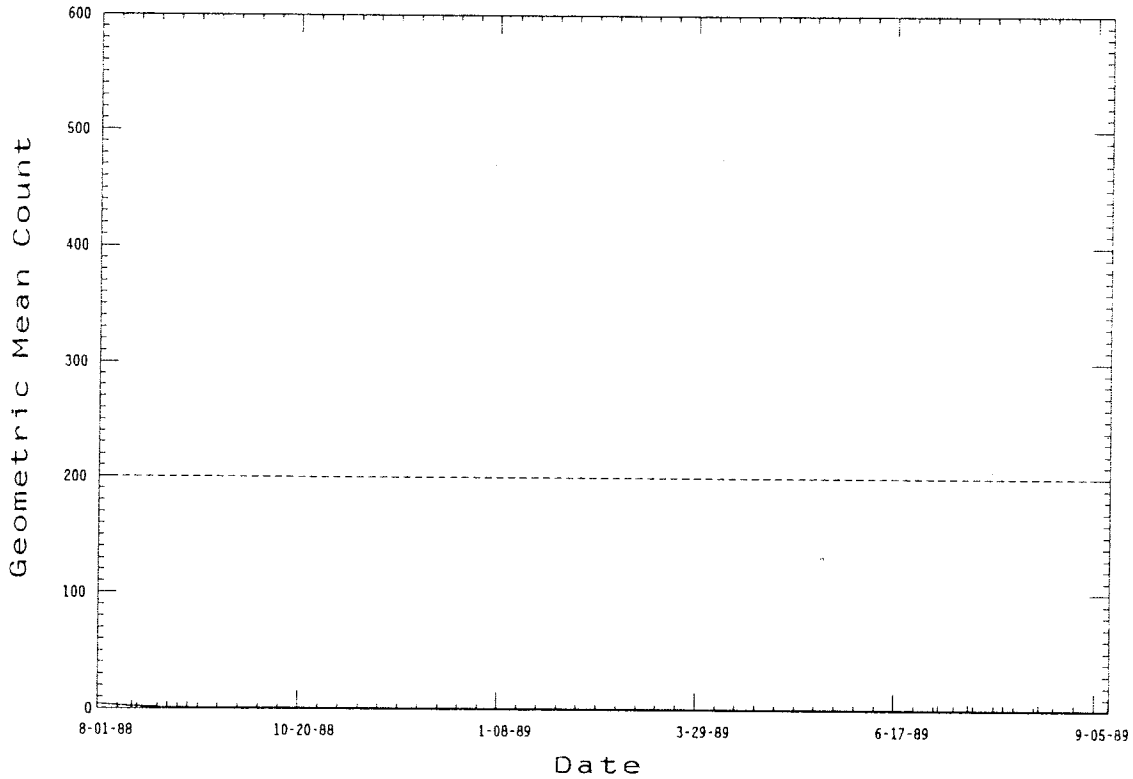


Running Geometric Mean of BFMAR2 Over 736 Days



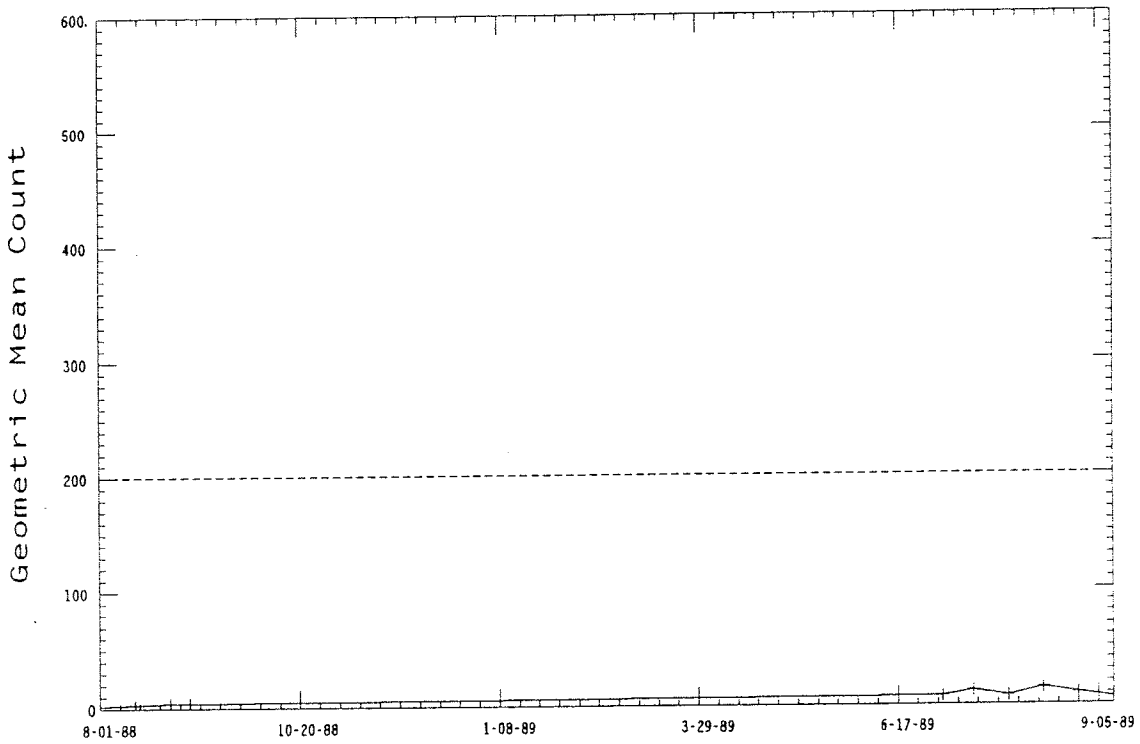
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of BFNOTCH Over 406 Days



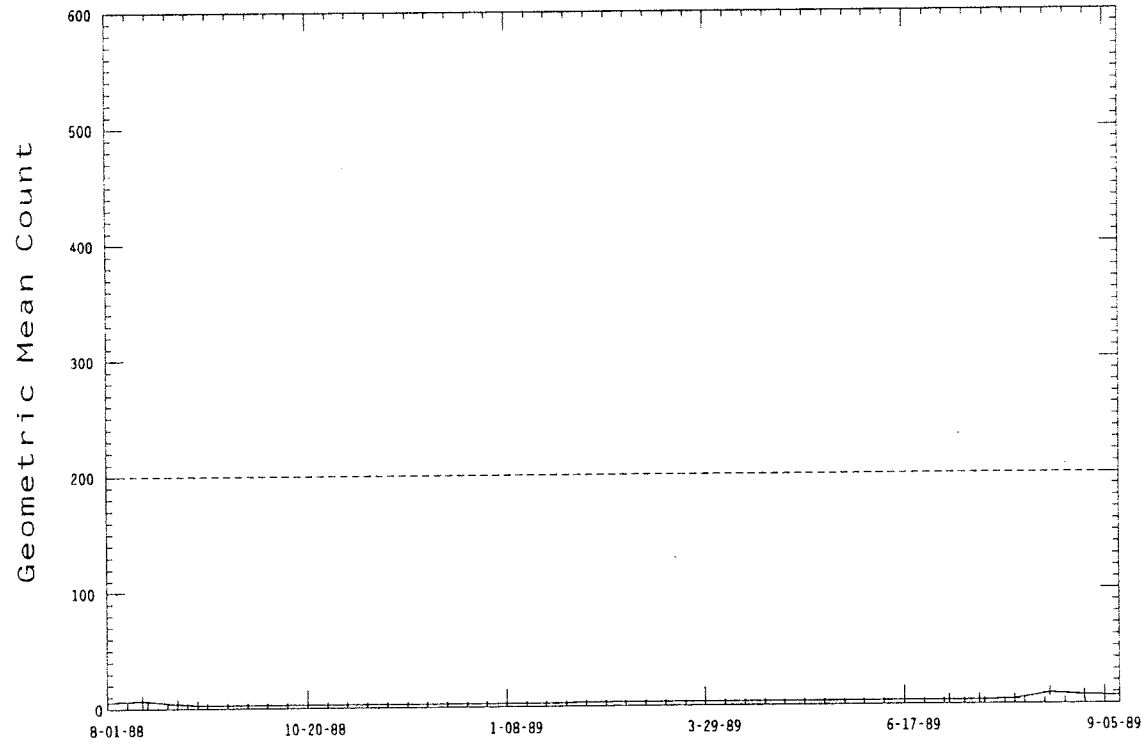
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of BFSB1 Over 406 Days



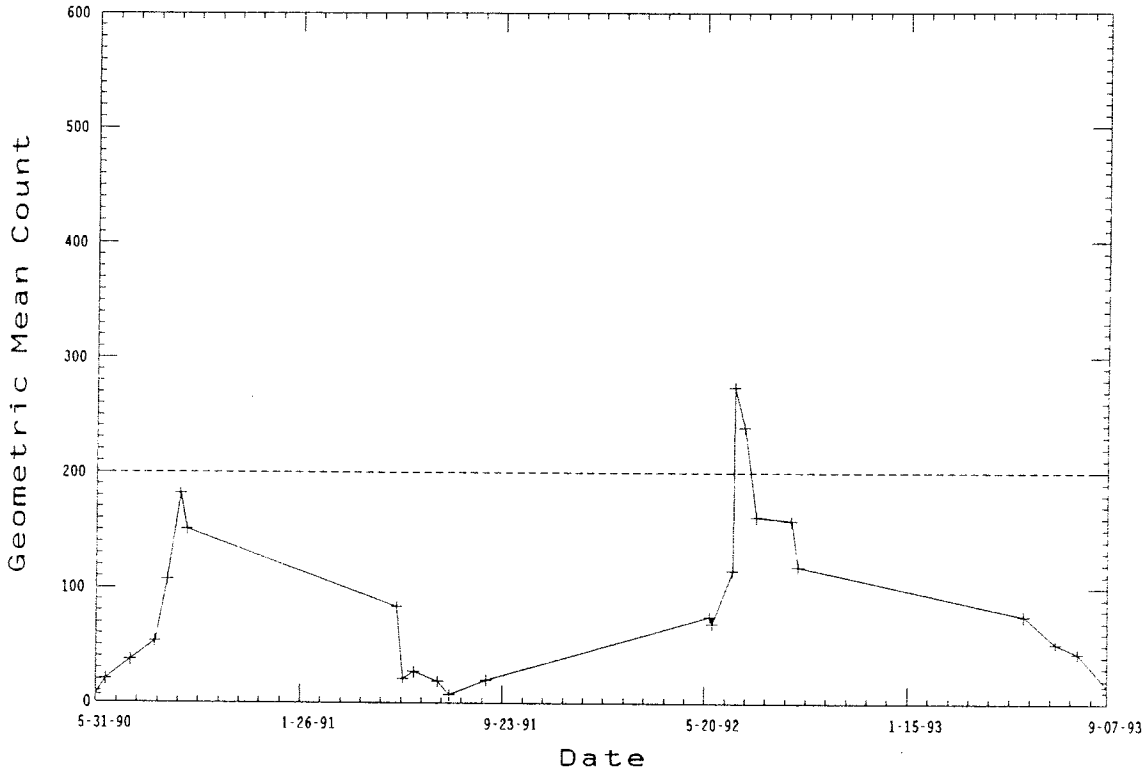
\+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of BFSB2 Over 406 Days



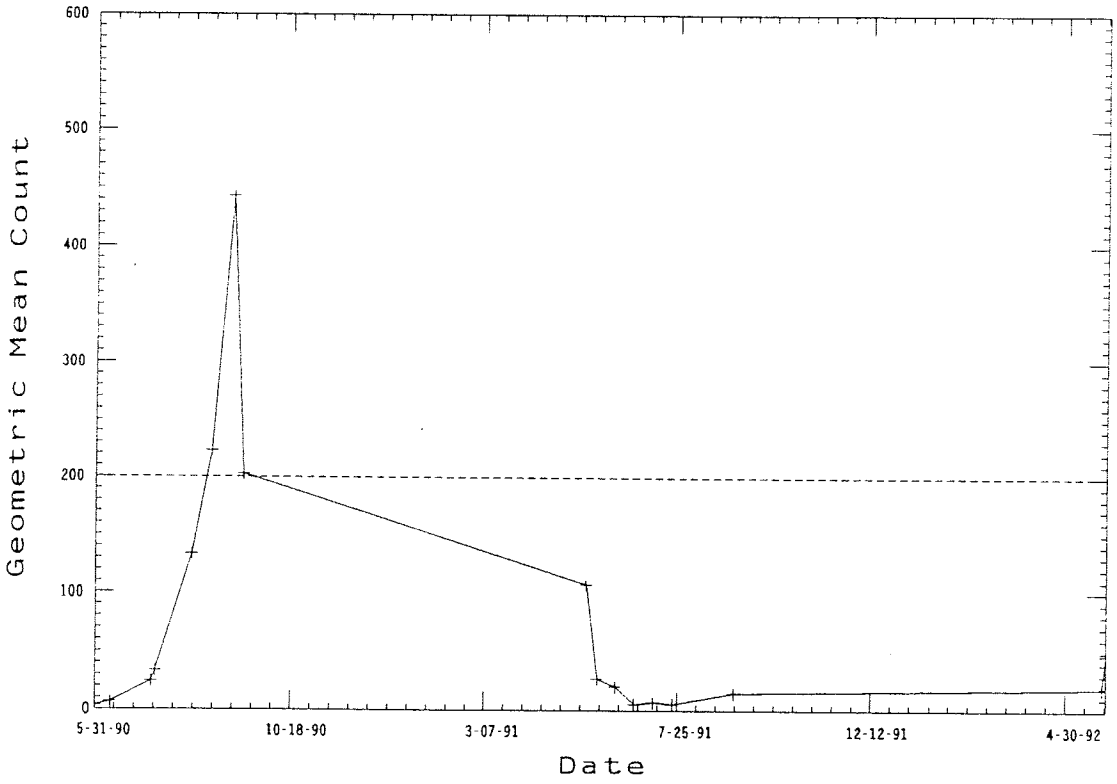
\+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of CHA1 Over 1195 Days



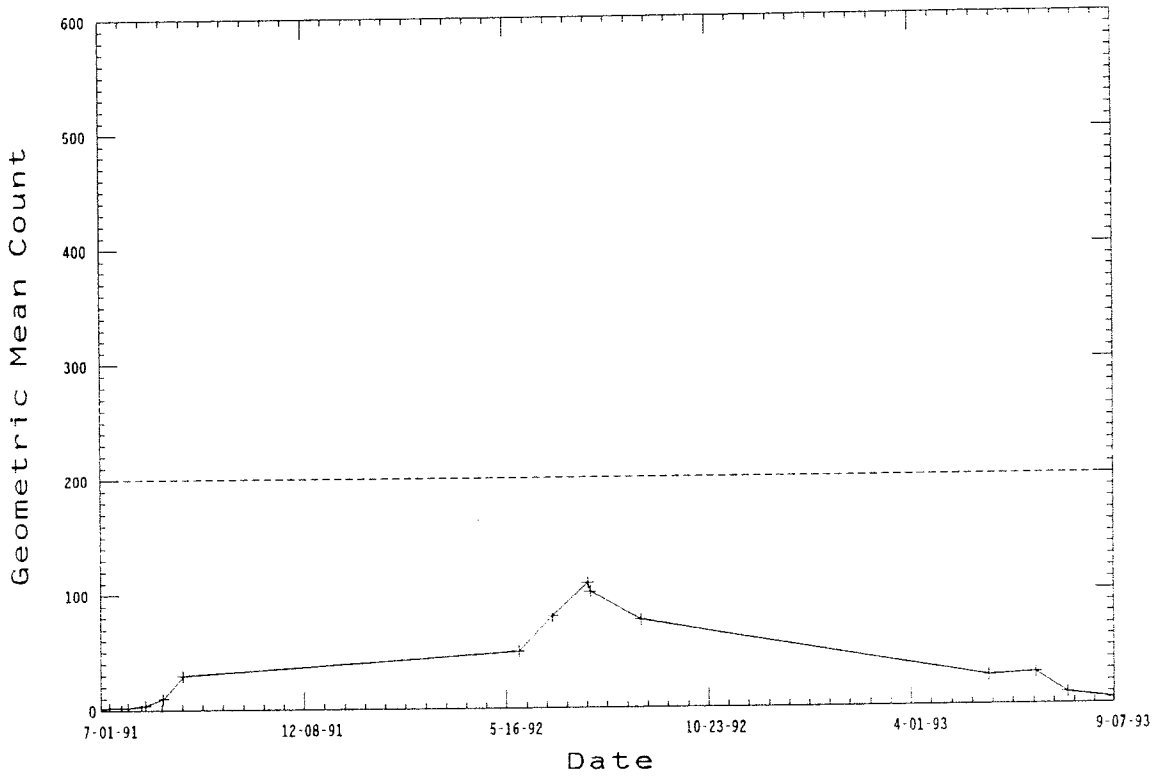
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of CHA2 Over 729 Days

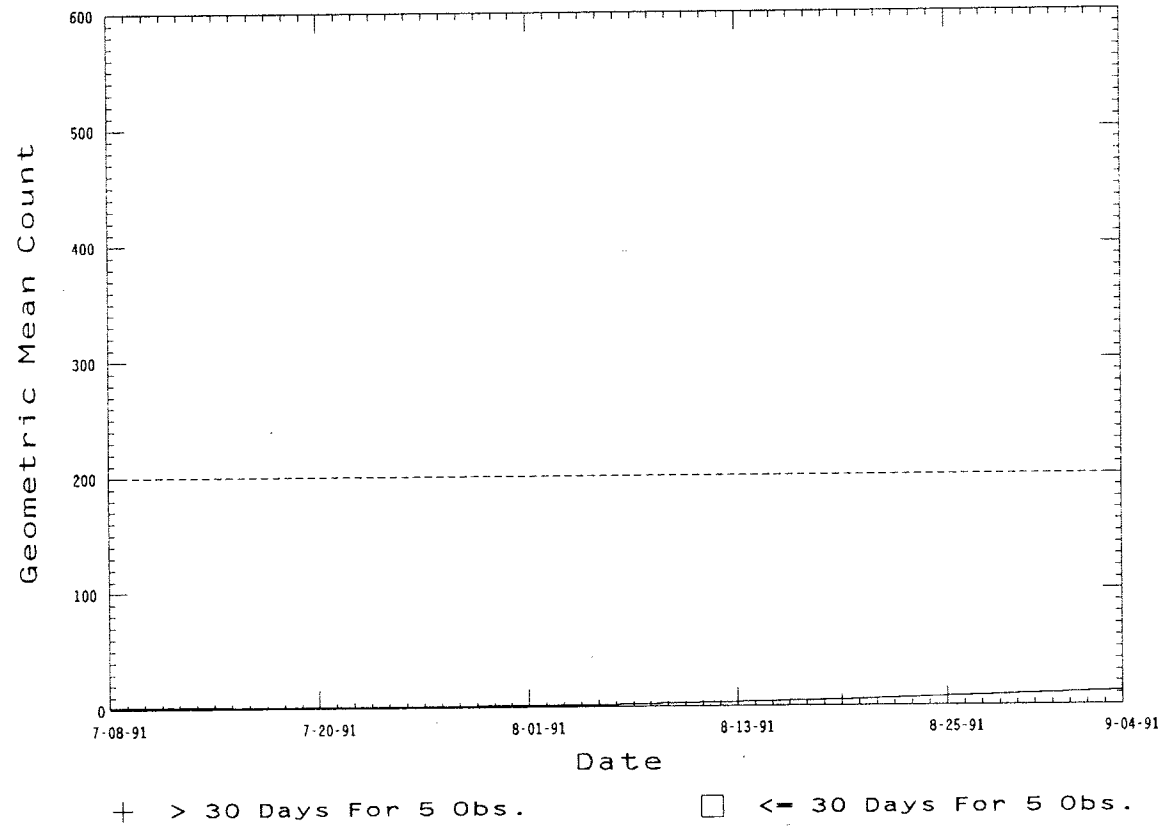


+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

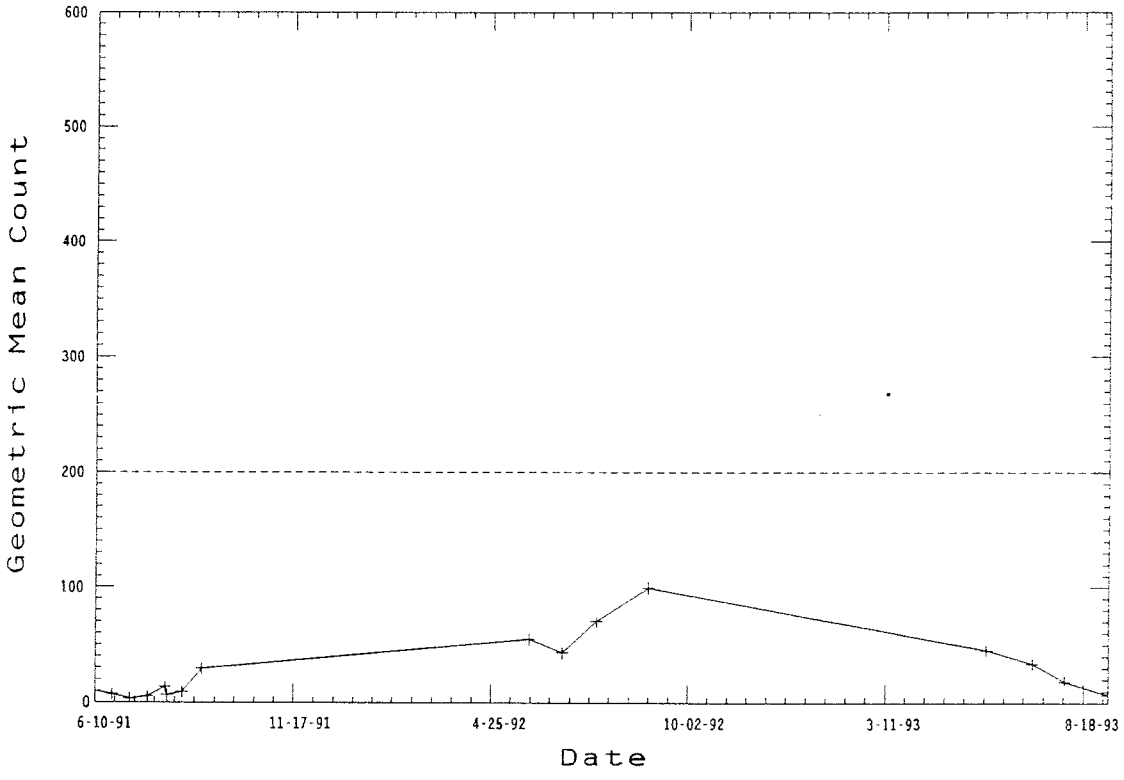
Running Geometric Mean of CUT1 Over 799 Days



Running Geometric Mean of CUT2 Over 58 Days

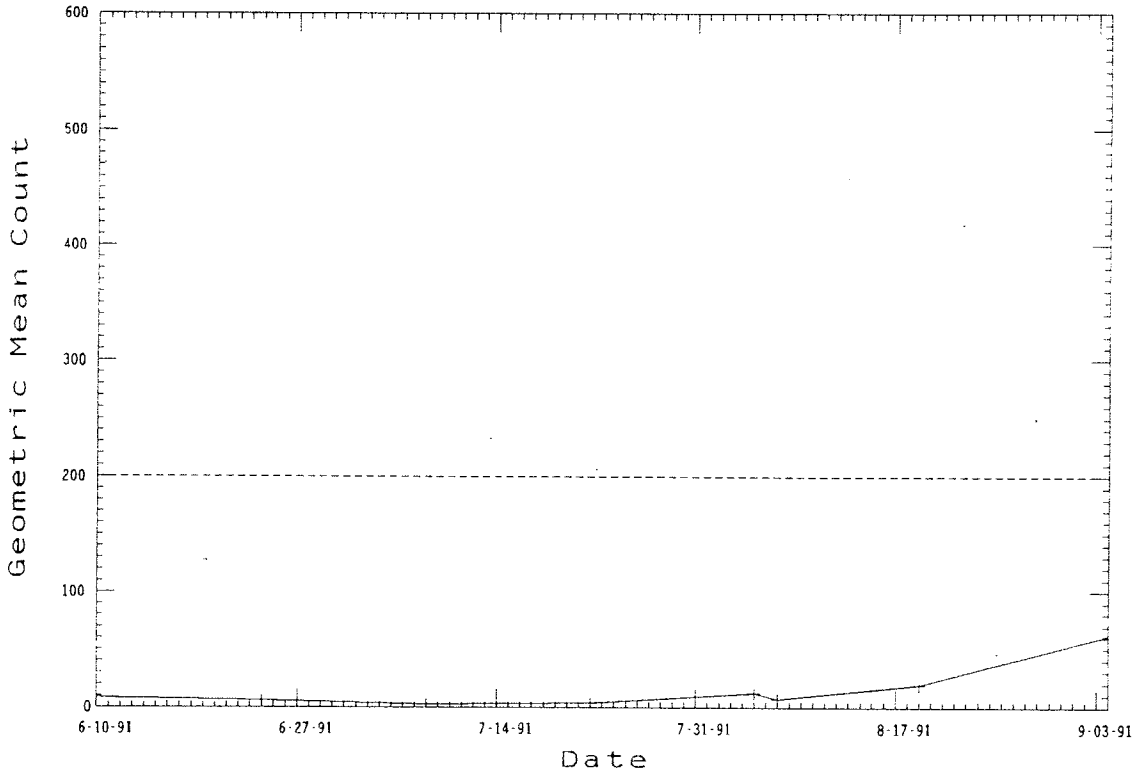


Running Geometric Mean of DCR1 Over 820 Days



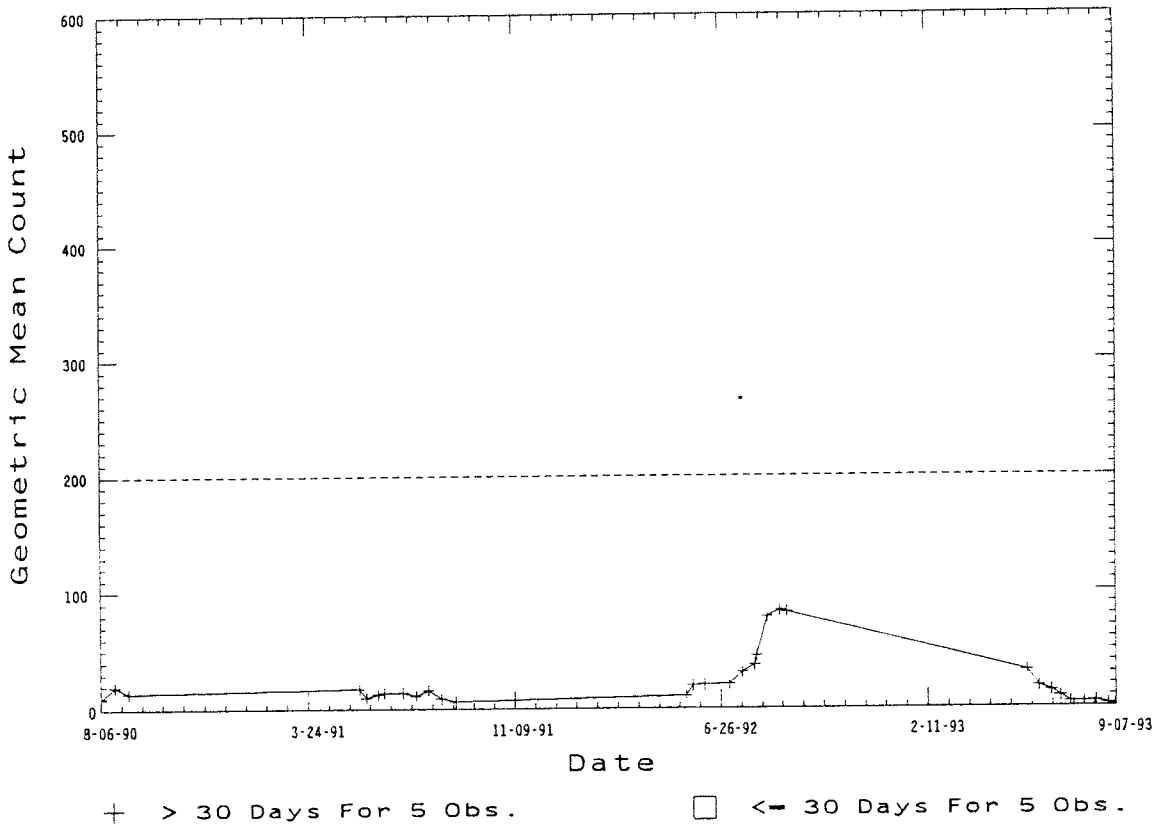
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of DCR2 Over 86 Days

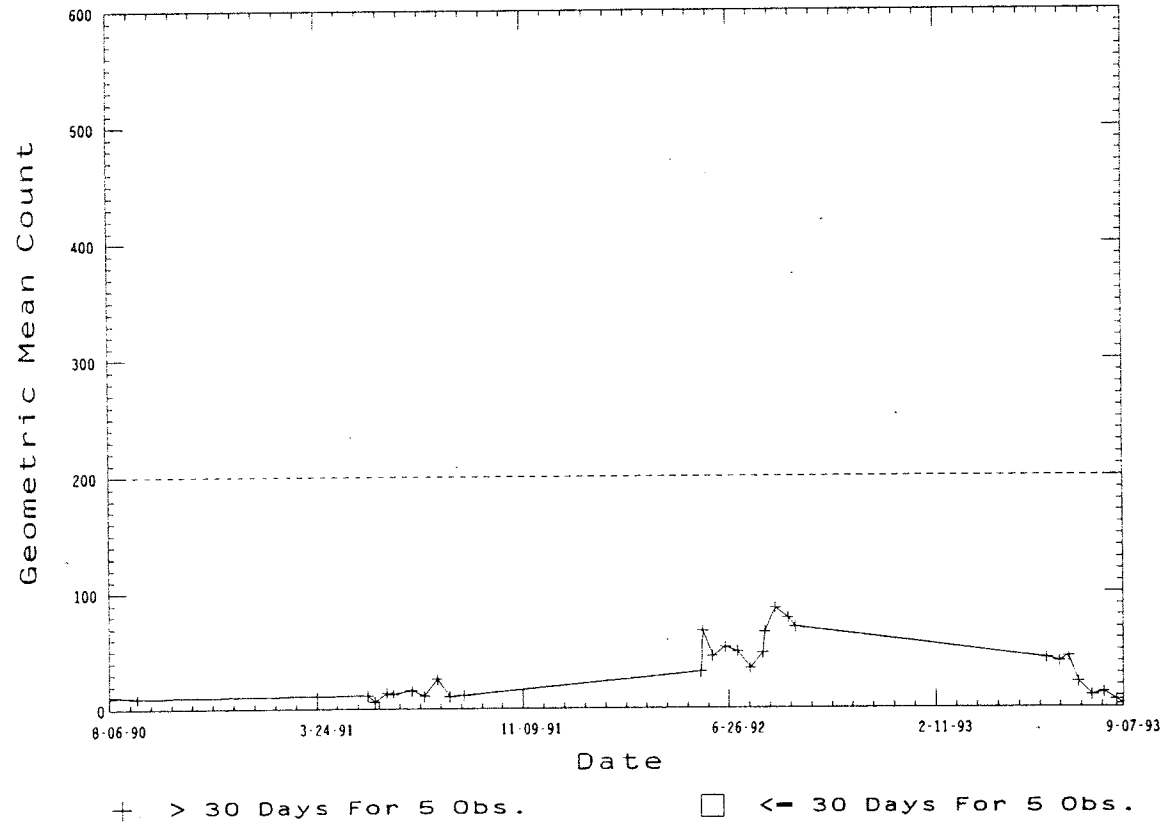


+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

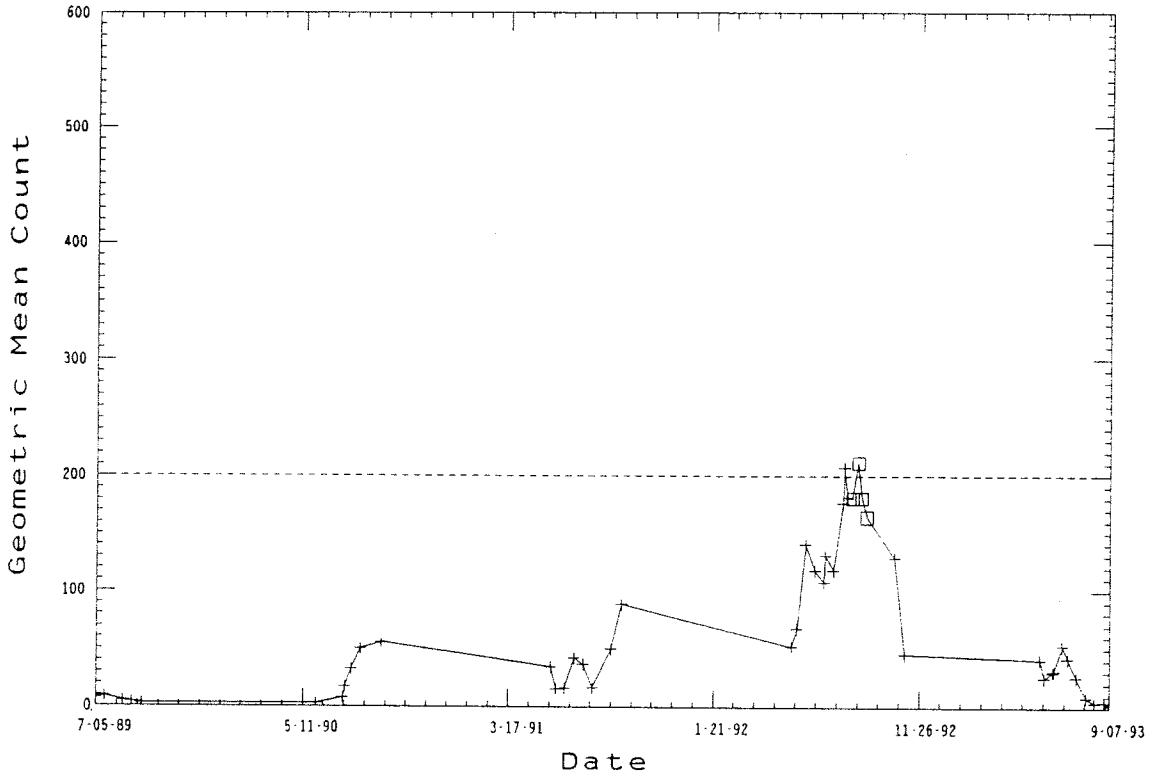
Running Geometric Mean of DRM1 Over 1128 Days



Running Geometric Mean of DRM2 Over 1128 Days

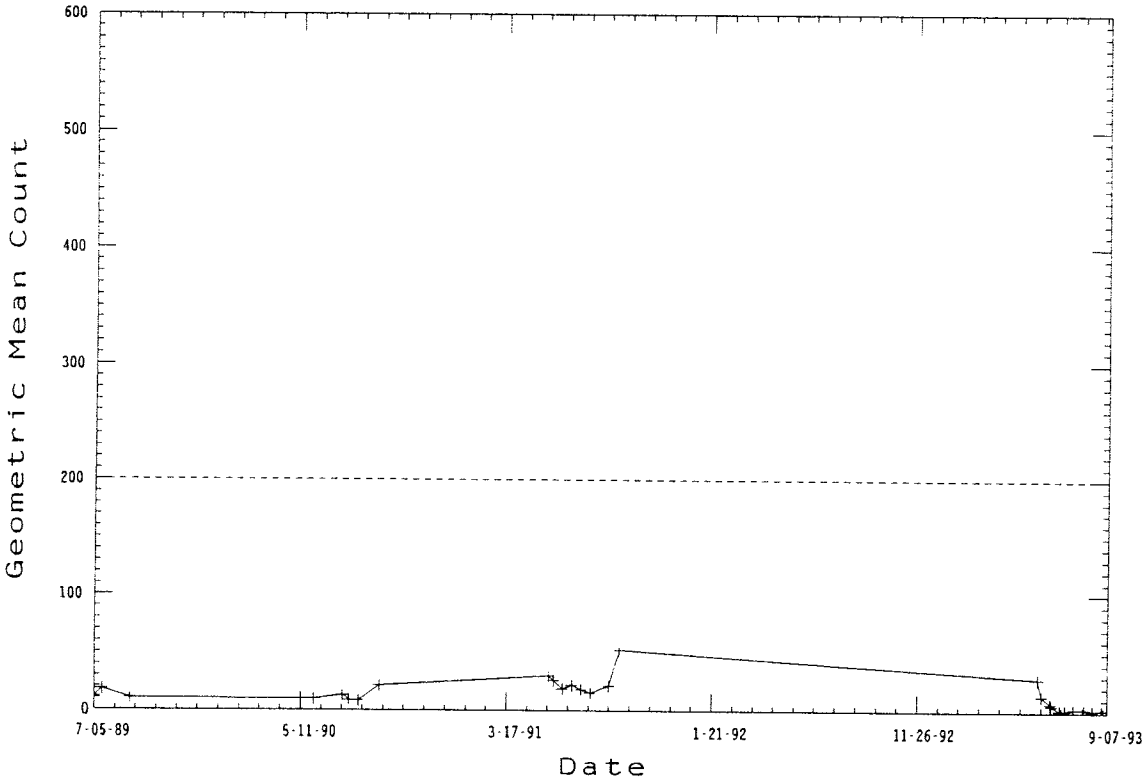


Running Geometric Mean of DVG1 Over 1525 Days



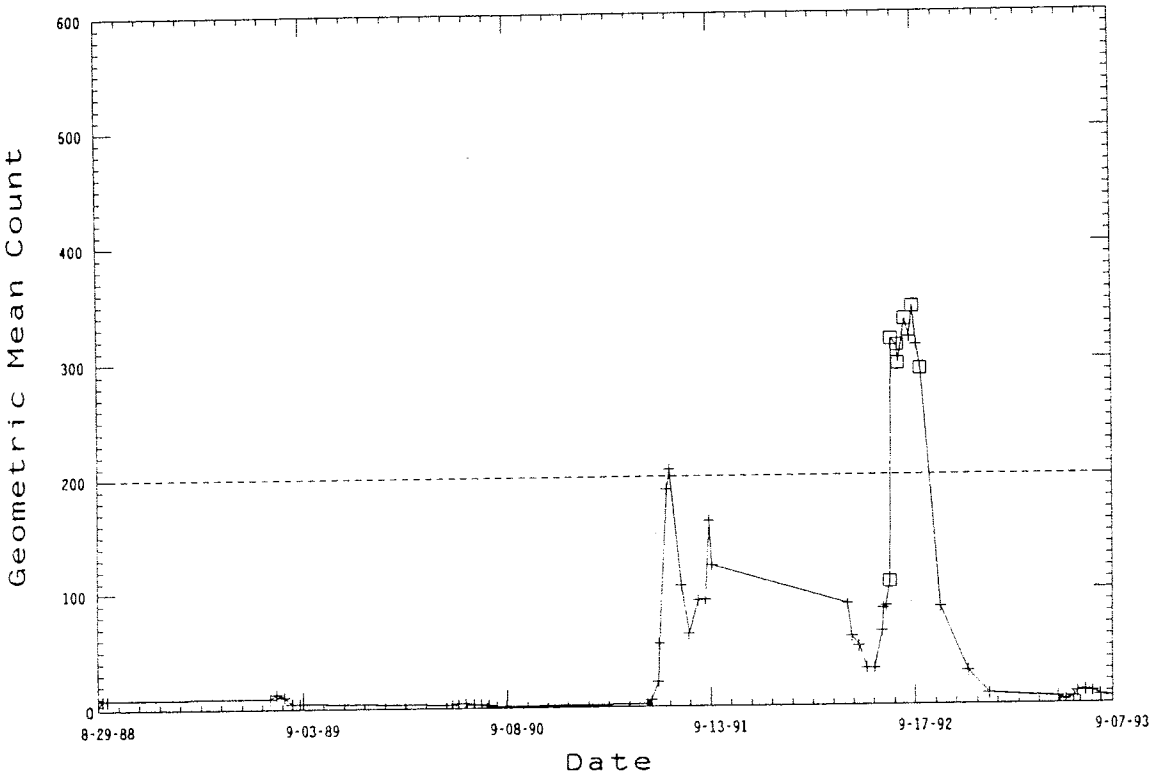
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of DVG2 Over 1525 Days

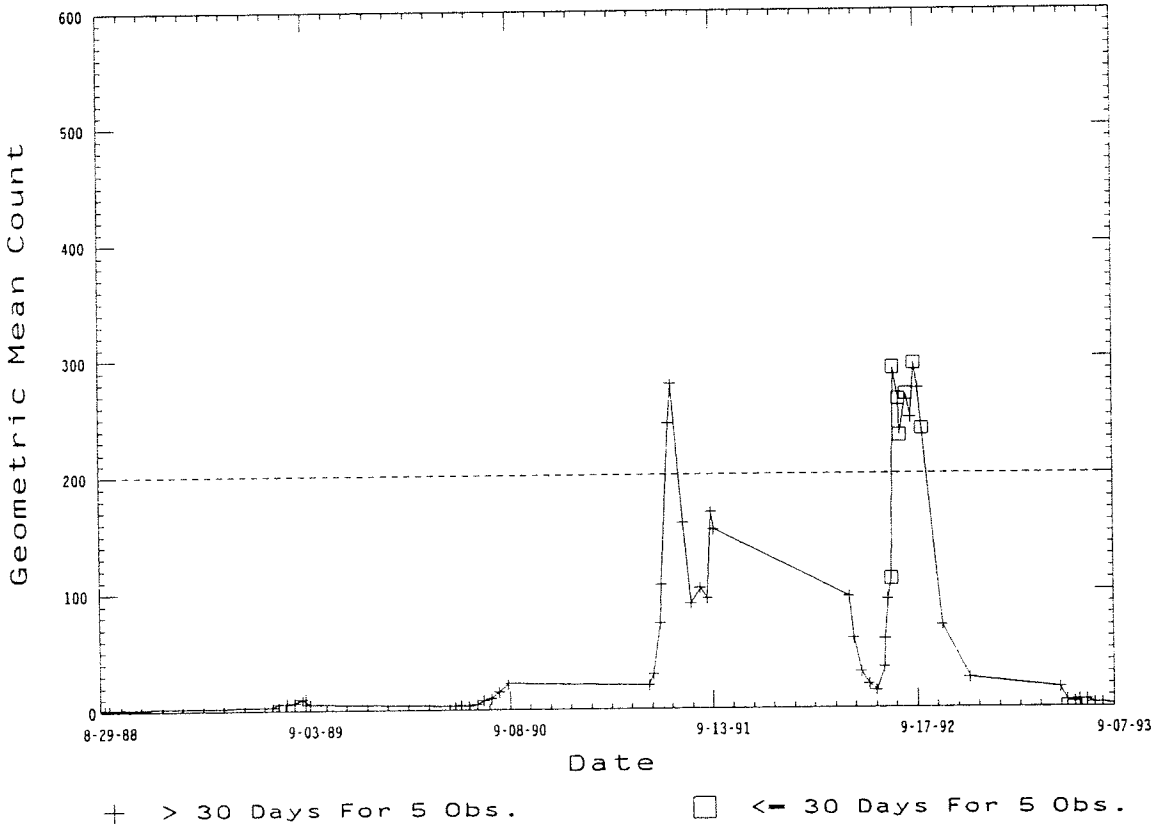


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

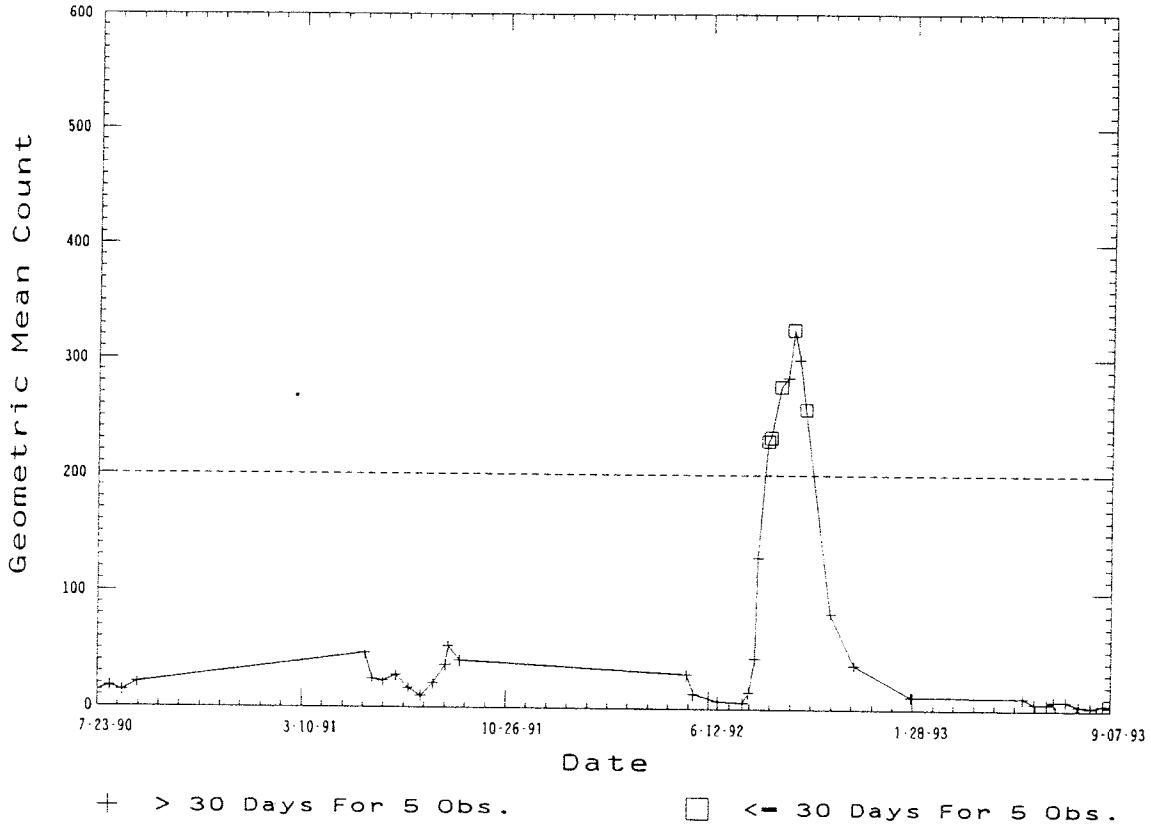
Running Geometric Mean of FAR1 Over 1835 Days



Running Geometric Mean of FAR2 Over 1835 Days

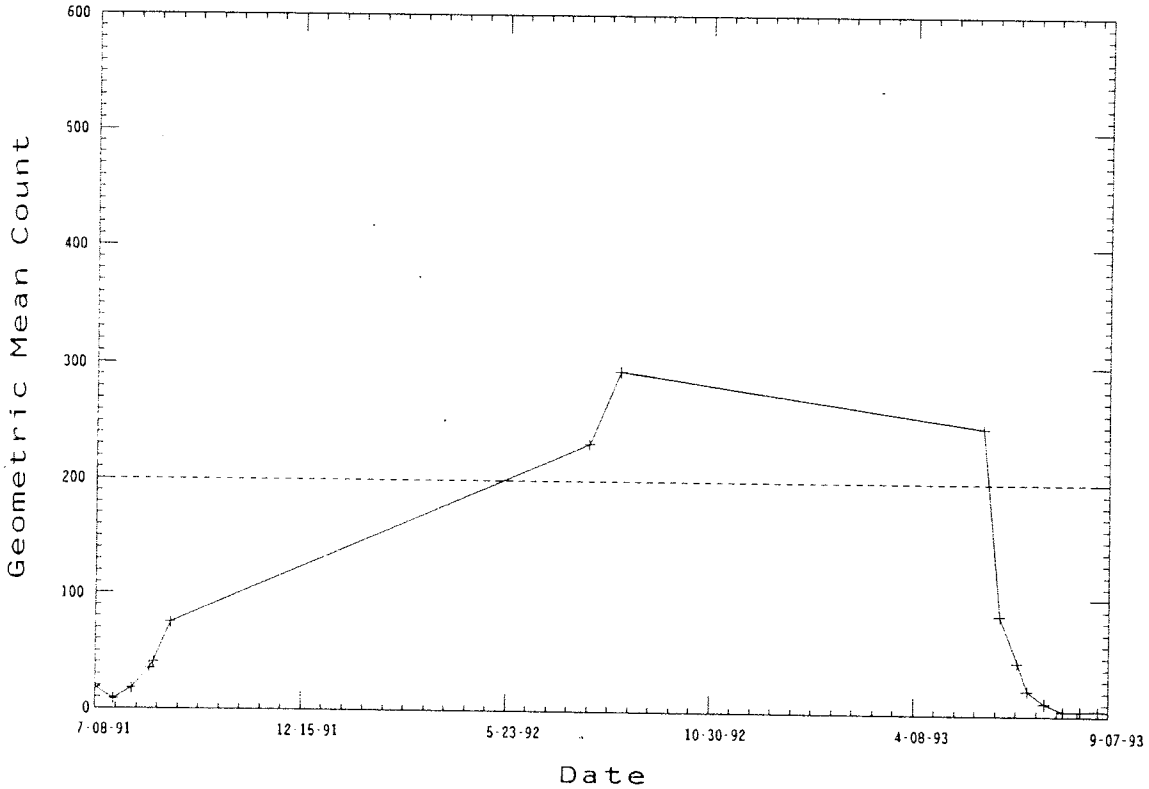


Running Geometric Mean of FOR1 Over 1142 Days



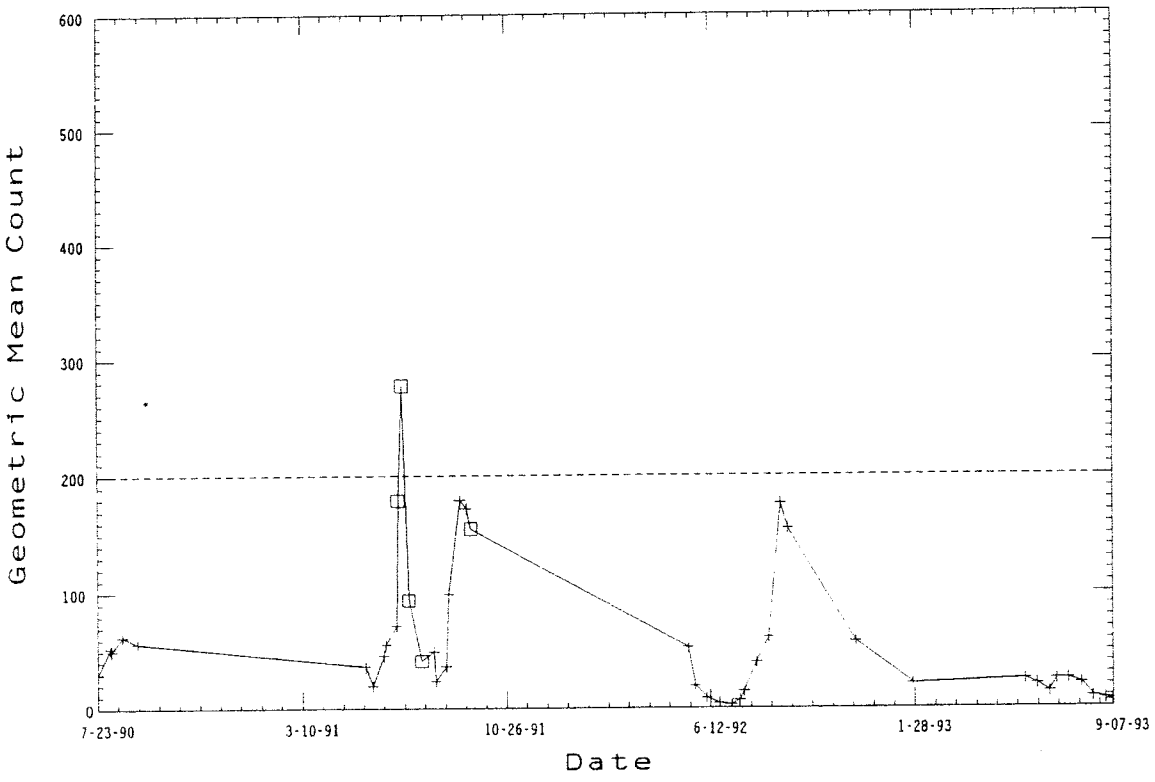
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of FOR2 Over 792 Days



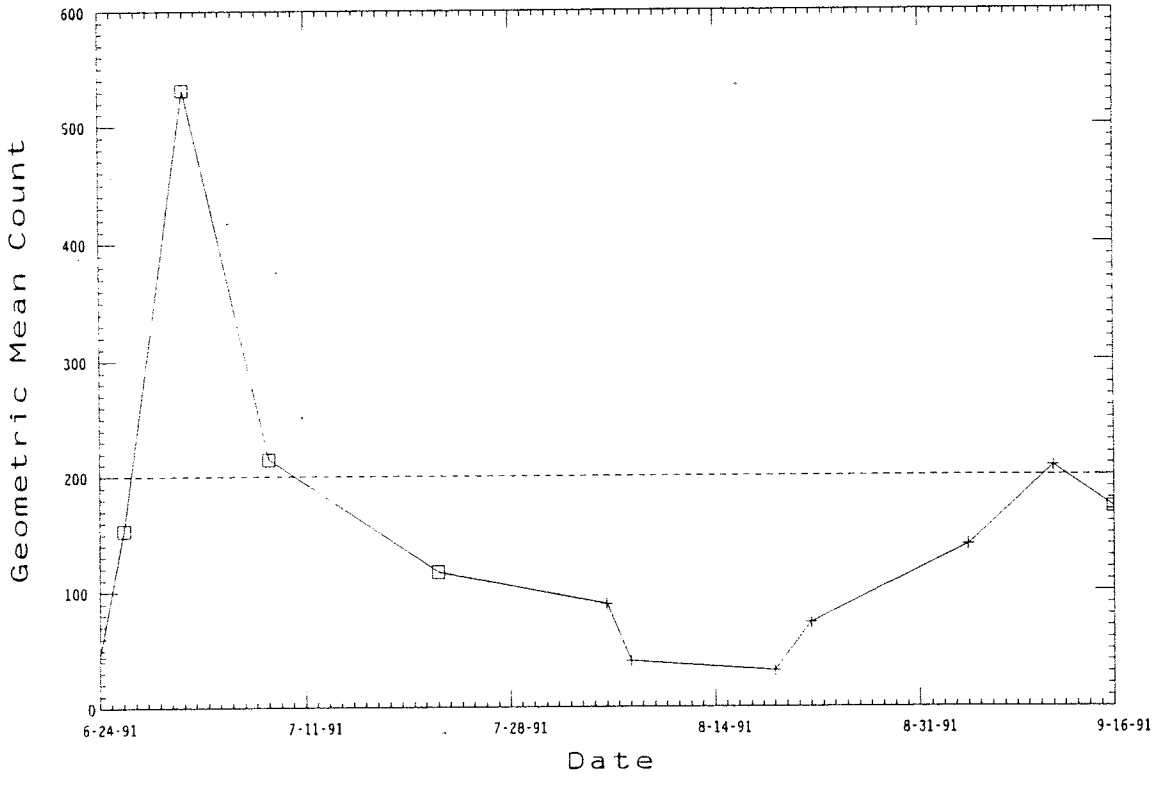
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of HAN1 Over 1142 Days



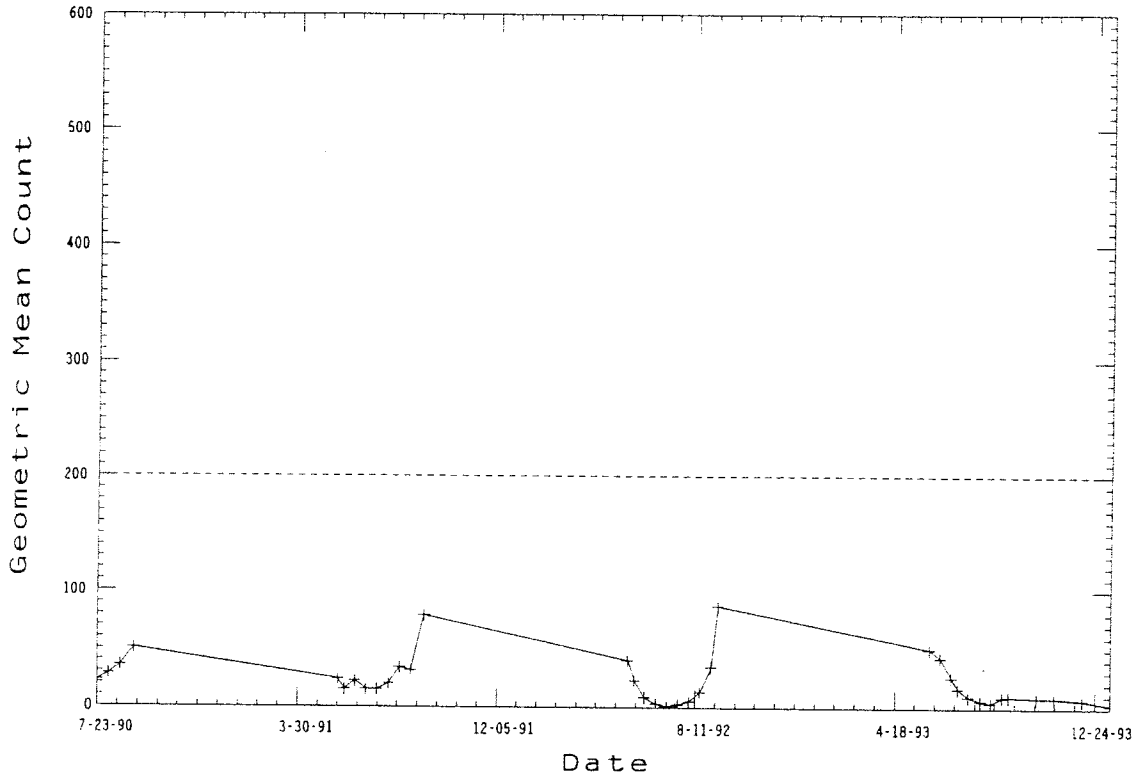
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of HAN2 Over 84 Days



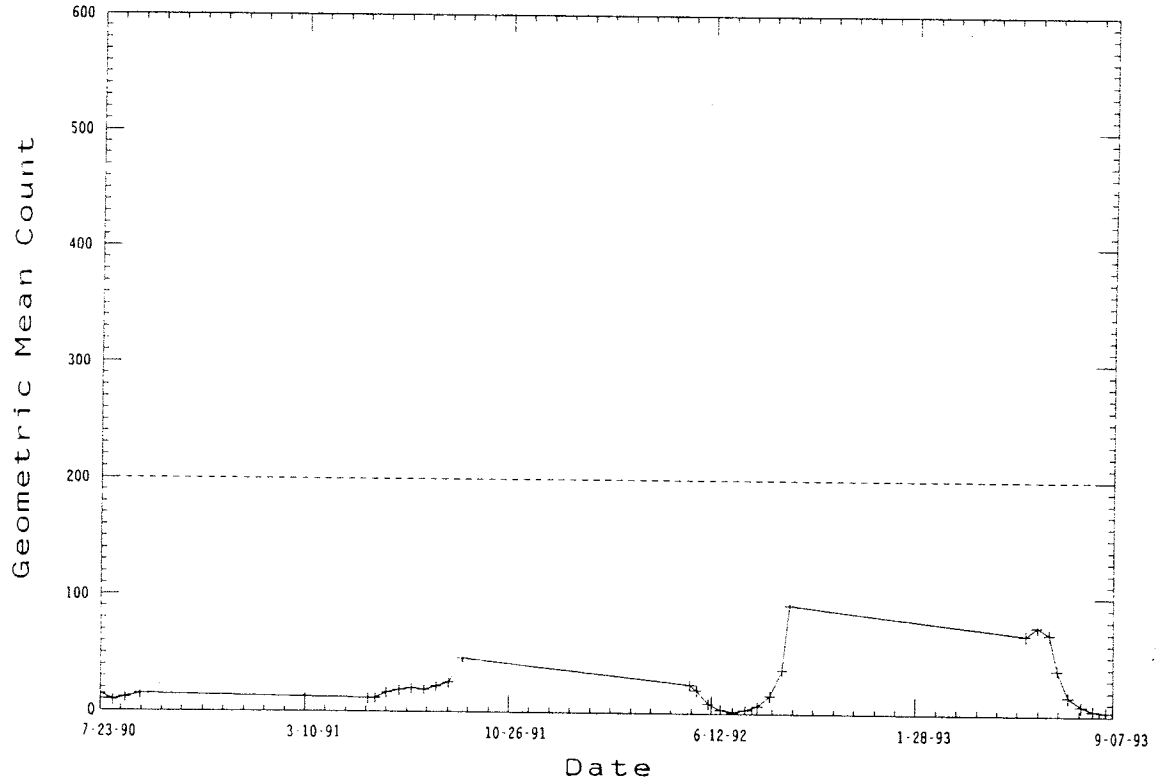
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of HCMAR1 Over 1269 Days



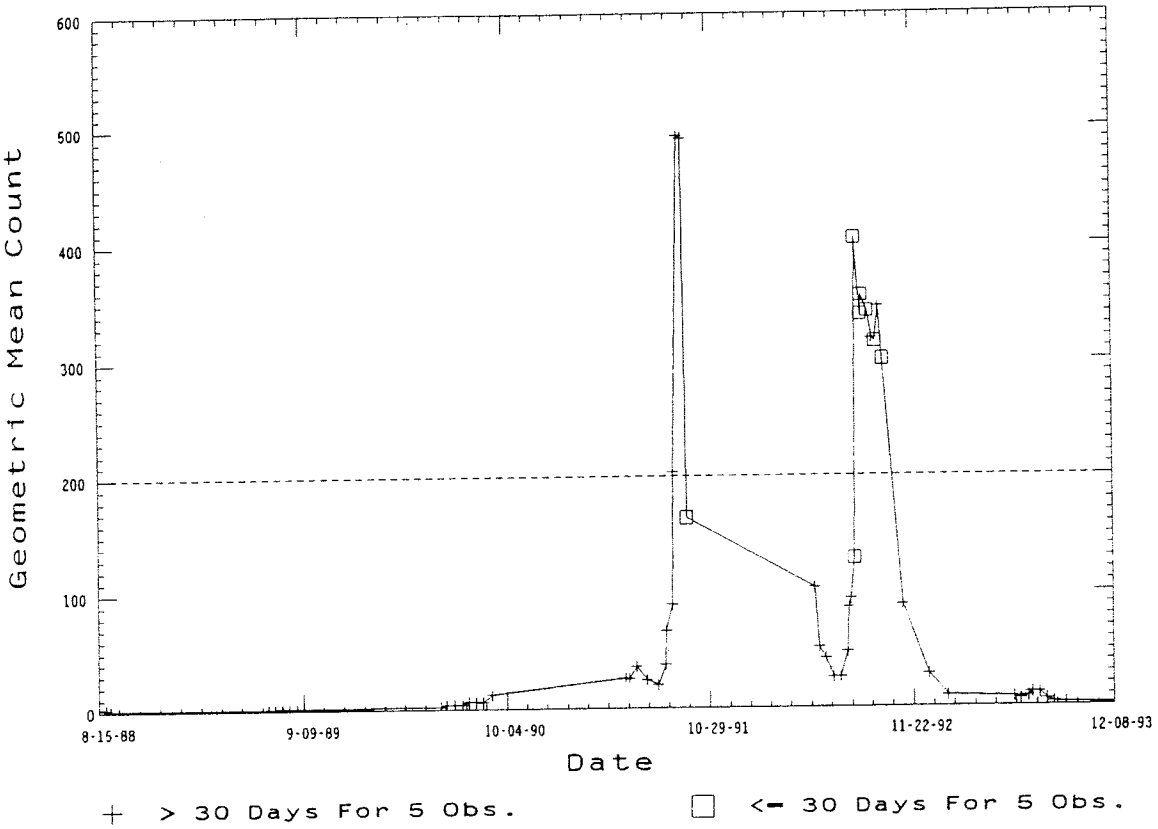
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of HCMAR2 Over 1142 Days

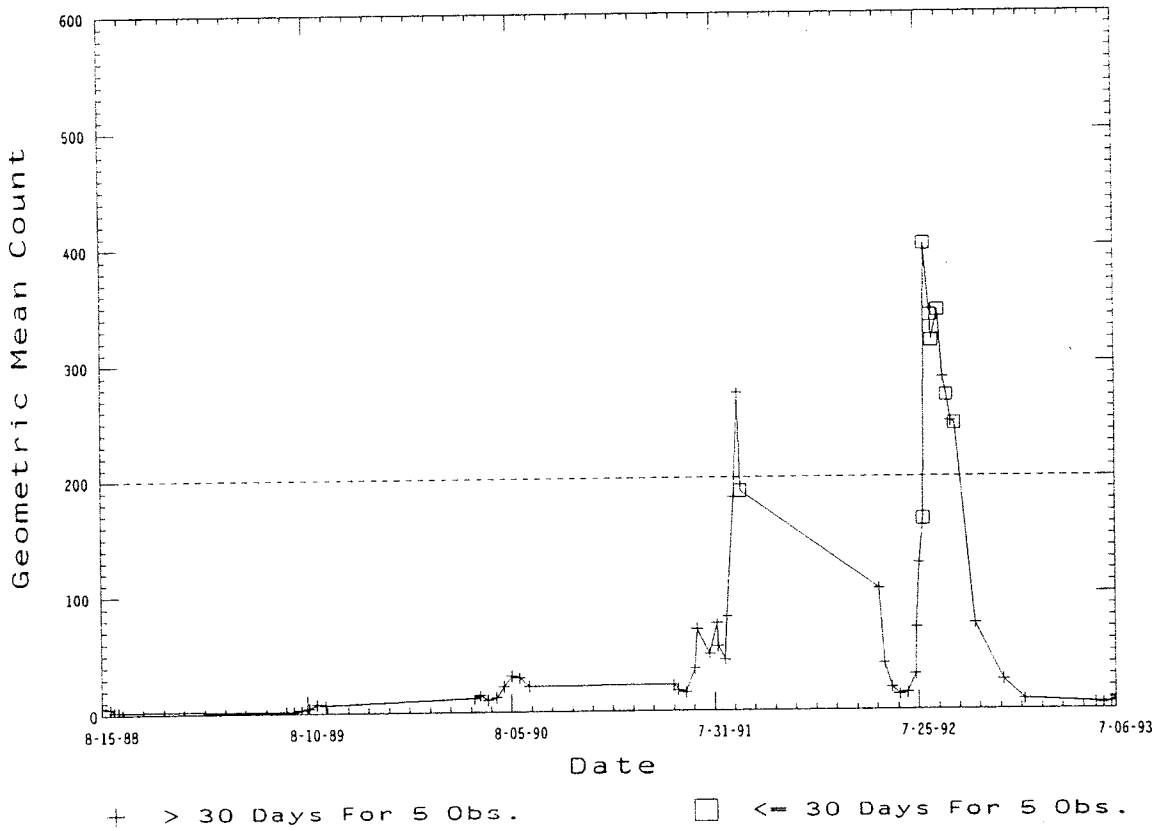


+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

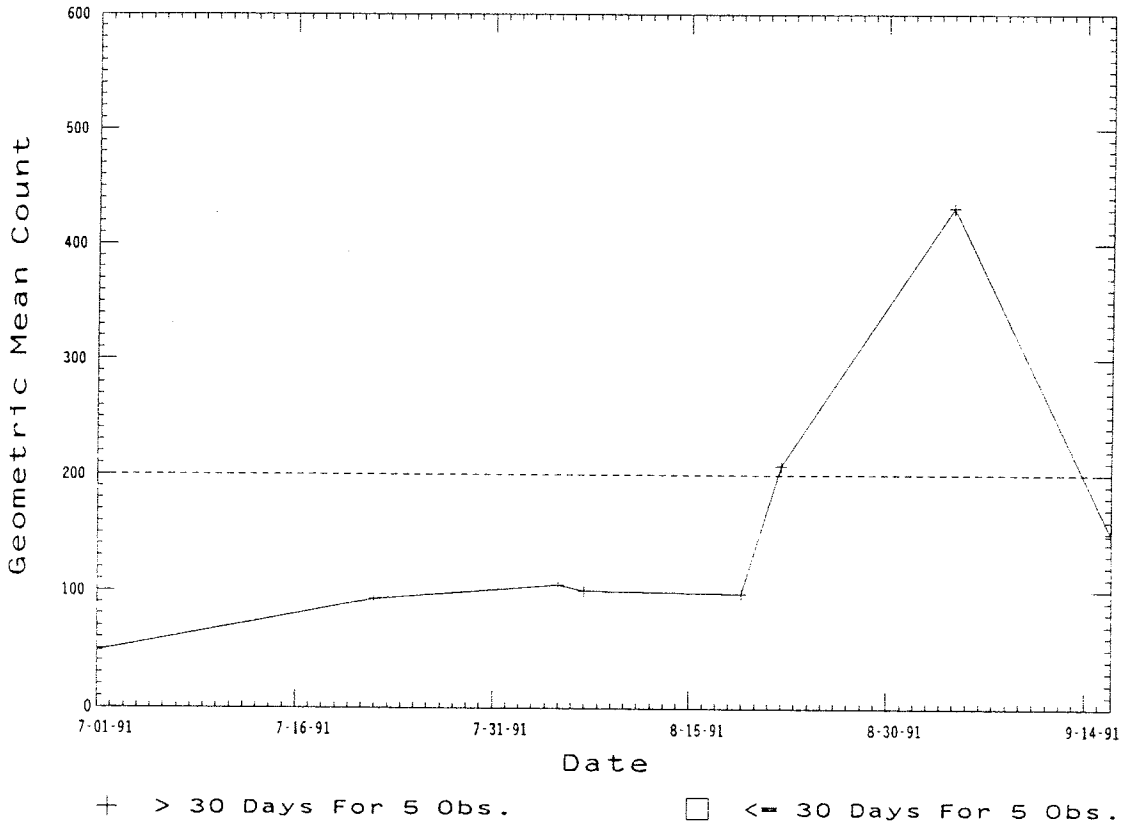
Running Geometric Mean of HIMAR1 Over 1941 Days



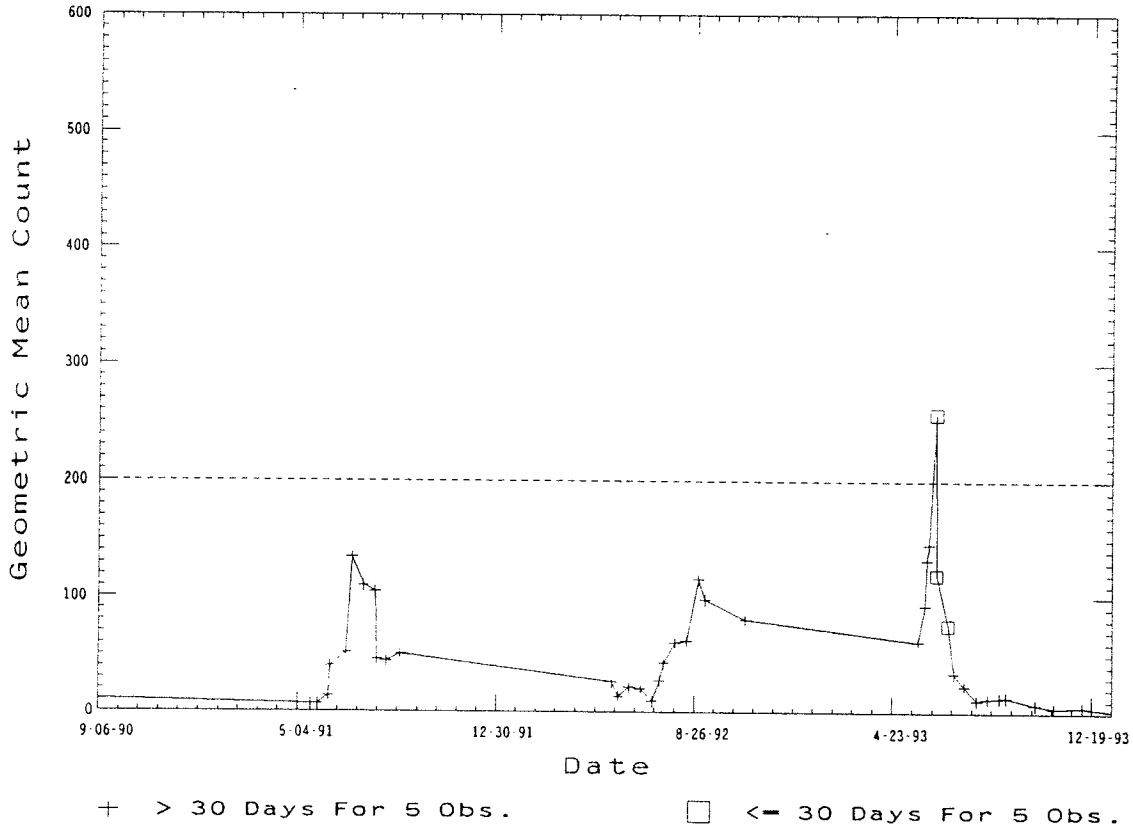
Running Geometric Mean of HIMAR2 Over 1786 Days



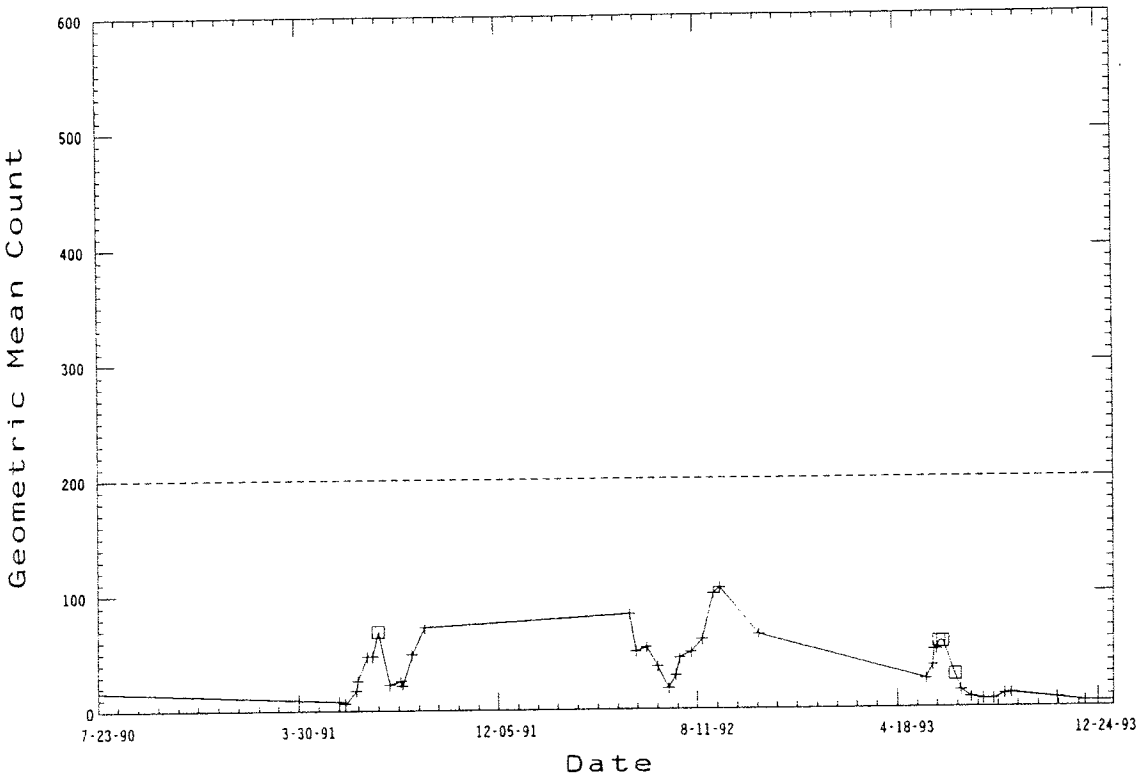
Running Geometric Mean of HIMAR3 Over 77 Days



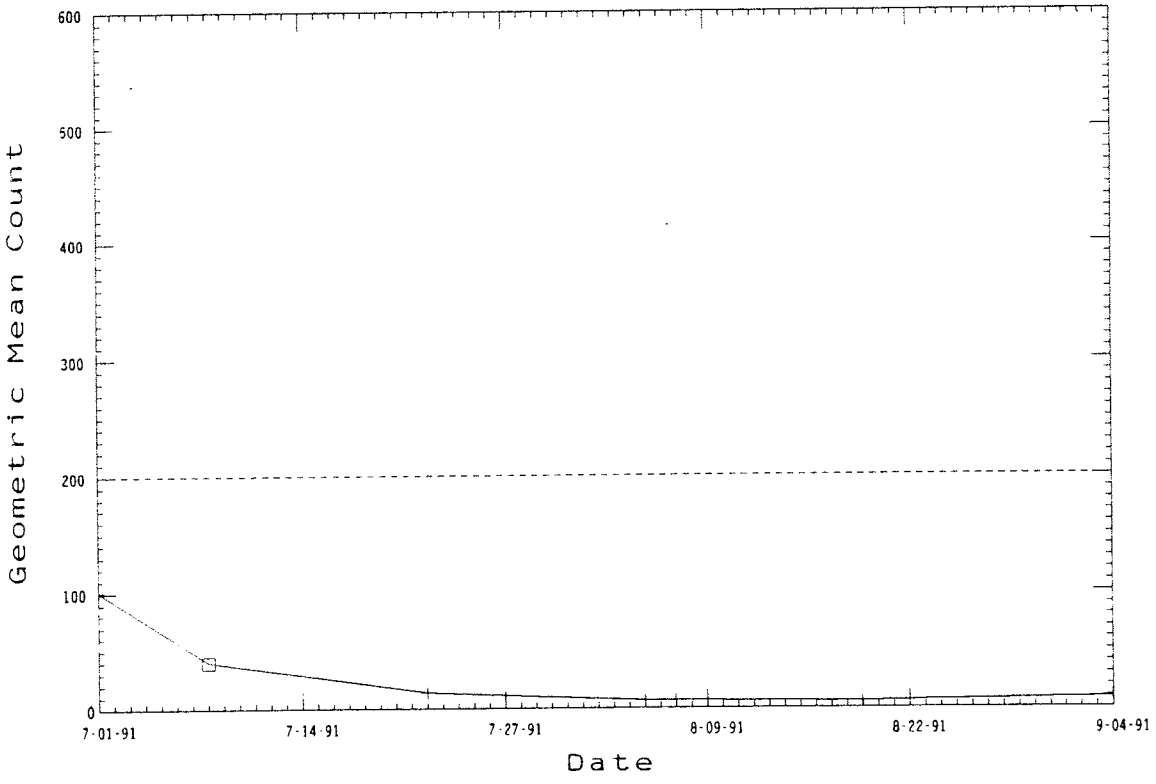
Running Geometric Mean of HOBI1 Over 1224 Days



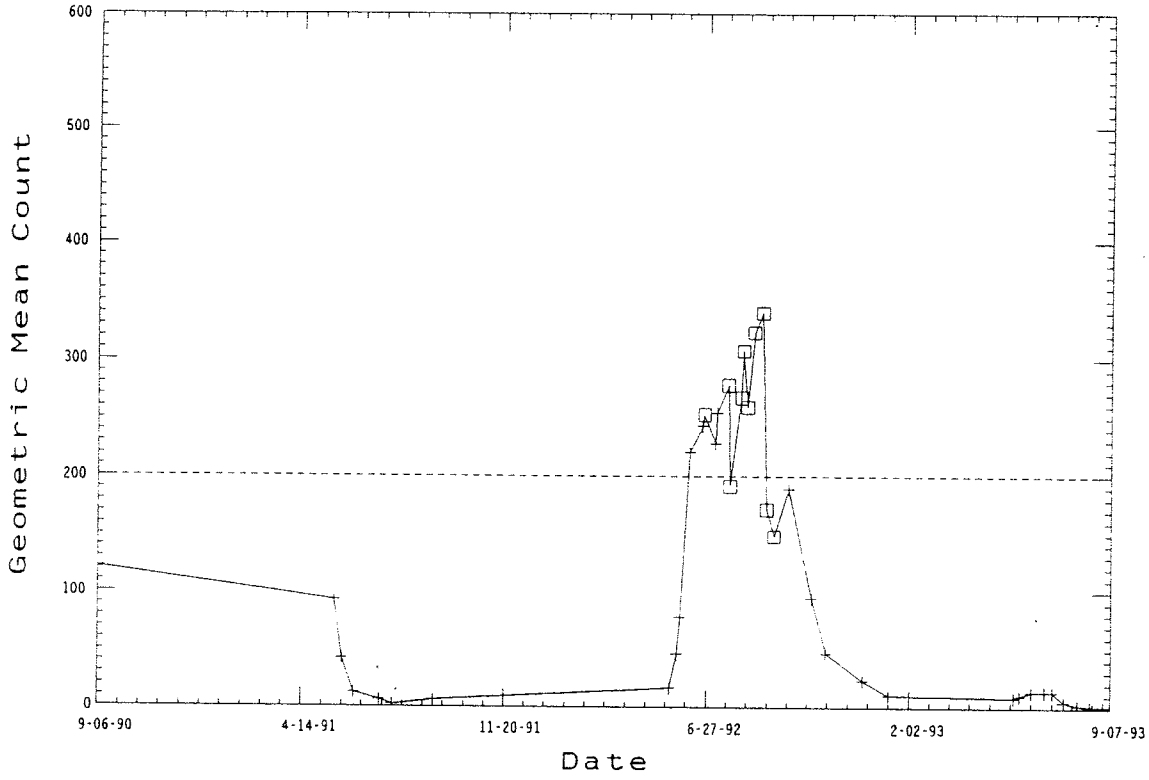
Running Geometric Mean of HOBI2 Over 1269 Days



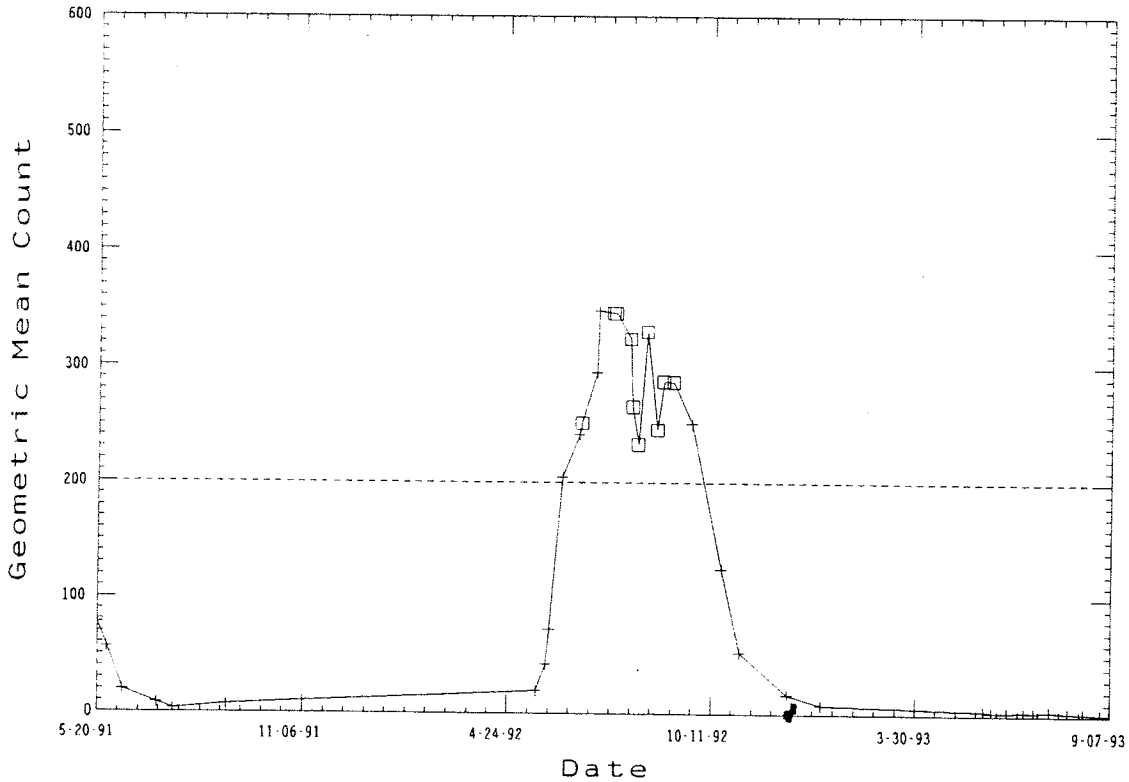
Running Geometric Mean of HOBI3 Over 65 Days



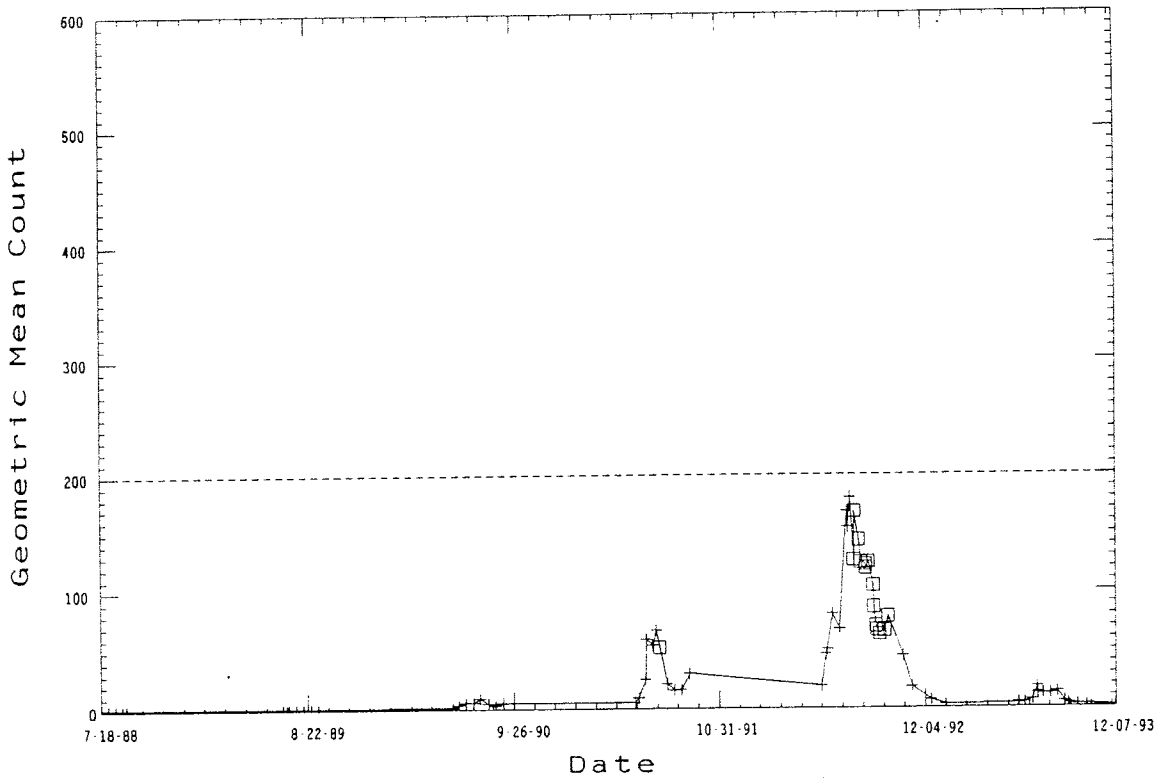
Running Geometric Mean of LEW1 Over 1097 Days



Running Geometric Mean of LEW2 Over 841 Days

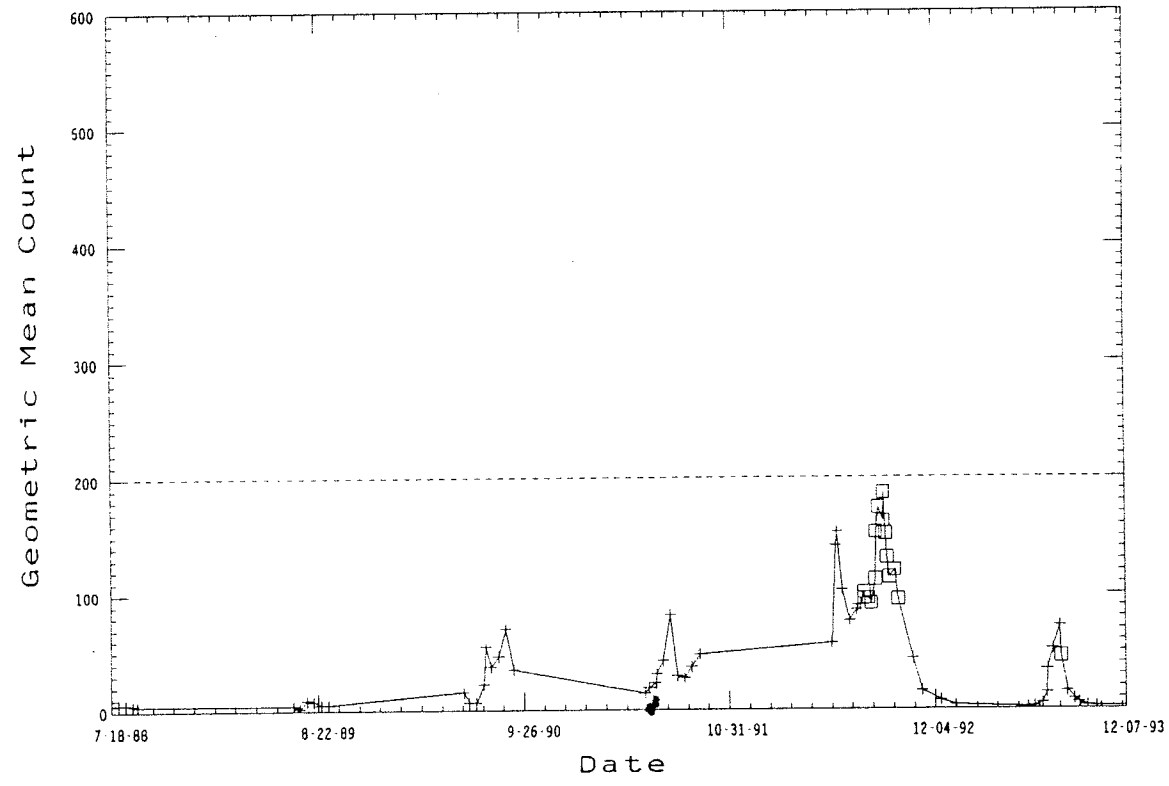


Running Geometric Mean of LONE1 Over 1968 Days



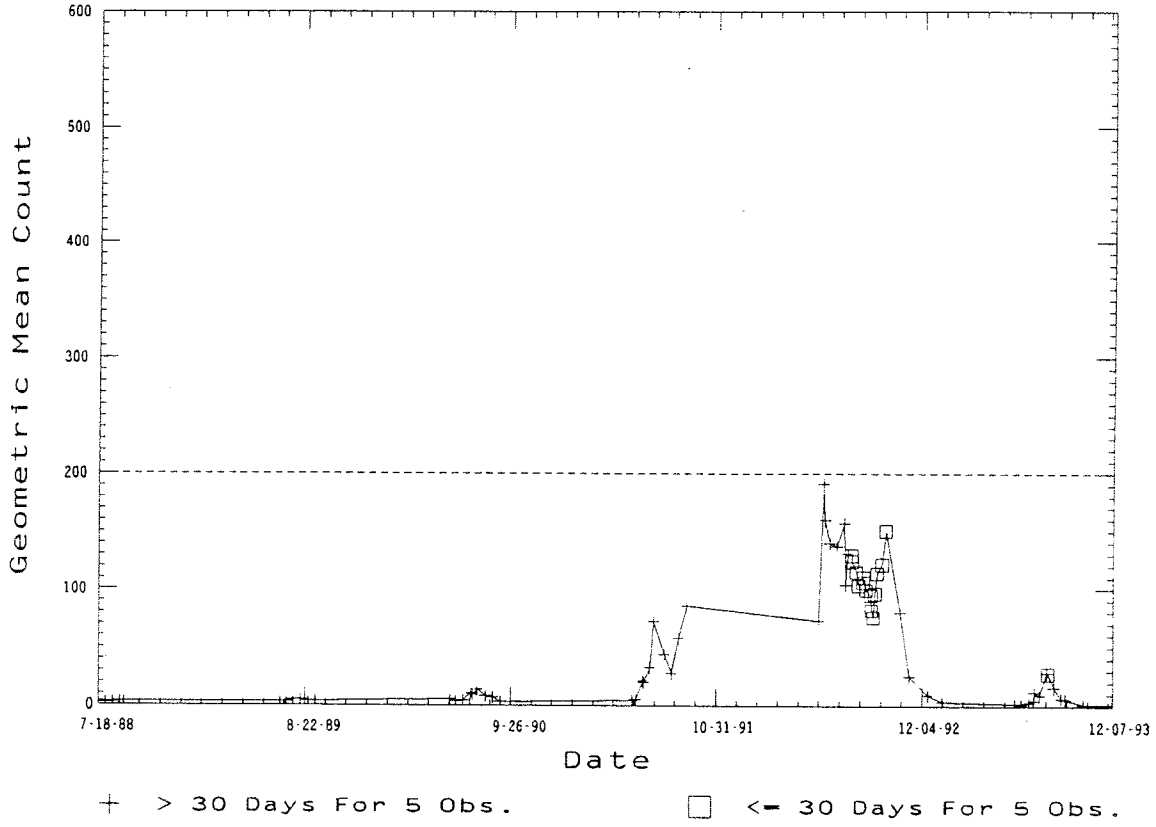
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of LONE2 Over 1968 Days

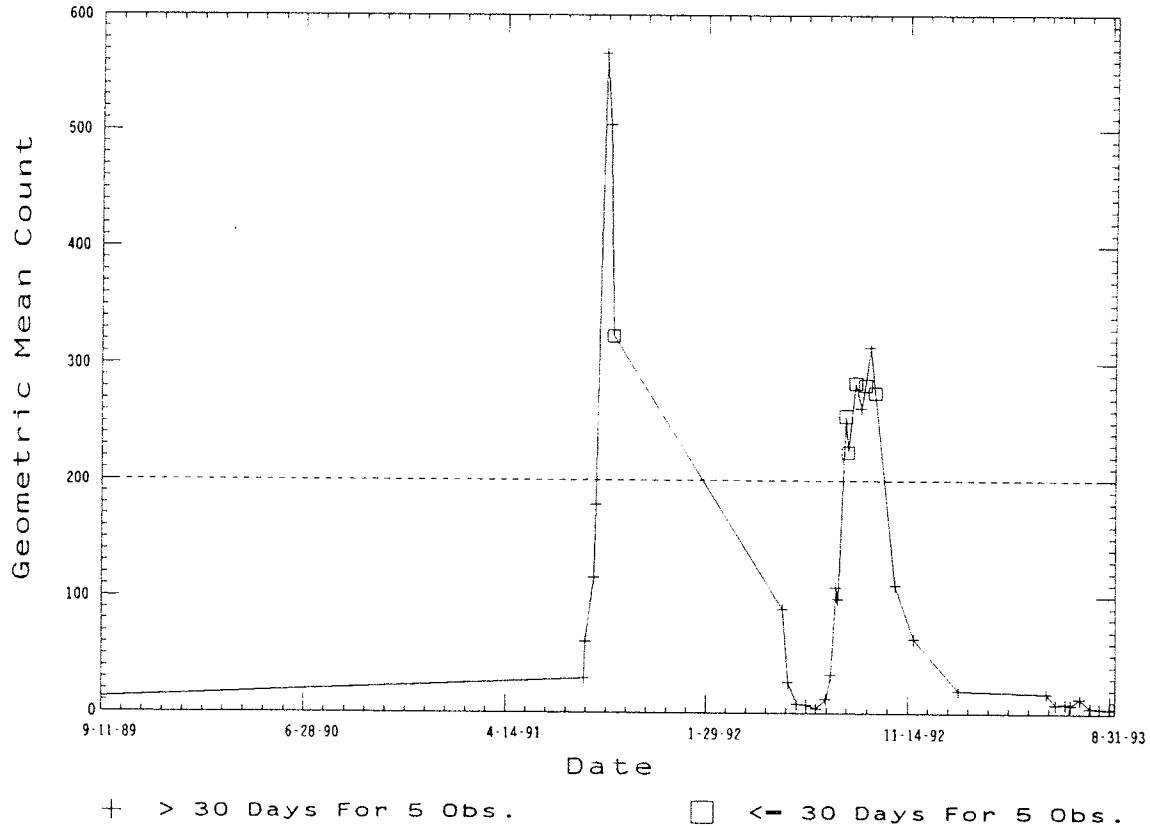


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

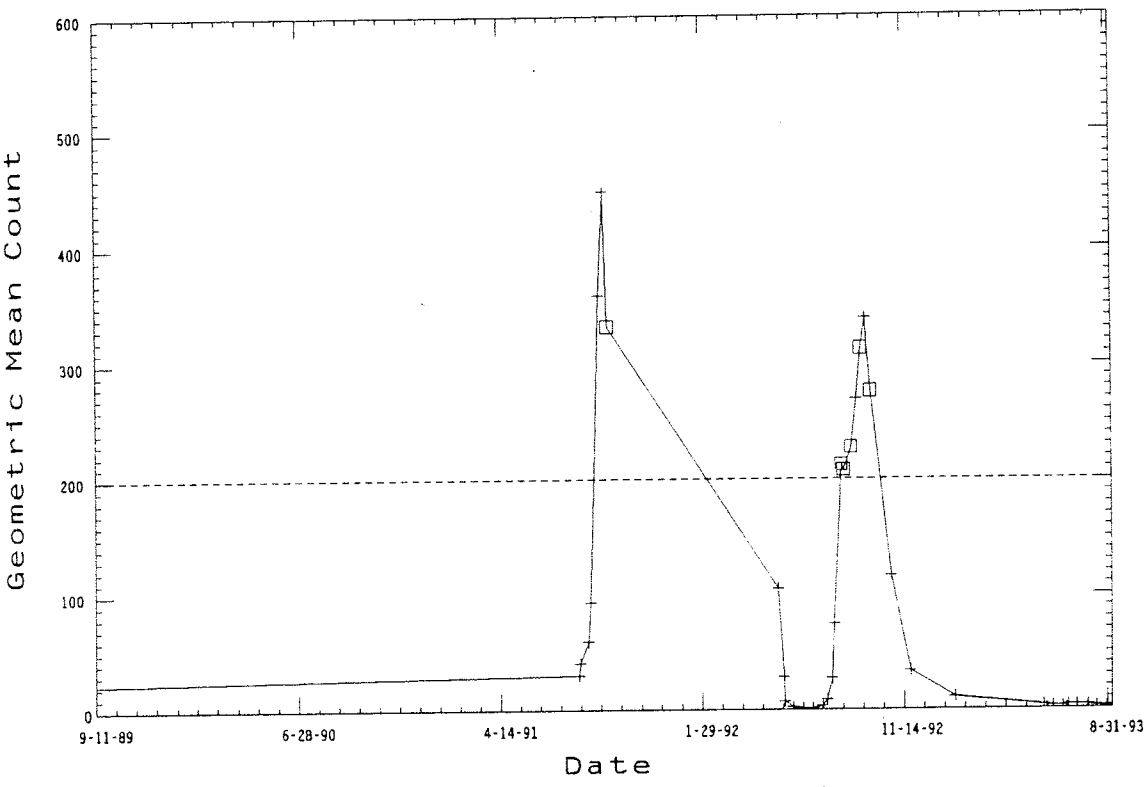
Running Geometric Mean of LONE3 Over 1968 Days



Running Geometric Mean of MOQUI1 Over 1457 Days

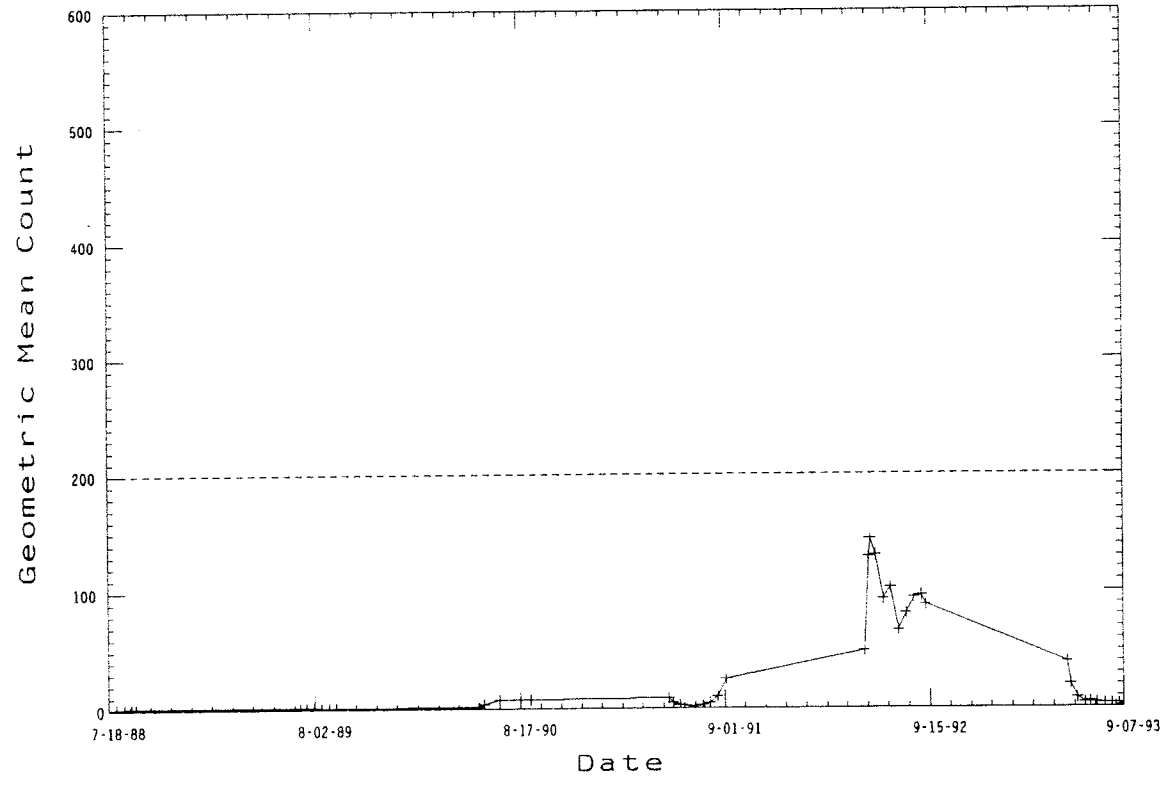


Running Geometric Mean of MOQUI2 Over 1457 Days



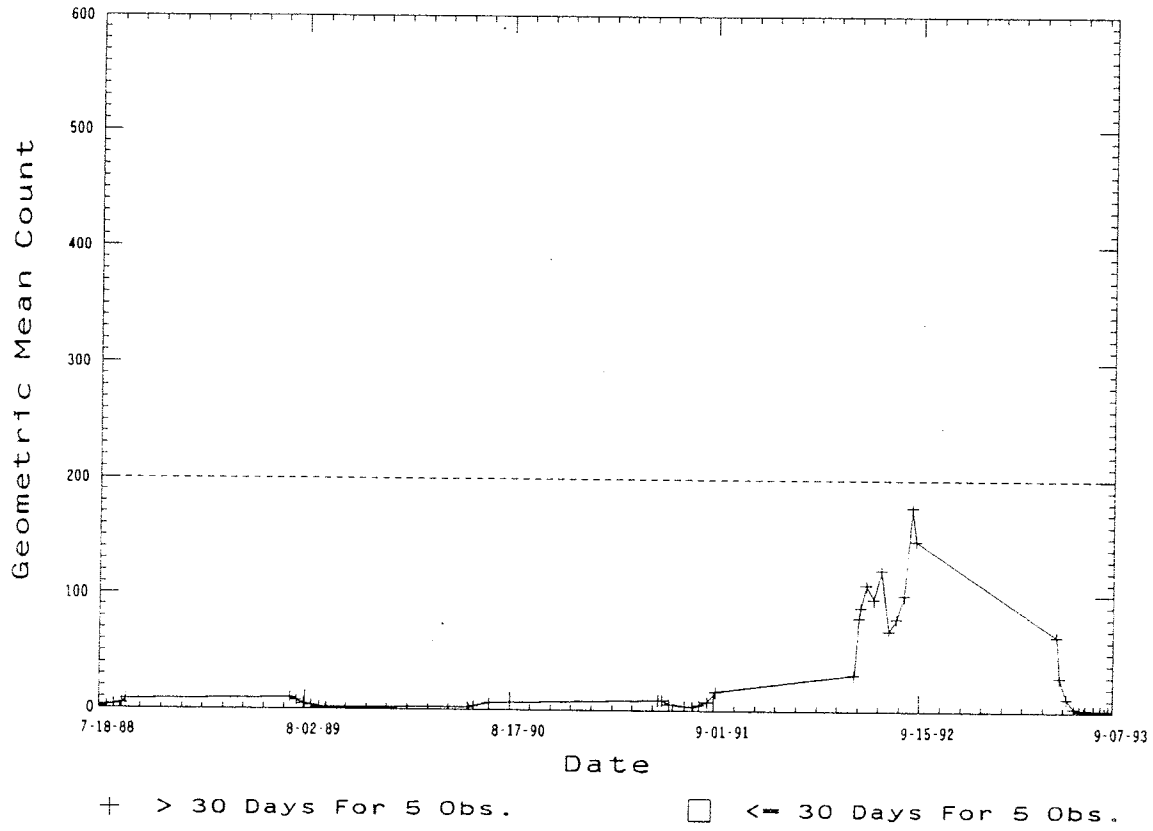
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of MSC1 Over 1877 Days

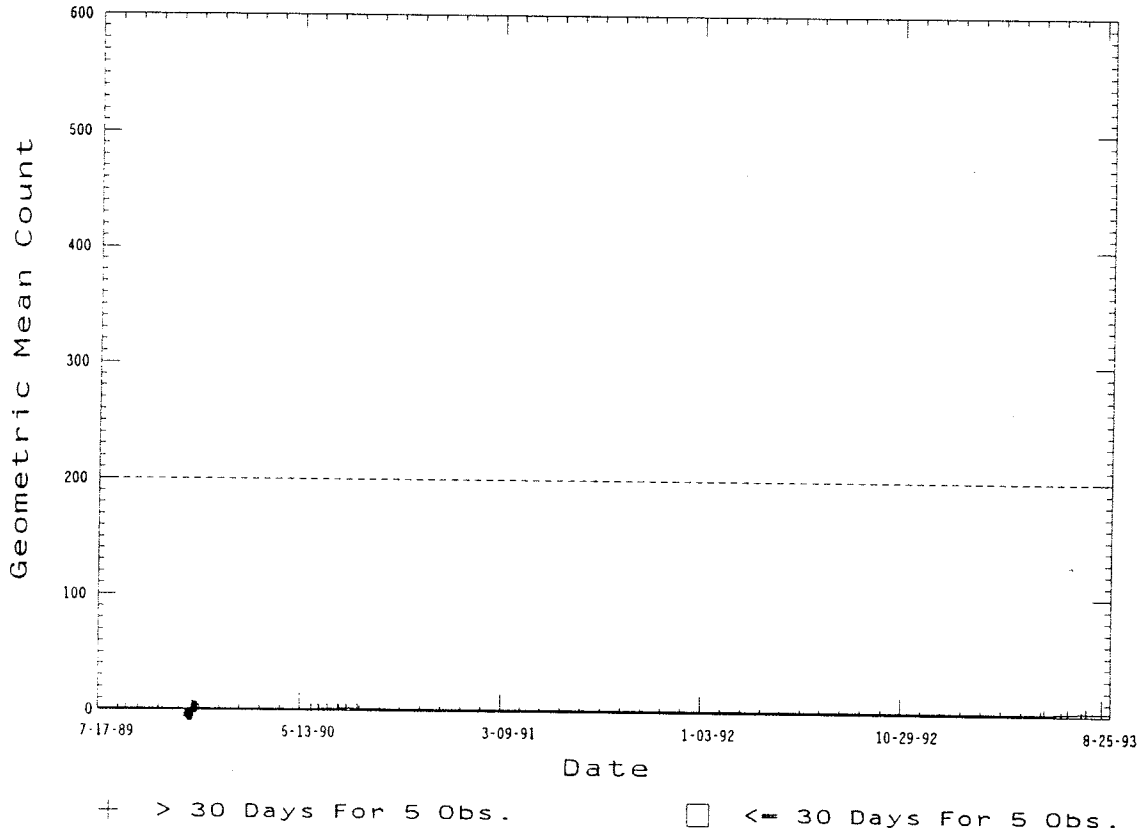


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

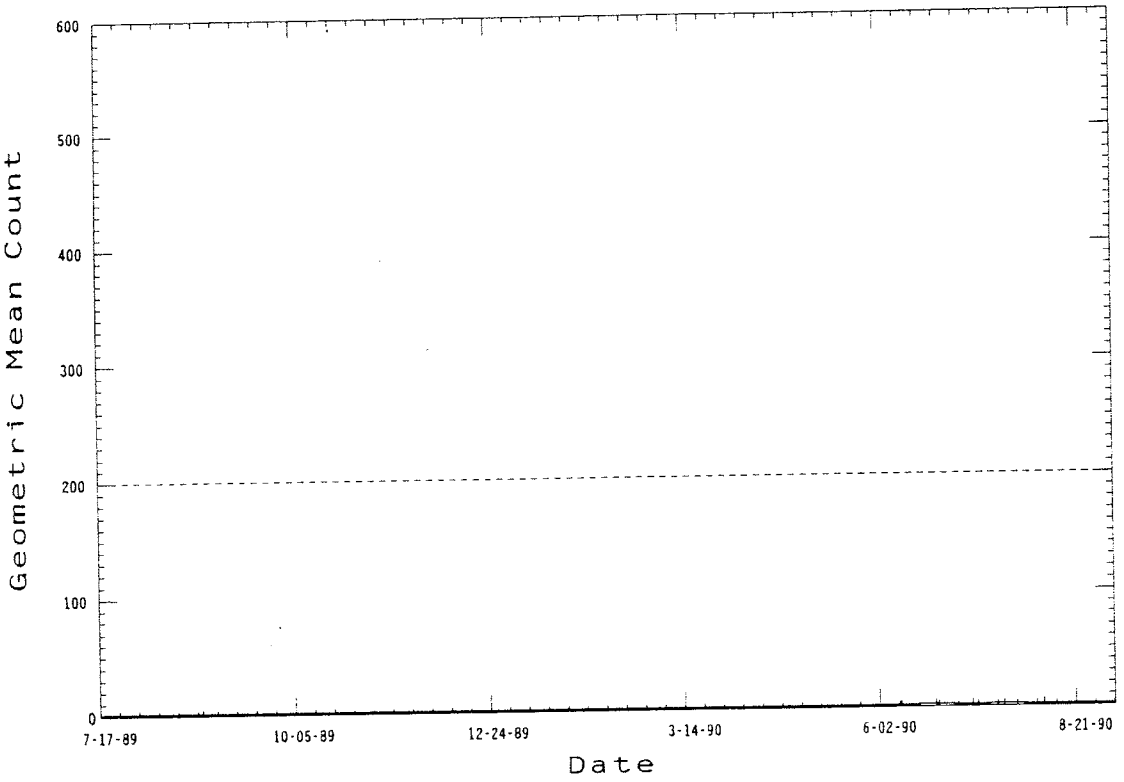
Running Geometric Mean of MSC2 Over 1877 Days



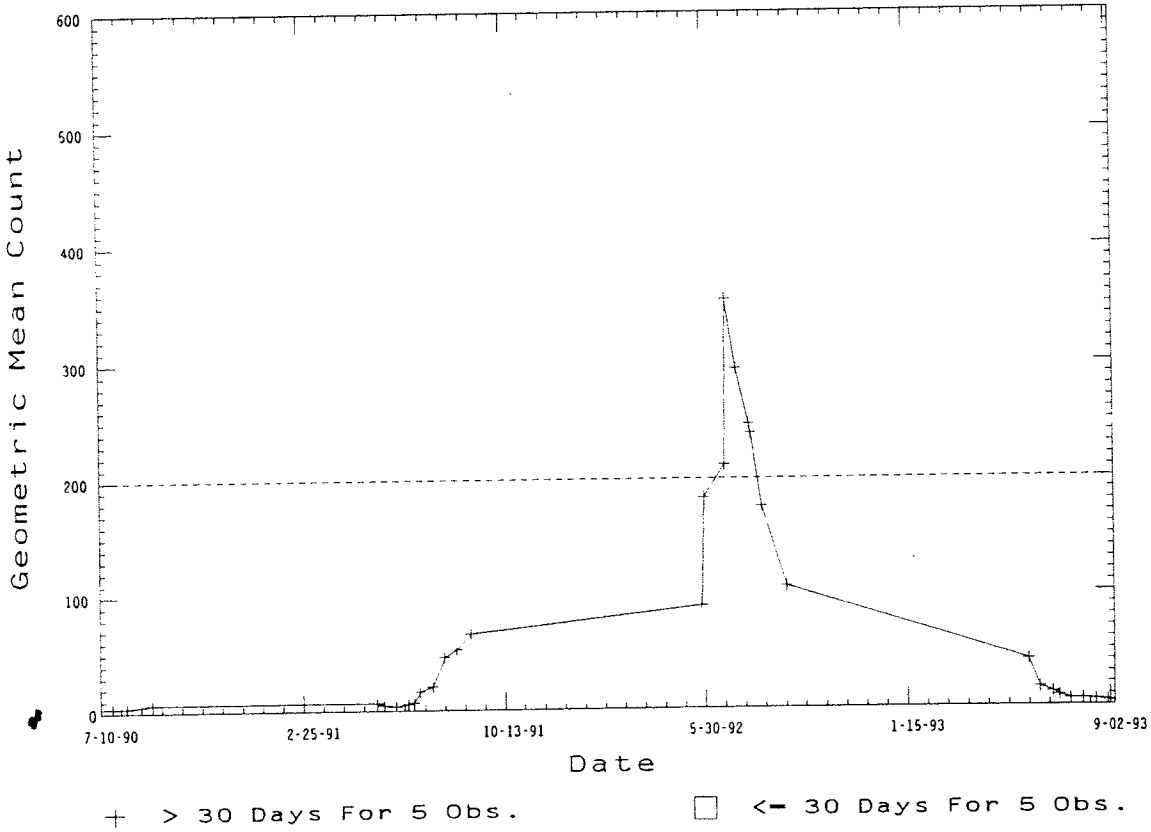
Running Geometric Mean of NARR1 Over 1513 Days



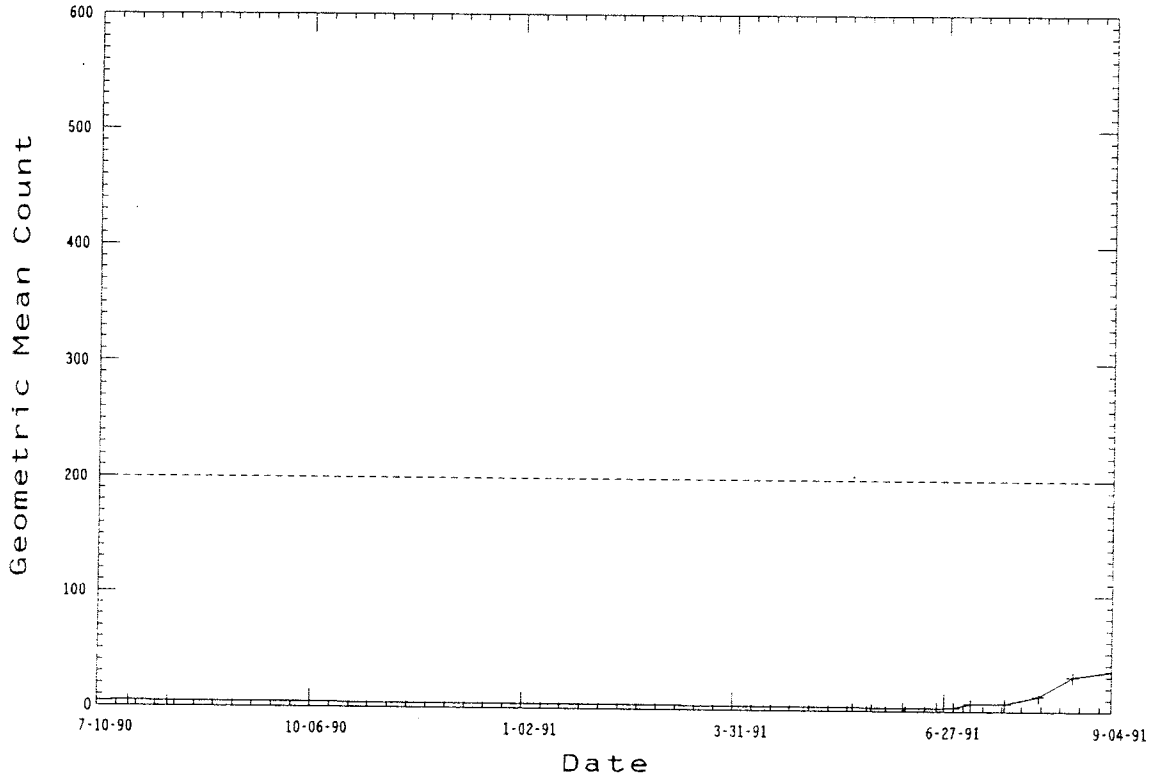
Running Geometric Mean of NARR2 Over 416 Days



Running Geometric Mean of NPS1 Over 1155 Days

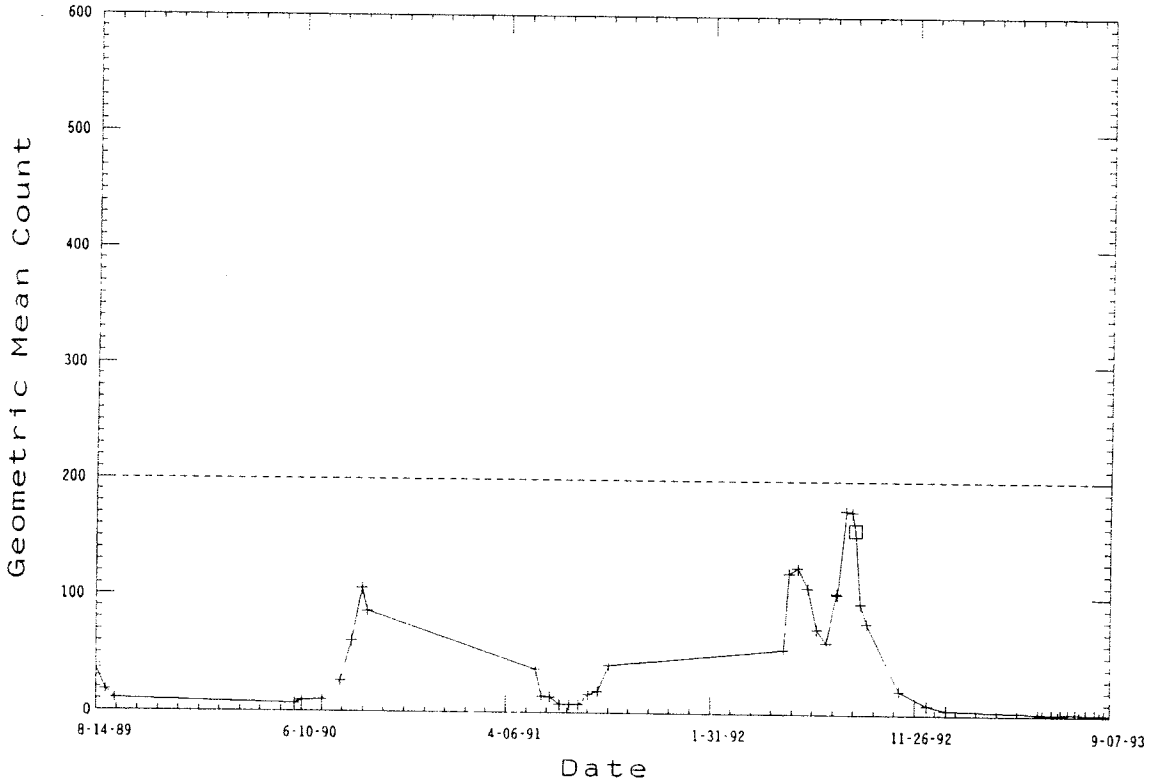


Running Geometric Mean of NPS2 Over 421 Days



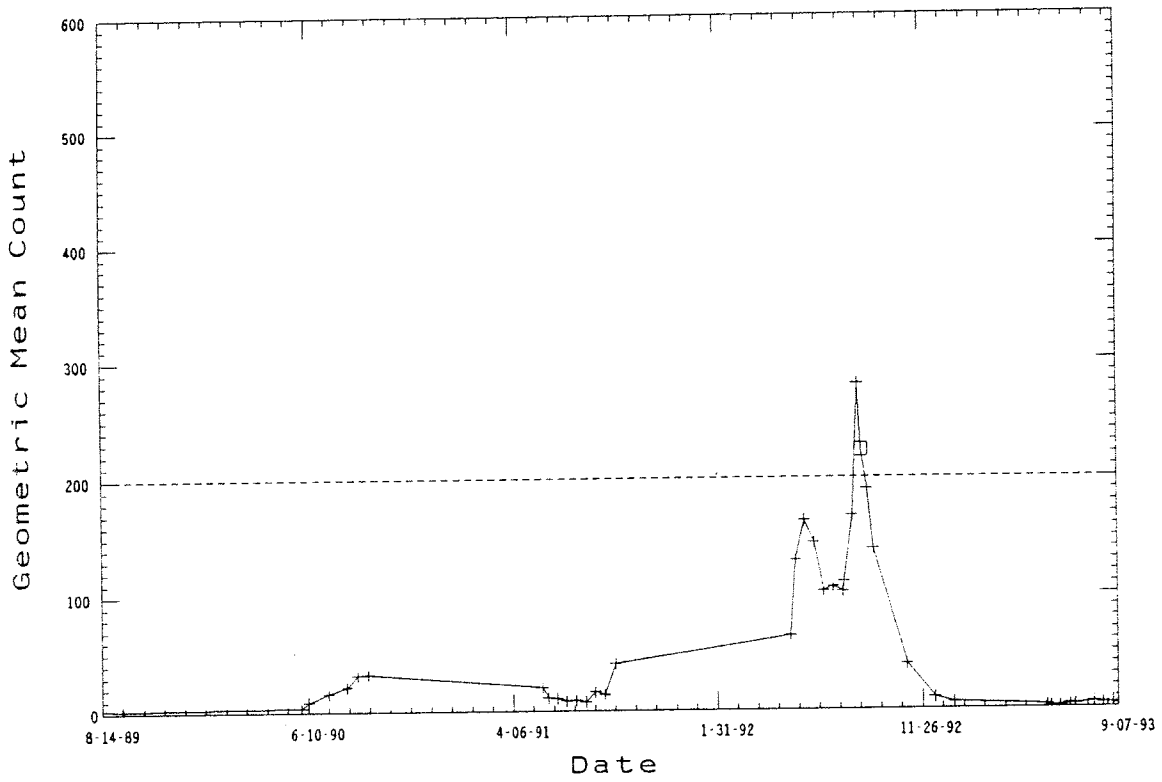
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of OAK1 Over 1485 Days



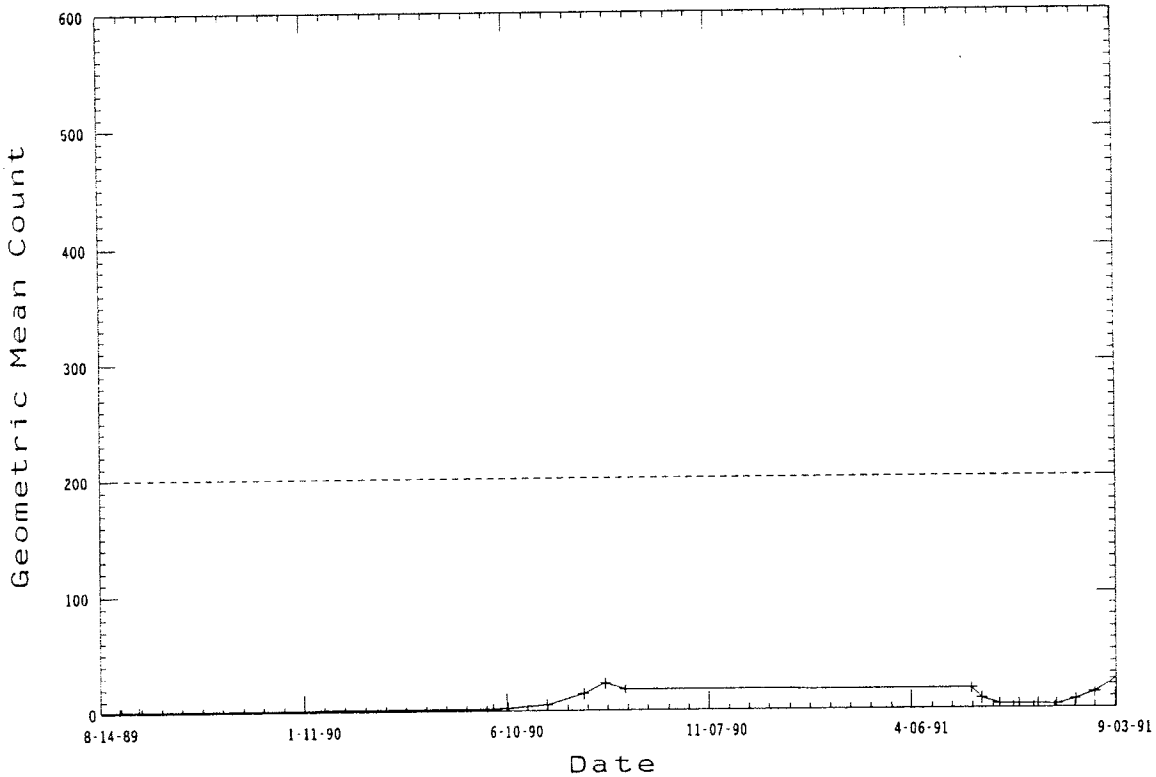
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of OAK2 Over 1485 Days

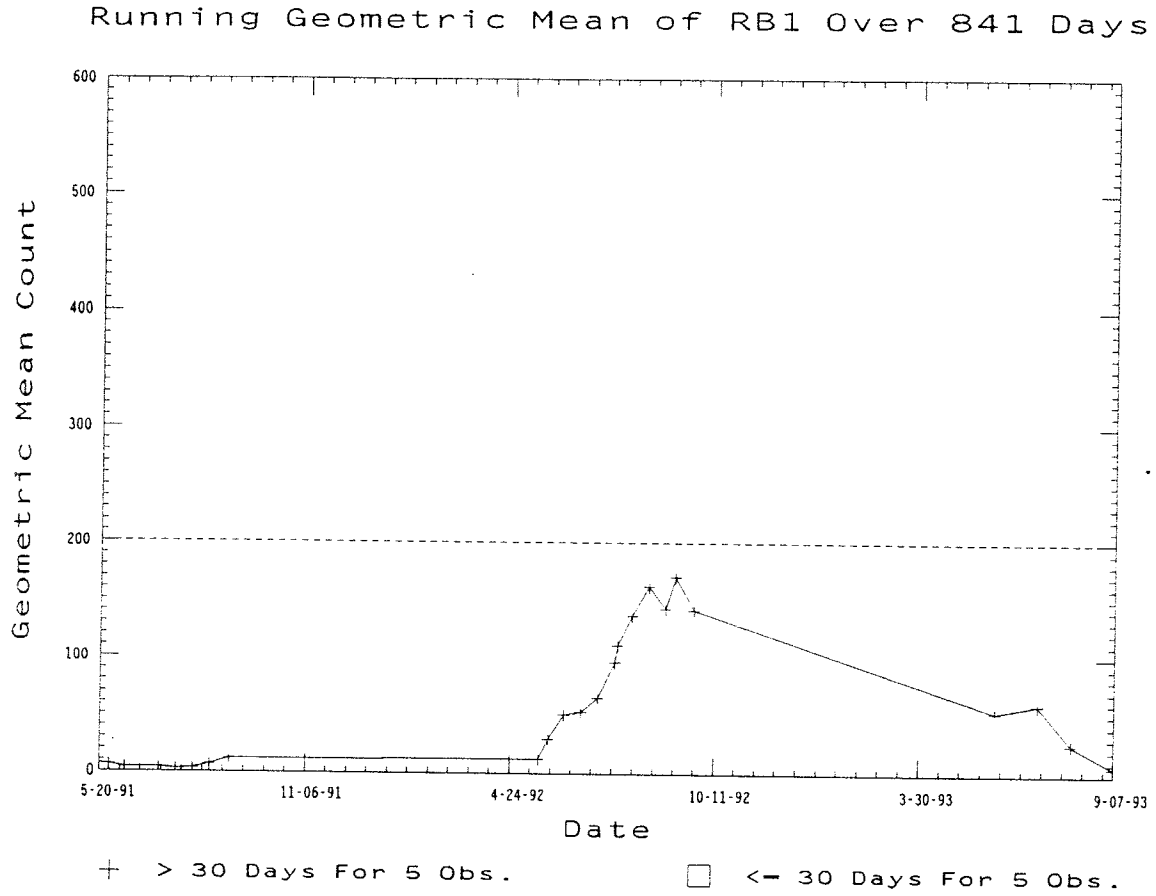


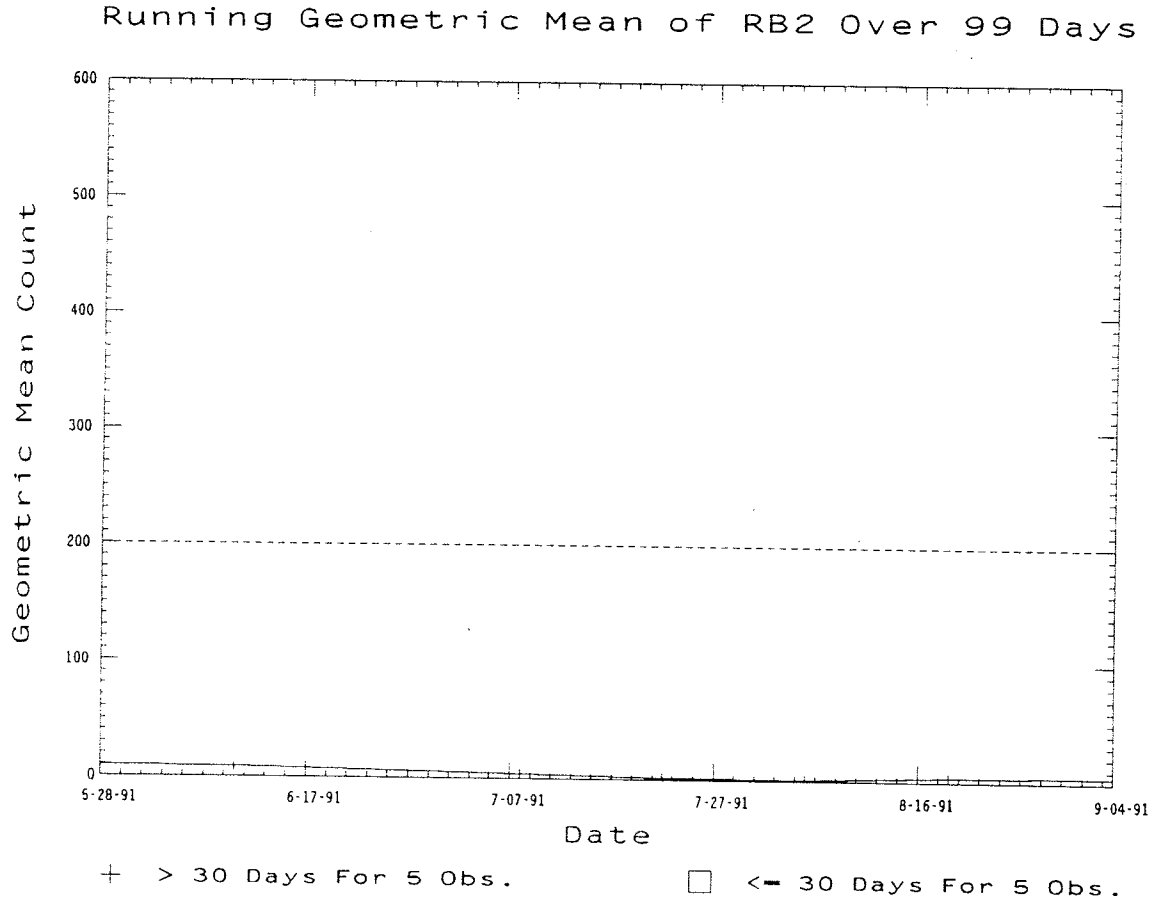
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of OAK3 Over 751 Days

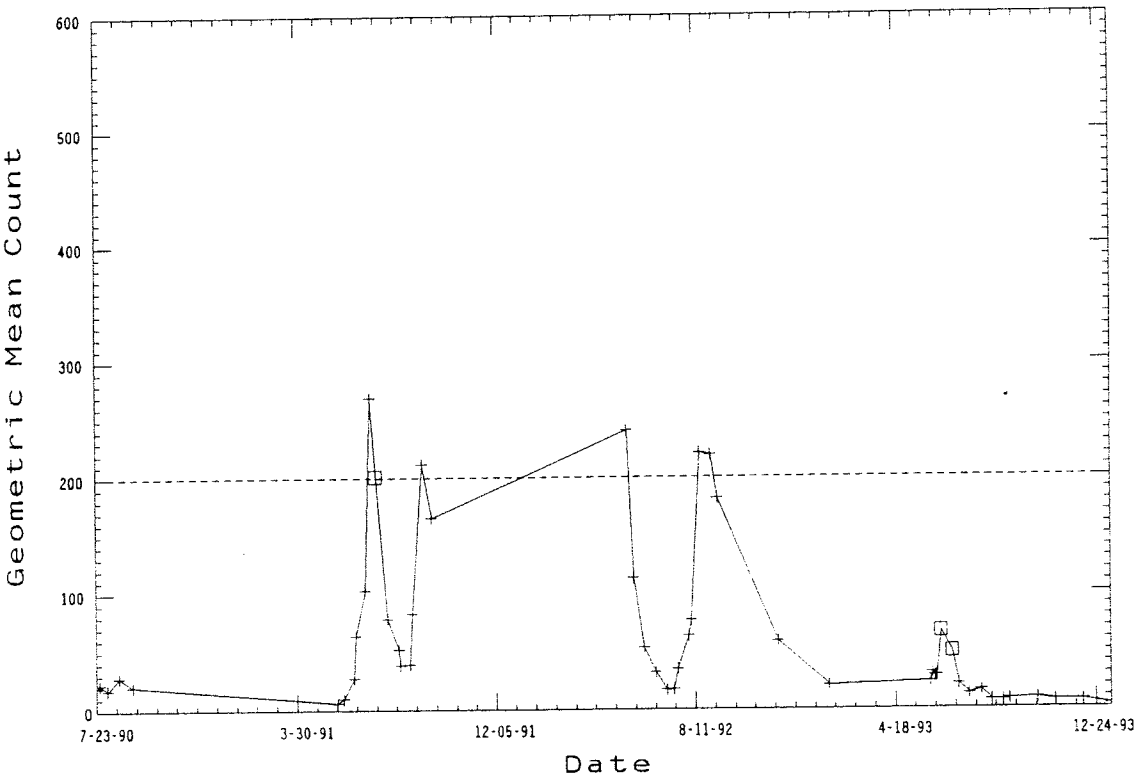


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.


Running Geometric Mean of RB1 Over 841 Days
Geometric Mean Count
600
500
400
300
200
100
0
5-20-91
11-06-91
4-24-92
10-11-92
3-30-93
9-07-93
Date
+ > 30 Days For 5 Obs.
□ <= 30 Days For 5 Obs.

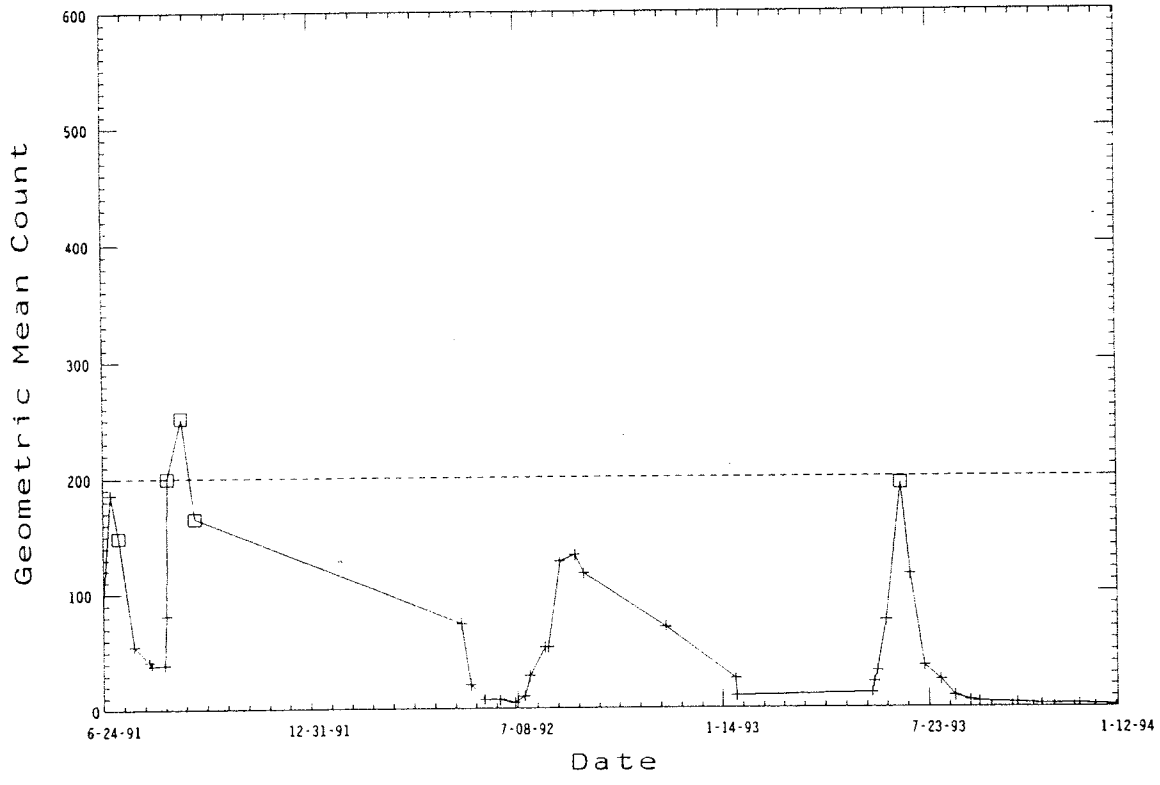

Running Geometric Mean of RB2 Over 99 Days
Geometric Mean Count
600
500
400
300
200
100
0
5-28-91
6-17-91
7-07-91
7-27-91
8-16-91
9-04-91
Date
+ > 30 Days For 5 Obs.
□ <= 30 Days For 5 Obs.

Running Geometric Mean of STAN1 Over 1269 Days



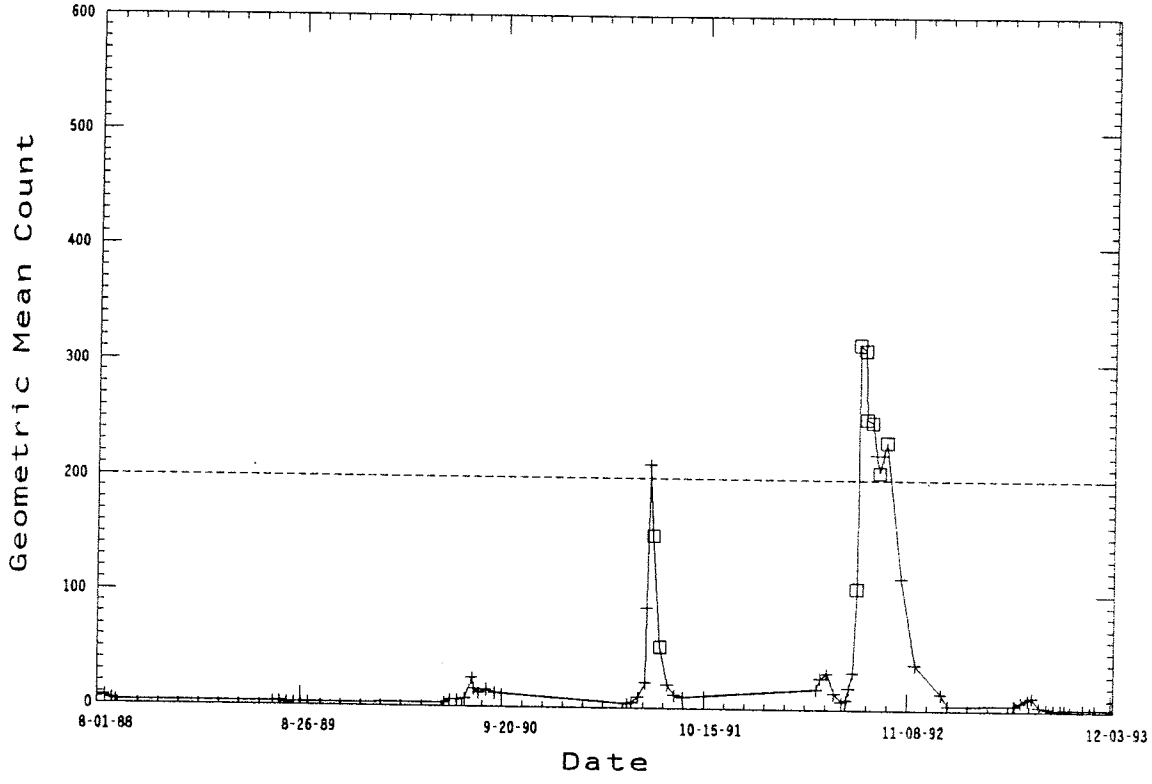
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of STAN2 Over 933 Days



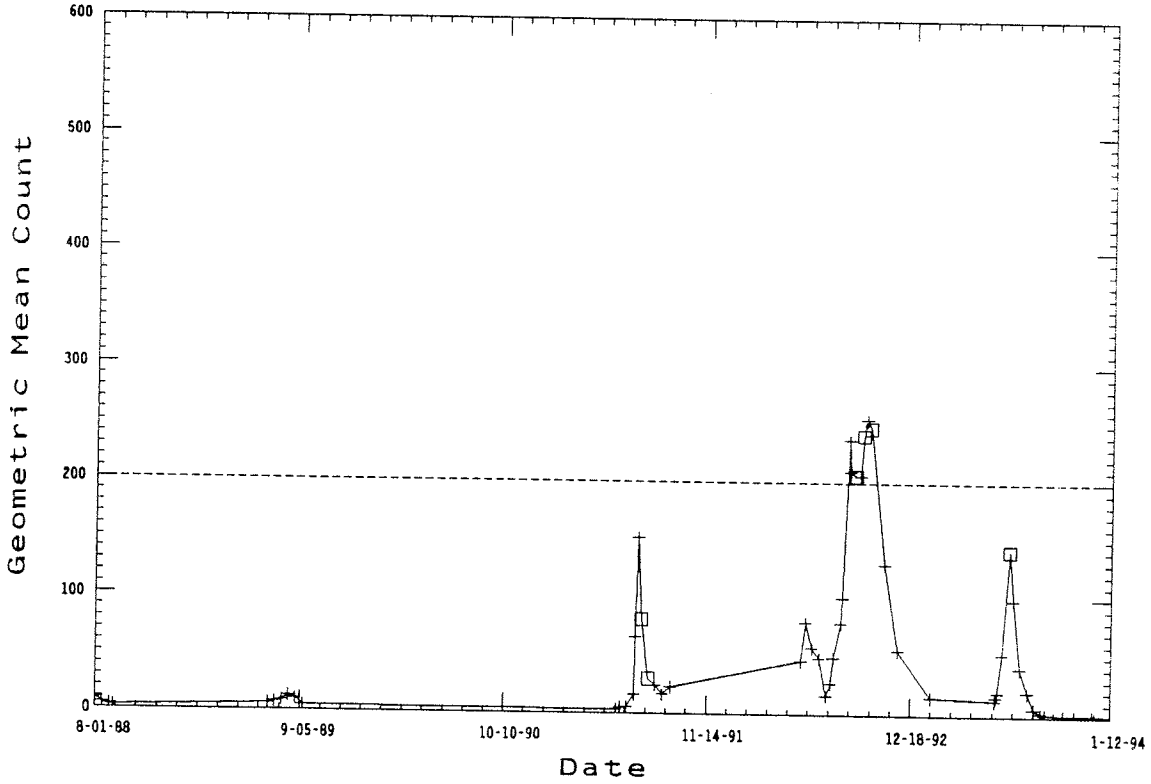
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of UBB1 Over 1955 Days



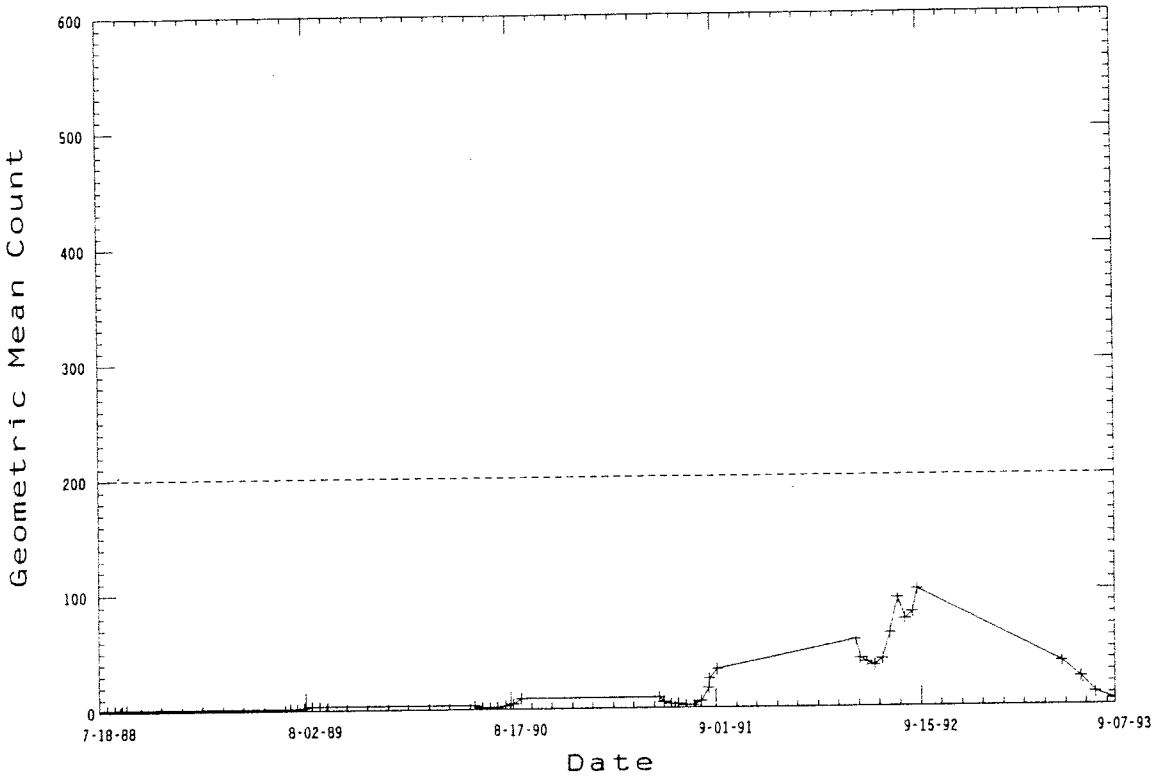
+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of UBB2 Over 1990 Days

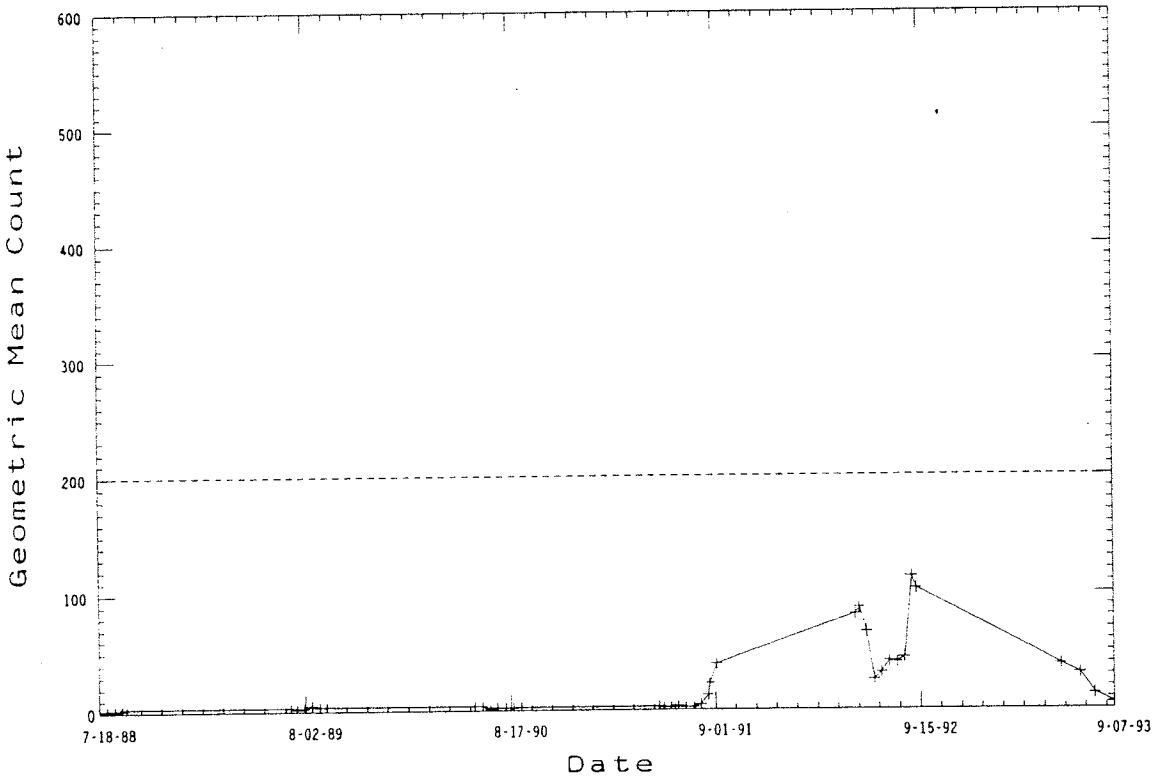


+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

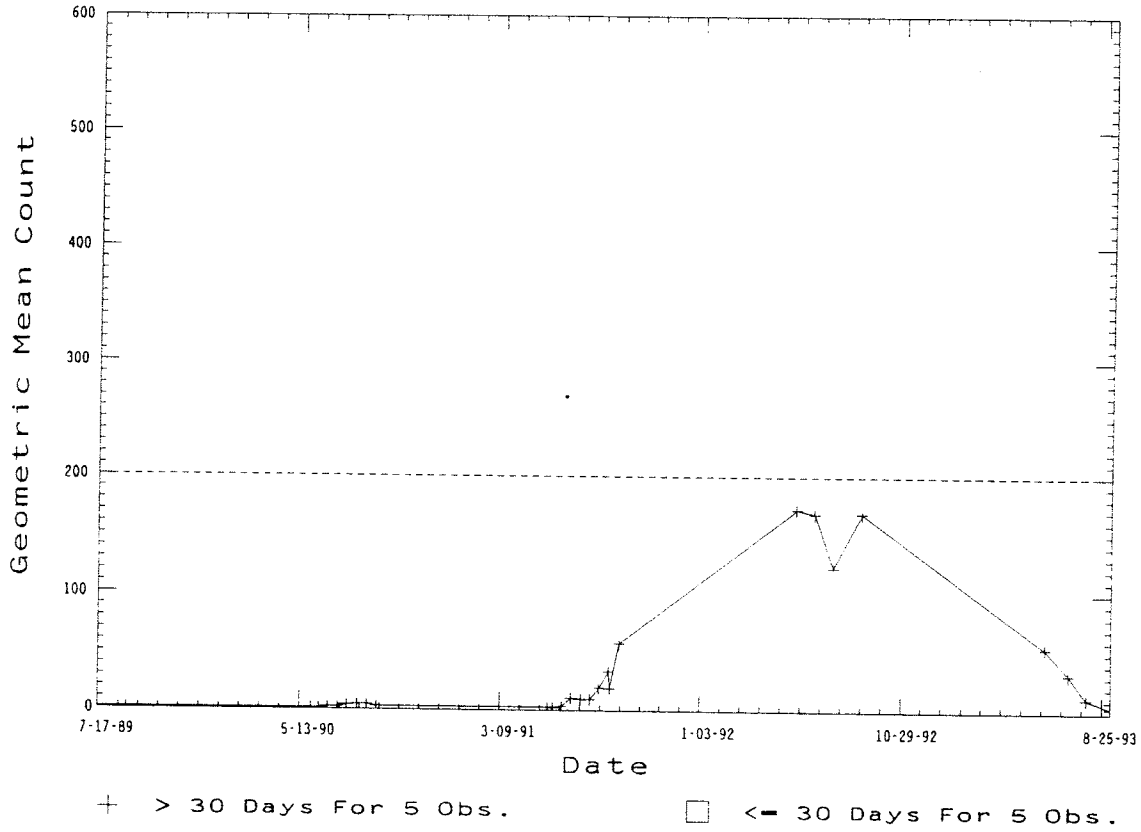
Running Geometric Mean of WCB1 Over 1877 Days



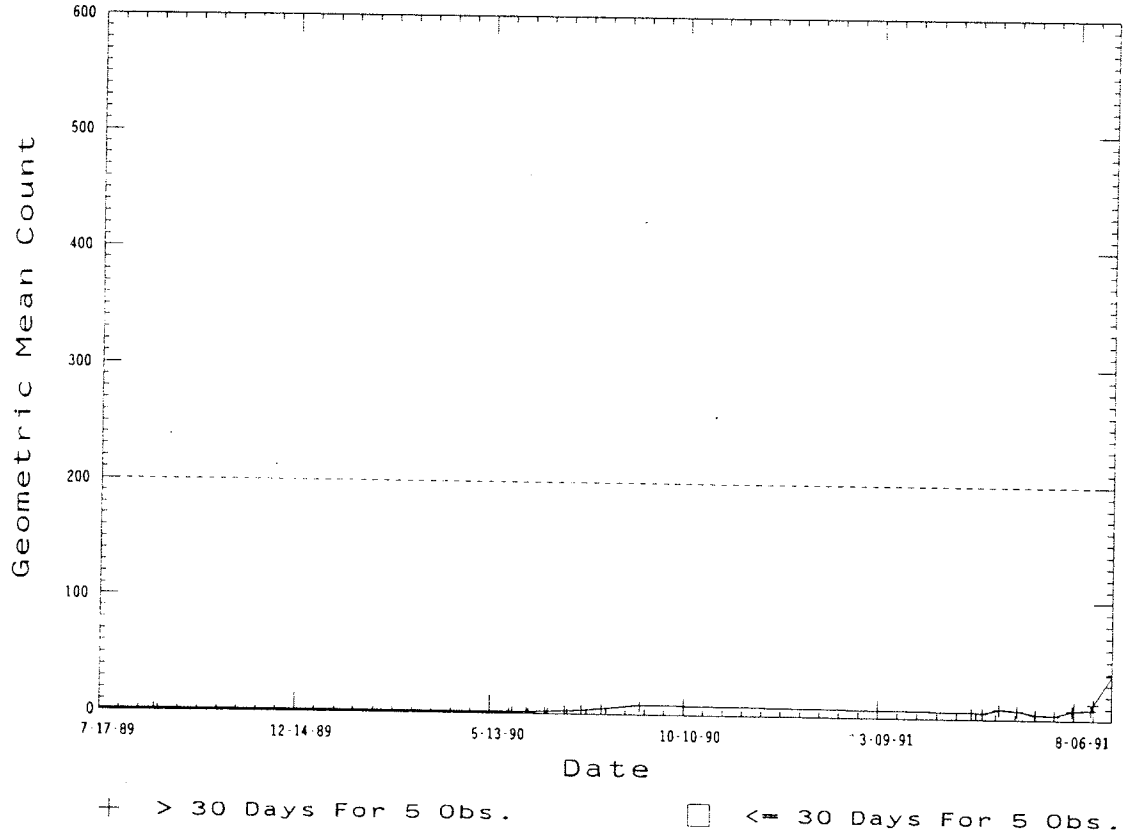
Running Geometric Mean of WCB2 Over 1877 Days



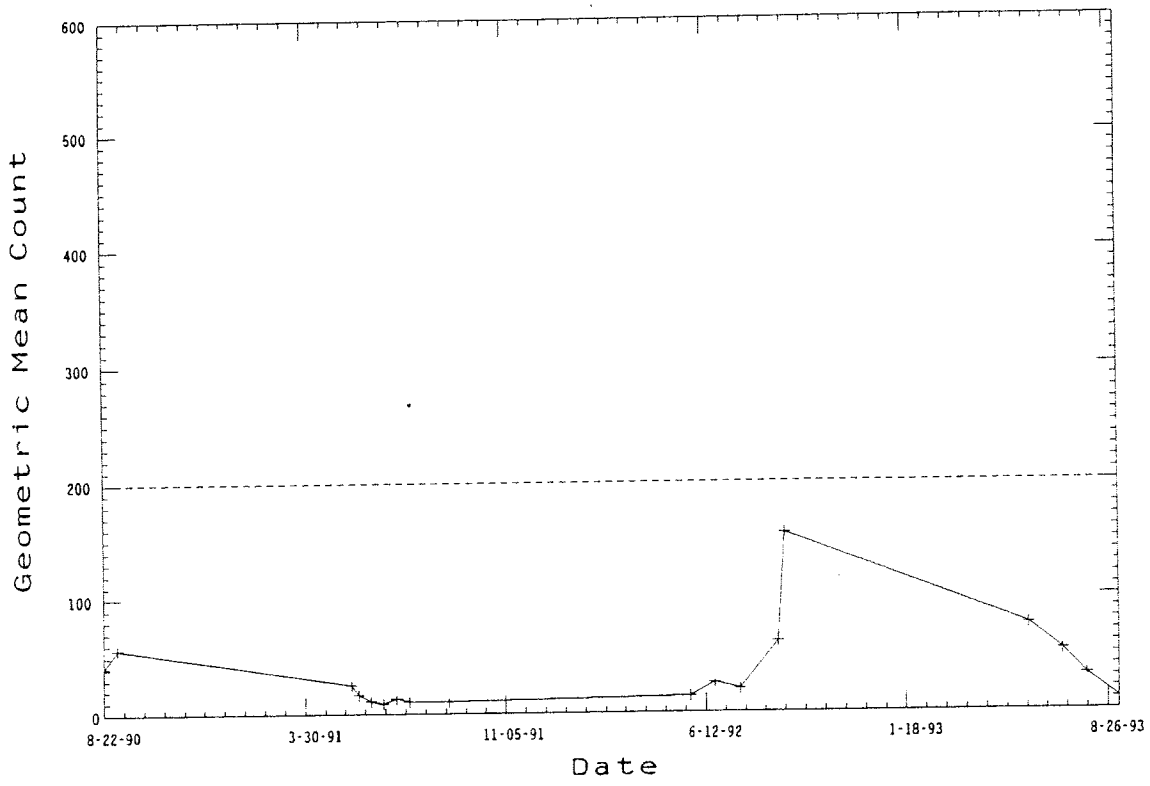
Running Geometric Mean of WCCA1 Over 1513 Days



Running Geometric Mean of WCCA2 Over 779 Days

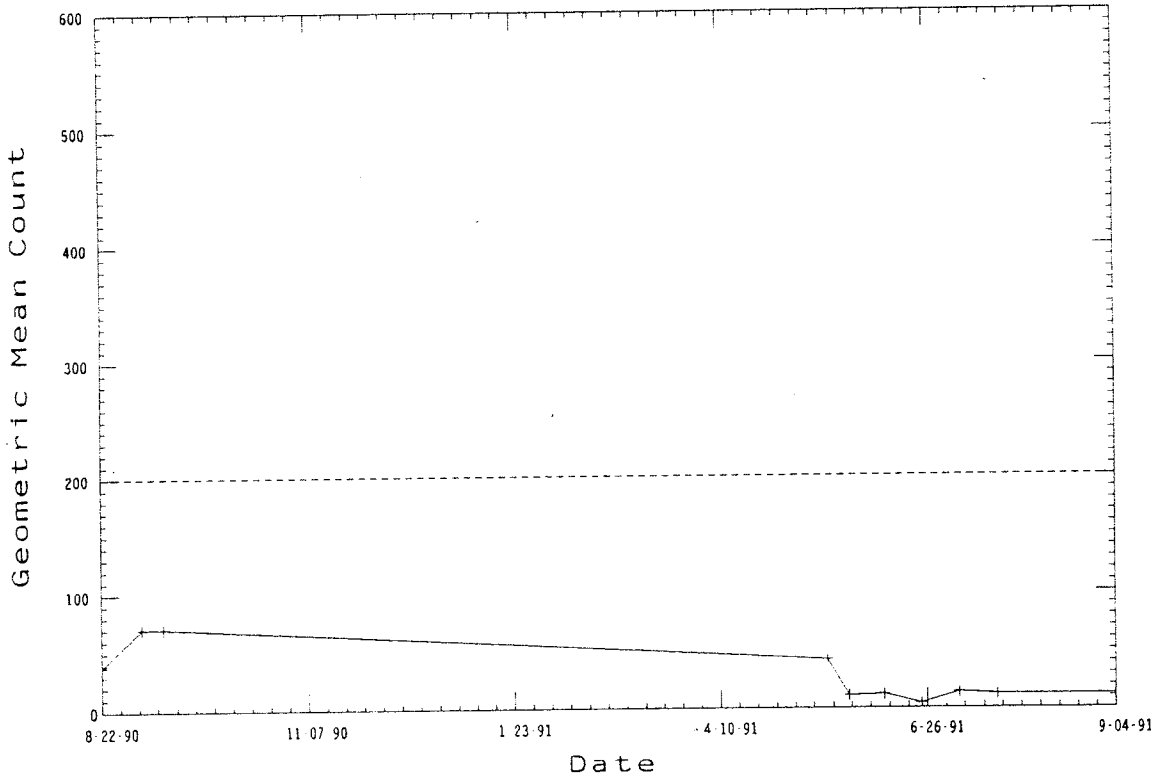


Running Geometric Mean of WIL1 Over 1112 Days



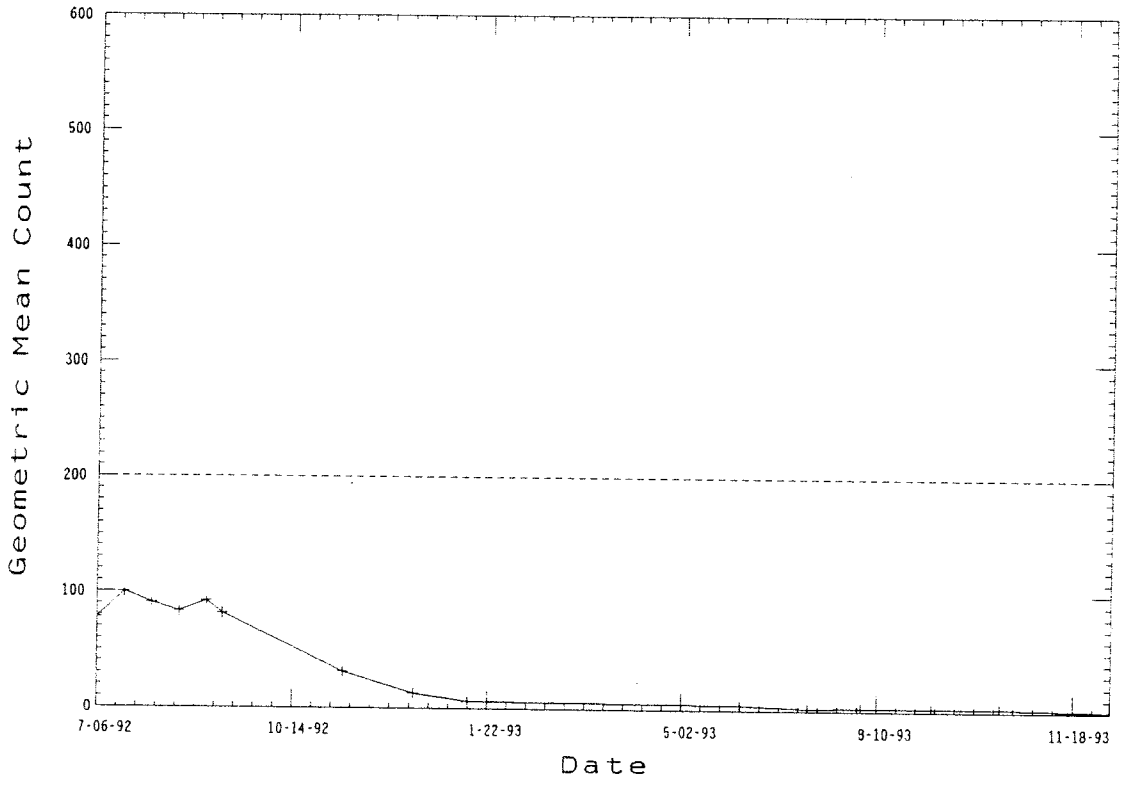
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of WIL2 Over 378 Days

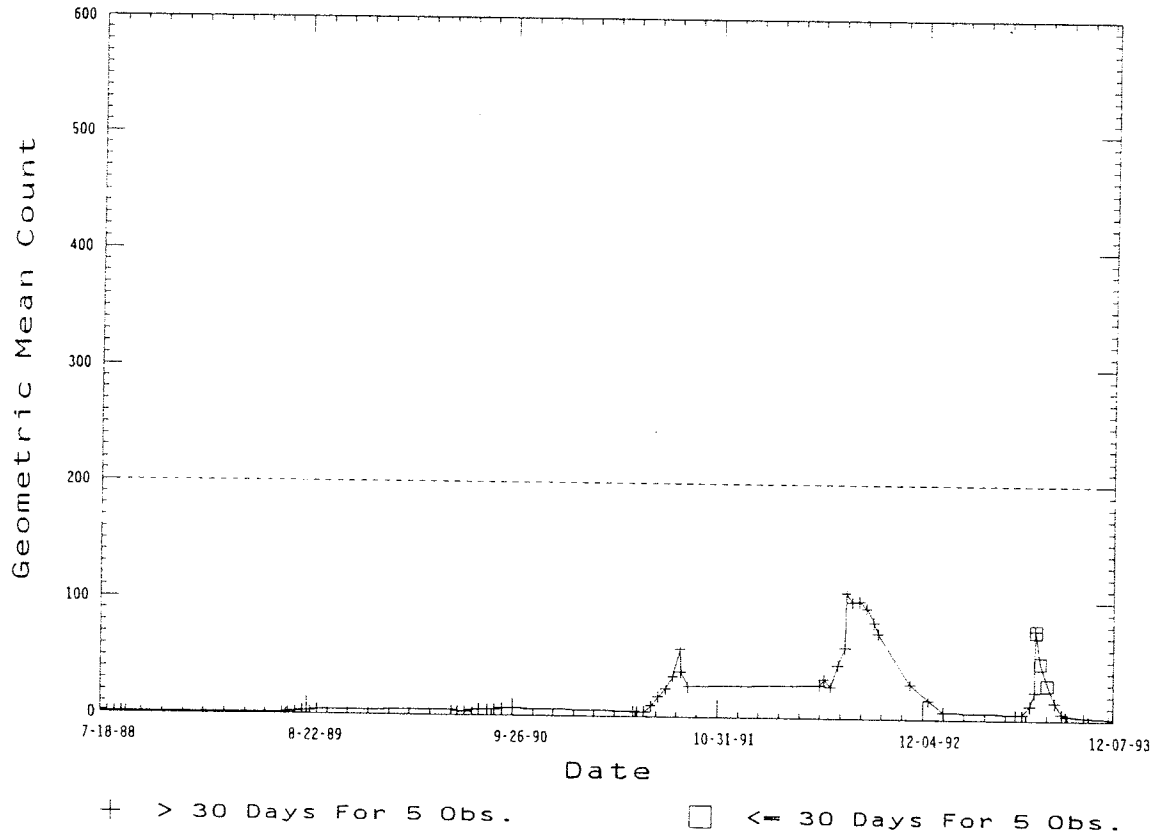


+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

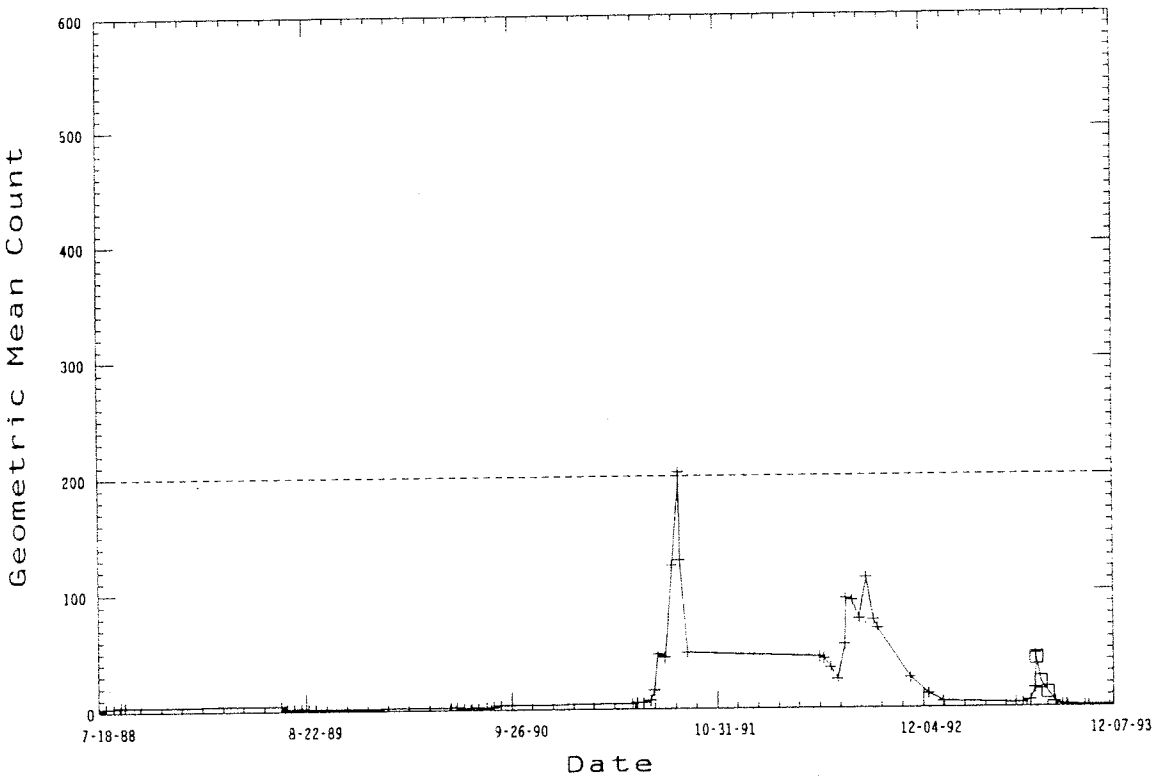
Running Geometric Mean of WWB Over 519 Days



Running Geometric Mean of WWLB1 Over 1968 Days

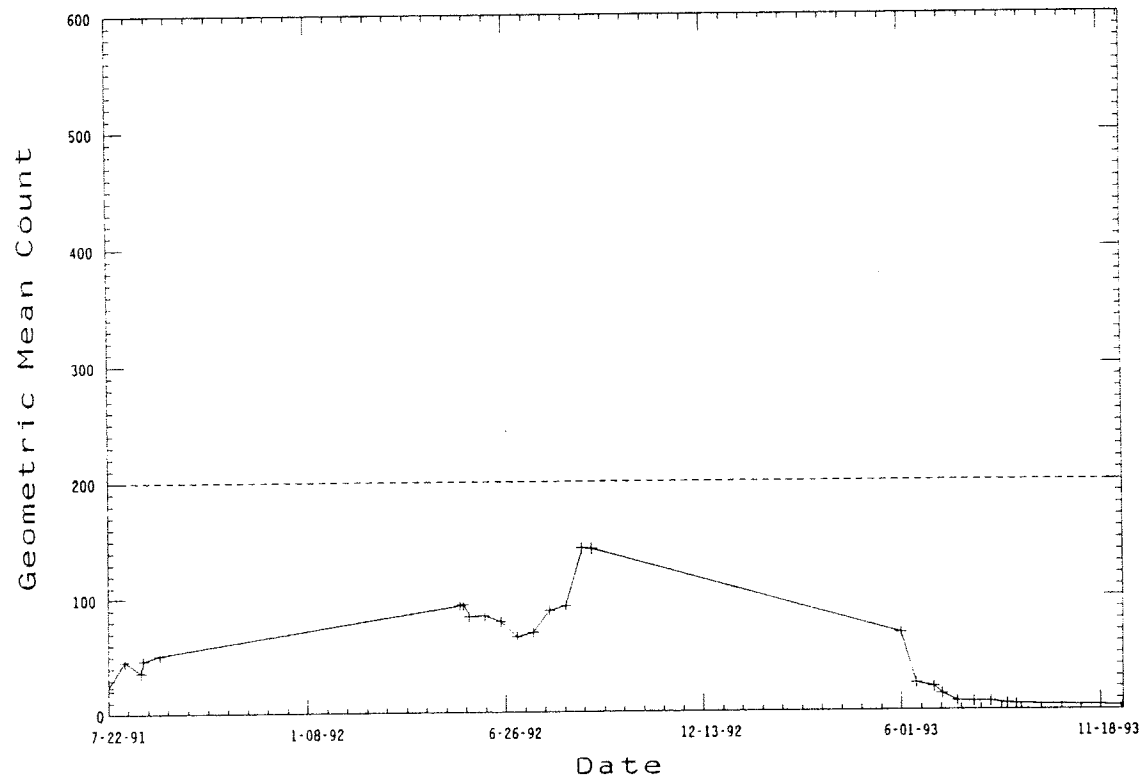


Running Geometric Mean of WWLB2 Over 1968 Days



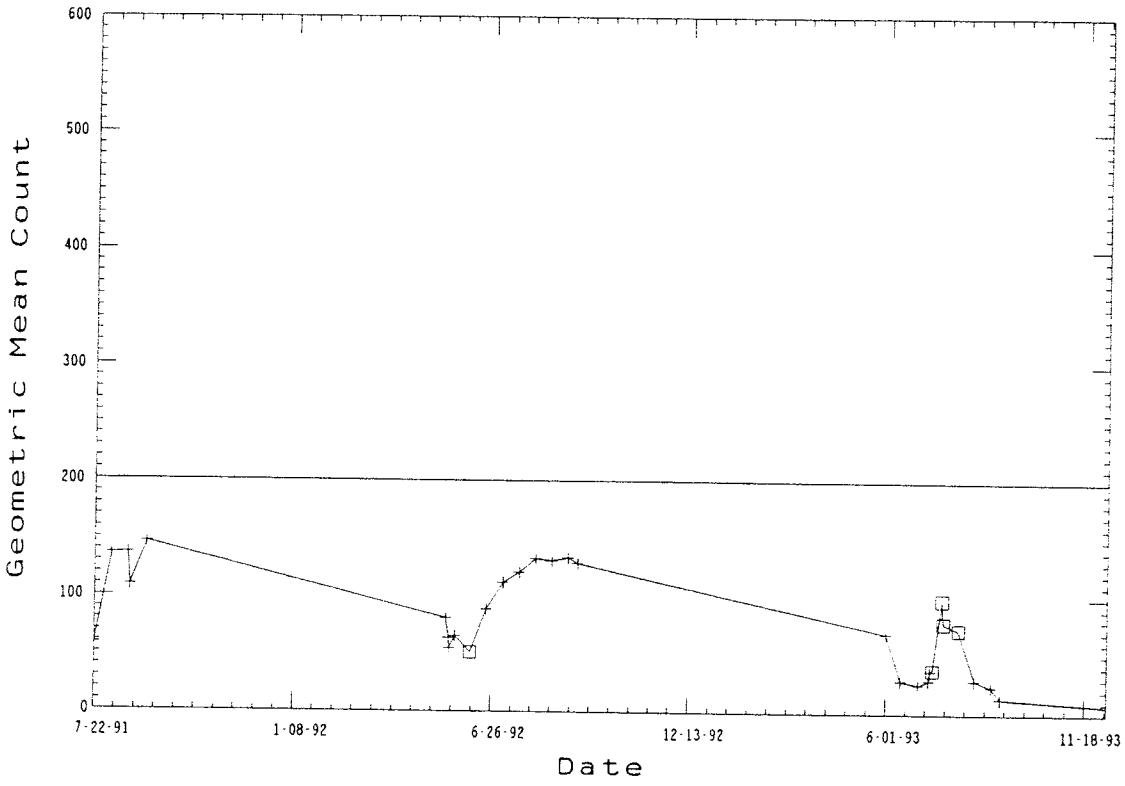
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of WWM1 Over 869 Days



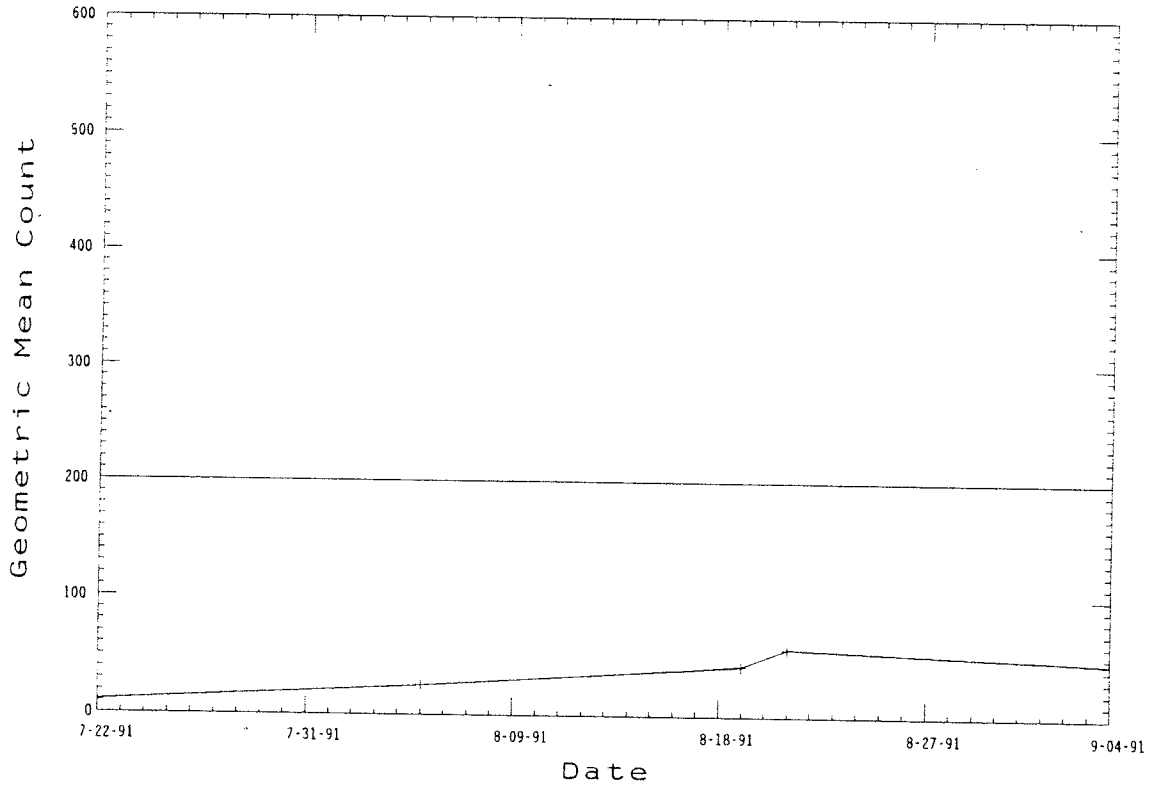
+ > 30 Days For 5 Obs. ☐ <= 30 Days For 5 Obs.

Running Geometric Mean of WWM2 Over 869 Days



+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Running Geometric Mean of WWM3 Over 44 Days



+ > 30 Days For 5 Obs. □ <= 30 Days For 5 Obs.

Appendix H

Utah and Arizona

Water Quality Standards

Utah Water Quality Standards

Lake Powell is classified as 1C, 2A, 2B, 3B, and 4.

These classifications are defined as follows:
Class 1C: Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Department of Health.
Class 2A: Protected for primary contact recreation such as swimming.
Class 2B: Protected for secondary contact recreation such as boating, wading, or similar uses.
Class 3B: Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.
Class 4: Protected for agricultural uses including irrigation of crops and stock watering.

The water quality standards for parameters measured at GLCA are as follows:

Parameter	Class			
	1C	2A, 2B	3B	4
Maximum water temperature			27 °C	
Maximum water temperature change			4 °C	
Turbidity increase		10 NTU [1]	10 NTU	
Fecal coliform	2,000/100 mL [2]	200/100 mL [2]		
Fecal streptococcus	There are no standards for fecal streptococcus			

[1] Nephelometric Turbidity Units
[2] Based on a 30-day geometric mean

Lake Powell is classified as aquatic and wildlife - cold water fishery (A&Wc), full body contact (FBC), domestic water source (DWS), fish consumption (FC), agricultural irrigation (AgI), and agricultural livestock watering (AgL).

These classifications are defined as follows:
A&Wc: The use of a navigable water by animals, plants or other organisms, including salmonids, for habitation, growth or propagation.
FBC: The use of a navigable water which causes the human body to come into direct contact with the water to the point of complete submergence. The use is such that ingestion of the water is likely to occur and certain sensitive body organs, such as the eyes, ears or nose may be exposed to direct contact with the water.
DWS: The use of a navigable water as a potable water supply. Coagulation, sedimentation, filtration, disinfection of other treatments may be necessary to yield a finished water suitable for human consumption.
FC: The use of a navigable water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to fish, clams, turtles, crayfish and frogs.
AgI: The use of a navigable water for the irrigation of crops.
AgL: The use of a navigable water as a supply of water for consumption by livestock.

The water quality standards for parameters measured at GLCA are as follows:

Parameter	Classification					
	A&Wc	FBC	DWS	FC	AgI	AgL
Maximum water temperature						
Maximum water temperature change	1.0 °C					
Maximum turbidity	10 NTU[1]	25 NTU				
Fecal coliform	1000/100 mL[2] 2000/100 mL[3] 4000/100 mL[4]	200/100 mL[2] 400/100 mL[3] 800/100 mL[4]	1000/100 mL[2] 2000/100 mL[3] 4000/100 mL[4]		1000/100 mL[2] 2000/100 mL[3] 4000/100 mL[4]	1000/100 mL[2] 2000/100 mL[3] 4000/100 mL[4]
Fecal streptococcus						

[1] Nephelometric Turbidity Units
[2] 30-day geometric mean (5 sample minimum)
[3] 10 percent of samples for a 30-day period
[4] single sample maximum

As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The Department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

NPS D-169 July 1995