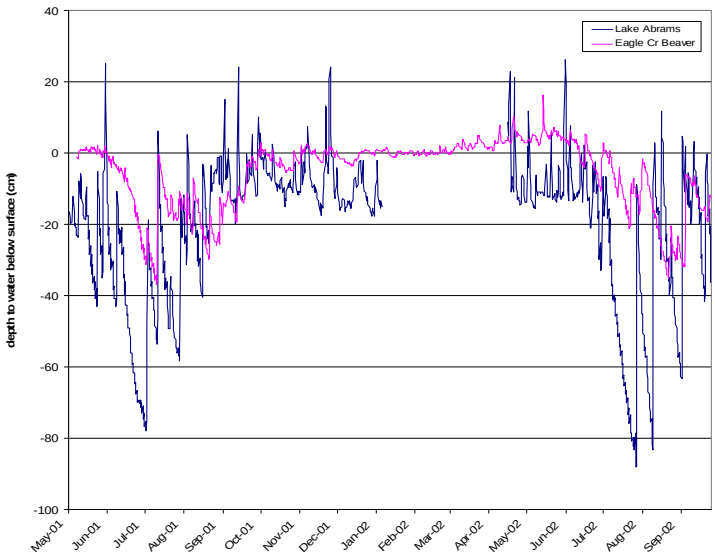
Long-term Terrestrial and Aquatic Resource Monitoring and Assessment Program for Cleveland Metroparks v. 1.0

Cleveland Metroparks Technical Report 2008/NR-04



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EXECUTIVE SUMMARY

Conserving and restoring natural ecosystems represents the most cost-effective way to maintain and improve the benefits humans derive from them. The monitoring and assessment framework proposed is will provide data-to implement an ecosystem approach to natural resource management in Cleveland Metroparks and the surrounding region. Long term data collected as part of a park-wide or region-wide monitoring and assessment program will have multiple applied uses including establishing baseline conditions of the resource, providing data for use in planning efforts, monitoring change over time and space, and developing regional preservation, restoration and research goals.

Cleveland Metroparks has a large amount of accrued institutional knowledge, species specific or topic specific studies, and observational data, but until recently, had not undertaken a park-wide scientific, statistically meaningful program to monitor and evaluate the state of its natural resources and they are changing over time due to the effects of urbanization, visitation, management activities, or in response to climate change. The Cleveland Metroparks Long-Term Terrestrial and Aquatic Resource Monitoring and Assessment Program will monitor the following key terrestrial and aquatic resources and report on their condition over time:

- Wetlands and key wetland types
- Terrestrial forests and major forest types
- Headwater streams
- Mainstem streams
- Condition of Reservations or watersheds that are the subject of comprehensive Ecosystem Management Plans
- Changes in hydrology and water chemistry on targeted mainstem and headwater streams.
- Various *ad hoc* short or long-term studies

This document outlines a 20 year monitoring and assessment program and estimates cost of the program. It is recommends the creation of three part-time or full-time field research coordinator positions Average annual part-time and seasonal staff cost for this program is estimated to be $193,000 a year which is only 55% more than seasonal researcher staff 2008 costs ($87,000). Based on costs of similar research programs, it is estimated that over the life of the program supply, equipment and travel costs would average $13,000 per year. Total annual average program costs would be $206,000 a year, although costs vary from a low of $143,000 to a high of $256,000 depending on the year of the program.

Purpose and Need

Local, regional and global problems relating to ecosystem health and services, sustainability, quality of life, global climate change, effect of local, state and federal regulatory programs to protect and restore aquatic resources, among others, require quantitative ecological, hydrological and chemical data in order to track change, monitor effectiveness and employ adaptive management. Most quantitative data that is available is limited in geographic extent and does not allow for analysis of trends over time. There are multiple existing planning and watershed efforts that have generally had to rely on coarse scale, remote sensing data sets evaluated with geographic information system (GIS) programs (e.g. green-space, open space, green infrastructure, low impact development, watershed planning, alternative futures and planned development planning). The primary exception to this lack of quantitative information an ecosystem condition has been data collected as part of Ohio EPA's fish, macroinvertebrate and chemistry sampling programs as part of rotating basin and Total Maximum Daily Load (TMDL) studies on mainstem streams.

Long term data collected as part of a park-wide or regional monitoring and assessment program has multiple applied uses:

1) developing baseline data sets of existing ecosystem condition and services;

2) developing quantitative data set for use in future planning efforts;

3) tracking short and long term changes in community composition and ecosystem health and services due to deer browse, development, climate change, etc.;

4) tracking short and long term changes in hydrology and aquatic ecosystem health and services due to effects of development, preservation activities, low-impact-development, stormwater regulations and stormwater utility, wetland/stream permitting programs, etc.; and

5) developing regional preservation and restoration goals and targets; providing context for regional research agenda.

Approach and Assumptions

The ecosystem concept has been one of the most resilient and useful concepts in the field of ecology. An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit. Ecosystems can vary size from a water-filled cavity in a tree to a woodland pool to the Great Lakes. The concept of an ecosystem provides a principled, knowledge-based framework for making decisions that reorients traditional political, disciplinary, or geographic boundaries so that they take into account the entire system and not just some of the component parts. While nearly self-apparent from the perspective of ecology, that is, that healthy, functioning ecosystems provide the services for a healthy, functioning human society, this paradigm is not intuitively apparent in human-dominated landscapes where issues related to the day-to-day repair and maintenance of the engineered infrastructure that supports our present society, appear largely divorced from natural ecosystem processes.

Conserving and restoring natural ecosystem structure and function represents the most cost-effective way to maintain and improve the benefits (services) humans derive from the ecosystems they inhabit. Ecosystem services are the benefits that people obtain from ecosystems and include 1) provisioning services (e.g. food and water), 2) regulating services (e.g. regulation of floods, drought, land degradation, and disease), 3) supporting services (e.g. soil formation and nutrient cycling), and cultural services (e.g. recreational, educational spiritual, religious and other nonmaterial benefits). Closely related to ecosystem services is the concept of ecosystem condition (health). Healthy ecosystems are capable of providing services to human society in a sustainable (i.e. long-term and low-cost) way. Natural ecosystems in good (sustainable) condition provide no-cost (or relatively low-cost) infrastructure to support human activities in the ecosystem. Replacing natural infrastructure with human engineered infrastructure requires a large initial capital investment and perpetual repair and replacement costs from human society.

Thus, activities to maintain and increase the services an ecosystem provides necessarily involves improving ecosystem condition. To the extent the resource is an aquatic ecosystem (wetland or stream), ecosystem health and services is equivalent to the goal of maintaining the chemical, physical and biological integrity mandated in the Clean Water Act and the aquatic life use designations promulgated by the State of Ohio as goals for the state's aquatic resources. In this sense, "good" condition is equivalent to a stream or wetland being capable of supporting and maintaining a balanced, integrated, adaptive community of flora or fauna with a species composition, diversity and functional organization comparable to a similarly situated natural system.

An ecosystem-based decision-making framework is called an “ecosystem approach” and is defined as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions, and interactions among organisms and their environment. The ecosystem approach to management and restoration stresses the central, if not pivotal, role that the human species has played, and is playing, in world ecosystems. The monitoring and assessment framework proposed here would represent the data-driven decision support portion of an "ecosystem approach" to the Cleveland Metroparks and eventually the Lake Erie and

Allegheny Plateau Region. It has, as its primary goal, collection of the long term data sets necessary to monitor and assess the changes in Cleveland Metroparks and region and the maintenance and improvement of benefits those systems provide to human society.

Present status of comprehensive resource monitoring and assessment at Cleveland Metroparks

There have been numerous studies and resource information collected at Cleveland Metroparks. Examples include deer contraceptive studies, deer herd health assessment evaluation, wood duck box usage studies, deer browse photo plot studies, blandings turtle studies. However, only since 2003 have comprehensive resource monitoring studies been initiated.

1. Deer browse study. Cleveland Metroparks initiated a deer management program to cull deer from the parks in 1999 because of the devastating effects deer populations were having on forest understory vegetation and forest regeneration. After the 4th year of culling in winter 2002-03, a study was initiated to measure levels of deer browse and vegetation recovery (or non-recovery) with quantitative vegetation survey plots in each reservation (Petit, unpublished field protocols) using protocols developed by the National Park Service and used in the Cuyahoga Valley National Park. The basic study design is to assess ~100 plots per reservation selected using a semi-random sample. Of these 100 plots, 10 are permanent plots that were sampled 3 times per growing season. Permanent plots are selected qualitatively as the most representative of the vegetation and browse condition of the reservation. As of 2008, the following reservations a single sampling event was completed on most larger reservations: Bedford, Bradley Woods, Brecksville, North Chagrin, South Chagrin, Rocky River, West Creek. Resampling was initiated in 2008 with ~120 plots at Bedford and Brecksville (10 permanent, 50 nonpermanent and 10 permanent plots at North Chagrin and Bradley Woods. It is important to stress that except for this start at resampling the deer browse plots in 2008, Cleveland Metroparks as no quantitative vegetation data to show the effect, or non-effect, of the deer management program. All we have is a single snap shot of existing vegetation conditions collected over the course of seven field seasons, with the initial sample event being "completed" when Mill Stream Run and Hinckley are sampled in 2009.[1] Over 1100 plots and over 1400 plot visits will be assessed once the first sampling event is completed in 2009.

2. Park-wide wetland assessment. Sampling to assess wetland condition in the Cleveland Metroparks was done in 2005-06. Sampling in 2005 was done using a targeted approach. Sampling in 2006 was done using a spatial random sample using an ArcView random location extension (Durkalec et al. 2008). Over 300 wetlands were mapped using on the ground geographic positioning system units and assessed with the Ohio Rapid Assessment Method for Wetlands v. 5.0 (Mack 2001).

[1] Reservations not assessed include Big Creek, Brookside/Zoo, Euclid Creek, Garfield Park, Huntington, Ohio & Erie Canal, Rising Valley Areas of Hinckley Reservation, Washington Park). These reservations were not assessed due to there size or the expectation that culling would not occur there in the near future.

3. Headwater stream inventory and classification. With the development of a protocol to classify primary headwater streams in 2002 (Ohio EPA 2002), the Natural Resources Division initiated a program in 2003 to comprehensively inventory all primary headwater streams (<1 mi^2 watershed size) and headwater (1-10 mi^2 watershed size) in the Cleveland Metroparks (Weldon and Durkalec 2008). Initially, streams were located using existing stream maps and soil maps. By 2008, it became apparent that a significant number of streams were being missed using this approach and a more refined approach using digital elevation model (DEM) maps and interpretation of potential drainages from contour lines on topographic maps was developed. As of 2008 over 500 streams had been evaluated and it is projected that there will be over 1100 streams inventoried in the Cleveland Metroparks. The headwater stream inventory is planned to be completed by the end of the 2010 field season.

Why does Cleveland Metroparks need to monitor its natural resources?

Although there is

1) a large amount of accrued institutional knowledge within the staff of Cleveland Metroparks of the state of its resources and how they have been changing over time, and

2) many species specific or reservation specific studies conducted, and a large amount of accrued observational data of where significant species or resource features are located,

never in its 90 year history has the park initiated a scientific, statistically meaningful program to monitor and evaluate the current state of its natural resources, and, how it might be changing over time, due to changes in climate or due to the effects of urbanization, visitation, or in response to natural resources management activities (for example the deer management program). However, the efforts discussed above form the ground work for this program.

How will Cleveland Metroparks monitor its natural resources?

The Cleveland Metroparks Long-Term Monitoring Terrestrial and Aquatic Resource Monitoring and Assessment Program proposes to monitor key terrestrial and aquatic resources including the following:

1. Primary terrestrial and wetland plant communities: beech-maple, northern (hemlock)-hardwood forest, floodplain forest, mixed mesophytic forest, dry-mesic oak forests, swamp forests, emergent wetlands (marshes, wet meadows), shrub swamps.
2. Deer Browse Vegetation Survey for primarily upland forests in Cleveland Metroparks.
3. Headwater streams (primary headwater <1 mi^2 and headwater 1-10mi^2)
4. Mainstem streams (>10mi^2)
5. Ecosystem Management Plan (West Creek, Lake-to-Lake Ecosystems)
6. Targeted hydrological and water quality monitoring of mainstem, headwater, stormwater outfalls, BMPs

7. Ad Hoc Monitoring Projects (e.g. Mitigation wetland monitoring, vernal pool monitoring, managed meadows, prairies, cliff faces and other communities of limited number or extent, etc.).

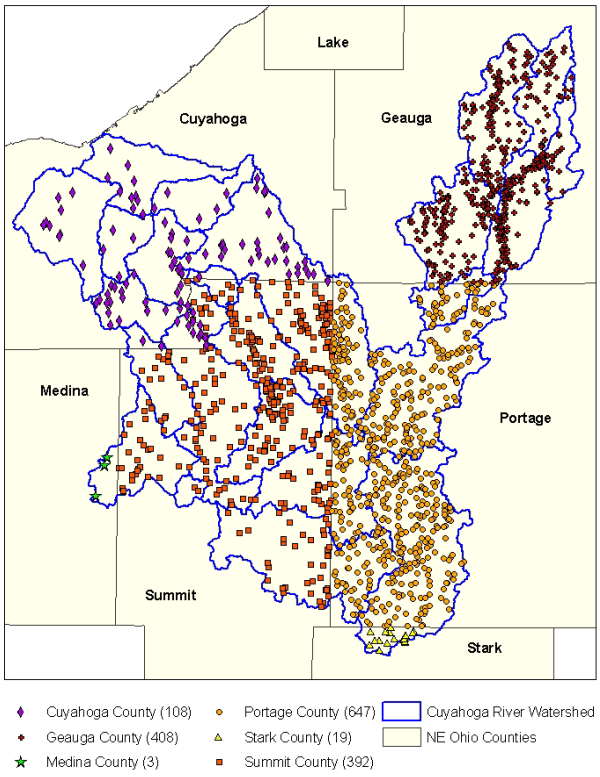
Assessment Tools and Sampling Protocols

The State of Ohio has a rich tradition of developing applied monitoring and assessment tools for aquatic resources. Well-developed tools exist for wetlands and streams that can be used throughout Ohio and the region. These include the Ohio Rapid Assessment for Wetlands v. 5.0 (ORAM), Vegetation Index of Biotic Integrity for Ohio Wetlands v. 1.0 (Vegetation IBI), Amphibian Index of Biotic Integrity for Depressional Forested and Shrub Wetlands in Ohio (AmphIBI), Qualitative Habitat Evaluation Index (QHEI) (for streams >1, Index of Biotic Integrity (fish IBI) for streams, Modified Index of Well Being (fish MwBI), Invertebrate Community Index (ICI), Headwater Habitat Evaluation Index (HHEI), Headwater Macroinvertebrate Field Evaluation Index (HMFEI).

In contrast, there is a paucity of standardized protocols for evaluating terrestrial ecosystem health, although well-established methods exist for sampling vascular plants (e.g. Whitaker plots) and birds (e.g. point-count methods) in terrestrial systems and there is a relatively extensive literature characterizing typical communities. In particular, terrestrial plant communities can be sampled using the same vegetation protocols used for wetlands. It is expected that with a modest effort, wetland forest vegetation IBIs developed for Ohio could be extended to terrestrial forest communities.

Survey Design

1. Plant community (terrestrial and wetland). The survey design will be similar to probabilistic designs developed by U.S. EPA for the wadable streams program and used in Ohio for wetland assessment in the Cuyahoga River Basin (Fennessy et al. 2007). Sites included in the monitoring network will be selected using the Generalized Random Tesselation Stratified (GRTS) survey design for an areal resource, with reverse hierarchical ordering, developed by the U.S. EPA's EMAP program (Diaz-Ramos et al. 1996, Herlihy et al. 2000, Olsen et al. 1998, Stevens 1997, Stevens and Olsen 1999, Stevens and Urquhart 1999, Stevens and Olsen 2004). This method provides a geospatially balanced, stratified random sample. Several sample frames are available are available that could be used separately or merged into a single integrated frame: National Wetland Inventory (NWI)



Spatially-balanced random sample of wetlands in the Cuyahoga River watershed using GRTS survey design. Represents a 1600 point over-sample. 400 points were evaluated and 243 points actually sampled during the project.

maps, Ohio Wetland Inventory (OWI) maps, known mapped wetlands and forest types within Cleveland Metroparks and NatureServe Predictive Model for plant communities of Northeast Ohio (Comer 2008). The latter model is the only unified model available at this time.[2] Approximately 50 permanent sample plots per plant community type (8 types) for a total of 400 permanent plots[3] (1 plot for every 55 acres). A five year sample event approach will be used with 100 plots sampled each year for 4 years with year five for data analysis and report writing.

2. Deer Browse Vegetation Survey. The Monitoring and Assessment program proposes to continue the Deer Browse Vegetation Study initiated in 2003 and scheduled to be completed in 2009 (basically, the first survey event) by resampling the 10 permanent plots and 40 additional non-permanent plots every three years. Year 4 is set aside for data analysis and report writing. During years 1-3 of the survey cycle, approximately 150-170 deer browse plots (equals 210-250 plots visits) will be sampled (permanent plots are visited 3X per year).

3. Primary Headwater and Headwater streams. Once the headwater stream inventory is completed, Cleveland Metroparks will have a complete census of the population (~1100) of headwater streams. Population variances will be calculated and the number of streams that will need to be evaluated to detect changes in the headwater stream resource will be determined. It is expected that this will be approximately 50 streams.[4] Headwater stream monitoring will use the HHEI and HMFEI, as well as yet to be developed assessment tools (e.g. headwater IBIs, or headwater rapid assessment methods). A four year monitoring cycle is proposed with ~50 randomly selected streams assessed every three years, with year for set aside for data analysis and report writing.

4. Mainstem Streams. The number of mainstem (>10 mi^2) and headwater (1-10 mi^2) streams in Cleveland Metroparks is much smaller. It is expected that there are less than 50 headwater streams within Cleveland Metroparks resource and less than 20 mainstem streams (Abram Creek, Baldwin Creek, Big Creek, Burk Branch, Cahoon Creek, Chagrin River (including Aurora Branch), Chippewa Creek, Cuyahoga River, Euclid Creek, Mill Creek, Rocky River (including East and West Branches), Porter Creek, Tinkers Creek, West Creek. There are multiple existing mainstem stream monitoring locations (Ohio

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[2] The NatureServe Predictive Model for plant communities of Northeast Ohio (Comer 2008) is the best existing sample frame at the following aggregated scale: Dry-Mesic Oak Forest and Woodland, Beech-Maple Forest, Floodplain Forests, Northern-Hemlock Hardwood Forests, Mesophytic Forest. There are other upland communities with of relatively small number or area in Cleveland Metroparks and the region (e.g. Cliff and Talus Communities Glade and Barrens, Oak Savanna and Barrens, Tallgrass Prairie, Alvar, and Dune) but they are of such small area that they can be monitored with targeted sampling).

[3] There are two plot-based vegetation sampling approaches being evaluated. The Whitaker plot (0.1 ha, 20 x 50 m) plot used in the Ohio Vegetation IBI and the U.S. Forest Service Forest Inventory Assessment (FIA) program.

[4] Other local agencies have been inventorying there headwater stream resource. Lake County has inventoried over 1700 streams in Lake County using soil maps to identify stream locations. Cuyahoga Valley National Park is also inventorying every 1/3 of its potential mapped streams within its boundaries.

EPA, NEORSD). It is expected that this existing monitoring network will be used and expanded with additional locations to track changes in condition over time. Existing River Mile maps developed and used by Ohio EPA for the State's Stream Bioassessment Program will be used to select monitoring reaches. A four year monitoring cycle is proposed with permanent sites being monitored once every three years and year four set aside for data analysis and report writing. It is expected that ~50 permanent sites will be monitored per year using electrofishing techniques and the QHEI.

In addition to the random or semi-random survey designs for 1 to 4 above, targeted and ad hoc monitoring will need to occur over the long-term for the following:

5. Sampling within Ecosystem Management Plan watersheds (West Creek, Abram Creek) including vegetation monitoring, bird monitoring, and hydrologic and water chemistry monitoring.

6. Targeted hydrologic and water chemistry monitoring on mainstem, headwater, primary headwater streams within the watershed.

7. Ad hoc monitoring of mitigation wetlands (<5 years), managed meadows and prairie creation areas, vernal pools, or communities of limited size or number, e.g. cliff faces.

Level of Effort to Determine Condition by Resource Type, Region or Subregion

To be an effective monitoring and assessment program, a sufficient number of sample events will need to occur within each resource class or area for which a "report card" on current status and trends is desired. Fennessy et al. (2007) assessed wetland condition in the Cuyahoga watershed of northeast Ohio. Above 100 sampled wetlands, there was no improvement in evaluations of overall wetland condition for the watershed. The rule-of-thumb in U.S. EPA's Ecosystem Monitoring and Assessment Program (EMAP) is that approximately 50 data points per resource type or geographic area are needed in order to report on resource condition. For example, to evaluate beech-maple forest condition in Cleveland Metroparks landholdings, ~50 data points will need to be sampled. To evaluate beech-maple forest in North Chagrin Reservation of Cleveland Metroparks, approximately 50 data points in North Chagrin may need to be sampled, assuming there are 50 beech-maple forests in North Chagrin Reservation that can be found to sample. In some instances 50 points may represent a census of the resource type. For example, there are less than 50 headwater streams in the Rocky River Reservation of Cleveland Metroparks, so sample size can be adjusted based on the population size for that resource.

The program outlined here will allow the reporting of resource condition and changes in resource condition over time for the following:

1. Wetlands in Cleveland Metroparks, and wetland types (emergent, forest, shrub) and probably dominant hydrogeomorphic class types (riverine, depression, slope) in Cleveland Metroparks.

2. Terrestrial forests in Cleveland Metroparks and the five main terrestrial forest types found in Cleveland Metroparks (beech-maple, northern (hemlock)-hardwood, floodplain, mesophytic, and dry-mesic oak forests).

3. Headwater streams in Cleveland Metroparks.

4. Mainstem streams in Cleveland Metroparks.

5. Condition of Abram Creek and West Creek watersheds, changes in vegetation, birds, water chemistry and hydrology due to restoration activities.

6 Changes in hydrology and water chemistry on targeted mainstem and headwater streams.

7. Status reports and performance of various ad hoc assessment projects.

Estimates of staff time and program costs to implement program

In 2008, the Division of Natural Resources had 13 individual seasonal staff working on its ongoing natural resource monitoring and research efforts. Total seasonal staff hours allocated to research was 8894 at a cost of $87,000.[5] Several "seasonal" research staff are professional scientists retired from earlier careers, or younger researchers who started working for the park during the degree programs and continued after graduation. This has given the NR research program a degree of stability and continuity it would not otherwise have. In effect, many positions have become *de facto* part-time permanent positions.

Table 1 outlines a 20 year monitoring and assessment program and estimates cost of the program. It is strongly recommended that three part-time permanent positions are created as part of this effort to ensure year-to-year program continuity: a aquatic field research coordinator, a vegetation field research coordinator, and a hydrologic field research coordinator. Average annual part-time and seasonal staff cost for this program is estimated to be $193,000 a year which is only 55% more than 2008 seasonal research staff 2008. Based on supply, equipment and travel costs of similar research programs it is estimated that over the life of the program these costs would be ~$13,000 per year. Total annual average program costs would be $206,000 a year, although costs vary from a low of $143,000 to a high of $256,000.

The program is set up so that in any given year some aquatic, hydrologic, or vegetation data is being collected so that expertise and continuity can be maintained over the course of the 20 year effort.

Indicator Development Needs

Several data gaps exist in developing a regional monitoring and assessment. First, protocols for the assessment of terrestrial communities, particularly terrestrial forests, need to be developed. Existing vegetation-based protocols for wetland plant communities should be able to be extended to terrestrial forests with a modest

[5] In contrast, there were 9 individual seasonal staff doing primarily land management or deer management program activities that worked 5485 hours at a cost of $57,500.

development effort. IBIs need to be extended to primary headwater streams (Moore, unpublished).

CLEVELAND METROPARKS MONITORING AND ASSESSMENT PROGRAM 2009-2029

	Ad Hoc Projects	EMP Monitoring and Assessment		Long-term Aquatic Resource and Assessment Program		Long-term Vegetation and Plant Community Assessment Program					
	ADDITIONAL SHORT TERM VEGETATION MONITORING	WEST CREEK AND LtoL VEGETATION MONITORING one 3 person field crew every 3 years or 3 weeks	WEST CREEK, LtoL AND OTHER HYDROLOGY/WATER CHEMISTRY MONITORING	HEADWATER STREAM ASSESSMENT After 2009, one 3 person field crew	MAINSTEM AND FISHERIES ASSESSMENT one 3 person field crew (often made up of PWH field crew staff)	DEER BROWSE STUDY after 2009 field season, two 2 person field crews, 150-170 plots, 210-250 plot visits per season	PLANT COMMUNITY ASSESSMENT two 3 person field crews starting 2013, 100 plots per year	TERRESTRIAL VIBI-FOREST DEVELOPMENT one 3 person field crew, 50 plots per year	PT or seasonal hours per year	PT or seasonal FTEs (@1500/year)	cost @avg pay of $11/hr
2009	Snowville Wetland YEAR 1 (5 plots), RRMC (6 plots), Crocker-Bassett Mitigation (1-2 plots) (one 3 person field crew)	West Cr Wetlands (7 plots), LtoL (Fowles Wetland) (10 random, 2-3 permanent) (one field crew, 3 persons)	4-8 USGS gages, 4-8 stormwater stations, 20-30 water level recorders, 10-20 West Cr BMP stations, 5-10 PWH flow locations	SURVEY, continue PWH/HW inventory, two field crews (6 staff)	SURVEY begin mainstem and fisheries surveys	SURVEY, Mill Stream, Hinckley, Huntington, Garfield 3 field crews (5 staff)		preliminary data collection an comparison to VIBI-F (~5-10 plots)			
HRS	600	600	1500	4000	1000	5500		600	13800	9	$ 193,800
2010		West Cr and LtoL (20 random, 4-6 permanent each) (1 field crew, 3 persons)	run hydrologic network, QA data, summarize and report data	SURVEY, finish PWH/HW inventory, two field crews (6 staff)	SURVEY continue mainstem and fisheries surveys	Data entry, analysis; database completion; final report	SURVEY, 50 emergent wetland and 50 shrub wetland plots	50 plots - 10 beech-maple, 10 northern (hemlock)-hardwood, 10 flood plain, 10 dry-mesic oak forest, 10 mesophytic			
HRS		1200	1500	4000	1000	3000	5000	2500	18200	12	$ 242,200
2011	Snowville Wetland YEAR 3 (5 plots)		run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	SURVEY continue mainstem and fisheries surveys	RESURVEY (#2) Bedford, Brecksville, Bradley, Brookside, Euclid	SURVEY, 50 forested wetland and 50 beech-maple forest plots	50 plots - 10 beech-maple, 10 northern (heml.)-hardwd, 10 flood plain, 10 dry-mesic oak forest, 10 mesophytic; develop TVIBI-F			
HRS	300		1500	1000	4000	4000	5000	2500	18300	12	$ 243,300
2012			run hydrologic network, QA data, summarize and report data	RESURVEY (#1) PWH/HW streams	SURVEY finish mainstem and fisheries surveys	RESURVEY (#2) N. Chagrin, S. Chagrin, Hinckley	SURVEY, 50 northern (hemlock)-hardwood and 50 mesophytic plots	Test and finalize TVIBI-F			
HRS			1500	2500	2000	4000	5000	1500	16500	11	$ 223,500
2013	Snowville Wetland YEAR 5 (5 plots)	West Cr and LtoL (50 random, 6-8 permanent) (1 field crew, 3 persons)	run hydrologic network, QA data, summarize and report data	Data entry, analysis; database completion; final report	Data entry, analysis; database completion; final report	RESURVEY(#2) Mill Stream, Rocky River, West Cr	SURVEY, 50 dry-mesic oak and 50 floodplain plots				
HRS	300	2000	1500	1500	1500	4000	5000		15800	11	$ 215,800
2014			run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	RESURVEY(#1) continue mainstem and fisheries surveys	RESURVEY (#3) Bedford, Brecksville, Bradley, Brookside, Euclid	Data entry, analysis; database completion; final report				
HRS			1500	1000	4000	4000	1500		12000	8	$ 174,000
2015			run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	RESURVEY(#1) continue mainstem and fisheries surveys	Data entry, analysis; database completion; final report	RESURVEY(#1), 50 emergent wetland and 50 shrub wetland plots				

CLEVELAND METROPARKS MONITORING AND ASSESSMENT PROGRAM 2009-2029

	Ad Hoc Projects	EMP Monitoring and Assessment		Long-term Aquatic Resource and Assessment Program		Long-term Vegetation and Plant Community Assessment Program					
	ADDITIONAL SHORT TERM VEGETATION MONITORING	WEST CREEK AND LtoL VEGETATION MONITORING one 3 person field crew every 3 years or 3 weeks	WEST CREEK, LtoL AND OTHER HYDROLOGY/WATER CHEMISTRY MONITORING	HEADWATER STREAM ASSESSMENT After 2009, one 3 person field crew	MAINSTEM AND FISHERIES ASSESSMENT one 3 person field crew (often made up of PWH field crew staff)	DEER BROWSE STUDY after 2009 field season, two 2 person field crews, 150-170 plots, 210-250 plot visits per season	PLANT COMMUNITY ASSESSMENT two 3 person field crews starting 2013, 100 plots per year	TERRESTRIAL VIBI-FOREST DEVELOPMENT one 3 person field crew, 50 plots per year	PT or seasonal hours per year	PT or seasonal FTEs (@1500/year)	cost @avg pay of $11/hr
HRS			1500	1000	4000	1500	5000		13000	9	$ 185,000
2016		West Cr and LtoL (50 random, 6-8 permanent) (1 field crew, 3 persons)	run hydrologic network, QA data, summarize and report data	RESURVEY (#2) PWH/HW streams	RESURVEY(#1) finish mainstem and fisheries surveys	RESURVEY (#3) N. Chagrin, S. Chagrin, Hinckley	RESURVEY(#1), 50 forested wetland and 50 beech-maple forest plots				
HRS		2000	1500	4000	1000	4000	5000		17500	12	$ 234,500
2017			run hydrologic network, QA data, summarize and report data	Data entry, analysis; database completion; final report	Data entry, analysis; database completion; final report	RESURVEY(#3) Mill Stream, Rocky River, West Cr	RESURVEY(#1), 50 northern (hemlock)-hardwood and 50 mesophytic plots				
HRS			1500	1500	1500	4000	5000		13500	9	$ 190,500
2018			run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	RESURVEY(#3) continue mainstem and fisheries surveys	Data entry, analysis; database completion; final report	RESURVEY(#1), 50 dry-mesic oak and 50 floodplain plots				
HRS			1500	1000	4000	1500	5000		13000	9	$ 185,000
2019		West Cr and LtoL (50 random, 6-8 permanent) (1 field crew, 3 persons)	run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	RESURVEY(#3) continue mainstem and fisheries surveys	RESURVEY (#4) Bedford, Brecksville, Bradley, Brookside, Euclid	Data entry, analysis; database completion; final report				
HRS		2000	1500	1000	4000	4000	1500		14000	9	$ 196,000
2020			run hydrologic network, QA data, summarize and report data	RESURVEY (#3) PWH/HW streams	RESURVEY(#3) finish mainstem and fisheries surveys	RESURVEY (#4) N. Chagrin, S. Chagrin, Hinckley	RESURVEY(#2), 50 emergent wetland and 50 shrub wetland plots				
HRS			1500	4000	1000	4000	5000		15500	10	$ 212,500
2021			run hydrologic network, QA data, summarize and report data	Data entry, analysis; database completion; final report	Data entry, analysis; database completion; final report	RESURVEY(#4) Mill Stream, Rocky River, West Cr	RESURVEY(#2), 50 forested wetland and 50 beech-maple forest plots				
HRS			1500	1500	1500	4000	5000		13500	9	$ 190,500
2022		West Cr and LtoL (50 random, 6-8 permanent) (1 field crew, 3 persons)	run hydrologic network, QA data, summarize and report data	Ad hoc PWH/HW surveys	RESURVEY(#4) continue mainstem and fisheries surveys	Data entry, analysis; database completion; final report	RESURVEY(#2), 50 northern (hemlock)-hardwood and 50 mesophytic plots				
HRS		2000	1500	1000	4000	4000	5000		17500	12	$ 234,500

CLEVELAND METROPARKS MONITORING AND ASSESSMENT PROGRAM 2009-2029

	Ad Hoc Projects	EMP Monitoring and Assessment		Long-term Aquatic Resource and Assessment Program		Long-term Vegetation and Plant Community Assessment Program					
	ADDITIONAL SHORT TERM VEGETATION MONITORING	WEST CREEK AND LtoL VEGETATION MONITORING one 3 person field crew every 3 years or 3 weeks	WEST CREEK, LtoL AND OTHER HYDROLOGY/WATER CHEMISTRY MONITORING	HEADWATER STREAM ASSESSMENT After 2009, one 3 person field crew	MAINSTEM AND FISHERIES ASSESSMENT one 3 person field crew (often made up of PWH field crew staff)	DEER BROWSE STUDY after 2009 field season, two 2 person field crews, 150-170 plots, 210-250 plot visits per season	PLANT COMMUNITY ASSESSMENT two 3 person field crews starting 2013, 100 plots per year	TERRESTRIAL VIBI-FOREST DEVELOPMENT one 3 person field crew, 50 plots per year	PT or seasonal hours per year	PT or seasonal FTEs (@1500/year)	cost @avg pay of $11/hr
2023				Ad hoc PWH/HW surveys	RESURVEY(#4) continue mainstem and fisheries surveys	RESURVEY (#5) Bedford, Brecksville, Bradley, Brookside, Euclid	RESURVEY(#2), 50 dry-mesic oak and 50 floodplain plots				
HRS				1000	4000	4000	5000		14000	9	$ 196,000
2024				RESURVEY (#4) PWH/HW streams	RESURVEY(#4) finish mainstem and fisheries surveys	RESURVEY (#5) N. Chagrin, S. Chagrin, Hinckley	Data entry, analysis; database completion; final report				
HRS				4000	1000	4000	1500		10500	7	$ 157,500
2025				Data entry, analysis; database completion; final report	Data entry, analysis; database completion; final report	RESURVEY(#5) Mill Stream, Rocky River, West Cr	RESURVEY(#3), 50 emergent wetland and 50 shrub wetland plots				
HRS				1500	1500		5000		8000	5	$ 130,000
2026				Ad hoc PWH/HW surveys	RESURVEY(#5) continue mainstem and fisheries surveys		RESURVEY(#3), 50 forested wetland and 50 beech-maple forest plots				
HRS				1000	4000		5000		10000	7	$ 152,000
2027				Ad hoc PWH/HW surveys	RESURVEY(#5) continue mainstem and fisheries surveys		RESURVEY(#3), 50 northern (hemlock)-hardwood and 50 mesophytic plots				
HRS				1000	4000		5000		10000	7	$ 152,000
2028				RESURVEY (#5) PWH/HW streams	RESURVEY(#5) finish mainstem and fisheries surveys		RESURVEY(#3), 50 dry-mesic oak and 50 floodplain plots				
HRS				4000	1000		5000		10000	7	$ 152,000
	TOTAL SURVEY EVENTS	6	6	6	6	6	4	total for 20 years	274600	183	$ 3,860,600
								average per year	13730	9	$ 193,030
								supplies per year	$ 3,000	x 20 years	$ 60,000
								equipment per year	$ 7,500	x 20 years	$ 150,000
								travel per year	$ 2,500	x 20 years	$ 50,000

GRAND TOTAL OVER 20 YEARS $ 4,120,600
GRAND AVERAGE $ 206,030
MINIMUM ANNUAL COST $ 143,000
MAXIMUM ANNUAL COSTS $ 256,300