
Great Lakes Fish Monitoring and Surveillance Program

Quality Assurance Project Plan for Sample Collection Activities

Version 3.0, September 2025

Great Lakes Fish Monitoring and Surveillance Program

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Revision History

| Version/Date | Description | Affected QAPP Sections |
|----------------|--|---|
| Ver. 1.0, 2008 | Original QAPP prepared/signed | All |
| Ver. 2.0, 2012 | 1. Updated program name to Great Lakes Fish Monitoring <i>and Surveillance</i> Program 2. Updated program history, recent activities, and program changes since 2008 3. As the program has matured, more detail has been documented regarding program elements including quality objectives and criteria, quality control, reports to management, data review, validation and verification requirements, etc. | 1. Throughout 2. Throughout 3. Throughout |
| Ver. 3.0, 2025 | 1. Conducted technical review of document 2. Conducted technical review of SOPs 3. Updated Program Organization Chart in QAPP 4. Updated Project Implementation Roles in QAPP 5. Removed descriptions of GLFMSP CSMI/Special Studies Program Collection of individual Lake Trout or Walleye, eggs, stomach contents, and forage fish species from the body of the QAPP 6. Removed Appendix B.2 (<i>GLFMSP CSMI/Special Studies Program Collection of Individual Fish, Eggs, and Stomach Contents Field Recording Form and Chain-of-Custody Record</i>) 7. Removed Appendix B.3 (<i>GLFMSP CSMI/Special Studies Program Collection of Forage Fish Field Recording Form and Chain-of-Custody Record</i>) | 1. Throughout 2. Throughout 3. A4.1 4. A4.2 5. Throughout 6. Appendix B.2 7. Appendix B.3 |

Great Lakes Fish Monitoring and Surveillance Program

Quality Assurance Project Plan for Sample Collection Activities

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Acronyms and Abbreviations

| | |
|--------|--|
| CEC | Contaminants of Emerging Concern |
| CSMI | Cooperative Science and Monitoring Initiative |
| CWTs | Coded Wire Tags |
| DNR | Department of Natural Resources |
| DQOs | Data Quality Objectives |
| EPA | U.S. Environmental Protection Agency |
| FAA | Fatty Acid Analysis |
| GLENDa | Great Lakes Environmental Database |
| GLFC | Great Lakes Fisheries Commission |
| GLFMP | Great Lakes Fish Monitoring Program |
| GLFMSP | Great Lakes Fish Monitoring and Surveillance Program |
| GLNPO | Great Lakes National Program Office |
| GLRI | Great Lakes Restoration Initiative |
| GLWQA | Great Lakes Water Quality Agreement |
| GPS | Global-Positioning System |
| LAMPs | Lakewide Action and Management Plans |
| LOY | Lake of the Year |
| MQOs | Measurement Quality Objectives |
| PI | Principal Investigator |
| QA/QC | Quality Assurance/Quality Control |
| QM | Quality Management |
| QMP | Quality Management Plan |
| QAPP | Quality Assurance Project Plan |
| SCA | Stomach Contents Analysis |
| SIA | Stable Isotope Analysis |
| SOP | Standard Operating Procedure |
| SQAB | Science and Quality Assurance Branch |
| US EPA | United States Environmental Protection Agency |
| USFDA | United States Food and Drug Administration |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |

A.3 Distribution List

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Principal Investigator(s) of the Great Lakes Fish Monitoring and Surveillance Program (identified every 5 years)

Field Sampling Teams (identified annually)

Data Verification and Validation Contractor

A.4 Project/Task Organization

This Quality Assurance Project Plan (QAPP) describes the quality assurance (QA) and quality control (QC) activities and procedures associated with collecting samples of fish tissue for the Great Lakes Fish Monitoring and Surveillance Program (GLFMSP). The purpose of this document is to present the methods and procedures that are used for the collection of fish from the five Great Lakes as part of cooperative efforts to monitor the concentrations of contaminants in fish tissues. This document addresses the fish sample collection efforts of the GLFMSP only.

A4.1 Project Management

The GLFMSP is implemented by the United States Environmental Protection Agency's (US EPA) Great Lakes National Program Office (GLNPO). Fish samples utilized in this program are collected by partners including Great Lakes States resource agencies, federal agencies, and tribal organizations. Sampling teams record sample weights, measurements, and complete field recording forms prior to shipment of collected fish to the homogenization laboratory. The homogenization laboratory is responsible for taking physical measurements (e.g., weight, length, gender and maturation stage assessments, etc.), identifying abnormalities, collecting samples for aging purposes (e.g., scales, otoliths, and coded wire tags) and compositing and homogenizing the samples. The homogenization laboratory prepares aliquots of each sample composite and ships them to an EPA contracted archival facility and an EPA-funded cooperator analytical laboratory. The analytical laboratory is responsible for analyzing the samples received from the homogenization laboratory.

This section describes the overall management and lines of authority within GLNPO and the participants supporting the GLFMSP. It includes an organization chart illustrating the relationships between groups participating in the major study activities (Figure 1).

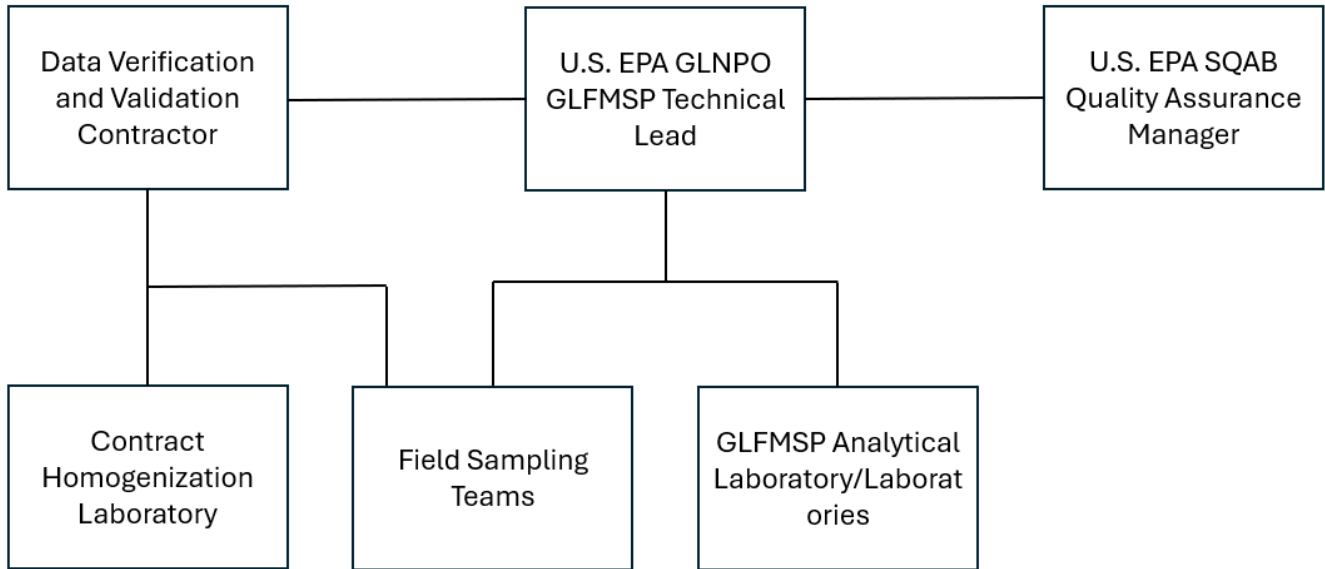


Figure 1. Participants in the Great Lakes Fish Monitoring and Surveillance Program

A4.2 Project Implementation

Great Lakes National Program Office Director

The **GLNPO Director** is responsible for providing programmatic oversight and approving use of financial and staff resources necessary to meet project objectives and implement the requirements described in this QAPP.

Science, Monitoring, Evaluation, and Reporting Section Supervisor

The **Science, Monitoring, Evaluation, and Reporting Section Supervisor** reports directly to the Great Lakes Remediation and Restoration Branch Manager and is responsible for overseeing and assisting the GLFMSP Technical Lead in implementing the GLFMSP.

SQAB Quality Assurance Manager

The **SQAB Quality Assurance Manager**, is responsible for reviewing and approving all QAPPs. Additional SQAB Quality Assurance Manager responsibilities include reviewing and evaluating field procedures, conducting external performance and system audits of the procedures, and participating in Agency QA reviews of the study.

GLFMSP Technical Lead & Quality Assurance Manager

The **GLFMSP Technical Lead & Quality Assurance Manager**, is responsible for:

- providing oversight for implementation of GLFMSP study design,
- ensuring adherence to study design and accomplishment of project objectives,
- reviewing and approving project work plans, updating the GLFMSP QAPP, approving analytical datasets, and other materials developed to support the project,
- coordinating with contractors, cooperators, and Federal, States, tribal fish collection partners to ensure technical quality and contract/grant adherence, and
- managing GLFMSP records.
- coordinating with Data Verification and Validation Contractor to address and correct data issues that arise from field sampling teams

Field Sampling Teams

Field sampling teams are partnered with GLNPO and may include personnel from:

- state resource management agencies,
- federal agencies, and
- tribal organizations and/or tribal members

Field sampling teams are identified by GLNPO prior to the sampling event. A field sampling team leader is identified as the primary contact for study implementation. Sample collection personnel are responsible for performing fieldwork, including: collection, preparation, shipment of fish tissue samples, and completion of field sampling records. The field sampling teams must adhere to the established sample collection protocols (see Appendix A). They must perform all work in adherence with the project work plan and the QAPP, to the best of their abilities. Labeling of individual fish is required to ensure the integrity of the samples and to maintain proper sample identification during handling. In this role, field sampling teams are responsible for:

- reviewing standard operating procedures (SOPs) and this QAPP prior to sample collection,
- determining the appropriate sampling techniques,
- choosing and preparing appropriate sampling gear,
- inspecting sampling gear prior to use,
- collecting fish samples,
- receiving and inspecting the sample containers,
- completing, reviewing, and signing appropriate field recording form and chain-of-custody record (Appendix B),
- preparing and adhering labels to each individual fish sample,
- maintaining custody of the samples by controlling and monitoring access to samples while in their custody,
- shipping samples to appropriate destinations, and
- ensuring all sampling and sample handling activities are in compliance with GLNPO procedures as described in this QAPP and the attached SOPs.

Field sampling teams ship samples to the EPA-designated homogenization contract laboratory.

Data Verification and Validation Contractor

The Data Verification and Validation contractor is responsible for coordinating with field samplers to create a schedule for shipping sampling supplies and procuring fish homogenization laboratory services. The Data Verification and Validation contractor creates sampling kits and shipping kits and ships them to the field sampling teams. The Data Verification and Validation contractor also provides the field sampling teams with hardcopy versions of the field recording form and chain-of-custody record, SOPs, and fish sample identification labels on an annual basis. The Data Verification and Validation contractor staff arrange for the shipment of samples between the field sampling teams, homogenization laboratory, and analytical laboratory. The Data Verification and Validation contractor is responsible for sub-contracting homogenization laboratory services support to the GLFMSP.

The Data Verification and Validation contractor formats the field data submitted by field sampling teams to the Great Lakes Environmental Database (GLENDa) reporting standard, conducts checks to ensure that all necessary information has been provided, and takes action to resolve any discrepancies. The Data Verification and Validation contractor enters data provided by the homogenization laboratory into GLENDa for the applicable sampling year and conducts a check on the data to ensure accuracy. The Data Verification and Validation contractor takes action to resolve any discrepancies in the data.-All support provided to the GLFMSP by the Data Verification and Validation contractor is done according to procedures described in the *Quality Assurance Project Plan for CSRA Support to the Great Lake Fish Monitoring and Surveillance Program (Version 1.0, April 2020)*.

Homogenization Laboratory

Field sampling teams ship fish samples to the homogenization laboratory. The homogenization laboratory records physical measurements, collects coded wire tags, scales, and otoliths when applicable, records any abnormalities (e.g., tumors, fins missing, wounds, etc.), prepares composites of the samples, homogenizes the samples utilizing the whole-fish, and prepares mega-composites of the samples. Each mega-composite includes tissue from all “regular” composites from a single site. The homogenization laboratory also prepares aliquots from composites, individual samples, and mega-composites and sends them to an EPA-specified archival facility and the EPA cooperator analytical laboratory.

The homogenization laboratory must adhere to the sample receipt requirements, sample preparation and physical data collection requirements, homogenization requirements, aliquot creation requirements, sampling handling and custody requirements, and QC requirements outlined in their Statement of Work (SOW) with the Data Verification and Validation contractor. The SOW for the homogenization laboratory is updated and reviewed annually by the Data Verification and Validation contractor. The homogenization lab must have approved SOPs in place prior to beginning work. Any deviations from the SOPs should be approved prior to implementation by the GLFMSP Technical Lead or if the deviation was unintentional, reported by the Data Verification and Validation contractor to the GLFMSP Technical Lead.

Homogenized samples are shipped by the homogenization laboratory to the EPA cooperator analytical laboratory. The analyses of the fish tissue samples are *not* covered by this QAPP.

A.5 Problem Definition/Background

The GLFMSP is a long-term monitoring program designed to: 1) collect, analyze, and report contaminant concentrations in Great Lakes top-predator fish (Lake Trout [*Salvelinus namaycush*] and Walleye [*Sander vitreus*]), 2) improve understanding of contaminant cycling throughout food webs in the Great Lakes, and 3) screen for emerging chemicals in fish tissue to identify priority chemicals warranting future trend analysis and study.

Fish collection for the program is performed by partnering federal agencies, Great Lake states, and tribal organizations and/or tribal members. The design of the GLFMSP includes these components:

1. Base Monitoring Program
2. New and Emerging Chemical Surveillance and Special Studies

More information about these programs is provided in Section A6. Table 1 provides a brief history of the GLFMSP.

Table 1. GLFMSP History

| Date | Event |
|-----------|--|
| Mid 1960s | U.S. Geological Survey Great Lakes Science Center (USGS-GLSC) (formerly known as U.S. Fish and Wildlife Service Great Lakes Fishery Laboratory) begins monitoring fish in Lake Michigan to measure the contaminant levels of various organic substances in Lake Trout in the Great Lakes ecosystem. |
| 1977 | USGS-GLSC collaborates with US EPA/GLNPO to form the Great Lakes Fish Monitoring Program (GLFMP) to monitor top predator fish in the Great Lakes. The original study design is modified to generate more data by including additional species, sampling locations, and contaminants. Through this cooperative agreement, a partnership is formed, with USGS collecting and processing the fish, and US EPA funding the analyses. |

| Date | Event |
|-------------|--|
| Early 1980s | <p>GLFMP is expanded to include sport fish (Coho and Chinook salmon) to directly link the condition of the Great Lakes to the health of it users. Each Great Lakes State collects 15 fillets from Coho of Chinook salmon at designated sites.</p> <p>The Great Lakes States and the U.S. Food and Drug Administration (USFDA) become additional partners, with the States voluntarily collecting sport fish and the USFDA processing and analyzing the samples for toxic chemicals.</p> |
| 1998 | USFDA withdraws from the cooperative agreement to analyze contaminants in sport fish. |
| 2003 | USGS-GLSC discontinues cooperative agreement to analyze contaminants in whole fish, leaving GLNPO as the sole supporter of the program, both financially and through staff support. |
| 2005 | A program review sponsored by the US EPA occurred. The program review included an overview of the history of the GLFMP, current sampling plan, historical record of target analytes and data management, current program, Quality Management Program data storage, stakeholder use of GLFMP data, and technical charge. The GLFMP review panel made recommendations for consideration by GLNPO to help revise and enhance the GLMFP to better fit with current environmental conditions and better serve stakeholders. |
| 2007 | A peer review is conducted on the GLFMP to enhance the quality and validity of the program and ensure that the data generated under the program are statistically sound and representative of the current environment. |
| 2009 | <p>In response to suggestions provided in peer review and careful assessment by GLNPO Management, Sport Fish Monitoring is eliminated from the GLFMP.</p> <p>The Emerging Chemical Surveillance Program is added to the GLFMP.</p> <p>The program name changes from GLFMP to Great Lakes Fish Monitoring and Surveillance Program (GLFMSP).</p> |
| 2011 | The CSMI/Special Studies Program is added to the GLFMSP. |
| 2025 | The collection of individual Lake Trout and forage fish is removed from the GLFMSP. |

Since the inception of the GLFMSP, a suite of metals and organic chemicals have been analyzed in fish samples collected in the Great Lakes Basin. The list of analytes has changed in response to both funding availability and information needs regarding new and emerging contaminants.

Analytes and fish tissue parameters measured by the GLFMSP are listed in Table 2.

Table 2. Analytes and parameters analyzed in fish composite samples by the GLFMSP.

| Analyte |
|---|
| Polychlorinated biphenyl (PCB) congeners (143) |
| Coplanar PCBs (4) |
| Total PCBs |
| Hexabromocyclododecane isomers (3) |
| Total hexabromocyclododecane |
| Total toxaphene and toxaphene homologs (3) |
| Polybrominated diphenyl ether (PBDE) congeners (25) |
| Total PDBEs |
| Total mercury |
| Organochlorine pesticides (21) |
| Polybrominated biphenyl (PBB)-153 |
| Polychlorinated dibenzodioxin (PCDD) congeners (7) |
| Polychlorinated dibenzofuran (PCDF) congeners (10) |
| Total PCDDs |
| Total PCDFs |
| Polychlorinated naphthalenes (41) |
| Polycyclic aromatic hydrocarbons (PAHs) (16) |
| Per- and polyfluoroalkyl substances (PFAS) including perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid (PFHxS), perfluoroheptanoic acid (PFHpA), perfluorobutanoic acid (PFBA), perfluorobutane sulfonic acid (PFBS), perfluoroalkyl carboxylic acid (PFCA) (26) |
| Short-chain chlorinated paraffins (SCCPs) |
| Lipid fraction of fish composites |
| Omega-3 fatty acids of fish composites (39) |
| Sample percent moisture of fish composites |

A.6 Project/Task Description

The GLFMSP consists of the Base Monitoring Program and the New and Emerging Chemical Surveillance and Special Studies Program. The GLFMSP is a long-term monitoring program designed to: 1) collect, analyze, and report contaminant concentrations in Great Lakes top-predator fish (Lake Trout [*Salvelinus namaycush*] and Walleye [*Sander vitreus*]), 2) improve understanding of contaminant cycling throughout food webs in the Great Lakes, and 3) screen for emerging chemicals in fish tissue to identify priority chemicals warranting future trend analysis and study.

A6.1 Base Monitoring Program

The Base Monitoring Program is designed to monitor the health of the Great Lakes ecosystem, using whole top predator fish (Lake Trout and Walleye) as biomonitors, for select contaminants to determine general trends through collection of high quality data using identified and approved methodology. These data also can be used to assess the risks of such contaminants on the health of this important fishery, and on wildlife that consume them. The Base Monitoring Program involves collection and analysis of predatory fish from all five Great Lakes on an annual basis, with slight differences in design during even and odd years. Top predator fish like Lake Trout and Walleye have been extensively used as bioindicators of the overall condition of the Great Lakes system and serve as excellent contaminant biomonitors by encompassing both water and sediment exposures through pelagic and benthic routes. During odd years, 50 Lake Trout (*Salvelinus namaycush*) in the size range of 600 mm to 700 mm will be collected in each of the five Great Lakes. During even years, 50 Lake Trout in the size range of 600 mm to 700 mm will be collected from four of the five Great Lakes (Huron, Michigan, Ontario, and Superior) and 50 Walleye (*Stizostedion vitreum*) in the size range of 400 mm to 500 mm will be collected from Lake Erie. Composites of each species, consisting of five individual fish, are analyzed for contaminants to assess temporal trends in organic contaminants and mercury in the open water of the Great Lakes. Because this part of the program was designed to assess the overall effects of toxic chemicals on fish, whole fish are used for analysis, including parts not routinely eaten by humans such as liver and bones.

Each lake contains two sampling sites. Chosen sites represent offshore fishing grounds (i.e., sampling sites should represent open water populations of fish) and are well removed from tributaries or other potential sources of contaminants. These locations are sampled alternately each year at approximately the same time of year. Detailed information on GLFMSP sampling sites is provided in Section B.

A6.2 New and Emerging Chemical Surveillance and Special Studies

The New and Emerging Chemical Surveillance and Special Studies component is directed at screening for emerging chemicals in fish tissue according to their persistent, bioaccumulative, and/or toxic chemical properties. This program utilizes samples collected for the Base Monitoring Program to determine the presence of Contaminants of Emerging Concern (CEC), identify and guide State and Federal monitoring programs in the development of their analyte lists and priority setting, and to incorporate emerging CECs into the routine analyte list for the Base Monitoring Program. Identification of CECs is accomplished through two methods. The first method involves performing a detailed “Full Scan” analysis of Great Lakes fish by screening for a set of previously identified contaminants in composite samples and analyzing extracts for previously unidentified peaks (non-legacy contaminants). The second method involves working from the US EPA sponsored *Potential Emerging Contaminant List* developed by Muir and Howard (*Howard & Muir, 2010*). This list is based on high and medium production volume chemicals in the United States and Canada. Retrospective analysis may be conducted upon archived samples if a CEC is identified.

The goals of the New and Emerging Chemical Surveillance and Special Studies component are to:

- Screen for a set of previously identified CECs,
- Determine the presence of CECs,
- Incorporate CECs into the routine analyte list for the Base Monitoring Program
- Allow analytical laboratory to propose additional monitoring activities to enhance the GLFMSP.

The analytical laboratory may propose additional special studies within submitted applications for funding. These studies are subject to GLNPO approval and are not detailed within this QAPP.

A6.3 Project Design

Field sampling teams collect fish using methods described in the EPA *GLFMSP Base Monitoring Program Sample Collection SOP V.2.0* (Appendix A). Samples include Lake Trout and Walleye (which are grouped into composites by the homogenization laboratory). Field sampling teams must adhere to the established sample collection protocols for collection, labeling, and shipping samples (Appendix A), to the best of their abilities. This QAPP is for fish sample collection efforts only.

When sample collection efforts are complete, field sampling teams ship their samples to the EPA-designated homogenization laboratory.

The homogenization laboratory performs the following steps:

- Collect physical data on the samples,
- Identify external abnormalities (e.g., tumors, fins missing, wounds, etc.),
- Collect samples for aging purposes (e.g., scales, otoliths, and coded wire tags),
- Prepare composites of samples,
- Homogenize composites,
- Prepare mega-composites of samples from each site (representing all samples from a given lake or site),
- Prepare aliquots, and
- Ship the aliquots to the cooperator analytical laboratory/laboratories and EPA-designated archival facility.

A generalized fish collection work schedule is shown in Table 3.

Table 3. Fish Collection Work Schedule

| Date* | Action | Person Responsible |
|---|---|---|
| January prior to fall collection | Begin to coordinate collection efforts | GLFMSP Technical Lead Technical Lead and Data Verification and Validation Contractor |
| April – May prior to fall collection | Distribute collection SOPs and sampling materials to Field Sampling Teams | Data Verification and Validation Contractor |
| August - October of collection year | Samples collected | Identified collection personnel |
| October – December of collection year | Coordination of sample shipment to homogenization laboratory | Data Verification and Validation Contractor |
| January – April following a collection year | Homogenization of samples | Contract homogenization lab personnel |
| April following a collection year | Coordination of shipment of homogenized samples to analytical laboratory/laboratories and archival facility | Data Verification and Validation contractor |
| May following a collection year | Coordination of shipment of coded wire tags, otoliths, fish scales, and fin clips from the homogenization laboratory to Data Verification and Validation contractor | Data Verification and Validation contractor |
| June following a collection year | Submission of final homogenization deliverable package to Data Verification and Validation contractor | Contract homogenization lab personnel |
| July following a collection year | Review of final homogenization deliverable package and submission to GLFMSP Technical Lead | Data Verification and Validation contractor |
| May – July following a collection year | Review of sample analysis report | GLFMSP Technical Lead, Quality Manager |

* These are estimated timeframes.

A.7 Quality Objectives and Criteria

A7.1 Representativeness

Several factors played a role in the selection of Lake Trout for the GLFMSP. Lake trout are top predators and long lived and are considered to be excellent concentrators of contaminants. Walleye were chosen to be collected in western Lake Erie because they also share a similar trophic position as Lake Trout and were available in greater abundance than Lake Trout within western Lake Erie.

A limitation of the GLFMSP is the fact that fish are difficult to use as indicators of environmental quality without adequate past history information. Scientists do not know the full locational history of where each fish has traveled and resided throughout its lifetime, and without that information it is difficult to georeference the environment for which that sample represents. These fish are highly mobile, however sampling sites remain fixed and the collection period is constrained to the same temporal window every year in order to minimize introduction of spatial and temporal variability. GLFMSP data is used for site-specific statements, not lake-wide

statements. Because each lake is a unique ecosystem, a discussion of each individual lake's representativeness is included below.

Lake Michigan

There are two GLFMSP sampling sites located in Lake Michigan:

- Saugatuck in the southeastern part of the lake, and
- Sturgeon Bay in the northwestern part of the lake.

Schmalz et al. 2002 studied a population of Lake Trout in northwestern Lake Michigan to determine the distances that they would travel. Based on other Lake Trout movement studies that have been completed in Lake Michigan and Lake Superior, they hypothesized that Lake Trout would occupy an area within 80 km of the tagging location. Their results concurred with the prior studies, showing that Lake Trout recaptured during 1983-1997 in northwestern Lake Michigan did not travel far, but rather remained within a fairly well-defined area with a radius of approximately 68 km. The Lake Trout tagged in the fall did return to the same spawning reefs in successive years, but it appeared that the Lake Trout occupied the same general area during the whole year, rather than demonstrating distinct movement patterns in the fall. Lake Trout movement tended to be greater along the western shore than across the open waters of Lake Michigan. The Lake Trout in the study would only have had to travel 80 km directly east to reach the Michigan shore; however, only nine recaptures were made on the Michigan side of the lake, compared to 182 recaptures along the western shore at distances more than 80 km. This suggests that areas of open water may separate Lake Trout stocks in northern Lake Michigan.

The two GLFMSP sites in Lake Michigan represent distinct populations of Lake Trout. Based upon their locations, it can be assumed that there is very little transfer of fish between the sites. However, there may always be exceptions to the rule. Some factors that could cause Lake Trout to move further than expected could be increased adult population density, which can lead to increased dispersal radius, spawning, food and environmental conditions. Other movement is simply random. Fish collected at each GLFMSP site in Lake Michigan have most likely traveled over long distances during their life cycles and thus are representative of an area of approximately 68 km surrounding the collection site.

Lake Superior

There are two GLFMSP sites in Lake Superior:

- The Apostle Islands in western Lake Superior in Wisconsin waters, and
- Keweenaw Point in eastern Lake Superior in Michigan waters.

The Wisconsin Department of Natural Resources (DNR) Bayfield Office has participated in GLFMSP Lake Trout collections from the Apostle Islands site since the early 1990s. The Wisconsin DNR has collected the fish in 7.5-19.8 feet of water off of the Gull Island Shoal during spawning in mid-October. Recaptures and tag returns from anglers indicate that many Lake Trout stay within the Gull Island Refuge after spawning, while some travel east to the Keweenaw Peninsula in Michigan. Some Lake Trout may travel around the Peninsula into Keweenaw Bay. Generally, the fish collected at the Apostle Islands represent the western end of Lake Superior and are not influenced by Duluth Harbor (Schram, 2005). Michigan DNR in Marquette assisted in collection of Lake Trout from the Keweenaw Point site prior to 2005, and since that time Lake Trout at this site are collected by the Great Lakes Indian Fish and Wildlife Commission Michigan DNR has suggested that Lake Trout in Lake Superior travel about 50 km from their home spawning area. In addition to the physical separation between the two Lake Superior sites, GLNPO may also need to take into consideration the differences between

the types of fish in Lake Superior (e.g., siscowet Lake Trout versus lean Lake Trout). The Keweenaw Point site has a large siscowet population and these fish tend to live in deeper waters while lean Lake Trout (collected for GLFMSP) tend to inhabit more shallow waters. Since these morphotypes have different habitats, their contaminant exposure is different during their lifetimes. A concern exists that siscowets are frequently found in deeper water and can be mistaken for lean Lake Trout when collected by inexperienced staff. In order to avoid this situation, Michigan DNR has suggested to GLNPO to take lateral head photographs and whole body shots to create a photographic archive to decrease variability in future collections. At a minimum, fish collectors should be trained to distinguish between the two morphologies before annual collections (Sitar, 2005). Currently, EPA is piloting studies using stable isotopes to differentiate habitats of these Lake Trout morphotypes when interpreting contaminant data.

Lake Superior Lake Trout are mostly wild fish and have homing instincts to return to their spawning reefs every fall. For this reason, fish are collected from the same population every year at each site and those populations are distinct from one another. Historically, before the wild Lake Trout populations stabilized, some hatchery fish were collected along with wild fish. Although the hatchery fish do not have the homing instincts of the wild fish, they tend to stay in the same general area where they were released so distinct populations were still most likely being collected. Because the diets of the hatchery fish and wild fish are similar (e.g., smelt, whitefish, chubs and herring), the mix of hatchery and wild Lake Trout most likely did not significantly affect measured contaminant concentrations. Kapuscinski et al., 2005 studied the movement of Lake Trout in Lake Superior from 1973 to 2001 and found that a fair proportion of the fish do not travel long distances, but rather stay within about 42 km of the spawning reef. Some Lake Trout do travel further distances and may integrate more of the lake. However, based on the observations of scientists in the field and the Kapuscinski et al. 2005 study, it can be assumed that the fish from each site are representative of a surrounding area of about 50 km.

Lake Huron

There are two GLFMSP sites located in Lake Huron:

- Rockport in the northwest area of the lake, and
- Port Austin in the southwest area of the lake.

Both sites are located in Michigan waters of Lake Huron. The Michigan side of Lake Huron is essentially divided into three separate management units and populations of Lake Trout (MH1 – MH3) (Johnson et al., 2004). MH1 extends from the Straights of Mackinaw south to Rogers City (Northwest of Rockport) and is the coldest part of the lake. Lake trout are slower growing in MH1 due to the limited nutrients associated with this area and seem to have the most lamprey wounds compared to the other two regions. MH2 is located in the Rockport area and extends from Rogers City south to the Black River Harbor (south of Thunder Bay). The GLFMSP site of Rockport is included in this management area. MH3 is located in the Port Austin area and extends from River Harbor to the southernmost point in the lake. The GLFMSP site of Port Austin is included in this management area. There is a gradient across the management units with increasing growth rates and decreasing lamprey wounding rates from north to south. The MH1 fish do not migrate into any other management units (McClain et al, 1998), while the MH2 fish do sometimes migrate to the MH1 area. MH3 fish tend to migrate in a southeasterly direction (McClain et al., 1998), although some do migrate into Saginaw Bay, which is not included in MH3 (Johnson, 2005). There is some mixing between Canadian and U.S. Lake Trout in the Lake's main basin, but there is no mixing between the Georgian Bay and the North Channel and the main basin. Lake Huron has a lot of structural diversity which helps explain why the fish are separate populations and do not travel far from their management units.

Lake Erie

There are two GLFMSP sites located in Lake Erie:

- Dunkirk in the eastern basin of the lake along the New York coastline, and
- Middle Bass Island in the western basin of the lake Erie off the coast of Ohio.

Lake Erie is separated into three distinct basins along an east-west axis and separated by shoals and reefs. The western basin extends from Toledo in the U.S. at the western tip of the lake to Point Pelee in Ontario and is the shallowest basin with an average depth of around seven meters. The central basin extends from Point Pelee to Long Point in Ontario and averages about 20 meters in depth. The eastern basin extends from Long Point to Buffalo, NY in the U.S. and has an average depth of about 40 meters. At the time the program was designed, Walleye were selected for the GLFMSP in Lake Erie due to the limited availability of Lake Trout. The Lake Trout population is now self-sustaining in the eastern basin of Lake Erie; therefore, in 2011 Lake Trout began to be collected in the eastern basin during odd years. Collection of Lake Trout in Lake Erie allows for data comparison with Lake Trout collected in the other Great Lakes. Lake Erie's sample collection site in the western basin is still not capable of supporting a self-sustaining Lake Trout population due to the shallow waters; therefore, Walleye are still collected there during even years.

Several tag-recapture studies have been completed over the years examining Walleye movement and distribution in Lake Erie. These studies include two New York State Department of Environmental Conservation reports, "Distribution of Marked Walleye in New York Waters of Lake Erie and A Preliminary Examination of Walleye Distribution" (Einhouse and Shepard, 1988) and "Exploitation in the Eastern Basin of Lake Erie Using Tag-Recapture Data" (Einhouse and Haas, 1995). Both of these studies suggest that the eastern Walleye occupying New York waters are essentially local and do not seem to stray much from their original spawning sites. The 1995 study, however, also demonstrated that unlike the eastern Walleye, the western Walleye do tend to migrate large distances and thus contribute to lake-wide fisheries. Large female Walleye were typically the segment of the western basin tagged Walleye population that has a range extending into eastern Lake Erie. These studies also demonstrated the homing behavior of Walleye to their spawning site each spring. Although the GLFMSP fish sampling teams collect Lake Trout during their fall spawning season, the Walleye are still migrating during the fall collection and do not return home until the spring to spawn. Because of this migration, it can be assumed that some western basin Walleye are collected each fall in the Dunkirk site. However this is no longer a concern since Lake Trout have been the target species at the Dunkirk site since 2011. The Middle Bass Island collection site is most likely composed of western basin Walleye, some which may have traveled throughout the entire lake during their lifetimes. These fish also may have traveled north after spawning into the Detroit River, Lake St. Clair, and into Lake Huron.

Lake Ontario

There are two GLFMSP sites located in Lake Ontario along the New York coastline:

- North Hamlin in the central part of the lake, and
- Oswego in eastern part of the lake.

North Hamlin is located approximately equidistant from the western and eastern coasts near Rochester, N.Y. Oswego is located well east of North Hamlin, near the mouth of the Oswego River. There have been two main studies published regarding Lake Trout dispersal in Lake Ontario (Elrod, 1987, Elrod, et al., 1996), and both have concluded that most of the Lake Trout remain in the same general region where they were initially stocked. According to these studies, fish stocked east of the Niagara River rarely crossed the river mouth into Canadian waters west of the river. Also, few Lake Trout moved across Lake Ontario between the north and south shores, or between the eastern outlet basin and the main lake basin. North Hamlin is one of the stocking sites in Lake Ontario, and both studies found that fish stocked at North Hamlin tend to disperse both east and west. Elrod 1987 reported that the dispersal was not caused by random swimming movements, but was greatly affected by

currents. North Hamlin is one of four south-shore stocking sites, and 84% of the fish stocked at those sites were found within 30 km of where they were stocked (Elrod, 1987). Although Oswego is not one of Lake Ontario's four stocking sites, it does lay between two of the south-shore sites, Sodus and Mexico Bay. Based on the 1996 study, fish stocked at North Hamlin tend to move along most of the southern shore and do not typically travel west of the Niagara River or into the eastern basin of Lake Ontario. Fish stocked near Oswego, also tend to integrate much of the southern shore of Lake Ontario. However, fish stocked at North Hamlin appear to be spending more time integrating the western side of the southern shore, while the Oswego fish appear to spend more time integrating the eastern side of the southern shore (Elrod et al., 1996). It appears that mature Lake Trout do have some tendencies to return to their stocking sites in preparation for fall spawning. However, this tendency appears to be weak (Elrod et al., 1996).

A7.2 Comparability

Size is used as a surrogate to age during collection activities; therefore fish in a narrow size range (Table 5) are targeted each year. These fish are collected from the same sampling location every other year at approximately the same time of year, allowing for the assessment of trends across years.

A7.3 Project Quality Objectives

The Data Quality Objective (DQO) process can be used for systematic planning and is described in US EPA's document *Guidance for the Data Quality Objective Process* (US EPA, 2006). Generally, DQOs are qualitative and quantitative statements that clarify the intended use of the data, define the type of data needed to support the decision, identify the conditions under which the data should be collected, and specify tolerable limits on the probability of making a decision error due to uncertainty in the data. Essentially, the DQO design is intended to answer the primary question of the program. It is the responsibility of the GLFMSP Technical Lead to define this allowable uncertainty and develop DQOs.

Sources of error or uncertainty include the following:

- Sampling error: The difference between sample values and *in situ* true values from unknown biases due to collection methods and sampling design.
- Measurement error: The difference between sample values and *in situ* true values associated with the measurement process. This includes error sources or biases associated with compositing, sample handling, storage, and preservation.
- Natural variation: Natural spatial heterogeneity and temporal variability in population abundance and distribution.

Original Project Quality Objectives

GLNPO entered into a cooperative agreement with the USGS-GLSC in 1977 (Appendix C.8 of GLFMSP QMP). This cooperative program built upon an existing USGS-GLSC Lake Michigan Lake Trout monitoring program that originated in the 1960s. This existing USGS-GLSC program was used to estimate the appropriate sample size and any resulting uncertainties from collection. The original sampling design stated that a 10% change in contaminant residue levels was statistically significant in a sample size of 40-60 individuals or 12 composites of 10 in the 240-280 mm size range (*Contaminants Surveillance Program for the Great Lakes, Rationale and Design* [Appendix C.6 of GLFMSP QMP]). The original design of the GLFMSP attempted to

balance the USGS-GLSC's sampling design with a limited budget. The resulting goal of the GLFMSP Base Monitoring Program became the ability to detect a 20% change from current contaminant levels by analysis of variance where $\alpha = .05$ and $\beta = .20$ with a minimum collection of 20 fish within a specified size range. The GLFMSP's collection scheme called for the collection of 60 Lake Trout (or Walleye) per site each year in 3 size categories, small (300-450 mm), medium (451-650 mm), and large (>650 mm), with 20 fish in each category. To reduce analytical costs, the fish were grouped into four composite samples consisting of five fish each within each size category. The GLFMSP was initially designed to compare contaminant levels in fish, both temporally and spatially, in the three size categories collected from each site through analysis of covariance (DeVault *et al.*, 1986).

The original sampling design of the GLFMSP was adhered to following the creation of the cooperative agreement. However, the design was not sufficient to meet the program's goal of a 20% detectable change in contaminant concentration between consecutive sampling periods at each site within the 95% confidence interval. In 1979, the analytical and collection designs of the program were revised to use mean statistics for specific size ranges of fish to compare contaminant concentrations between sites and within sites over time.

Deviations from GLFMSP Standard Operating Procedures

Sample Size

The number of fish collected for the GLFMSP may vary from year to year due to unforeseen circumstances when collecting live fish. When fewer than the target of 50 fish (ten composites of five fish) are collected at a site for the Base Monitoring Program, then fewer than the target number of composites are analyzed, while keeping the number of fish per composite constant at five in order to maintain consistency in data at the individual composite level. For example, if only 47 fish are caught at a site in a given year, then nine composites of five fish would be prepared, rather than creating seven composites of five fish and three composites of four fish (or a different alternate scheme). An alternative approach may be considered if the number of fish collected is significantly lower than the target. Variability in the data should be taken into account when making final decisions.

The original sampling design for the GLFMSP Base Monitoring Program called for the collection of Walleye from Lake Erie in the 400 – 500 mm size range (DeVault *et al.*, 1996). However, according to the USGS QAPP for sample collection, *Monitoring Trends of Selected PCB Congeners and Pesticides in Fish from the Great Lakes, 1991, 1992, and 1993*, the range for Walleye collection was between 450 and 550 mm. USGS was responsible for fish collections for the GLFMSP from 1977 through 2003 and performed chemical analysis for the program in the early and mid 1990s. Historical data shows that the mean Walleye length falls below the 450-550 mm size range in the years 1977, 1978, 1979, 1980, 1981 and 1982 and that the mean length values have never been above 500 mm. Thus the data supports a Walleye size range of 400-500 mm as documented by DeVault in his 1996 manuscript. However, mean Walleye length does range between 450 – 550 mm for 2003 and 2004 fish and returns to the 400 – 500 mm mean length in the following years. This deviation occurred following the introduction of a new program manager to the GLFMSP in 2003, the dissolution of the USGS – GLSC cooperative agreement with US EPA, and the incorrect quality documentation in the USGS QAPP.

A7.4 Sampling Quality Objectives

Accurate taxonomic identification is essential in assuring and defining the organisms that have been composited and submitted for analysis. Under no circumstances should individuals from different species be used in a single composite sample. The field personnel identify the species of each fish during collection. The accuracy of the

taxonomic identification in the field is assured through use of experienced field personnel. Personnel that are collecting fish are responsible for field collection for state, federal, or tribal-sponsored fish monitoring studies.

Fish lengths are recorded to the nearest mm (or sixteenth of an inch) by the field personnel using hand-held rulers or tape measures. Field sampling teams are instructed not to use cooler lids or other less accurate means. All top-predator fish collected are weighed to the nearest gram (if applicable). An aggregate weight (to the nearest gram) is collected for each species of forage fish.

Base Monitoring Program

The goal of this sample collection effort is to collect 50 fish (Lake Trout or Walleye) in specific size ranges at each designated sampling location in all five lakes. Each lake contains two sampling sites, one representing an industrial area and one representing a non-industrial area. Chosen sites represent offshore fishing grounds (i.e., sampling sites should represent open water populations of fish) and are well removed from tributaries or other potential sources of contaminants. These locations are sampled alternately each year at approximately the same time of year.

As both fish size and age affect contaminant concentrations, the GLFMSP has focused on collection of fish in a specified size range that are assumed to be a similar age for use in composite samples. (Devault, 1996).

Composites of each species, consisting of five individual fish, are analyzed for contaminants to assess temporal trends in organic contaminants and mercury in the open water of the Great Lakes. If sufficient numbers of fish within the designated size range cannot be obtained by a reasonable sampling effort, it is acceptable to expand the size range by approximately 5%. However, if possible, an attempt should be made to include similar numbers of fish above and below the designated size range so that the mean size of fish remains near the middle of the range.

Fish retained for a composite sample must meet the following criteria:

- All be of the same species,
- Satisfy any legal requirements of harvestable size (or weight), or at least be of consumable size if no legal harvest requirements are in effect,
- Be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual, and
- Be collected as close to the same time and location as possible, but no more than one week apart.

A.8 Special Training/Certification

Each field sampling team is required to have the necessary knowledge and experience to perform all field activities. This includes both knowledge and experience in the collection and identification of fishes, in the use of fisheries sampling gear needed to successfully implement the study, and in the operation of small boats. The GLFMSP Technical Lead annually reviews the study requirements, sample collection procedures, and documentation with all field personnel and verifies that they do not have any questions.

The field sampling crews are primarily composed of state, tribal, and federal fisheries biologists with a strong technical background in fisheries sampling activities.

A.9 Documents and Records

Thorough documentation of all field sample collection and handling activities is necessary for proper identification in the laboratory and, ultimately, for the interpretation of study results. Field sample collection and handling is documented in field recording forms that have been created by GLNPO for this project. This documentation includes a field recording form, chain-of-custody record, and sample labels.

Field sampling personnel are required to submit to GLNPO a field recording form and chain-of-custody record (Appendix B) at the time that the samples are shipped to the homogenization or analytical laboratory. The field recording form is used to document the sample collection effort and includes specific information regarding each fish specimen such as length, weight, and species. The form also is used to document shipment and handling of all fish from the field personnel to the sample homogenization laboratory or analytical laboratory. Field sampling teams are provided with *Packing and Shipping Instructions for Great Lakes Fish Monitoring and Surveillance Program* (Appendix C) that provides information on filling out the required forms. Field recording forms and chain-of-custody records for Base Monitoring Program collections are located in Appendix B.

Base Monitoring Program

The field recording form is designed to capture a unique tracking number for each fish composite collected for the Base Monitoring Program. This tracking number is used by GLNPO and the homogenization and analytical laboratories to identify each composite and report results. The field sampling teams generate the composite IDs for the fish collected for the Base Monitoring Program. Field sampling teams record composite IDs on sample labels and field recording forms and chain-of-custody records.

The tracking number or composite ID includes the following:

- A two-character code for each lake (e.g., LO for Lake Ontario, LM for Lake Michigan, etc.),
- The fish species code,
- The four digit year of collection,
- The grid number or port code, and
- A sequential number indicating the number of each composite from a specific location and year (e.g., 001, 002, etc.).

Sample specific data is recorded on labels and adhered to each sample. The type of data recorded for the Base Monitoring Program fish collection efforts is detailed in the attached SOPs and their associated field recording forms (Appendix A.1). Table 4 provides a list of types of data recorded for each fish collected for the Base Monitoring Program.

Table 4. Types of Field Data Recorded for the Base Monitoring Program.

| Data Type | Measurement Units or Allowed Entries |
|--------------------------|--|
| Lake Name | Erie, Huron, Michigan, Ontario, Superior |
| Collector Identification | Vessel and collector's name |
| Collection Date | MM/DD/YY |
| Fish Length | Millimeters (mm) or inches, total length |

| Data Type | Measurement Units or Allowed Entries |
|--------------|---|
| Fish Weight | Grams |
| Composite ID | First Letter of Lake Name [e.g., LS = Lake Superior], Fish Species, Year Fish Collected, Grid #, Composite # [e.g., 001, 002, etc.] Example: 1 st composite of Lake Superior Lake Trout collected from grid # 1028 in year 2011 = LSLakeTrout20111028001 |

All records and reports pertaining to sample collection are sent to the GLFMSP Technical Lead, as soon as collection has been completed. All field records and electronic correspondence are retained by the GLFMSP Technical Lead for at least five years. All study reports and documentation are retained by the GLFMSP Technical Lead and uploaded to the Public Record Access of a National Assessment System (PRANAS).

B.1 Sampling Process

Field sampling teams collect samples according to the attached SOPs (Appendix A) and ship them to the homogenization laboratory.

This section provides details on the sampling process design for Base Monitoring Program

B1.1 Sample Number and Type

Due to expensive contaminant analyses, the goal for sample size when the GLFMSP was created was to find the least number of samples necessary to detect statistically annual changes in contaminant concentrations. Decreasing the variability between replicate samples was one way to increase the ability to detect change. The use of whole fish was recommended as a way to decrease both biological and analytical variance. Biological variance was less for whole fish, because while there were seasonal differences in contaminant concentrations in various fish body tissues, total body burden varied little on a seasonal basis. Analytical variance can be introduced through sample preparation, including filleting, packaging, homogenization, etc., due to human error or inconsistent technique.

Shortly after the creation of the GLFMSP, it was decided that fish would begin to be collected according to size as an indication of age (see GLFMSP significant events, Significant Events of the Great Lakes Fish Monitoring and Surveillance Program [Appendix D.1 of GLFMSP QMP]). At the time that the GLFMSP was created, appropriate size data were limited. The original design of the program called for extensive sampling in the first year to establish a statistically reliable sampling protocol. The most reliable data available at the time were produced by the USFWS (Willford, 1982). These data indicated a 10% change in contaminant residue levels was statistically significant in a sample size of 40–60 individuals or 12 composites of 10 in the 240–280 mm size range (*Contaminants Surveillance Program for the Great Lakes, Rationale and Design* [Appendix C.6 of GLFMSP QMP]).

The original design of the GLFMSP attempted to balance the USGS-GLSC’s sampling design with a reduced budget. The GLFMSP’s collection scheme called for the collection of 60 Lake Trout with 20 fish in the small category (300–450mm), 20 fish in the medium category (451–650 mm) and 20 in the large category (>650 mm). Both a spatial and temporal comparison of samples was to be conducted using all three size categories of fish using analysis of covariance techniques. Unfortunately, the data did not meet the requirements for the test and the original design had to be abandoned and was replaced by the use of mean statistics with specific size ranges of fish. Lake trout in the larger size range (>650 mm) were not available in Lake Ontario until 1982. Smaller Lake Trout were collected at the Lake Ontario sites prior to 1982, and the resulting data were probably skewed lower in contaminant concentrations than they would have been if fish of the appropriate size had been available.

In 1982, a final program design for the Base Monitoring Program was adopted. This program design called for fish between the ages of six and eight to be collected. Size is used as a surrogate to age; therefore fish in a narrow size range are targeted each year. 50 Lake Trout in the size range of 600 mm to 700 mm are collected from Lakes Huron, Michigan, Ontario, and Superior each year. 50 Walleye in the size range of 400 mm to 500 mm are collected from Lake Erie each year. Beginning in 2011, Lake Trout began to be collected in the Eastern basin sampling site of Lake Erie during odd years. For each lake, these 50 fish are grouped into 5 composites of 10 whole fish.

The species, size ranges of samples (if applicable), number of samples per location, and number of locations for each collection effort are listed in Table 5.

Table 5. Number and Type of Samples Collected

| Collection Effort | Species | Size | Samples/Location | Number of Locations |
|-------------------|---------|------|------------------|---------------------|
|-------------------|---------|------|------------------|---------------------|

| Collection Effort | Species | Size | Samples/Location | Number of Locations |
|-------------------------|--|---|------------------|----------------------|
| Base Monitoring Program | Odd years: Lake trout in all lakes Even years: Lake trout in Lakes Huron, Ontario, Superior and Michigan and Walleye in western Lake Erie | Lake Trout: 600 to 700 mm Walleye: 400 to 500 mm | 50 | 1 per lake (5 total) |

Fish collected for the Base Monitoring Program are grouped into composites of similar sizes prior to shipment to the homogenization laboratory.. Base Monitoring Program fish grouped together for a composite sample must meet the criteria listed in Section B2.3.

Fish identified for a composite are homogenized together in the homogenization laboratory to prepare a single homogeneous fish paste suitable for chemical analysis. Accurate taxonomic identification is essential in assuring and defining the organisms that have been composited and submitted for analysis. Under no circumstances should individuals from different species be used in a single composite sample. This is assured through four standard procedures:

1. use of experienced field personnel,
2. use of standard documentation for field sampling (Appendix B),
3. review of field documentation by the GLFMSP Technical Lead, and
4. notification of the GLFMSP Technical Lead by the homogenization laboratory of field record and specimen discrepancies and occurrences where fish from a single composite do not appear to be the same species.

B1.2 Selection of Sites within Lakes for Sampling

Selection of sampling sites is based on the availability of fish populations. Each lake contains two sampling sites. Chosen sites represent offshore fishing grounds (i.e., sampling sites should represent open water populations of fish) and are well removed from tributaries or other potential sources of contaminants.

Sampling locations for each lake are identified in Table 6. These locations are sampled alternately each year for the Base Monitoring Program (i.e., one site is sampled during even years and one site is sampled during odd years). Each sampling site has been identified with a grid number and associated longitude and latitude. It is appropriate to collect fish from grids immediately adjacent to the designated grid if the specified grid does not contain good fishing grounds, if collection from that grid will cause conflicts with management practices (e.g., excessive impact on native fish versus hatchery produced fish), or if it is impractical. The guiding rule should be that the site sampled represents offshore fishing grounds (i.e., open-water populations of fish) and is relatively remote from tributaries or other potential sources of contaminants.

Table 6. Fish Sampling Locations for the GLFMSP

| Lake | Grid | Site | Year | Longitude | Latitude |
|----------|------|--------------|------|-----------|----------|
| Michigan | 2210 | Saugatuck | E | 86°25' | 42°35' |
| Michigan | 906 | Sturgeon Bay | O | 87°15' | 44°45' |

| | | | | | |
|----------|------|--------------------|---|--------|--------|
| Huron | 1413 | Port Austin | O | 82°45' | 44°05' |
| Huron | 710 | Rockport | E | 83°15' | 45°15' |
| Erie | 904 | Middle Bass Island | E | 82°55' | 41°35' |
| Erie | 424 | Dunkirk | O | 79°35' | 42°25' |
| Ontario | 713 | North Hamlin | O | 77°55' | 43°25' |
| Ontario | 623 | Oswego | E | 76°15' | 43°35' |
| Superior | 1028 | Keweenaw Pt. | O | 87°35' | 47°25' |
| Superior | 1311 | Apostle Islands | E | 90°25' | 46°55' |

E = even year collection
O = odd year collection

B1.3 Sampling Period

Because there are seasonal variations in body burdens of fish, it was determined that collections needed to be made at the same time every year. The fall was suggested as a time when there would be the greatest availability of fish and also the least likelihood of shifts in body burdens of contaminants caused by spawning, except by fall spawners.

The Base Monitoring Program, sampling sites in each lake are sampled alternately each year at approximately the same time of year. Table 7 details species collected by lake and even or odd year for the Base Monitoring Program.

Sample collection activities commence in June and are completed before November. Because the field sampling teams establish their schedules individually, this time frame can change based on local conditions such as weather.

B.2 Sampling Methods

B2.1 Target Species

Base Monitoring Program

According to the *Contaminants Surveillance Program for the Great Lakes, Rationale and Design* (Appendix C.6 of GLFMSP QMP), when the GLFMSP was created, the selection of species to be sampled was dependent upon several different factors including population distribution, availability, longevity, contaminants to be monitored, representativeness, lake to lake comparison, and importance in commercial and sport fisheries. Overall, eight species were considered as strong candidates: smelt, yellow perch, Walleye, carp, alewife, Lake Trout, whitefish and coho salmon.

The GLFMSP species collection originally included Lake Trout (Walleye in Lake Erie and Lake St. Clair) and smelt. However, smelt collection was never fully funded or implemented. Sport fish were added to the program in the early 1980s (but discontinued in 2009). Several factors played a role in the selection of Lake Trout for the

GLFMSP. Lake trout are representative of the offshore zone in the three upper lakes, but not in Lakes Erie or Ontario due to the fact that the populations sampled are relatively in close proximity to their spawning areas. Lake trout are top predators and long lived and were considered to be excellent concentrators of contaminants. Walleye were originally chosen to be collected in Lake Erie because they occupy similar trophic positions as Lake Trout and were available in greater abundance. Beginning in 2011, Lake Trout began to be collected in the eastern basin sampling location in Lake Erie during odd years because the Lake Trout population was thought to have become self-sustaining. Walleye continued to be collected in the western basin sampling location in Lake Erie which was still not capable of supporting a self-sustaining Lake Trout population. Collection of Lake Trout in Lake Erie allows for data comparison with Lake Trout collected in the other Great Lakes.

Every effort will be made to collect the desired species and number of fish specified in Section B1.1. However, the outcome of field sampling efforts will ultimately depend on the natural diversity and abundance of fish in the study lakes. Documentation of collection site physical data for each fish is recorded on the *Field Recording Form and Chain-of-custody Records* (Appendix B).

B2.2 Sample Collection

Fish collection methods can be divided into two major categories, active and passive. Each method has advantages and disadvantages. Active collection methods involve a wide variety of sampling devices including electro fishing units, seines, trawls, and boat shocker. The active collection methods generally require more field personnel and more expensive equipment than passive collection methods. Passive collection methods employ a wide array of sampling devices, including gill nets, dip nets, trap net and cage trap. Passive collection devices (e.g., gill nets) must be checked frequently (e.g., at least once every 24-hours) to ensure a limited time lag between fish entrapment and sample preparation. Passive collection methods, while time-consuming, generally require less fishing effort than active methods, but normally yield a much greater catch than would be required for a contaminant-monitoring program. Although active collection requires greater fishing effort, it is usually more efficient than passive collection for covering a large number of sites and catching the relatively small number of individuals needed from each site for tissue analysis.

Field sampling personnel choose the collection method and appropriate sampling gear to meet the study objectives pertinent for their fish collection effort. Each sampling team may determine the sampling technique that best fits the situation. Selection of the most appropriate gear for a particular target lake will be at the discretion of the experienced on-site fisheries biologists or collection personnel.

As soon as fish are obtained via active collection methods, or removed from passive collection devices, they are identified to species. Species identification should be conducted only by experienced personnel knowledgeable of the taxonomy of species in the waters of the Great Lakes. Nontarget species collected by the field sampling team should be returned to the water. Field sampling team personnel are instructed to wear clean nitrile gloves when handling fish and sample collection equipment. Individuals of the selected target species are rinsed in ambient water to remove any foreign material from the external surface and placed in clean holding containers (live well, buckets, etc.) to prevent contamination. The buckets are cleaned according to the procedures described in Section B3.2.

Each fish collected for the Base Monitoring Program is measured to determine total body length (mm). Maximum body length should be measured and is defined as the length from the anterior-most part of the fish to the tip of the longest caudal fin ray (when the lobes of the caudal fin are depressed dorsoventrally). Other

physical measurements are recorded according to the procedures detailed in the sample collection SOPs (Appendix A).

When collection efforts are complete, fish are wrapped in acetone-washed foil, placed in polyethylene tubing, placed in large composite bags (if applicable) according to the sample collection SOPs, and immediately placed in freezer at -20°C for temporary storage. Sample handling procedures are detailed in Section B3.1.

B2.3 Composite Sampling

Composite samples are a cost-effective means for estimating average tissue concentrations of target analytes in target species populations, and compositing ensures adequate sample mass for analysis of all target analytes. Composite samples will be prepared and analyzed for fish collected for the Base Monitoring Program. Composites for the Base Monitoring Program will consist of five fish each. Composites are intended to estimate the mean fish tissue contaminant concentration for the lake for each target parameter. All fish will be homogenized as whole fish with guts intact. Base Monitoring Program fish retained for a composite sample must meet the following criteria:

- All be of the same species,
- Satisfy any legal requirements of harvestable size (or weight), or at least be of consumable size if no legal harvest requirements are in effect,
- Be of similar size so that the smallest individual in a composite is no less than 75% of the total length of the largest individual (for the Base Monitoring Program), and
- Be collected as close to the same time and location as possible, but no more than one week apart.

Fish identified for a composite are homogenized together in the homogenization laboratory to prepare a single homogeneous fish paste suitable for chemical analysis.

B.3 Sample Handling and Custody

B3.1 Sample Handling

This section describes sample handling procedures. Instructions for sample handling also are provided in the fish collection SOPs in Appendix A and in the *Packing and Shipping Instructions for the Great Lakes Fish Monitoring and Surveillance Program* in Appendix C.

When fish are collected, they are identified to species by experienced personnel knowledgeable of the taxonomy of species in the Great Lakes. Field sampling personnel wear clean nitrile gloves to handle fish and sampling equipment. All fish must be whole and without incisions. Individual fish are rinsed in ambient water to remove any foreign material from the external surface and placed in clean holding containers (e.g., live well, buckets, etc.) to prevent contamination. The buckets are cleaned according to the procedures described in Section B3.2. Each individual fish is placed in a separate container in order to avoid any contamination from other fish, fuels, or other sources. The importance of this procedure is emphasized to the field sampling teams. When the fish are brought ashore they are prepared for storage and shipment to the homogenization laboratory.

For all collection efforts, once packaged, samples should be immediately frozen for shipment or placed on ice for transport to a processing facility where fish will be immediately frozen. All fish must be kept at $\leq -20^{\circ}\text{C}$, and

maintained frozen until they reach the designated homogenization laboratory. Collection facilities must be able to retain frozen samples for at least 4 weeks, or until the GLFMSP Technical Lead has specified a shipment date. All records and reports pertaining to sample collection should be sent to the GLFMSP Technical Lead, as soon as collection has been completed.

Base Monitoring Program

As soon as possible after collection, fish are wrapped in acetone-washed foil and immediately placed in pre-cut heavy-duty polyethylene tubing. Each sample is labeled with the information described in Section A9 and also in the GLFMSP Base Monitoring Program Sample Collection SOP in Appendix A.1. The field sampling teams prepare two labels for each sample. One label is placed inside the bag with the fish and the second label is secured to the outside of the bag. After five fish are collected that meet the specifications for a composite as described in Section B2.3, the individually bagged fish can be combined in groups of five into large composite bags.

B3.2 Sample Integrity

A critical requirement of the GLFMSP is the maintenance of sample integrity from the time of collection to the arrival at the analytical laboratory. Sample integrity involves preventing loss of target analytes that might be present in the sample and taking precautions to avoid possible introduction of contaminants during handling. The loss of target analytes can be prevented in the field by minimizing the laceration of fish skin. Proper storage of the fish also will prevent loss of target analytes.

Special precautions must be taken by field sampling personnel to prevent contamination of the fish with any foreign materials. Sources of contamination include the sampling gear, oils and greases on boats, spilled fuel, skin contact, contact with soil or sand, boat motor exhaust, and other foreign materials. All potential sources should be identified prior to and during sample collection, and appropriate measures should be taken to minimize or eliminate them. Examples of preventative measures include the following:

- collection nets should be free of any potential contaminants,
- the use of tarred collection nets is prohibited,
- boats should be positioned so that engine exhaust does not fall on the deck area where samples are being handled,
- ice chests and other sample storage containers should be scrubbed clean with detergent and rinsed with distilled water prior to use (containers originating from the sample control center will be prewashed and rinsed), and
- samples should not be placed directly on dry ice, but should be stored inside acetone-washed foil, and plastic bags first.

B3.3 Custody Requirements

As soon as possible following collection, the field sampling teams begin the process of identifying, labeling, packaging, and storing the samples. Each sample will be identified and tracked with labeling information described in Section A9 and in the field collection SOPs (Appendix A). Base Monitoring Program fish are then shipped on dry ice to the homogenization laboratory. Fish eggs are shipped on dry ice directly to the analytical laboratory.

Field sampling personnel are required to submit to GLNPO a field recording form and chain-of-custody record (Appendix B) at the time that fish are shipped to the homogenization laboratory. This form is used to document shipment and handling of all fish from the field personnel to the sample homogenization laboratory. The form requires signatures of field personnel shipping the fish and signatures for the personnel at the homogenization laboratory receiving the fish. Field sampling teams are provided with *Packing and Shipping Instructions for the Great Lakes Fish Monitoring and Surveillance Program* (Appendix C) that provides information on filling out the required forms.

When fish are shipped to the homogenization laboratory, the Data Verification and Validation contractor notifies the laboratory of the shipment, and any tracking numbers associated with the shipment are provided. Chain-of-custody forms accompany all shipments. The laboratory is instructed to confirm receipt of the shipment in writing. The laboratory also notes on this confirmation if the fish arrived frozen and in good condition.

When fish are shipped to the analytical laboratory, the Data Verification and Validation contractor notifies the GLFMSP Technical Lead and the laboratory of the shipment, and any tracking numbers associated with the shipment are provided. Chain-of-custody forms accompany all shipments. The laboratory is instructed to confirm receipt of the shipment in writing. The laboratory also notes on this confirmation if the fish arrived frozen and in good condition.

When fish are shipped to the archival facility, the Data Verification and Validation contractor notifies the archival facility, and any tracking numbers associated with the shipment are provided. Chain-of-custody forms accompany all shipments. The archival facility is instructed to confirm receipt of shipment in writing. The archival facility also notes on this confirmation if the fish arrived frozen and in good condition.

When CWTs, scales, otoliths, and fin clips are shipped to the Data Verification and Validation contractor, the Data Verification and Validation contractor reviews the chain-of-custody form to ensure all samples have been received in good condition.

B.4 Analytical Methods

After processing at the homogenization laboratory, fish homogenate samples are shipped to the analytical laboratory. Sample processing and analytical testing are discussed in the PI's approved QAPP. These analytical methods are not detailed within this document.

B.5 Quality Control

Sample Collection Quality Control

Data quality is addressed by use of knowledgeable field sampling teams, use of SOPs, and consistent performance of the procedures documented in the SOPs. The SOPs include instructions for preventing loss of target analytes from the fish and preventing contamination of the fish from sampling equipment or other sources. The GLFMSP Technical Lead annually reviews the study requirements, sample collection procedures, and documentation with all field personnel and verifies that they do not have any questions.

The accuracy of the taxonomic identification in the field is assured through use of experienced field personnel. Personnel that are collecting fish are responsible for field collection for state, federal, or tribal-sponsored fish monitoring studies.

Fish lengths are recorded to the nearest mm (or sixteenth of an inch) by the field personnel using hand-held rulers or tape measures. Field sampling teams are instructed not to use cooler lids or other less accurate means. All Lake Trout and Walleye are weighed to the nearest gram.

The field sampling team leader is responsible for ensuring all sampling equipment is in good working condition and is used properly by the field sampling personnel. The field sampling team leader is responsible for reviewing all required documentation discussed in Section A9. After review, the leader signs the field recording form indicating their review and approval of the documentation.

Field sampling personnel are required to submit to GLNPO a field recording form and chain-of-custody record at the time that fish are shipped (Appendix B). This recording form is used to document information regarding each fish and the sample collection effort and to document shipment and handling from the field personnel to the sample homogenization laboratory. For example, the grid number where each fish was collected (grid numbers are listed in Table 6) is documented by field personnel. Additionally, the latitude and longitude where each fish was collected also are documented as a means of verifying the grid where the fish was collected (latitude and longitude coordinates are listed in Table 6). Latitude and longitude coordinates are recorded for each sampling location using Global-Positioning Systems (GPS).

The field personnel also are required to document other data as described in Section A9. To ensure accurate documentation, the GLFMSP Technical Lead will discuss the SOP and specifics regarding the field data with field personnel prior to sampling.

Additional Quality Control Checks

The GLFMSP Technical Lead reviews the records submitted by the field personnel. If any discrepancies or questions arise, the GLFMSP Technical Lead will contact the field personnel and document the resolution. All field data are submitted to the homogenization and analytical laboratories to ensure proper identification of each fish in the study. These laboratories are instructed to inform GLNPO of any discrepancies noted among sample labels (discussed in Section A9) and documentation.

Accurate taxonomic identification is essential in assuring and defining the organisms that have been composited and submitted for analysis. The homogenization laboratory is instructed to notify the Data Verification and Validation contractor if any fish targeted for a single composite do not appear to be the same species. The Data Verification and Validation contractor then notifies the GLFMSP Technical Lead. The GLFMSP Technical Lead will resolve any discrepancies with the field sampling teams.

Fish lengths, weights, and other physical data recorded in the field are measured in the homogenization laboratory as a QC check for the field data. The homogenization laboratory is instructed to notify the Data Verification and Validation contractor if any lab data do not appear to match field data. The Data Verification and Validation contractor then notifies the GLFMSP Technical Lead. The GLFMSP Technical Lead will resolve any discrepancies with the field sampling teams.

Fish that are collected outside the acceptable length range will be flagged in GLENDA using “Llong” and/or “Lshort” in the Field Remark Code field of the field sample worksheet.

CWTs, fin clips, scales, and otoliths from collected fish specimens are removed by the homogenization laboratory according to their SOW and shipped to the Data Verification and Validation contractor. The Data Verification and Validation contractor reviews all fin clip information against the field documentation and ensures that all CWTs, fin clips, scales, and otoliths are received. The GLFMSP Technical Lead will resolve any discrepancies with the field sampling teams.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

All field equipment is inspected by the field sampling team leader prior to each sampling event to ensure that all equipment is in good working condition. For example, the team leader must verify that boats or electro fishers are operating correctly and that the sample nets do not have any defects. Additional maintenance includes ensuring that:

- collection nets are free of any potential contaminants,
- collection nets are not tarred, and
- ice chests and other sample storage containers should be scrubbed clean with detergent and rinsed with distilled water prior to use (containers supplied by the Data Validation and Verification contractor will be prewashed and rinsed).

B.7 Instrument/Equipment Calibration and Frequency

Field sampling teams ensure scales are calibrated according to manufacturer requirements prior to the collection of physical measurements (weight) of each fish.

B.8 Inspection/Acceptance of Supplies and Consumables

Careful and thorough planning is necessary to ensure the efficient and effective completion of the field sample collection task. It is the responsibility of each field sampling team to gather and inspect the necessary sampling gear prior to the sampling event and to inspect the sample packaging and shipping supplies received from the laboratory. The field recording form includes verification that sampling equipment and supplies were inspected and found to be suitable for use.

B.9 Non-Direct Measurements

Non-direct measurements are not used in the sample collection component of this study.

B.10 Data Management

Samples will be labeled and tracked via sample identification labels and field recording forms and chain-of-custody records as detailed in Section A9. Because the sampling efforts are cooperative and involve many different partner agencies and groups, the diligence of the field sampling teams in completing the proper records is essential. Field team leaders will be responsible for reviewing all completed documentation as described in Section A9. Any corrections should be noted, initialed, and dated by the reviewer. Shipment of samples to the homogenization laboratory (Section B3) must be conducted by a delivery service that provides constant tracking of shipments. Sampling data are documented on field recording forms by field sampling teams and generated by the homogenization laboratory. All records and reports pertaining to sample collection are sent to the GLFMSP Technical Lead as soon as collection has been completed. All field records and electronic correspondence are retained by the GLFMSP Technical Lead for at least five years. All study reports and documentation are retained by the GLFMSP Technical Lead.

Laboratory sample receipt and document control, records, and information management procedures are discussed in the analytical laboratory/laboratories QAPPs.

C.1 Assessment and Response Actions

External and internal audits will be carried out to evaluate the project progress and the adherence to QAPP. External audits will be carried out as directed by GLNPO. Internal audits (i.e., systems audits, performance evaluations and data audits) will be carried out to monitor the program in terms of the degree of adherence to QAPP and procedures. Internal audits are conducted by the GLNPO, US EPA Quality Staff, Inspector General and others, who are independent of the area to be evaluated. QA audit assessment procedures are described below.

System Audits

The GLFMSP Technical Lead will serve as the primary contact for any questions or issues that arise from the field sampling teams. The GLFMSP Technical Lead will contact the GLNPO Quality Manager and cooperating analytical laboratory/laboratories, if needed, to provide recommendations to field personnel. The GLFMSP Technical Lead, with support from the GLNPO Quality Manager, is responsible for ensuring that any corrective actions identified are implemented and documented.

If during review of the field documentation or through communication with the samplers the GLFMSP Technical Lead identifies a discrepancy, the sampler will be contacted to resolve the issue. If an error in the sample collection process is identified that will significantly impact the results of the study, the field sampling team will obtain additional samples if possible.

The analytical laboratory will be notified of any issues that arise with the sampling teams. The analytical laboratory also will be notified of any errors in the field documentation or discrepancies identified during review of the fin clips against the documentation. Ideally, sample collection anomalies will be discussed in reports developed by the GLFMSP Technical Lead and the cooperator PIs.

C.2 Reports To Management

The GLFMSP Technical Lead provides project status to GLNPO management on an on-going basis. The status updates will document results of performance evaluations and audits, results of periodic data quality assessments, and any significant QA problems.

The Data Verification and Validation contractor fulfills the requirements in the *Quality Assurance Project Plan for CSRAC Support to the Great Lakes Fish Monitoring and Surveillance Program V.1.0* (CSRACSC, 2020) which include providing the GLFMSP Technical Lead with monthly updates on project status.

D.1 Data Review, Verification, and Validation

The Data Verification and Validation contractor updates and provides the field sampling teams with a hardcopy version of the field recording form on an annual basis. The field sampling teams complete the recording form and typically submit the form via facsimile. There are instances where the field sampling teams do not utilize the program field recording form but provide the necessary data elements using their own reporting forms. Field sampling team leaders will be responsible for reviewing all completed documentation as described in Section A9. Any corrections should be noted, initialed, and dated by the reviewer.

Upon receipt of the completed field recording forms, the Data Verification and Validation contractor conducts a 100% completeness check to ensure all necessary information has been provided. The following checks are performed:

- Assure all individual fish samples are included in both the Sample Collection and Individual Organism files.
- Assure all composite samples are included in both the Sample Collection and Multiple Organism files.
- Assure the link between all individual fish and the composites are defined in the Sample Group file.
- Assure all collected species of fish are identified in the Class Definition file, and all defined species were collected.
- Assure all sample collections are defined in the Station Visit file, and all defined station visits have associated samples.

Instances where the data are missing or illegible are raised to the field sampling team for resolution. All resolutions are documented.

The Data Verification and Validation contractor formats the field data submitted by field sampling teams to the GLENDA reporting standard. This ensures that data can be directly imported to GLENDA and ensures the comparability of field data collected in multiple years.

The GLFMSP Technical Lead reviews all field documentation for discrepancies or anomalies and contacts the field sampling team leader to resolve any issues. This includes all data recorded on the field recording form and chain-of-custody record that can be verified by the GLFMSP Technical Lead including sample locations, fish lengths and weights, and fish species. Coded wire tags and fin clips found in any fish specimens are removed by the homogenization laboratory and shipped to the Data Verification and Validation contractor. Fin clips and coded wire tags removed from any of the fish samples will be reviewed against the field documentation. The GLFMSP Technical Lead will resolve any discrepancies with the field sampling team.

The fish homogenization laboratory provides the laboratory lengths and weights for each fish in their final report. The Data Verification and Validation contractor enters these data into the GLENDAs files for the applicable sampling year. The fish homogenization laboratory's final report also provides the field lengths and weights for each fish. The Data Verification and Validation contractor conducts a 100% check while entering the fish lab lengths and weights to ensure accuracy of the fish field lengths and weights already provided in the GLENDAs files. If a discrepancy exists, the Data Verification and Validation contractor views a copy of the fish sample identification label provided in the homogenization laboratory's final report and uses that value to serve as the final fish field length or weight. If the fish sample identification label is not legible, then Data Verification and Validation contractor staff flags the value for resolution by another staff member. The team member reviews the hardcopy field recording forms, fish sample identification labels, and fish homogenization final report in an attempt to resolve the discrepancy. If QA staff is unable to resolve the discrepancy, they may contact the field sampling team for input. All resolutions are documented. The Data Verification and Validation contractor conducts a 50% check on the entry of the fish lab lengths and weights using a different Data Verification and Validation contractor staff member. Differences in lab and field lengths and weights are assessed and entered into the GLENDAs files. The fish homogenization laboratory also provides the fish sex and age in a separate Microsoft Excel spreadsheet. These data are transferred to the GLENDAs files and entered for each fish.

As an additional assessment, the homogenization laboratory documentation is reviewed to confirm that the homogenization laboratory ID and the corresponding field sample IDs are consistent throughout all documentation.

Data review regarding sample homogenization and analysis is discussed in *The Great Lakes Fish Monitoring and Surveillance Program Quality Management Plan* (US EPA, 2012).

D.2 Verification and Validation Methods

The GLFMSP Technical Lead will employ data verification and validation methods to ensure the data documented for the field effort is complete and correct to the best of their knowledge. They will perform point-by-point comparisons for all field documentation against documentation submitted by the homogenization laboratory and against their expertise regarding fish populations in the Great Lakes. Fin clips removed from any of the fish samples will be reviewed point-by-point against the field documentation. The GLFMSP Technical Lead will resolve any discrepancies with the field sampling team.

The Data Verification and Validation contractor and the GLFMSP Technical Lead also will perform a 100% review of all submitted field documentation reported in the field recording forms against the location information provided in Table 6.

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