



BUREAU OF CLEAN WATER

LAKE FISHERIES SAMPLING PROTOCOL

JULY 2013

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I. INTRODUCTION:

All surface waters of the Commonwealth, including lakes, are protected according to their designated uses. The aquatic life use refers to the health of the biotic community in the lake. Fish are sensitive to environmental conditions and are a major component in a lake, therefore, the fish community is a good indicator for the aquatic life use, and is one of the elements suggested by EPA (Guidance for 2006 Assessment, Listing and reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act). Fishery information is also an important tool in evaluating the recreational use of lakes.

Pennsylvania has a diverse assemblage of lakes, reservoirs, and ponds that are both public and private. Public lakes are normally surveyed and managed by the Pennsylvania Fish and Boat Commission (PFBC), whereas private lakes may not be actively managed for a specific purpose. The focus of the PFBC lake inventory program is to establish relationships among various characteristics and determine how they affect boating use, angler use, and harvest (Hoopes 1989); some aspects of PFBC fishery data can be used by DEP to evaluate designated uses, but fish collection procedures and gear used by PFBC may be biased towards specific gamefish. DEP uses PFBC lake data to evaluate use applicability/attainability via contact with the Area Fisheries Manager and through a review of existing data. In addition, DEP may determine that PFBC data is inadequate and elect to conduct additional fish surveys on public lakes where recent information (< 10 years) is not available.

The DEP protocol was developed for lakes that have not been recently surveyed or will not be surveyed by the PFBC (e.g. private lakes). The protocol was developed to collect fish for both population assessments and tissue analyses.

II. PURPOSE:

This survey protocol is intended to define the standard methods for collecting fish population information needed to support decisions concerning aquatic life and recreational uses of Pennsylvania's lakes and reservoirs. The protocols described can be used to help make decisions on impairment, or to confirm designated use attainment.

Fisheries data are used for impairment decisions, not as stand-alone data, but rather as supporting evidence for trends indicated by sampling physical or chemical variables. Confirmation of a source and cause of impairment in a lake is usually determined through other studies such as water chemistry, macrophyte coverage, land use determinations, and citizen surveys. DEP fisheries surveys should be conducted concurrent with lake trophic state index (TSI) surveys, or within a 2 to 3 year time frame, if fisheries data will be used to support attainment decisions. This document intends to

standardize DEP lake fisheries protocols for different gears and to establish a framework for data analysis and interpretation.

III. FIELD ASSESSMENTS:

Boat electrofishing is the primary method for all fish collections in lakes. All fisheries surveys conducted by DEP will be carried out in littoral habitats (< 3 meters deep). However, electrofishing gear may not be practicable for all situations and other gears may be necessary because of environmental (e.g. water clarity), physical (e.g. access), or social (e.g. permission from private landowners) conditions. The PFBC utilizes a multiple gear approach in fisheries assessments; data collected by DEP should follow similar procedures for improved assessments and comparison, when time permits. All fisheries surveys should be conducted in the spring or fall when a variety of species are vulnerable for capture and when water temperatures are cool (< 20 °C). The recommended collection period for fisheries assessments, excluding fish tissue collections, is September 15 – June 15.

Boat Electrofishing - Fish Community Collections

Lakes are sampled with boat-mounted electrofishing gear in the spring or fall when water temperatures are between 15 and 20 °C. Fish are collected at night (beginning at dusk) using several shoreline segments per lake. The number of shoreline segments electrofished per lake is determined by lake area (Table 1). Each pass consists of 240 seconds (4 minutes) of electrofishing time. Shoreline segments around the lake perimeter are randomly chosen using a random numbers table and a shoreline GIS map with numbered grids; additional segments may be selected using Best Professional Judgment (BPJ) when different or special habitats are identified. Carefully note on the field sheets transects that were chosen based on BPJ rather than randomly selected. Voltage is adjusted to optimize output and the range of output current is generally 4-6 amperes DC. AC may also be used depending on circumstances. Stunned fish at or below the water surface are netted using long handled nets with 1/4" mesh and handles constructed of a non conductive material, such as fiberglass. All samples will be collected in accordance with DEP's electrofishing policies (Standardized Biological Field Collection and laboratory Methods 391-3200-015, www.dep.state.pa, DEP keyword eLibrary, Draft Technical Documents, February, 13, 2009).

Table 1. The number of shoreline electrofishing units for all species collections. An additional station may be added to target different or special habitats.

Lake Area (ha)	Number of shoreline electrofishing segments
1-4	2
5-14	3
15-29	4
30-74	5
75-149	6
150-249	7
250-599	8

Netters attempt to capture all stunned fish, with the exception of large carp which are visually counted. Fish are placed into holding containers and processed at the end of each shoreline segment. The sampling time (total seconds) for each electrofishing transect is recorded, along with the GPS or map location of the start and end of each electrofishing transect. All species will be processed according to procedures described in this document.

Boat Electrofishing – Gamefish

In some instances, the Department may need to collect additional fisheries information beyond routine fish community collections. Additional information may be required to further support a designated use decision or to obtain an adequate sample size, to evaluate certain characteristics of the fish population. The PFBC routinely conducts nighttime electrofishing surveys to inventory gamefish species. The use of this data or re-visiting historical stations and methods, may be beneficial for comparison. The boat electrofishing gamefish procedure focuses on an evaluation of the top predators in a lake (primarily black bass) and can be used to make inferences about the structure and condition of the fish community when it is combined with all species collections. The procedure may also be used on private lakes where additional data collection would better characterize the gamefish community and mimic PFBC collection procedures conducted on public lakes. The recommended collection period is the same for all species collections.

Additional electrofishing runs using the gamefish protocol may be included with all species surveys. Fish are collected at night (beginning at dusk) by boat electrofishing, using several shoreline segments per lake. Sample the entire shoreline if the lakes surface area is less than 15 hectares (ha). The number of shoreline segments for lakes greater than 15 ha is determined by lake area (Table 2). Each pass consists of 900 seconds (15 minutes) of electrofishing time or until the entire shoreline is sampled. Longer sampling may be necessary when gamefish density is low. Low density is determined by catch per unit effort (CPUE) and best professional judgment (BPJ) is applied to decide if continued sampling is applicable. Once more experience is gained using this collection method it should be possible to replace BPJ with a numerical definition of low density. Shoreline segments around the lake perimeter are randomly chosen in larger lakes (> 75 ha), using a random numbers table and a shoreline GIS map. Additional segments may be selected using Best Professional Judgment if different or unique habitats have not been sampled. Voltage is adjusted to optimize output, with the current generally ranging from 4-6 amperes DC. Stunned fish at or below the water surface are netted using long handled nets with 1/4" mesh.

Netters attempt to capture all stunned gamefish species. Fish are placed into holding containers and processed at the end of a shoreline segment. The sampling time (total seconds) for each electrofishing transect is recorded along with the location of the start and end of each electrofishing transect using a GPS unit or by marking points on a lake map. All species are processed according to the fish processing procedures described in this document.

Table 2. The number of nighttime electrofishing stations using the fish community and gamefish species collection methods. Stations must be distinctly separated. The numbers in parenthesis are the minimum number of stations required if a gamefish survey is conducted independently.

Lake Area (ha)	Fish community	Gamefish Species
1-4	2	Entire Shoreline
5-14	3	Entire Shoreline
15-29	4	2 (3)
30-74	5	3 (4)
75-149	6	4 (5)
150-249	7	5 (6)
250-599	8	6 (7)

Experimental Gill Net

Use experimental gill nets as a single gear type, in areas where electrofishing boat access is not available or in lakes where electrofishing efficiency is low. Gill nets may also be used to account for size selectivity and bias associated with electrofishing surveys, or may be utilized in multiple gear assessments. When using multiple gears, identify which fish were captured with what gear.

The Department will utilize a 6-panel 150' (length) experimental gill net that is 6' deep (height). Individual panels have a bar mesh size of 0.5, 1, 1.5, 2, 2.5, and 3 inches. Nets are randomly placed in areas free of snags, heavy vegetation, or other obstructions. Nets are placed perpendicular to the shoreline, beginning with the smallest mesh size and extending outward from the shoreline. Gill nets can be tied to a solid structure (e.g. root, shrub, or tree) on the shoreline edge or can be anchored at both ends with attached buoys. All gill nets are placed in littoral habitats (≤ 3 m depth). Gill net sites are selected using a random numbers table and a shoreline GIS map. Additional segments may be selected onsite using Best Professional Judgment when bottom substrate has not been adequately represented. The number of gill net sites is based on area and is a modification of the EMAP lake protocol (Baker et al. 1997; Table 3).

Water temperature and soak time are factors in catch efficiency and mortality. In order to increase gear efficiency and reduce catch mortality, gill nets may be set overnight in the spring and fall when water temperatures are less than 20 °C. The suggested index period for gill net sampling is September 15 – June 15. To reduce catch mortality, nets should be tended on a frequent basis (hourly) in productive waters, where a higher density of fish is expected. The Department may utilize other experimental gill net dimensions or data collected from other agencies. In these instances, net dimensions will be specified in lake reports.

Table 3. The minimum number of littoral gill net stations based on lake area. Additional stations may be necessary where bottom substrate differences are apparent.

Lake Area (ha)	Number of gill nets
1-4	2
5-14	2
15-29	3
30-74	4
75-149	5
150-249	6
250-599	7

Modified Fyke Net

Modified fyke nets or “framed fyke nets” may be utilized as a single gear type or in multiple gear assessments. Fyke nets are beneficial in some lakes (e.g. private lakes). They can be an effective gear for panfish species such as crappie and sunfish; however these nets are not effective for capturing black bass species or larger predators.

The Department uses a framed fyke net with a 100 foot lead and box dimensions measuring: 3 feet high, 6 feet wide, and 32 inches long. Detailed net specifications are located in Appendix 1. The modified fyke net has been extensively used in other states such as: North Dakota, Oklahoma, Kentucky, and Ohio. It was also selected because of its light weight, ease of deployment, and cost. The PFBC uses the PA style trapnet for all inventories, but these nets are very cumbersome, labor intensive, and are three times the cost of a fyke net.

Catch differences between PA trap nets and fyke nets have been documented. Hollender and Kristine (1996) compared catches between Pennsylvania trap nets and modified fyke nets and found no significant differences in bluegill and black crappie abundance. They did find differences in species composition and pumpkinseed abundance. Additional fyke net sets may have increased the species richness, but most differences between the two gears were single specimens. Therefore, the Department may need to conduct additional studies to determine gear bias and comparable effort, if PFBC trapnet data is used in DEP fisheries assessments.

Fyke nets should be placed perpendicular to the shoreline in the littoral zone, in areas free of snags. The net may be anchored at both ends or the lead may be tied to the shoreline. Nets should be set a reasonable distance from public access points and shoreline areas where vandalism is a concern. All fyke net sites are selected randomly by picking a starting point on the shoreline and establishing stations every 100 meters. A random numbers table is used to select the fyke net stations. Nets may be set within 30 meters of the designated sample point to avoid obstructions. Additional segments may be selected onsite using Best Professional Judgment if certain habitats were not sampled. The number of fyke net sites is based on surface area and is a modification of the EMAP lake protocol (Baker et al. 1997; Table 4).

Table 4. The minimum number of littoral fyke net stations based on lake area, when used as a single gear. Additional stations may be necessary where habitat differences are apparent or fish density is low. Numbers in parenthesis indicate the effort that should be used in multiple gear surveys.

Lake Area (ha)	Number of fyke nets
1-4	2 (2)
5-14	3 (3)
15-29	6 (4)
30-74	9 (5)
75-149	12 (6)
150-249	15 (7)
250-599	18 (8)

Fish Processing

All fish are identified to species and measured to the nearest millimeter (mm). All fish over 25 mm, with the exception of Cyprinidae species, are weighed to the nearest gram (g). It is advantageous to weigh as many individuals as possible. However, samples with a high number of individuals in a size group may be sub-sampled to reduce processing time. A minimum of 15 individuals should be weighed for each 10 mm size group, for any species that is sub-sampled. Fish are examined for deformities, erosions, lesions or tumors (DELTs) and these anomalies are recorded on field data sheets. Specimens difficult to identify are preserved in 10% formalin for laboratory identification. All live fish are released upon processing. Fish retained for tissue analysis are processed according to Pennsylvania’s Surface Water Quality Monitoring Network document (PA DEP 2005).

IV. Data Processing and Analysis:

Data collected from fisheries surveys are interpreted with an understanding of the attributes and/or biases of sampling equipment and methods. Pennsylvania’s public lakes, ponds, and reservoir fisheries are managed under several strategies such as panfish enhancement, trout stocking, and big bass regulations. The response of the fish community, as a whole, towards different management strategies is largely unknown, but must be considered when evaluating designated use. The Department selects a number of variables to evaluate abundance, size structure, and condition of certain species, in order to determine if a response is affected by water quality conditions or nuisance vegetation. Since fish communities can be affected by both abiotic and biotic conditions, the Department uses best professional judgment in evaluating data.

Data processing and analysis

Fisheries data collected in lakes is entered into the Department’s Instream Comprehensive Evaluation (ICE) database. The type of fisheries analysis will depend on the evaluated designated use (Aquatic Life or Recreation). Results from the analysis are used in combination with other water quality indicators (i.e. water chemistry or vegetation), agency reports, land use determinations, and citizen surveys as weight-of-

evidence for attainment/impairment decisions. The fisheries variables that should be considered when evaluating the Aquatic Life Use and Recreational Use of a lake are listed below.

Aquatic Life Use:

- Abundance expressed as catch per unit effort (CPUE) for all species, individual species, and trophic groups (e.g. gamefish)
- Taxa richness
- Percent of acid tolerant taxa
- Shannon Diversity
- Length frequency data for individual species (10-mm size groups) where a minimum of 100 individuals are collected
- Mean relative weight (W_r) (Anderson and Neumann 1996) for species where 50 individuals have been weighed
- Mean relative weight (W_r) by 10-mm size groups where at least 15 individuals have been weighed
- Percentage of catch with DELT's;
- PFBC inventories and reports regarding water quality and the response of the fish community.

Recreational Use:

- Abundance expressed as catch per unit effort (CPUE) for all species, individual species, and trophic groups (e.g. gamefish)
- CPUE of stock length and preferred length gamefish and panfish species
- Length frequency data for individual species (10-mm size groups) where a minimum of 100 individuals are collected
- Mean relative weight (W_r) by species where 50 individuals have been weighed
- Mean relative weight (W_r) by 10-mm size groups where at least 15 individuals have been weighed
- Proportional Stock Density (PSD) and Relative Stock Density (RSD) of all gamefish and panfish species where at least 20 stock length fish have been collected
- PFBC inventories, creel surveys, and any other applicable information from outside sources regarding the quality of the fishery.

References

- Anderson, R. O. , and R. M. Neumann. 1996. Length, weight, and associated structural indices. Pages 441-482 *in* B.R. Murphy and D. W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.
- Baker, John R., David V. Peck, and Donna W. Sutton (editors). 1997. Environmental Monitoring and Assessment Program Surface Waters: Field Operations Manual for Lakes. EPA/620/R-97/001. U.S. Environmental Protection Agency, Washington D.C.
- Environmental Protection Agency. 2005. Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act. Office of Water, Assessment and Watershed Protection Division. 69 pp.
- Hollender, B. and D. Kristine. 1996. A comparison of the Pennsylvania trap net and fyke net. Pennsylvania Fish and Boat Commission, Fisheries Management Division Area 3. 450 Robinson Lane. Bellefonte, Pennsylvania.
- Hoopes, R. L. 1989. Lake examination manual. Pennsylvania Fish and Boat Commission 450 Robinson Lane. Bellefonte, Pennsylvania.
- Pennsylvania Department of Environmental Protection (PA DEP). 2005. WQN Program Guidance for Fish Tissue Sampling Methods: Document No. 3800-FS-DEP2700 on the web at: (www.dep.state.pa.us) Harrisburg, PA.

Appendix 1

Modified Fyke Net Specifications:

Miller Net Company Inc., Memphis, TN or equivalent.

5/8" diameter fiberglass frame construction with pot dimensions measuring 6 feet in width, 3 feet in height, and 32 inches in depth between the frames having a pot volume of 48 ft³ (1.44 m³). Four hoops of 1/2" by 1/2" fiberglass with 30" diameter frames will be approximately 32" from the second frame and the remaining hoops will be approximately 24 inches apart. Netting material will be 1/2" square #126 L knotless nylon, with #18 nylon twine to set nets to frame and the net set will be treated after it is tied to frame. Netting from the second frame will have a slit throat and the first hoop will have a 6 inch throat. The cod end of the net will have a drawstring closure with 5 feet of #5 braided nylon tail rope with 2" O.D. ring of 1/4" galvanized steel attached.

The fyke net lead (attached to the center support) will measure 100 feet in length and 3 feet in height. The net set will be treated and constructed of 1/2" square # 126L knotless nylon. The floating line is made of 5/16" polypropylene rope with #12 lead every 8 inches, bridle made of 5/16 polypropylene rope. One end to be extended 3 feet with O.D. ring of 1/4" steel attached. The other end must be permanently attached to the fyke net frame.