Ohio 2010 Integrated Report

Section F

Evaluating Beneficial Use: Recreation

F1. Background

Prior to the 2002 Integrated Report (IR), the reporting of recreation use impairment in Ohio was sporadic. Section 305(b) reports (1998 and earlier) may have included an indication of the potential for recreation use impairment in various streams, but a cohesive listing was not presented. The 2002 IR employed a uniform methodology to examine readily available data on fecal coliform counts. This approach was based on counting the number of exceedances of the secondary contact recreation use maximum criterion [5000 colony forming units (cfu)/100 ml fecal coliform or 576 cfu/100 ml *Escherichia coli (E. coli)]*. Any assessment unit with five or more samples over the last five years above these values was listed as having an impaired recreation use.

The 2004 IR adopted a more statistically robust methodology for assessing the recreation use attainment of the State's surface waters linked more directly to the applicable water quality standards. The methodology adopted in 2004 continued to be used through the 2008 IR. The 2008 IR also included a preview of changes anticipated at the time for the 2010 report based on the expectation that the watershed assessment unit (WAU) would change from a larger watershed size (11-digit hydrologic unit) to a smaller watershed size (12-digit hydrologic unit) and on four anticipated revisions to the water quality standards: 1) dropping the fecal coliform criteria; 2) creation of a tiered set of classes of primary contact recreation waters based on recreation use intensity; 3) revision of the geometric mean averaging period; and 4) extension of the recreation season. Revisions to the water quality standards pertaining to the recreation use were adopted on December 15, 2009. The linkage of the methodology to the Ohio WQS is summarized in Table F-1 and subsequent text.

Table F-1. Summary of the recreation use assessment methods.

Bathing Waters		
Indicator	Criterion (Table 7-13, OAC 3745-1-07)	Assessment Method Summary
E. coli	Seasonal geometric mean *E. coli* content* based on samples from the recreation season within a calendar year is 126 cfu/100 ml; single sample maximum is 235 cfu/100 ml.	Applied to the three Lake Erie shoreline assessment units, exceedance of the geometric mean bathing water criterion or an exceedance of the single sample maximum for more than 10% of the recreation season is considered an impairment of the bathing water use.
Primary Contact and Secondary Contact		
Indicator	Criterion (Table 7-13, OAC 3745-1-07)	Assessment Method Summary
E. coli	Seasonal geometric mean *E. coli* content* based on samples from the recreation season within a calendar year is: Primary Contact Waters Class A: 126 cfu/100 ml Class B: 161 cfu/100 ml Class C: 206 cfu/100 ml Secondary Contact Waters 1030 cfu/100 ml	Applied to streams and inland lakes. Data from a recreation season are assessed on a site-by-site basis and compared to the applicable geometric mean *E. coli* criterion whenever more than one sample result is available for a watershed assessment unit. Assessment units are considered to be in full attainment if all sites assessed within the assessment unit meet the applicable geometric mean criterion and in non-attainment if one or more sites assessed within the assessment unit exceed the applicable geometric mean criterion.

* *E. coli* concentrations are expressed in colony forming units (cfu) per 100 milliliters (ml)

F2. Evaluation Method

Lake Erie (Shoreline)

Attainment of recreation water quality standards for the three Lake Erie assessment units (AUs) was based upon examination of *E. coli* data from public bathing beaches provided by the Ohio Department of Health (ODH). Routine bacteria monitoring is performed by local health districts, ODH, and the Northeast Ohio Regional Sewer District (NEORSD) in order to monitor bacteria levels at public bathing beaches and advise the public when elevated bacteria are present that represent an increased risk of contracting waterborne illness as a result of exposure to pathogens while recreating in the water. Since 2006, beach advisory recommendations have been based upon exceedance of the single sample maximum *E. coli* criterion of 235 cfu/100 ml, consistent with provisions of the 2004 federal BEACH Act rule as well as the *E. coli* criterion applicable for bathing waters in Ohio's water quality standards. Bacteria data collected by local or state health agencies at public beaches during the recreation season from 2004 through 2008 were included in the analysis. Ohio's water quality standards define the recreation season as May 1 through October 31, though Lake Erie beach monitoring typically is focused between Memorial Day and Labor Day weekends.

Each of the 23 public beaches (shown in Figure F-1) was individually analyzed to evaluate the percentage of recreation days during which the bathing water single sample maximum criterion of 235 cfu/100 ml was exceeded since this is the criterion used by health departments to post a health advisory at a given beach. The frequency of beach advisory postings is a direct measure of recreation use impairment, since potential users may often be discouraged from utilizing a beach on days when a health advisory is posted.

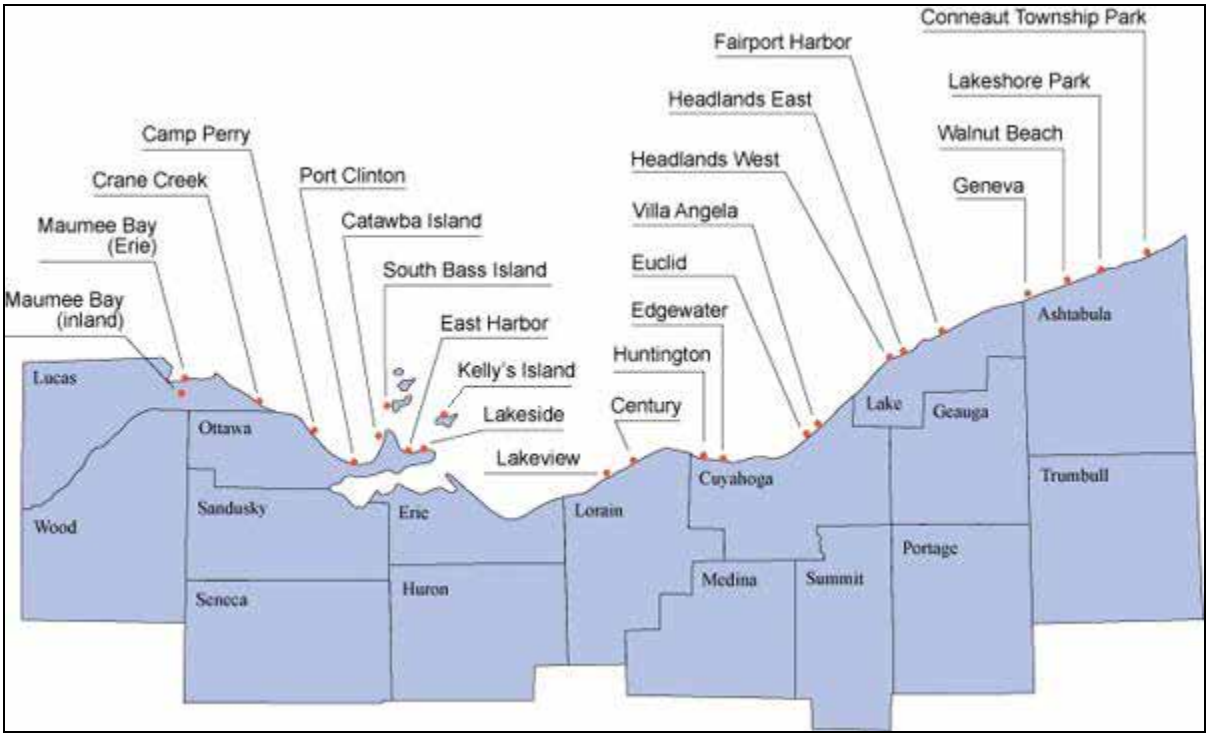

Figure F-1. Lake Erie public beaches sampled under Ohio's bathing beach monitoring program.

The total number of recreation days in a recreation season for any particular beach was determined by adding the number of days beginning with the first day of sampling and ending with Labor Day, or the date the final sample was collected (whichever was later). The total number of days that a beach exceeded the single sample maximum *E. coli* criterion of 235 cfu/100 ml during the recreation season (as defined above) was tallied. A measured exceedance was assumed to continue until a subsequent sample documented that the criterion was not being exceeded. Similarly, a beach was presumed to meet the criterion following a measurement that met the criterion until a subsequent sample was found to exceed the criterion. Sampling frequency varied from year-to-year and from beach-to-beach. A sampling frequency of four times per week was typical, though some beaches were sampled daily while the two beaches in the Lake Erie island assessment unit were sampled only once per week.

The exceedance frequency of the bathing water criterion was determined for each beach over a five-year period (2004-2008) on an annual basis. Results for each individual beach were sorted into the corresponding Lake Erie recreation assessment unit for the purpose of determining the attainment status of each of the three Lake Erie assessment units. The assessment status for each Lake Erie AU was based upon whether the frequency of exceedance of the single sample maximum *E. coli* criterion was greater than 10% as described in the Table F-2 below.

Table F-2. Determining assessment status of Lake Erie shoreline AUs.

Lake Erie AU Assessment Status	Attainment Status of Individual Beaches
Full	Frequency of advisory postings less than 10% of recreation season for all of the beaches in the AU for all years assessed
Non	Frequency of advisory postings more than 10% of recreation season for one or more of the beaches in the AU for one or more of the years assessed

A 10% exceedance frequency has been used as the threshold for attainment determination in the last three assessment cycles and has its origins in the water quality standards as well as Ohio's 1998 State of the Lake Report prepared by the Ohio Lake Erie Commission (Ohio LEC, 1998). While the stated goal in the State of the Lake report for beaches is to have clean beaches all of the time (no days under advisement), the report considered having ten or fewer days under advisement to be "excellent" (note that ten days translates to 10% of the season based on a 100-day season). The Ohio Lake Erie Commission's latest edition of the State of the Lake Report (Ohio LEC, 2004) continues to use these benchmarks in rating the swimmability of Lake Erie beaches along Ohio's 262-mile shoreline. The 2010 IR also continues to use these criteria in determination of impairment at the assessment unit level. In addition, statistical summaries are included in Table F-1 for individual beaches to provide additional detail and allow performance comparisons among individual beaches.

Rivers and Streams

The 2010 recreation use impairment list was developed using ambient *E. coli* data collected from May 2004 through October 2008 by Ohio EPA. Previous integrated reports also used ambient bacteria data collected by point source dischargers (801 upstream and 901 downstream station data) as part of their NPDES monitoring requirements and reported to Ohio EPA. However, because of the recent adoption of the *E. coli* criteria into Ohio's water quality standards, NPDES dischargers have not yet begun to monitor for *E. coli* and therefore no discharger *E. coli* data were available for use in the 2010 recreation use analysis. Ohio EPA anticipates that some *E. coli* data will be available from NPDES dischargers for the 2012

Integrated Report as monitoring for *E. coli* is phased into NPDES permit monitoring requirements.

Approximately 10,400 *E. coli* bacteria records were used in the analysis. Data were sorted into their respective 12-digit watershed assessment units (WAUs) and large river assessment units (LRAUs) using a geo-spatial analysis of the latitude/longitude data (and other geographical data if needed) associated with each *E. coli* value. Data within a WAU were further sorted by sampling location and date (calendar year) on which they were collected.

Site-by-Site Analysis

Recreation use assessment determinations for rivers and streams are based on the following two-step process. First, *E. coli* data from each site were compared to the geometric mean *E. coli* criterion applicable to the particular site, considering the recreation use and class (for PCR). The geometric mean was calculated using the "geomean" function in Microsoft Excel 2007® on a site-by-site basis using the pooled dataset of all *E. coli* data (minimum of two data points required) from the site during a single recreation season. When data were available for multiple recreation seasons, the data from each season were independently analyzed for each recreation season to determine the geometric mean for each season.

Data collected outside of the recreation season, as defined in Ohio's WQS (May 1st through October 31st), were excluded from the analysis. Certain qualified values, such as sample results indicated to have exceeded proper holding time or those that have otherwise been indicated to have significant quality assurance deficiencies, were also excluded from the analysis. Values reported as "too numerous to count" ("TNTC") were used in the analysis when it was possible to estimate a value based on the dilutions used and/or the maximum reporting limits. Values reported as "greater than" were also used in the analysis. A geometric mean calculated using one or more "greater than" or "TNTC" values in the data set was reported as a "greater than" geometric mean. Values reported as "less than" values of greater than 50 were excluded since acceptable test methods can detect much lower concentrations when appropriate dilutions are used in the analysis. Values reported as less than 50 or less were used in the analysis. The value used in statistical analysis was one-half the reported "less than" value. A value of one was substituted for the purpose of computing the geometric mean in any case where a value of less than one was reported. Geometric means cannot be calculated using data sets that contain a value of zero. Results from duplicate B were used for calculation of the geometric mean in cases where duplicate sample results were reported, except if the *E. coli* densities of the duplicate samples were more than 5x apart from one another, in which case both values were rejected.

Assessment Unit Analysis

In the second step of the analysis, the assessment status of the WAU or LRAU was determined based on the attainment status of all the individual sites within the assessment unit and within the assessment period (2004-2008) as described in Table F-3 below.

Table F-3. Determining assessment status of WAUs and LRAUs.

AU Assessment Status	Attainment Status of Individual Locations
Full	Sufficient data exist to calculate a geometric mean for at least one location within the WAU (or a minimum of one site for every ~5-7 river miles of a LRAU); applicable geometric mean(s) attain applicable geometric mean criterion at all assessed sites within the AU
Non	Sufficient data exist to calculate a geometric mean for at least one location within the WAU (or a minimum of one site for every ~5-7 river miles of a LRAU); geometric mean(s) exceed applicable geometric mean criterion at one or more assessed sites within the AU
Insufficient Data	Insufficient data to calculate a geometric mean for any site within the WAU (or for a minimum of one site for every ~5-7 river miles of a LRAU)

Inland Lakes

Inland lakes were assessed in a manner similar to that described above for the rivers and streams. Inland lake data were analyzed on a site-by-site basis, with each resulting geometric mean values compared to the geometric mean criterion applicable to each site. Lake sampling locations generally included a beach and/or open water location, with 5-9 samples per location. Inland lakes are considered a component of the assessment unit(s) in which they are geographically located, so sample results may affect the assessment status of the AU(s) and the index scores for the AU(s).

The Ohio Department of Natural Resources, as part of Ohio's Bathing Beach Monitoring Program, monitors *E. coli* levels during the summer at public beaches of lakes located in state parks. While Ohio EPA was unable to establish the level of credibility of these data for use in official listing determinations for this report, a summary of the advisory postings for the 67 beaches monitored in the program is included. Though similar to the beach monitoring program along Lake Erie, there are several differences. Notably, the sampling frequency is much lower at the inland lake beaches compared to the Lake Erie beaches as a result of funding disparity. Secondly, because of the large geographic area, beach samples from inland lakes are analyzed by a multitude of consulting labs across the state.

Recreation Use Attainment Index Score

The recreation use attainment index score provides a way to compare the relative difference between the *E. coli* concentrations at sites sampled within an assessment unit and the recreation use geometric mean criterion that applies to each of the sampled sites. Those assessment units having *E. coli* concentrations that tended to be much greater than the applicable criteria had the lowest scores, while those assessment units having *E. coli* concentrations that attained the applicable criteria, or tended to only slightly exceed the applicable criteria, had the highest scores.

An index score was assigned for each site having sufficient data to calculate a geometric mean (i.e., two or more samples) by comparing the geometric mean *E. coli* concentration at the site to the applicable geometric mean criterion based on the scale depicted in Table F-4.

Table F-4. Recreation index score matrix.

Site Geometric Mean	Index Score
Meets criterion	100
Exceeds up to 2x criterion	75
Exceeds more than 2x up to 5x criterion	50
Exceeds more than 5x up to 10x criterion	25
Exceeds more than 10x criterion	0

An average index score was computed for assessment units with multiple site index scores based on data from multiple sites and/or recreation seasons. Index scores are reported in Table F-11 for the LRAUs. When only one site index score was available for an assessment unit, that index score was used to represent the assessment unit. The index score for the assessment unit is based upon the same scale as described above for the index score for a particular site.

F3. Results

Using the methodology outlined in the previous section and available *E. coli* data collected at 23 public beaches along Ohio's Lake Erie shoreline (6,330 samples); at hundreds of locations from Ohio's rivers and streams (10,414 samples) including ten of Ohio's largest rivers; and for the first time, from nine of Ohio's inland lakes (90 samples); results for the recreation use attainment analysis are presented in this section. Samples used in this analysis were collected from 2004 through 2008 during the recreation season of May 1 – October 31. More detailed recreation use statistics are provided at http://www.epa.ohio.gov/dsw/tmdl/2010IntReport/index.aspx.

F3.1 Lake Erie Public Beaches

Information about water quality conditions at Lake Erie public bathing beaches is summarized in Tables F-5 through F-8 and Figure F-2. The location of these beaches is shown in Figure F-1. The methodology used for assessing the beaches along Ohio's Lake Erie shoreline is unchanged from the 2008 report.

Table F-5 contains the seasonal geometric mean *E. coli* levels at each of Ohio's 23 public beaches along Lake Erie for the past five recreational seasons (2004-2008). The seasonal geometric mean *E. coli* criterion for bathing waters was exceeded at two beaches in 2006, three beaches in 2007, and six beaches in 2008. Only two beaches exceeded the seasonal geometric mean bathing water criterion for three consecutive years – Euclid and Villa Angela. Not surprisingly, these two beaches had the most days under swimming advisory in 2006 and 2007, and among the most in 2008.

Highlighted cells in Table F-5 indicate impairment of the recreation use at a given beach in a given year. The table also indicates the number of beach advisories for each beach based upon the two following criteria:

1. Comparison of the five sample rolling geometric mean to Ohio's geometric mean *E. coli* criterion for beaches (126 cfu/100 ml) was used by the Ohio Department of Health and local health departments to trigger the issuance of beach advisories through 2005.
2. Ohio began using the single sample maximum *E. coli* criterion for beaches of 235 cfu/100 ml to trigger the issuance of beach advisories in 2006. This change was made to comply with

the federal BEACH Act rule (*Water Quality Standards for Coastal and Great Lakes Recreation Waters*, 69 FR 67217, November 16, 2004), which became effective on December 16, 2004.

In Table F-6, the beaches are arranged alphabetically according to the Lake Erie assessment unit in which they are geographically located. The table indicates the number of days (and the percentage for all years) when Ohio's Lake Erie public beaches exceeded Ohio's bathing water single sample maximum criterion compared to the total number of days in the recreation season sampling period.

As depicted in Figure F-2, the frequency with which individual beaches were recommended for a swimming advisory based on elevated bacteria levels above the state water quality standards ranged from 0% at several beaches to near 90% of the 2004 recreation season at Lakeview beach. Considerable variation in the frequency of advisories was observed between beaches. However, several beaches stand out as consistently good performers over the last five recreation seasons, including Catawba, Conneaut, Crane Creek, East Harbor, Fairport, Geneva, Headlands East, Headlands West, Kelly's Island, Lakeside, Port Clinton, South Bass Island, and Walnut Beach. These beaches infrequently exceeded the goal of fewer than 10 days per season under advisement. There were also several beaches that performed poorly on a consistent basis with two or more of the last five seasons under advisement for more than one-third of the season, including Edgewater, Euclid, Lakeshore, Lakeview, and Villa Angela beach.

High variation in bacteria levels was also seen between seasons for some beaches. For example, Lakeview beach was under advisement for 11 days in 2007, but under advisement for 44 days in 2008. On average, bacteria levels were higher at Ohio's Lake Erie public beaches in 2008 (average 18 days) compared to 2006 and 2007 (average 15 days). Seven of the 23 public beaches monitored in 2008 met the goal of ten or fewer days in the recreation season recommended for an advisory posting, compared to eleven beaches in 2007 and eight of the beaches in 2006.

Impairment of the bathing water recreation use was determined by pooling data from beaches in each of the three Lake Erie assessment units and calculating the percentage of days in the recreational season when the *E. coli* criterion was exceeded. A threshold of impairment was set at 10 days per season based upon the Ohio Lake Erie Commission's evaluation system (Ohio LEC, 1998). This translates to a seasonal exceedance frequency of 10%, as the recreation season at Lake Erie's beaches in Ohio typically runs from Memorial Day weekend through Labor Day weekend. Results are shown in Table F-7. Results exclude data from the three Lake County beaches (Headlands-East, Headlands-West, and Fairport Harbor) since the data could not be verified as level 3 credible data. Only data considered to be level 3 credible data under Ohio's credible data rules can be used for official use support determinations in the Integrated Report. The Lake County beach data are used for informational purposes.

Table F-5. Seasonal geometric mean *E. coli* levels at Ohio's 23 public beaches along Lake Erie.

Beach	2004			2005			2006		2007		2008	
	Seasonal geomean	# of days posted		Seasonal geomean	# of days posted		Seasonal geomean	# of days posted	Seasonal geomean	# of days posted	Seasonal geomean	# of days posted
		5-day	SSM		5-day	SSM		SSM		SSM		SSM
Catawba Island	17	9	12	8	0	6	9	8	10	8	8	1
Century	37	7	16	35	6	11	35	10	23	2	196	53
Camp Perry	45	14	17	63	29	30	93	27	188	50	88	34
Conneaut	50	12	18	28	4	15	28	16	16	4	29	14
Crane Creek	28	0	2	33	7	9	92	21	31	8	n/a	n/a
Edgewater	59	9	11	63	6	18	81	21	100	38	157	37
East Harbor	18	0	1	8	0	7	11	4	23	12	10	0
Euclid State Park	82	30	19	34	7	16	148	52	347	66	182	51
Fairport Harbor	47	13	10	38	11	18	53	8	51	22	101	23
Geneva State Park	44	10	21	34	5	18	29	14	24	4	56	21
Headlands East	30	0	13	39	0	15	69	25	32	10	50	10
Headlands West	22	0	10	26	0	15	61	24	31	8	47	13
Huntington	47	12	21	40	6	21	83	30	42	15	48	14
Kelleys Island	9	0	0	12	0	0	8	0	13	0	10	0
Lakeshore Park	97	42	39	34	5	11	64	30	69	20	231	56
Lakeside	15	0	12	17	0	9	26	14	19	10	10	5
Lakeview	399	88	58	56	14	15	25	14	44	11	138	44
Maumee - Erie	75	20	16	66	8	31	95	23	76	25	67	17
Maumee - Inland	62	21	14	71	33	24	47	10	62	20	91	18
Port Clinton	27	3	7	12	12	14	23	8	20	13	16	9
South Bass Island	3	0	0	3	0	0	4	0	4	1	7	0
Villa Angela	81	24	27	105	40	30	184	44	356	63	153	49
Walnut	16	0	5	31	0	9	37	12	21	6	23	11

Highlighted cells indicate impairment of the recreation use. Impairment is triggered by an exceedance of the geometric mean on a seasonal basis *(Seasonal geomean)*, or if the 5-sample running geometric mean (2004-2005) *(5-day)* or the single-sample maximum criteria (2006-2008) *(SSM)* are exceeded more than 10% of the time during a season. The beach season is defined for this analysis as the time *E. coli* monitoring commences, typically in late May, though the end of the Labor Day weekend. The number of days posted is determined by counting the number of days a criteria is exceeded. Days for which no monitoring data were collected are presumed to be in exceedance if the preceding day's bacteria level exceeded the criteria. Likewise, unmonitored days are presumed to be below the criteria when preceded by a monitored day that was below the criterion.

Table F-6. The number of days per season (and the percentage for all years) when Ohio Lake Erie public beaches exceeded Ohio's single sample maximum *E. coli* criterion compared to the total number of days in the sampling period, 2004 – 2008.

Beach	2004	2005	2006	2007	2008	All years (%)
Western Basin Shoreline Assessment Unit						
Camp Perry	17/98	30/98	27/91	50/85	34/95	110/478 (34%)
Catawba Island State Park	12/98	6/98	8/91	8/86	1/95	35/468 (7%)
Crane Creek State Park	2/98	9/98	21/91	8/91	n/a	40/378 (11%)
East Harbor State Park	1/98	7/98	4/91	12/85	0/93	24/465 (5%)
Lakeside	12/98	9/98	14/91	10/85	5/95	50/467 (11%)
Maumee Bay State Park (inland)	14/98	24/98	10/91	20/85	18/95	86/467 (18%)
Maumee Bay State Park (Erie)	16/98	31/98	23/91	25/85	17/95	112/467 (24%)
Port Clinton	7/98	14/98	8/91	13/91	9/95	74/495 (15%)
Central Basin Shoreline Assessment Unit						
Century Beach	16/98	11/98	10/84	2/86	53/95	92/461 (20%)
Conneaut Park	18/98	15/98	16/84	4/85	14/95	67/460 (15%)
Edgewater State Park	11/106	18/106	21/105	38/105	37/122	125/544 (23%)
Euclid State Park	19/98	16/98	52/105	66/105	51/108	204/514 (40%)
Fairport Harbor	10/105	18/105	8/105	22/105	23/105	81/525 (15%)
Geneva State Park	21/98	18/98	14/84	4/85	21/95	78/460 (17%)
Headlands State Park (East Beach)	13/105	15/105	25/105	10/115	10/106	73/536 (14%)
Headlands State Park (West Beach)	10/105	15/105	24/105	8/115	13/106	70/536 (13%)
Huntington Beach	21/106	21/105	30/98	15/105	14/106	101/520 (19%)
Lakeshore Park	39/98	11/98	30//84	20/85	56/95	156/460 (34%)
Lakeview	58/98	15/98	14/84	11/85	44/95	142/460 (31%)
Villa Angela State Park	27/106	30/106	44/105	63/104	49/109	213/530 (40%)
Walnut Beach	5/98	9/98	12/84	6/83	11/95	43/458 (9%)
Lake Erie Island Shoreline Assessment Unit						
South Bass Island State Park	0/92	0/92	0/84	1/78	0/93	1/443 (0.2%)
Kelly's Island State Park	0/86	0/92	0/84	0/78	0/93	0/439 (0.0%)

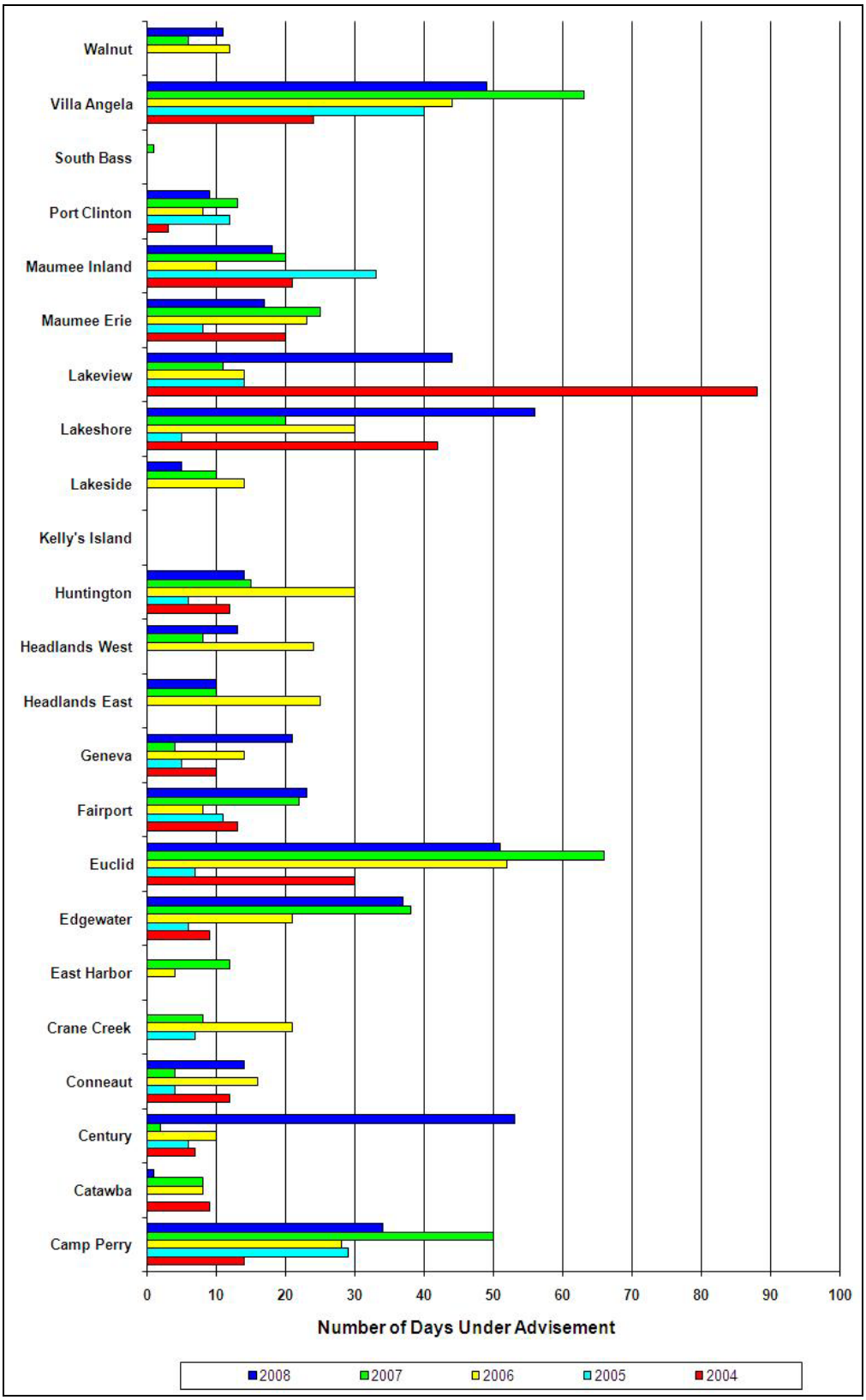

Figure F-2. Seasonal frequency of advisory postings at Ohio's Lake Erie public beaches.

Table F-7. Bathing water geometric mean *E. coli* exceedance frequency at 20[1] Lake Erie public beaches from 2004-2008 (pooled by Lake Erie assessment unit to report assessment status).

	Western Basin	Central Basin	Lake Erie Islands
Number of beaches	8	10	2
Total recreation days	3685	4867	882
Total days in exceedance	531	1221	1
Exceedance percentage	14.4%	25.1%	<0.1%
Average # of days *E. coli* criteria exceeded per beach per season [2]	13.3	24.4	0.1
Attainment status	Non attainment	Non attainment	Full attainment

[1]Excludes data from three Lake County beaches (Headlands East, Headlands West and Fairport Harbor) in the Central Basin since these data could not be determined to be level 3 credible data.
[2]Calculated by dividing the total days in exceedance in a basin by the number of beaches in the basin, then dividing that result by the number of seasons (5) from which the exceedance data were obtained.

F3.2 Rivers and Streams

Approximately 10,400 bacteria measurements were used in the 2010 recreation use attainment evaluation of streams and rivers in Ohio. As previewed in the 2008 IR, Ohio's recreation use attainment analysis is now based on an examination of *E. coli* data rather than fecal coliform data. As a result of this transition, the 2010 IR report on the recreation use attainment of streams and rivers is based on a smaller dataset, primarily because no *E. coli* ambient monitoring data were available from the NPDES dischargers in Ohio. Traditionally, the NPDES discharger monitoring data have accounted for about two-thirds of the bacteria data used in the evaluation of Ohio's recreation use analysis. However, as Ohio's revisions to the recreation use water quality standards were only recently adopted, monitoring for *E. coli* in place of fecal coliform in NPDES permits is not yet in place. This transition is expected to occur as permits are renewed.

The *E. coli* data used in this report were collected by Ohio EPA, typically as part of routine ambient monitoring associated with annual drainage basin surveys conducted around the state. Using the methodology described in Section F2, it was possible to determine the status of recreation use attainment for 31% of the WAUs. This is a reduction of about 15% compared to assessment capacity in the 2004, 2006, and 2008 Integrated Report assessment cycles (see Table F-8). The decline is not caused by a reduction in bacteria sampling conducted by Ohio EPA but instead because of changes in the methodology used in evaluating recreation use assessment. However, as previously mentioned, less data were available for the 2010 analysis compared to previous analyses as a result of the transition from fecal coliform to *E. coli* because of the lack of *E. coli* monitoring data available from NPDES dischargers. In addition, the 2010 methodology relies on a site-by-site analysis of data rather than an aggregation of data within a HUC11 watershed area. Finally, the 2010 methodology assessment units are based on HUC12s, which are much smaller and more numerous than HUC11 assessment units.

While these methodology changes make attainment determinations more locally relevant since the data likely represent a smaller geographical area and thereby provide a higher level of resolution, the changes also mean that more assessment units may not have any data available with which to make an assessment determination. In recognition of this, Ohio EPA revised its bacteria monitoring protocol in 2009 to encourage sampling strategies that provide sampling coverage of most assessment units in planned survey areas. The results of this change in monitoring strategy should be reflected in the 2012 IR with an increase in assessed areas.

Table F-8. Overall differences in the assessment of recreation use attainment, 2004 to 2010.

	2004 Report		2006 Report		2008 Report		2010 Report	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Total AUs	354	100	354	100	354	100	1576	100
Assessed	166	47	154	43	166	47	487	31
Not Assessed	188	53	200	57	188	53	1089	69
Attaining Recreation Use	56	33[a]	57	37[a]	63	38[a]	65	13[a]
Impaired Recreation Use	110	67[a]	97	63[a]	103	63[a]	422	87[a]

[a] Percentage of AUs reported as attaining the recreation use and not attaining the recreation use are based on the total AUs that were assessed (e.g., 487 in the 2010 analysis).

The overall attainment and impairment rates and the changes between reporting years are also summarized in Table F-8. Attainment and impairment rates in Table F-8 are based on the total number of watersheds for which sufficient data were available, and not on the total number of assessment units in the state. For the 487 assessment units having sufficient data available to determine the recreation use assessment status, 13% fully supported the use while 87% did not support the use. This is an apparent reduction in support of two-thirds compared to previous assessments. The reduction in recreation use support is primarily attributed to several changes in the assessment methodology, as described below, and not a decline in Ohio's water quality.

First, the 2010 assessment relies on a comparison of the applicable geometric mean criterion to the geometric mean(s) of the *E. coli* data rather than the comparison to percentiles (75th and 90th percentiles) used in previous reporting cycles. This approach allows for a direct comparison of the data to the recreation water quality standard. It also relies on the geometric mean rather than single sample maximum for making use attainment determinations for streams and rivers. The applicable recreation criteria are based on the *E. coli* indicator rather than the previously used fecal coliform indicator. Beginning with the 2009 monitoring season, Ohio EPA's ambient bacteria monitoring strategy was revised to encourage an increased number of sampling events at each location being monitored. This strategy will provide increased confidence in the geometric mean value calculated for each site based on a more robust dataset. The recently adopted revisions to the bacteria criteria make this sampling strategy more practical since the averaging period for the geometric mean is now the entire six month recreation season rather than the previous 30-day period.

Second, the 2010 assessment relies on a site-by-site analysis of *E. coli* data. Any site within an assessment unit failing to meet the applicable geometric mean *E. coli* criterion triggered a non-support determination for that assessment unit. This is in contrast to the methodology used in previous assessments, which relied upon an aggregation of bacteria data from multiple sites within the assessment unit to calculate statistics such as percentiles and geometric means for an entire HUC 11. The previous approach resulted in the determination of the "average" condition of the watershed, which could be found in full support of the use despite having individual sites in exceedance of the applicable criteria. Table F-9 demonstrates the attainment rates of the *E. coli* recreation use geometric mean criteria on an individual site basis. Attainment of the applicable geometric mean *E. coli* criterion is comparatively higher on an individual site basis as seen in Table F-9 relative to full support percentages for WAUs shown in Table F-8. Attainment rates at individual sites designated PCR Class A or Class B are roughly 2-3 times higher than full support rates for WAUs. This illustrates that some non-support WAUs do have individual sites within them that were in attainment of the applicable *E. coli* criteria.

Table F-9. Attainment of *E. coli* geometric mean criteria by site.

Recreation Use	Percentage of all sites attaining *E. coli* geometric mean
PCR Class A	44%
PCR Class B	30%
PCR Class C	15%
SCR	67%

Because assessment units can often be composed of monitoring sites having a range of *E. coli* geometric means, a recreation use index was developed to provide some differentiation between those assessment units composed of monitoring sites that greatly exceed the criteria versus those where exceedances are comparably lower. The index also serves as a useful tool in the TMDL prioritization process (see section J1.1 for more details). Index scores were assigned to those assessment units for which *E. coli* monitoring data were available to assess the recreation use attainment status as described in Section F.1 for at least one location within the WAU. Index scores range from 0-100 depending on the magnitude of exceedance of the site(s) within the AU. An index score of 100 means all sites fully attained the applicable geometric mean *E. coli* criterion, while lower scores indicate a progressively greater average level of exceedance from the criteria for monitored sites within the AU. Figure F-3 summarizes the index scores for the WAUs.

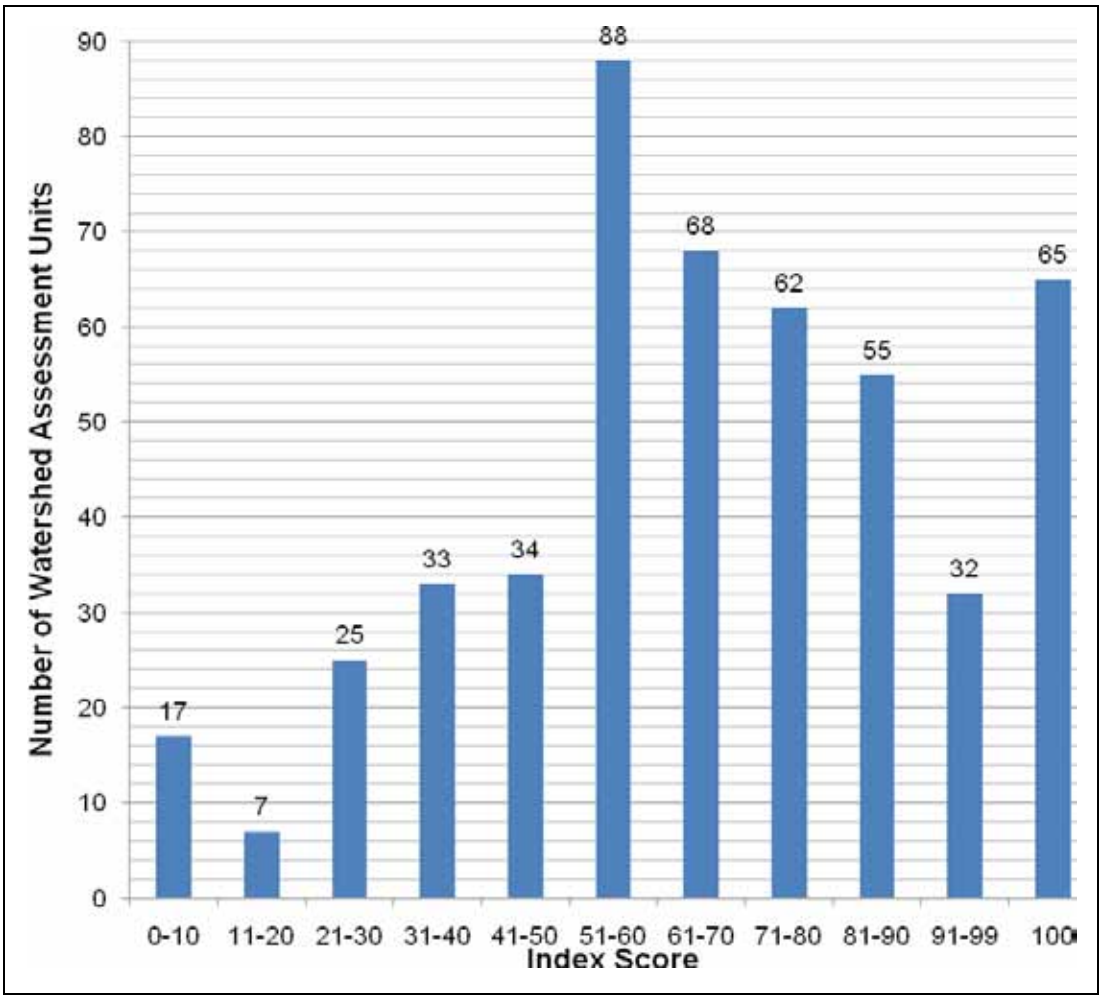

Figure F-3. Histogram of recreation use index scores for Ohio's watershed assessment units.

The recreation use attainment status of Ohio's 1,538 watershed assessment units is summarized in Table F-10. This table differs slightly from the summary presented in Table F-7 as this table accounts for those watersheds for which TMDLs have been completed and placed into category 4A.

Table F-10. Summary assessment status of the recreation use in Ohio's watershed assessment units.

Assessment Category	Number of Assessment Units Categorized	Percentage of Assessment Units Categorized
1	59	4
3	888	58
4	266	17
5	325	21
Total	1,538	100

There are also 23 large rivers in Ohio, eight of which are further divided into two or more subdivisions for a total of 38 assessment units. The large river assessment units were analyzed independently of the WAU through which they flow. Table F-11 summarizes the results of the analysis of *E. coli* data for the large river assessment units and the resulting recreation use assessment determinations. Sufficient data were available to determine the assessment status for 15 of the 38 LRAUs (40%). These LRAU subdivisions had a spatial sampling frequency of approximately every 7.5 miles or less. The LRAU with the greatest sampling intensity in terms of sampling location frequency was the Cuyahoga River, with an average distance of 2.8 river miles between sampling stations. Of the 15 LRAUs having sufficient data to assess, two (Paint Creek and Walhonding River) were fully supporting the use (13%) while the remaining 13 (87%) were not supporting the use. Six of the non-supporting twelve LRAUs are in fact very close to reaching full attainment, having index scores of 89 or more. The lower Tuscarawas River (Stillwater Creek to the mouth) had the lowest index score (38) followed by the Cuyahoga River (45) of the index scores calculated for the 15 assessed LRAUs.

Table F-11. Summary assessment status of the recreation use in Ohio's LRAUs.

LRAU	Length (miles)	# Sampling Stations	Avg Length per station (miles)	Index Score	Assessment Category
Auglaize River	12.86	0	n/a	n/a	3
Blanchard River	35.65	0	n/a	n/a	3
Cuyahoga River	25.34	9	2.8	45	5
Grand River	41.28	9	4.6	91	5
Great Miami River – Tawawa Creek to Mad River	48.93	1	48.9	n/a	3
Great Miami River- Mad River to Fourmile Creek	43.10	2	21.6	n/a	3
Great Miami River – Fourmile Creek to the mouth	38.38	0	n/a	n/a	3
Hocking River – Scott Creek to Margaret Creek	32.58	5	6.5	95	5
Hocking River – Margaret Creek to the mouth	36.38	5	7.3	89	5
Licking River	30.21	7	4.3	91	5
Little Miami River – Caesar Creek to O'Bannon Creek	26.92	7	3.8	97	5
Little Miami river – O'Bannon Creek	24.00	5	4.8	96	5

LRAU	Length (miles)	# Sampling Stations	Avg Length per station (miles)	Index Score	Assessment Category
to the mouth					
Mad River	18.38	0	n/a	n/a	3
Mahoning River	37.00	1	37.0	n/a	3
Maumee River – Indiana border to Tiffin River	42.11	0	n/a	n/a	3
Maumee River – Tiffin River to Beaver Creek	34.44	1	34.4	n/a	3
Maumee River – Beaver Creek to Maumee Bay	31.32	1	31.3	n/a	3
Mohican River	27.58	6	4.6	75	5
Muskingum River – Walhonding River to Licking River	34.94	5	7.0	75	5
Muskingum River – Licking River to Meigs Creek	46.78	8	5.8	78	5
Muskingum River – Meigs Creek to the mouth	29.42	5	5.9	83	5
Paint Creek	37.12	6	6.2	100	1
Raccoon Creek	37.55	1	37.6	n/a	3
Sandusky River – Tymochtee Creek to Wolf Creek	43.00	1	43.0	n/a	3
Sandusky River – Wolf Creek to Sandusky Bay	22.73	1	22.7	n/a	3
Scioto River – Little Scioto River to Olentangy River	32.70	0	n/a	n/a	3
Scioto River – Olentangy River to Big Darby Creek	31.42	1	31.4	n/a	3
Scioto River – Big Darby Creek to Paint Creek	37.30	0	n/a	n/a	3
Scioto River – Paint Creek to Sunfish Creek	36.68	1	36.7	n/a	3
Scioto River – Sunfish Creek to mouth	26.82	0	n/a	n/a	3
Stillwater River	32.38	1	32.4	n/a	3
Tiffin River	19.67	0	n/a	n/a	3
Tuscarawas River – Chippewa Creek to Sandy Creek	30.12	4	7.5	71	
Tuscarawas River – Sandy Creek to Stillwater Creek	26.05	2	13.0	n/a	3
Tuscarawas River – Stillwater Creek to mouth	47.05	6	7.8	38	5
Walhonding River	23.19	4	5.8	100	1
Whitewater River	8.26	0	n/a	n/a	3
Wills Creek	44.06	0	n/a	n/a	3

F3.3 Inland Lakes

Data availability for inland lakes is relatively limited compared to that for streams and rivers. In fact, the assessment for inland lakes is based upon a total of only 90 samples from nine lakes, compared to over 10,000 samples collected from streams and rivers. Ohio EPA has only recently begun to routinely conduct bacteria sampling in lakes as part of its renewed inland

lakes program. The data in this report were all collected in 2008 as no bacteria sampling occurred in 2004-2007 at inland lakes. It is expected that the 2012 report will contain more data, allowing for the recreation use assessment of additional lakes as the inland lakes sampling program is now established. However, the Ohio EPA has a relatively limited capacity in its lake sampling program. Additional details on the inland lakes sampling program can be found in Section I2 of this report and on Ohio EPA's web page at the following address: http://www.epa.ohio.gov/dsw/inland_lakes/index.aspx.

Table F-12 summarizes the assessment results for the recreation use of inland lakes. Geometric means were very low both at open water locations and beach/other sample locations. Based on the geometric means, the inland lakes sampled in 2008 are attaining the Class A and Bathing Water *E. coli* criteria at all locations sampled.

Table F-12. Summary assessment status of the recreation use for inland lakes.

Lake	Sample Location	Geometric Mean	Maximum Value	Index Score	Assessment Category
Buckeye Lake	Open Water	7	60	100	1
	Fairfield Beach	14	520	100	1
Clear Fork Reservoir	Open Water	6	20	100	1
Cutler Lake	Open Water	11	30	100	1
Dale Walborn Reservoir	Open Water	2	150	100	1
	Price Street	10	52	100	1
Deer Creek Reservoir	Open Water	2	100	100	1
	Boat Ramp	2	100	100	1
Dillon Lake	Open Water	8	40	100	1
	Beach	19	690	100	1
Maysville Reservoir	Open Water	7	10	100	1
Swift Run Lake	Open Water	2	3	100	1
Veteran's Memorial Reservoir	Open Water	1	2	100	1

The Ohio Department of Natural Resources (Ohio DNR) Division of Parks and Recreation conducts routine bacteria sampling of public bathing beaches at inland state park beaches pursuant to Ohio Revised Code sections 1541.032 and 3701.18. Advisory signs are posted whenever notified by the Director of the Ohio Department of Health (ODH) that the bacteria levels in the waters tested present a possible health risk to swimmers. Advisory postings are recommended whenever the *E. coli* density of a water sample exceeds the bathing water single sample maximum of 235 cfu/100 ml. Sampling frequency at the inland state lake beaches is generally once every two weeks. This sampling frequency is much less intense compared to sampling frequency at the Lake Erie beaches, which is typically four or more days per week. Table F-13 summarizes the advisory postings from 2004 through 2008 at each of 67 of the state's inland state park beaches. These data are presented in the Integrated Report for informational purposes and not for official use support determinations since the level of data credibility was indeterminate at the publication of this report. Its inclusion here is intended to notify readers of the existence of this sampling program for an important recreational resource in Ohio and to provide some information as to the relative amount of data and relative water quality conditions with respect to bacteria indicators. Should Ohio EPA affirm the data as level 3 data in the future, it will be considered in the process for making official use support determinations. Ohio EPA partnered with Ohio DNR in the summer of 2009 to understand common goals and lay groundwork for potentially using Ohio DNR beach data in future listings.

Table F-13. Swimming advisory postings at Ohio's inland lake public beaches (2004-2008).

Park	Beach	County	2004[a]	2005[a]	2006[a]	2007[a]	2008[a]	Total
Alum Creek	Main	Delaware	0/0	0/7	0/8	1/10	0/7	1
	Camp	Delaware	0/0	1/8	0/8	0/8	3/10	4
Barkcamp		Belmont	0/1	0/8	1/8	1/8	0/7	2
Blue Rock		Muskingum	1/10	1/9	0/7	1/10	1/9	4
Buck Creek	Main	Clark	0/0	0/7	1/8	0/8	0/9	1
	Camp	Clark	0/0	0/7	1/7	0/8	1/8	2
Buckeye Lake	Crystal Beach	Fairfield	0/0	0/0	0/12	0/14	0/7	0
	Fairfield Beach	Fairfield	0/0	3/13	0/12	1/14	1/8	5
	Brooks Park	Fairfield	0/0	2/13	1/12	0/14	1/8	4
Burr Oak	Main	Athens	0/0	0/8	2/10	1/11	0/6	3
	Lodge	Athens	0/0	0/8	0/8	0/9	0/7	0
Caesar Creek	North	Warren	0/0	0/7	0/7	0/2	0/7	0
	South	Warren	0/0	1/7	2/10	0/2	0/7	3
Cowan Lake	Main (S)	Clinton	0/1	0/7	0/8	0/3	0/7	0
	Camp (N)	Clinton	0/1	0/7	1/8	0/3	0/7	1
Deer Creek		Pickaway	0/4	1/6	2/10	0/7	0/13	3
Delaware		Delaware	0/0	1/8	0/7	3/11	6/12	10
Dillon	Boaters	Muskingum	0/0	1/14	0/10	0/14	3/13	4
	Swimmers	Muskingum	0/0	1/14	2/10	2/14	3/15	8
East Fork	Main	Clermont	0/0	0/15	1/14	0/13	0/12	1
	Camp	Clermont	0/0	0/15	0/14	0/13	0/11	0
Findlay		Lorain	0/2	1/7	0/5	1/6	0/5	2
Forked Run		Meigs	0/0	0/8	0/6	0/8	0/6	0
Grand Lake St. Marys	Main East	Auglaize	0/7	0/8	0/6	1/4	0/8	1
	Main West	Auglaize	0/7	0/7	1/6	1/4	0/8	2
	Camp	Auglaize	0/7	0/8	0/5	0/4	0/8	0
Guilford Lake	Main	Columbiana	0/2	1/8	0/3	0/1	0/5	1
	Camp	Columbiana	0/2	1/8	0/3	0/1	0/5	1
Harrison Lake		Fulton	3/11	0/8	1/9	0/2	0/4	4
Hueston Woods		Preble	0/0	1/5	0/7	1/8	0/6	2
Indian Lake	Fox Island	Logan	0/1	0/5	0/4	1/4	0/5	1
	Camp	Logan	0/1	0/4	0/4	1/3	0/5	1
	Oldfield	Logan	0/1	0/5	0/4	1/3	0/5	1
Jackson Lake		Jackson	0/0	0/7	0/8	1/8	2/6	3
Jefferson Lake		Jefferson	1/6	0/1	0/2	0/1	0/6	1
Kiser Lake		Champaign	0/0	0/8	0/7	0/5	0/2	0
Lake Alma	#1-West	Vinton	0/0	1/8	0/8	2/9	1/6	4
	#2-East	Vinton	0/0	0/8	0/8	0/8	0/5	0
Lake Hope		Vinton	0/0	0/6	0/6	1/8	0/6	1
Lake Logan		Hocking	0/0	0/9	0/9	0/8	1/10	1
Lake Loramie		Shelby	0/0	0/3	0/5	0/6	0/4	0
Lake Milton		Mahoning	0/6	0/6	0/6	0/3	0/7	0
Lake White		Pike	0/0	0/8	1/7	0/0	1/9	2
Madison Lake		Madison	0/0	5/14	1/14	2/13	2/15	10
Mosquito		Trumbull	0/0	0/5	0/5	0/3	0/7	0
Paint Creek		Ross	0/0	0/8	0/7	0/8	0/7	0
Pike Lake		Pike	0/0	0/7	1/9	0/8	1/9	2
Portage Lakes	Main	Summit	0/1	1/8	1/7	0/5	1/9	3
	Camp	Summit	0/0	0/0	0/7	0/5	0/7	0

Park	Beach	County	2004[a]	2005[a]	2006[a]	2007[a]	2008[a]	Total
Punderson		Geauga	0/4	1/11	1/6	0/8	0/7	2
Pymatuning	Main	Ashtabula	2/5	1/14	0/7	0/8	0/3	3
	Camp	Ashtabula	0/4	0/14	0/7	0/8	0/3	0
	Cabins	Ashtabula	0/3	1/14	1/7	1/8	0/3	3
Rocky Fork	North Shore	Highland	0/3	0/8	0/7	0/8	0/8	0
	South Shore	Highland	0/4	0/8	0/7	0/8	1/9	1
Salt Fork	Main	Guernsey	1/11	0/7	2/9	0/8	1/9	4
	Camp	Guernsey	1/8	0/7	0/7	0/8	1/9	2
	Cabins	Guernsey	1/7	0/6	0/7	0/8	0/8	1
Scioto Trail		Ross	0/0	0/6	0/6	0/7	2/10	2
Shawnee	Turkey Cr Lodge	Scioto	0/0	3/9	0/7	3/8	1/9	7
	Roosevelt-Camp	Scioto	0/0	1/7	0/7	1/8	1/9	3
Stonelick		Clermont	0/0	1/13	1/14	1/11	1/11	4
Strouds Run		Athens	0/0	1/9	2/9	0/6	0/7	3
Tar Hollow	Main	Ross	0/0	0/7	0/6	0/7	0/8	0
	Camp	Ross	0/0	0/6	0/6	0/6	0/8	0
West Branch		Portage	0/7	0/5	0/6	0/5	0/7	0
Wolf Run		Noble	0/0	1/8	0/7	0/6	0/7	1
	Total Advisory Postings		**10**	**33**	**27**	**29**	**36**	**135**

[a] Indicates the number of advisories posted followed by the number of samples collected.

Beaches at inland state park lakes are tested for bacteria less frequently compared to those beaches along Lake Erie. Dillon Lake, East Fork Lake, Stonelick Lake and Madison Lake had the most robust bacteria sampling programs of the inland state park beaches from 2005-2008. A total of 302 samples were collected at these four parks (totals from the main beaches at East Fork Lake and Dillon Lake were used for this analysis) compared to almost 440 samples from four Lake Erie beaches in just a single season (2008).

Sampling indicates that at most inland lake beaches, the bacteria criteria are not frequently exceeded, resulting in fewer postings compared to some of the beaches along Lake Erie. However, sample results at some inland lake beaches indicated a need for posting an advisory more often during some years. For example, five of the 14 samples collected at Madison Lake in 2005 triggered advisory postings, and half of the twelve samples collected at the Delaware State Park beach in 2008 resulted in the need for an advisory posting. More frequent sampling, particularly at beaches where previous sampling data indicates an increased chance of exceeding the recreation criteria, should be considered by beach managers so that the public can be adequately informed of actual water quality conditions at the time of their visit.