LAKEWIDE ASSESSMENT PLAN FOR LAKE MICHIGAN FISH COMMUNITIES

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Note: This document represents only an initial phase of the lakewide assessment plan. Contained within are plans for assessing some of the top predator fish in the Lake Michigan system. These plans will be modified and improved as they are used and tested. Future revisions will also contain assessment plans for important forage and inshore fish stocks including benthivores and planktivores.

Also note: If you are viewing this plan on a web page, please be aware that some figures, tables, and formatting do not appear as intended. If you wish to receive an electronic or paper copy of this document, you may contact P. Schneeberger at the address provided in Appendix 5.

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INTRODUCTION

Management of the Lake Michigan fish community is the shared responsibility of the four states surrounding the lake and the Chippewa/Ottawa Treaty Fisheries Management Authority. State, Native American, and Federal agencies each conduct annual assessments in Lake Michigan, but with the exception of some sampling for lake trout, assessments are rarely coordinated among agencies. During the last few decades, Lake Michigan fisheries management has largely concentrated on single-species issues. There have been splintered reactions to crises, inter- and intra-agency disputes, instances of politics transcending biology, and attempts to solve problems with little or no species life-history or current-status information. Also, the value of routine, long-term assessments has not been accorded appropriate importance.

The need for a more integrated and comprehensive management strategy was recognized almost 10 years ago by Great Lakes fisheries researchers (Christie et al. 1987). Events in the recent past have illustrated this need. For example, when the Lake Michigan chinook population crashed in the late 1980s, agencies were ill-prepared to deal with the situation. They knew little about the life history of chinook in the lake or how chinook fit into, affected, or were affected by the rest of the fish community. Basic mortality, growth, diet, and disease data had not been systematically collected to establish trends.

The overall goal of the lakewide assessment program, which is described on the pages that follow, is to annually assess the Lake Michigan fish community in a coordinated, collaborative, and standardized fashion. Initially, assessment work will focus on targeted sampling for three key predators: lake trout, chinook salmon, and burbot. Coordinated, standardized sampling of these predators will be implemented, evaluated, and refined over time. Knowledge gained from predator sampling will subsequently be used to develop complimentary sampling schemes that target other important species in the lake.

In addition to targeted sampling, supplemental data will be obtained from sampling schemes already in existence. For example, extant creel surveys are conducted around the lake. Creel survey data are somewhat fragmented among different state agencies at present but are being standardized and coordinated through the efforts of a creel survey subcommittee. Creel surveys provide important data for top predators and other species including yellow perch, a species of special concern in recent years, especially in southern waters of Lake Michigan. Specific netting, tagging, and early-life history sampling for yellow perch, as recommended by a special task group, will generate additional data that will be incorporated into the lakewide assessment plan.

Existing data pertaining to species from other trophic levels will also be meshed with targeted sampling data. Lakewide assessment of forage fish is currently being carried out by the United States Geological Survey/National Biological Service using hydroacoustics and trawls. Integration of hydroacoustic and trawl data is progressing and represents the best approach for estimating absolute abundance of forage fish. All agencies are strongly encouraged to support continuation of this effort.

Commercial fisheries are currently monitored by state and tribal agencies. Commercial fisheries data are used to assess the lakewide status of lake whitefish and to identify and resolve potential problem situations. Such monitoring should be continued and commercial fisheries data, shared among agencies, should be integrated with lakewide assessment data.

Lakewide assessment results will be presented in annual and multi-year reports prepared jointly by biologists representing each management entity. The fish community will be described using information from pooled single-species assessments and an adaptive "piggy-back" method suggested by Christie et al. (1987). As experience is gained, data requirements will be modified based on modeling efforts, funds available, and suggestions from biologists familiar with the lake. These data will enhance our understanding of species life histories and community-level interactions and will measure progress towards achievement of lakewide fish community objectives (Eshenroder et al. 1995).

PLAN OBJECTIVES

The primary objective of this lakewide assessment plan is to provide a sampling design to determine the relative abundance of three key predators: lake trout, chinook salmon, and burbot. Targeted sampling, detailed later in this document, will be conducted and summarized annually.

The secondary objective is to collect data to determine growth, population mortality, age-specific diet, juvenile recruitment, and general physical health of the three predators. Pertinent data will be collected each year, but may not necessarily be summarized on an annual basis.

The following discussion is organized around specific biological parameters that need to be evaluated or measured in order to accomplish plan objectives. Available methods to assess each life-history feature are mentioned and are followed by a more detailed discussion of methods deemed most appropriate for this plan.

FISH AGING

Accurate aging of sampled fish is the keystone for achieving the primary and secondary objectives in this assessment plan. Fish may be aged using length distributions, various hard structures (e.g., scales, otoliths, opercular bones), or marks (e.g., fin clips, tags).

Aging from length distributions can be confounded by differences in year-to-year growth, which may result from differences in climate, food availability, and/or species density. Overlap in length-at-age is extensive for the three predators of concern. Some of these overlaps may be accounted for using an approach described by Schnute and Fournier (1980) who analyzed length-frequency data taking growth structure into account.

Age determination from reading hard body structures is somewhat subjective. For example, individual biologists might assign different ages to the same fish from the same set of scale samples, or the same person might assign different ages reading the same scales twice. However, through practice and effort, reading scales has become a reliable method for aging Lake Michigan chinook salmon and lake trout. State of Michigan researchers developed a technique to age chinook with scales (Seelbach and Beyerle 1984), and their technique was validated using known-age chinook marked with coded wire tags (CWT) (Wesley 1996). For decades, lake trout researchers have relied on scales to confirm clip ages or to age un-clipped fish. Fiset and Casselman (1989), however, found that aging un-clipped Lake Michigan lake trout was best accomplished using a combination of scales and sectioned otoliths. Ages of burbot from Green Bay and Lake Michigan were determined by Bruesewitz (1990) using whole or sectioned otoliths.

Aging fish from distinctive marks, fin clips, or tags is the most accurate, despite possible confounding effects of fin regeneration, missed clips, shed tags, or size overlap among fish sharing like clips. Given the importance of accurate aging in determination of age-specific relative abundance, growth, mortality, diet, and recruitment, mass marking all hatchery products lakewide should ultimately be the goal of all agencies. However, marking is limited to hatchery fish and costs of marking, recovering marked fish, and interpreting marks may be prohibitive. As a start, states could mark all chinook salmon with oxytetracycline, then expand into fin clipping or use of CWTs. If such marking proves to be impossible to sustain on a continuous basis, a routine schedule (e.g., 5 yr on and 5 yr off) should be adopted.

A hierarchy of methods will be used to determine ages of fish collected in this lakewide assessment plan. Fin clips and/or CWTs will be used to age all marked fish. Ages of marked fish (chinook salmon and lake trout <800 mm TL) will be verified using scales from up to 20 fish per cm group per species. Scales will also be used to age unmarked lake trout and chinook salmon. Otoliths will be used to age burbot and to verify ages of lake trout 800 mm and larger. Age assignations using length distributions will only be attempted for crucial historical data sets for which no other means of aging exist.

Lake trout and chinook salmon scales will be taken from the area between the base of the dorsal fin and the lateral line, with the exception that caudal peduncle scales, the last to be resorbed, will be taken from early spawn-run salmon. Paired sagittal otoliths will be removed from appropriate fish because they are large enough to permit annular measurements for back-calculation.

RELATIVE ABUNDANCE

To determine the status of fish populations, assessing the age-specific relative abundance of those populations is the most critically important measure. Relative abundance of any particular fish species depends on a complex array of physical, chemical, and biological factors. As a result, fish populations are dynamic, not static (Everhart and Youngs 1981), and changes should be expected in fish populations whether or not they are exploited by humans (Hilborn and Walters 1992). Stock assessments are conducted to understand the dynamics of fish populations, which respond over time to management regulations, species interactions, and other extrinsic factors.

Fisheries management requires estimates of stock abundance and biomass. In the past, estimates were made only for economically important species or when serious management problems arose (Christie and Spangler 1987). More recently, generalized estimates have become critical for setting harvest quotas, determining stocking levels, solving multi-species management problems, and formulating strategic, lakewide fisheries-management goals. Trends in relative abundance or biomass are important indicators of fish community health and contribute to an understanding of fish community dynamics.

Gear used to assess relative abundance of fish may be passive (e.g., gill nets, trammel nets, trap nets, pound nets) or active (e.g., trawls, seines). Hydroacoustics is a relatively new tool that has great potential to estimate abundance, particularly of forage fish, without having to physically catch and handle the fish.

Every type of sampling gear has limitations and selectivity. Catches may be biased relative to fish species, size, or sex. Fish behavior, distribution, seasonal migrations, daily movements, schooling, and net avoidance can also affect sampling. In addition, catches may be influenced by such things as bottom type, depth, current, time of year, water temperature, stratification, and turbidity. In theory, catch rates of fish in sampling gear should be directly proportional to the abundance of the fish being collected, but interpretation of capture data must account for potential limitations and biases.

For this assessment plan, relative abundance of lake trout, chinook salmon, and burbot will be determined from catches in graded-mesh gill nets. Such nets have been used successfully for many years to collect these species at various sizes and depths. Gill nets can be set on the bottom over any type of substrate or they can be suspended in the water column. Bottom gill-nets will be the primary means used to collect lake trout and burbot because both species are bottom oriented. Chinook salmon are more pelagic and will be collected using both suspended and bottom gill nets. Relative abundance for each species will be expressed as the number caught by age per 1000 feet of net set for one night. Standard netting at selected locations by different agencies will produce relative abundance data for lake trout and burbot (Appendix 1). Sampling for chinook is still considered experimental, but is being refined by Michigan DNR researchers. Michigan DNR's sampling design for chinook salmon and steelhead trout (Appendix 2) details work initiated in Michigan waters of Lake Michigan in 1997 and will be used as a reference to expand chinook sampling lakewide. Supplementary information will be obtained from data on harvest, incidental kill, and, for chinook, escapement to weirs. Altogether, these data should provide estimates and trends in relative abundance lakewide.

GROWTH AND MATURATION

Growth, or the change in body size over time, is one of the most widely accepted statistics used to characterize the status of a fish population. It can be used to describe inter-specific, predator-prey, and food-web interactions. In populations prone to density-dependent growth, measures of growth may be a more reliable and less-biased indicators of the condition of the population than an estimate of population mortality. The presence or absence of a growth response in chinook following the collapse of the adult stock in the late 1980s was fiercely debated because agencies disagreed on a mutually acceptable method for determining growth.

At least three general methods may be used to estimate fish growth in natural populations: weight or length time-series analysis of age groups, back calculation of length history using hard body parts, and recapture of marked fish whose sizes at a previous capture are known (Busacker et al. 1990). To get a point estimate of age-specific growth for a population, length and/or weight must be measured from a representative, random sample of fish. Aging requires collection of scales, otoliths, or other suitable hard body parts from a representative subsample of fish, and fin-clip or CWT data also need to be recorded (see FISH AGING).

Age-specific growth can be expressed as an absolute or relative change in size or as an instantaneous rate. Length is a dependable, straightforward, and inexpensive measurement from which growth can be deduced. Back calculation is a more definitive method of determining growth, but it is very time-consuming despite the availability of a number of models that facilitate the process.

For this lakewide assessment plan, length-at-age will be used in calculations of growth. Sampled fish should be measured at once or preserved in a way that minimizes shrinkage. Samples of the three predators will be obtained using gill nets fished in the vicinity of 11 different ports or locations around the lake during spring (Appendices 1 and 2). Mean length-at-age and instantaneous growth rate (Ricker 1975) will be calculated for standard reporting. Weight data will also be collected and evaluated as a secondary measure of growth.

Age-specific maturation rate is a biological measure associated with growth. The portion of an age class that is mature usually varies by age and gender, and can only be determined when mature and immature fish occupy the same habitat and are collected in numbers proportionate to their true relative abundance. Spring is likely the best time to assess maturation rates for lake trout and burbot, but predicting the likelihood of whether or not a spring-sampled fish will spawn in the coming fall is problematical. Trying to evaluate if a spring-sampled fish had spawned the previous fall is slightly less problematical, and will be used as the criteria for assigning maturity status to fish in assessment nets. Unknown status should be noted for fish whose maturity cannot be accurately assessed. Gender should be determined for both mature and immature fish.

POPULATION MORTALITY

Mortality rates are directly related to relative abundance, growth, recruitment, and incidence of disease in fish populations. Estimates of mortality rates are important inputs for predator-prey fisheries models. Partitioning sources of mortality between natural (e.g., predation, disease, lamprey) and fishing (sport or commercial) components can be important for management considerations. Estimates of age-specific mortality are important for establishing stock-recruitment relationships, correlations between year-class strength and physical parameters, and factors of density-dependence.

Fish of different ages must be collected in numbers proportionate to their relative abundance for mortality estimates. Sampled fish need to be aged accurately and age frequencies need to be adjusted to compensate for year-to-year differences in stocking and recruitment from natural reproduction.

Various methods are available for calculating mortality from an aged sample. Age-specific mortality can be determined by following a cohort through time if long-term data sets are available. Catch curves, formulae using coded age frequencies, and regressions of catch and effort may be used to estimate mortality (not age-specific) if the following assumptions are met: a) survival is constant at all ages, b) recruitment of year-classes is the same from year to year, and c) all ages are equally vulnerable to the sampling gear (Ricker 1975).

For this lakewide assessment plan, mortality of lake trout, chinook salmon, and burbot will be estimated primarily from fish collected with assessment gill nets (Appendices 1 and 2) but also from other assessment gear or from commercial gear. Mortality for all three species will be calculated using regression-based catch curves (Ricker 1975) and by the "best" estimate method using coded age frequencies (Robson and Chapman 1961).

AGE-SPECIFIC DIET

Monitoring the diet of key predators within the fish community allows inferences to be made regarding predator-prey dynamics in the lake ecosystem. Since most top-level predators in Lake Michigan are maintained largely through stocking, the system is susceptible to trophic imbalance. Failure to stock at levels appropriate to system production, specifically forage abundance, can drastically affect the health of individual species and have a cascading effect on the health of the lake ecosystem as a whole. Diet studies can provide a measure of the composition of forage available to or consumed by key predators. When conducted correctly, they can also identify spatial or temporal forage limitations.

Methods for determining the diet of key predator species may follow one of two general procedures: direct analysis from field collections or indirect derivations using mathematical models. Modeling requires estimates of prey and predator abundance, distribution, and habitat overlap to predict the physical interactions or encounters between predators and prey and to infer diet composition. Estimates of the nutritional content of prey and the bioenergetic requirements of predators are typically used to estimate the amount of food predators must consume in order to exhibit the growth rate observed in the field. Lack of good estimates for many parameters needed for this approach has limited its usefulness.

Direct measures of predator diets are more common and fairly straightforward. Predator fish are captured, the contents of some part or all of their gastro-intestinal tract are removed, and prey items are identified and quantified. Advantages and disadvantages associated with these techniques are discussed in more detail by Elliott et al. (1996).

For this plan, methods for determining age-specific diet will follow those described by Elliott et al. (1996), except that stomachs will be examined from fish caught in assessment nets (Appendices 1 and 2), so Elliott's specifications regarding sampling gear and stratification by season and region will not be implemented. Percent diet composition by weight, prey length frequencies, and actual wet weight of undigested prey (as an index of ration) will be determined for lake trout, burbot, and chinook salmon selected randomly from catches in gill nets. Diet data resulting from lakewide assessment netting will not be as comprehensive as for the diet study outlined by Elliott et al., but will enable regional and year-to-year diet comparisons (composition and quantity) for the target species and will accommodate ongoing efforts to update lakewide models.

RECRUITMENT

In fisheries, the term recruitment is defined as: 1) the number of individual fish entering a fish population in the first year of life, or 2) the entry of individual fish into a fishery. Data pertaining to recruitment are necessary to understand population age structure and fish-community dynamics, both of which are important for developing management plans and evaluating management success (Kohler and Hubert 1993). On a lakewide basis, data are needed to determine recruitment of both predator and forage species. Historic records that include age-specific data may be analyzed to assess past recruitment.

There is a continuing need to differentiate between Lake Michigan salmonines of natural and hatchery origin. Possibilities for accomplishing this differentiation include: 1) identifying a naturally occurring morphometric or genetic marker; 2) identifying differential growth patterns; or 3) individually clipping, tagging, or mass-marking hatchery fish. Investigations have yet to identify reliable morphometric or genetic markers for Lake Michigan predators, and growth is influenced by too many internal and external factors to be useful as a differentiation tool. Marking of hatchery fish requires a considerable investment of time and money prior to stocking, but allows easy separation of wild and hatchery fish either in the field or the laboratory. Fin clipping of all hatchery-produced lake trout is a strategy used in the lake trout rehabilitation program, and consideration is being given to fin clipping all stocked steelhead. Oxytetracycline was used for several consecutive years in an attempt to mark all hatchery-reared chinook stocked in Lake Michigan. The goal was to quantify lakewide natural reproduction of chinook. Both fin clipping and oxytetracycline treatments may induce some unintended mortality.

For this plan, graded-mesh gill nets used to assess relative abundance (Appendices 1 and 2) can also provide recruitment estimates for all three predators beginning when they are 2- to 3- yr old. However, there is an urgency to document whether or not lake trout are reproducing in Lake Michigan. Several stocked year classes have reached maturity in the midlake and northern refuges and natural reproduction is now expected. Given the time and effort invested in lake trout rehabilitation, it would be imprudent to delay recruitment evaluation until anticipated progeny become large enough to be vulnerable to graded-mesh nets. Consequently, trawling will be used to assess larval and young-of-the-year (YOY) lake trout at appropriate locations (Appendix 3).

Early detection of burbot and chinook salmon recruitment is less critical than for lake trout. If the need arises to estimate recruitment of YOY chinook salmon leaving natal rivers, shoreline seining in the vicinity of appropriate streams can be used (see Methods in Elliott 1994).

FISH CONDITION AND HEALTH

Physical health of Lake Michigan fish species (individuals, localized stocks, populations) affects and is affected by all the other parameters measured in this plan. Measures of fish health may be indicative of particular stressors acting on particular fish species. For example, Cardwell and Smith (1971) used indices of fish health to evaluate effects of vibriosis on juvenile chinook salmon. Fish health analyses might also have broader implications, as illustrated by Adams et al. (1993), who used health assessment of fish species near the top of the food chain as an indication of overall health of an entire aquatic ecosystem. Health evaluations of hatchery-reared fish are important given the prevelance of stocking in the Lake Michigan management scheme. In Region 3 national fish hatcheries, Health Condition Profiles have been used by Nelson and Woolley (1993) to establish normal ranges of fish health parameters for lake trout and to evaluate performance of different strains, different fish-rearing practices, survival of fish stocked at different sizes, and different stocking methods. Wagner et al. (1994) used health parameters to compare feral brook trout with stocked brook trout and also to document changes in fish health before and after stocking in Michigan streams.

Methodologies for assessing fish health differ greatly in terms of advantages, limitations, complexity, and associated requirements of time, manpower, equipment, and expense. A quick and easy measure of fish health may be obtained by calculating growth and condition from length, weight, and age data. Much more difficult and expensive processes could be undertaken entailing measurement and analysis of several biochemical, physical, and pathological parameters. Between extremes, Goede and Barton (1990) devised an evaluation system based on various condition or organosomatic indices. Wisconsin fish health specialists use a form of this system for inspecting some lots of fish in hatcheries prior to stocking (S. Marcquenski, Wisconsin Department of Natural Resources, personal communication). The Goede and Barton system does not lend itself to statistical analyses, but Adams et al. (1993) modified the approach so indices were quantitative rather that subjective, thereby permitting statistical comparisons of different data sets.

For this plan, general fish health data will be recorded for all burbot, lake trout, and chinook salmon collected in lakewide assessment nets (Appendix 1). These data will provide an overall gross indication of fish health for the three target species in the eleven sampling sites each year.
More detailed information pertaining to overall fish health (blood tests), energy status (percent lipid analysis), and incidence of bacterial kidney disease (BKD) will be obtained from subsamples of lake trout and chinook (a few burbot will be collected for full necropsies in order to get an idea of what should be included in future core data) (Appendix 1). Target subsample numbers will be five fish per size group per site for each of the two species. It is unknown how many fish will be caught in nets, but this scheme could potentially result in 50+ fish/site being brought to shore for detailed health analyses that will be conducted at various fish health laboratories. These numbers of fish will be targeted the first year with the realization that handling and transporting this many fish may be too difficult and time-consuming, and may overload the labs. Target numbers of fish could be altered in subsequent years when more is known about expected catch sizes, parameter variability, and the time and effort required to process samples. For example, it may be found that it is possible to pool fish from adjacent sites so fewer fish would need to be analyzed from any specific site. Or it may be possible to cut back on numbers even without pooling. Another possibility would be taking the full compliment of fish at each site, but only for one or the other species on an alternate

year basis. Efficiency will be gained by doubling the use of some samples, i.e., fish needed for contaminant testing can be obtained from lakewide assessment net samples, and these same fish could provide both contaminant and lipid data.

Fish health specialists will be consulted annually, prior to lakewide assessment sampling, to review fish health monitoring goals for the coming year and to recommend sampling changes or refinements. Trends will be followed for core data that will be collected each year.

DATA ANALYSIS AND REPORTING RESPONSIBILITY

Data analysis, summarization, and reporting for each assessment will be the responsibility of the Lake Michigan Technical Committee. Each agency will provide raw assessment-summary data in a standardized electronic data base format to the chairperson of the Lake Michigan Technical Committee on an annual basis. The chairperson will delegate to committee members the responsibilities of data summarization and report preparation within a predetermined timetable. The format for synthesis of lakewide data and annual report preparation will be the responsibility of the Technical Committee. The reporting format and specific data to be reported will be determined by the Lake Michigan Committee.

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Appendix 1

Lakewide Assessment Sampling Design for Lake Trout and Burbot

This appendix describes the methodologies specifically designed to assess lake trout and burbot, but details are also provided for handling chinook salmon caught by these methods. Specific methodologies for lakewide assessment of chinook salmon are described in Appendix 2. See Appendix 3 for data forms.

Design of bottom nets:
Nets used to sample lake trout and burbot will be 2 m (6.5 ft) deep and will have 30-m (100-ft) panels of eight different mesh sizes (range = 64 -152 mm [2.5 - 6 in] stretched) arranged from smallest to largest (Table 1). Two such nets will be combined, creating a net totaling 488 m (1,600 ft). Floats will measure 127 mm (5 in) by 44 mm (1 ¾in) with a 10-mm (3/8-in) hole and will be either aluminum or plastic. Leads will be either 76 mm (3 in) pipe leads with 10-mm (3/8-in) holes or 76 mm (3 in) by 19 mm (3/4 in) clamp on leads with a weight of 6.6 per kg (3 per lb). Bottom nets will not represent a navigational hazard, so nets will be left in the water for 24 hours.

Table 1. Net specifications for lakewide assessment of lake trout and burbot.

Mesh size (stretched)	64 mm (2.5 in)	76 mm (3.0 in)	89 mm (3.5 in)	102 mm (4.0 in)	114 mm (4.5 in)	127 mm (5.0 in)	140 mm (5.5 in)	152 mm (6.0 in)
Thread size (nylon)	210/2	210/2	210/2	210/3	210/3	210/3	210/3	104
Phase size	190 mm (7.5 in)	190 mm (7.5 in)	222 mm (8.75 in)	203 mm (8.0 in)	229 mm (9.0 in)	190 mm (7.5 in)	210 mm (8.25 in)	229 mm (9.0 in)
Ties between leads	11	11	10	11	9	11	10	9
No. of leads per net	12	12	12	12	13	12	13	13
No. of meshes per tie	6	5	5	4	4	3	3	3
No. of meshes deep	32	27	23	20	18	16	14	13
Wt. of twine per net	0.68 kg (1.50 lb)	0.68 kg (1.50 lb)	0.79 kg (1.75 lb)	0.57 kg (1.25 lb)	0.57 kg (1.25 lb)	0.57 kg (1.25 lb)	0.45 kg (1.00 lb)	0.57 kg (1.25 lb)

Proposed Sampling Design
Sampling will be conducted each year at 11 selected sites (two refuge sites and nine port sites) around Lake Michigan (Figures 1-15; Table 2). Six sets (each set using the 488 m of graded-mesh gill net described above) will be made each year at each site. Additional sets may be made if time allows. Although the 11 sites will remain the same for the foreseeable future, set locations at each site will be randomly selected each year in an effort to increase the statistical robustness of the sampling design (see below). Sampling will be performed during early spring when the water column is not stratified and bottom temperatures at fishing depths are greater than 4ºC (39ºF). Sampling will be different at refuge and port sites.

Refuge sites: Netting locations at refuge sites will be determined by superimposing a grid system that subdivides surrounding waters into 1 x 1 minute cells (see representation in Figure 2). Each year, nets will be set within a minimum of six randomly chosen cells at Northern and Midlake refuge sites (Figures 5, 11, and 12). Netting locations may also be selected according to lake levels, weather conditions, and any other criteria deemed relevant by researchers.

Port sites: At each of nine port sites (Figures 4, 6-10, 13-15), researchers will superimpose a base line that is roughly parallel to shore, has the port as its center, and measures 56 km (30 nautical miles) in length (see representation in Figure 3). Thirty-one potential sampling vectors will be spaced at 1.8 km (1-nautical mile) intervals perpendicular to the base line (Figure 3). Each year, two vectors will be selected at random and sampling will be performed by setting gill nets cross-contour along the vector. Nets will be set in waters at each of three different depth ranges: 15-30 m (50-100 ft); 31-45 m (101-150 ft); and 46-60 m (151-200 ft). Researchers, captains, and crew will have discretion as to where to set nets within any given depth range along chosen vectors. Annual sampling along two vectors will amount to a total of six net sets, with two sets at each of the three different depth ranges.

Manistique, Washington Island, Waukegon, and Michigan City are four port sites that present special problems because all depth ranges (especially the 46-60-m range) may not be attainable along all potential vectors, or if they do exist, these depth ranges may lie at such distances from port that sampling is considered impractical. Follow the steps below for these sites:

1) Randomly select two vectors as described above.
2) Set nets at all depth ranges represented along selected vectors.
3) If any of the three depth ranges is NOT represented along a vector, randomly select additional vectors until one is selected where the missing depth range is represented (unless site has no vectors where missing depth range is represented or where missing depth range is beyond practical distance from port).
4) Set net within the missing depth range along the new vector.
5) If necessary, repeat steps 3 and 4 for the second original vector selected in step 1.

Physical Data:
For each set, record the collection number, date, vessel, moon phase, and site (see Table 2). At both ends of the net record latitude-longitude or LORAN-C coordinates as well as fishing depths. For both set and lift, record the time, temperature (top, mid, bottom, air), percent cloud cover, wave height, wind speed and direction, precipitation, and secchi disk reading (disk lowered from the shaded side of the boat).

Table 2. Sampling sites for lakewide assessment of lake trout and burbot.

Site	Name	Abbreviation[a]
1	Manistique	MA
2	Northern Refuge	NR
3	Washington Is. (Green Bay)	WI
4	Leland	LE
5	Sturgeon Bay	SB
6	Arcadia	AR
7	Sheboygan	SH
8	Midlake Refuge[b]	MR
9	Saugatuck	SG
10	Waukegan	WK
11	Michigan City	MC

[a] Site abbreviations to be used on sampling forms.
[b] The two reefs that compose Midlake Refuge (Sheboygan Reef and East Reef) will be sampled on an alternate year basis.

Biological Data:
General (Table 3): Biological data will be obtained from fish as follows: Obtain counts, group weights (nearest 50 g), and length ranges (mm) for all fish species other than lake trout, burbot, and chinook salmon. Obtain individual lengths (mm) and weights (g), and determine sex and maturity (immature, mature, unknown) for all lake trout, burbot, and chinook salmon. Collect scale samples from all chinook salmon and all lake trout measuring 800 mm or less. Collect otolith samples from all burbot and lake trout longer than 800 mm. Record all tags or marks and freeze heads of coded wire tagged (CWT) fish. Lamprey scars and wounding (A1-A3, B1-B3) should be recorded. For lake trout, burbot, and chinook salmon, stomachs should be removed, individually packaged, labeled and preserved for 10 fish/species/size group/day (Table 4). Method of stomach preservation should be noted on the data sheet. It is preferred that preserved stomachs be flash frozen using dry ice, but conventional freezing and formaldehyde are alternate methods. Some fish selected for stomach samples will be the same as those used for detailed health analysis, described below.

Fish Health (Table 4): Necropsies will be performed on all fish brought to shore as follows: All lake trout, burbot and chinook salmon will be examined for abnormalities or lesions on their bodies, skin, gills, eyes, abdominal cavities, hearts, digestive tracts, spleens, livers, kidneys, and gonads. Estimates will be made of the percent mesenteric fat, and a standardized color wheel will be used to evaluate the level of carotenes in flesh as a measure of what the fish has eaten in the recent past prior to being captured.

Table 3. Summary of general biological and fish health data to be collected from fish caught in lakewide assessment nets set for lake trout and burbot.

	Species			
Parameter	Lake trout	Burbot	Chinook salmon	Others (by species)
Count				All
Group weight				All
Length range				All
Length	All	All	All	
Weight	All	All	All	
Sex	All	All	All	
Maturity	All	All	All	
Scales	≤ 800 mm		All	
Otoliths	> 800 mm	All		
Stomachs	10/size grp/day[a]	10/size grp/day[a]	10/size grp/day[a]	
Clip/CWT	All		All	
Lamprey scars	All	All	All	
General health	All	All	All	

[a]See Table 4 for size group divisions.

Table 4. Species size groups for stomach and detailed health sampling during spring assessments.

	Size group (mm)				
Species	1	2	3	4	5
Lake trout	< 200	200-399	400-599	600-799	≥ 800
Burbot	< 200	200-399	400-599	600-799	≥ 800
Chinook salmon	< 450	450-700	> 700		

Note: Finclips should be recorded on scale envelopes for <u>all</u> fish. Use a wand on the boat to determine presence or absence of CWT tags in all lake trout. Indicate whether a coded wire tag is present or not by printing ND (Not Detected) or CWT (Tag Present) on the scale envelope. Further, if a CWT is present, keep the head and label the bag as usual but also record all clips on the bag as well as the scale envelope.

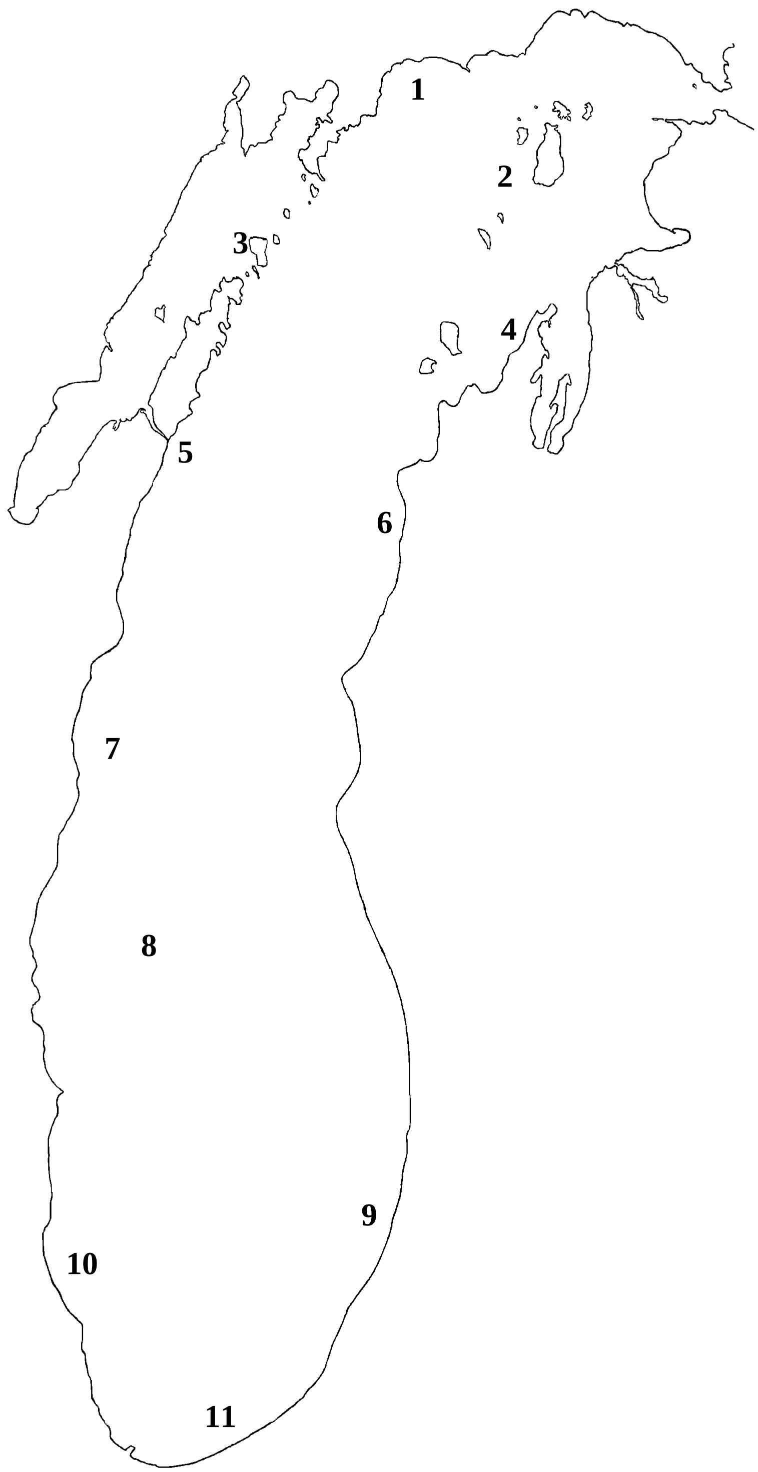

Figure 1. Approximate locations of 11 sampling sites for lakewide assessment of lake trout and burbot in Lake Michigan.

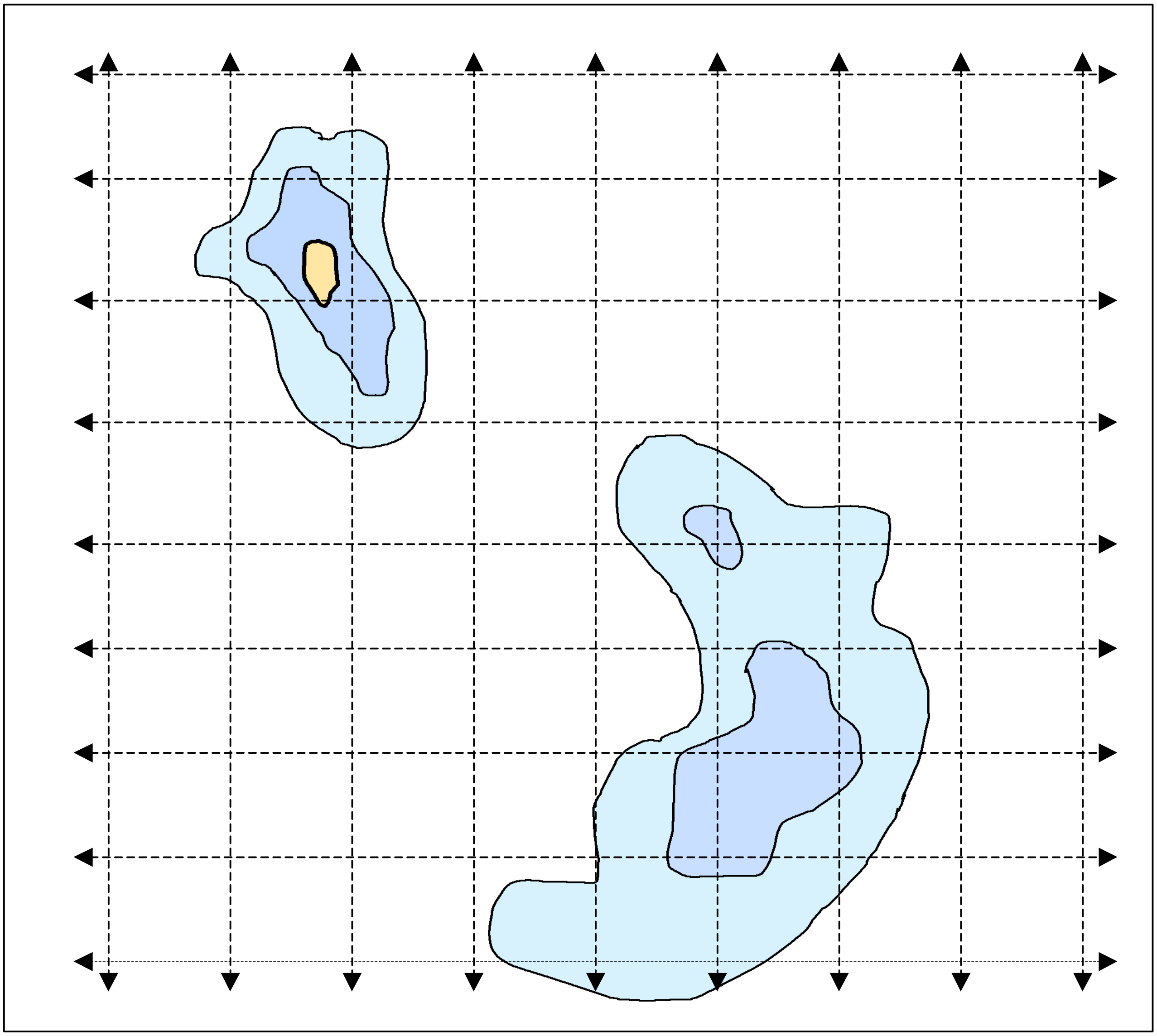

Figure 2. Generalized illustration of a refuge site with a grid superimposed over the area creating 1 x 1 minute cells. Refuge site sampling nets will be set within six randomly selected cells each year.

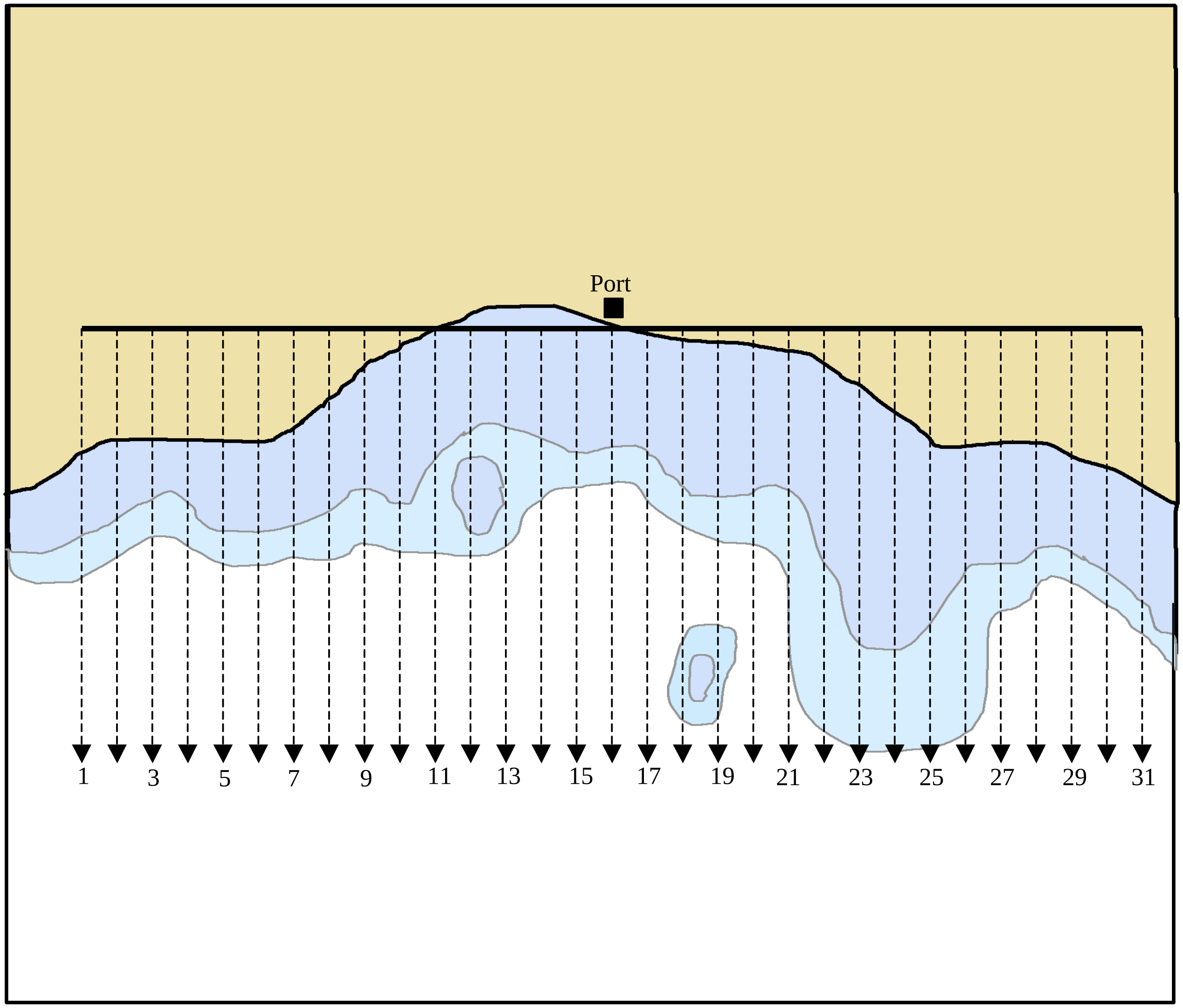

Figure 3. Generalized illustration of 31 possible sampling vectors originating from a base line drawn through a stylized port location. The thick black line runs roughly parallel to the shoreline with the port at its center. Vectors are 1.8 km apart and run perpendicular to the base line. Each year, sampling nets will be set within three depth ranges (15-30 m; 31-45 m; and 46-60 m) along two randomly selected vectors.

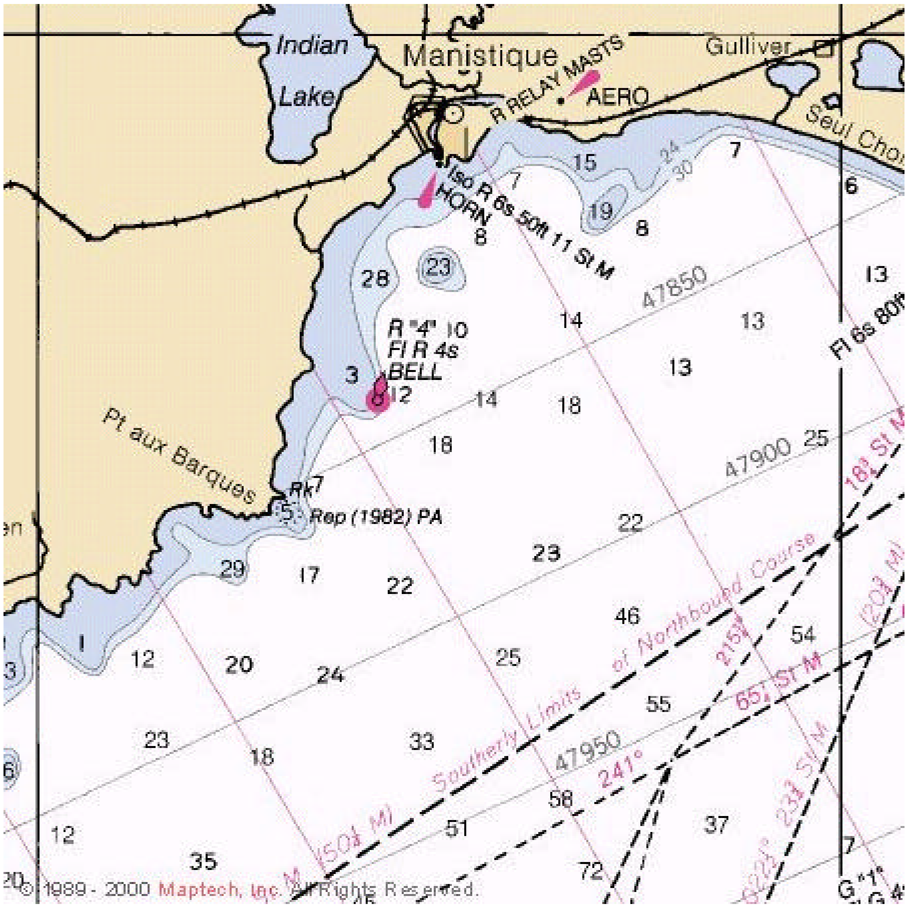

Figure 4. Lake Michigan map (scale = 1:500,000) near Manistique, MI. Area shown is centered at Latitude 45° 49' 01" N and Longitude 86° 14' 26" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

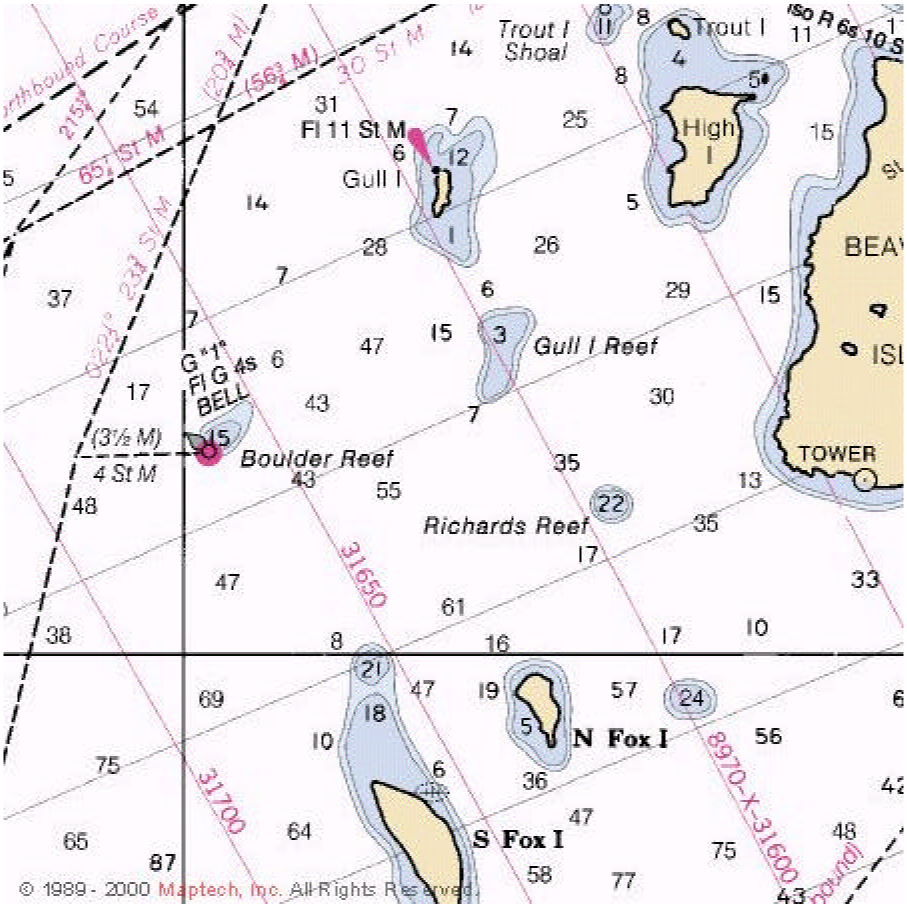

Figure 5. Lake Michigan map (scale = 1:500,000) near the Northern Refuge. Area shown is centered at Latitude 45° 35' 13" N and Longitude 85° 49' 54" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

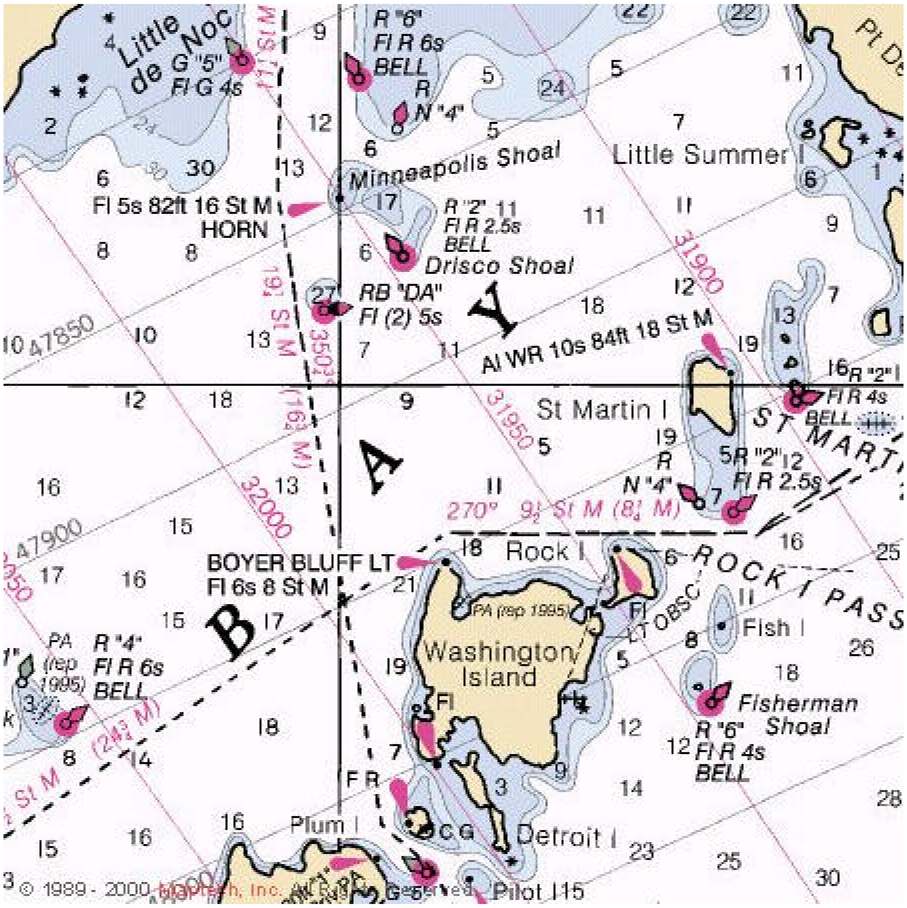

Figure 6. Lake Michigan map (scale = 1:500,000) near Washington Island, WI (sampling is to be conducted in waters on the Green Bay side of Washington Island). Area shown is centered at Latitude 45° 28' 09" N and Longitude 86° 55' 46" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

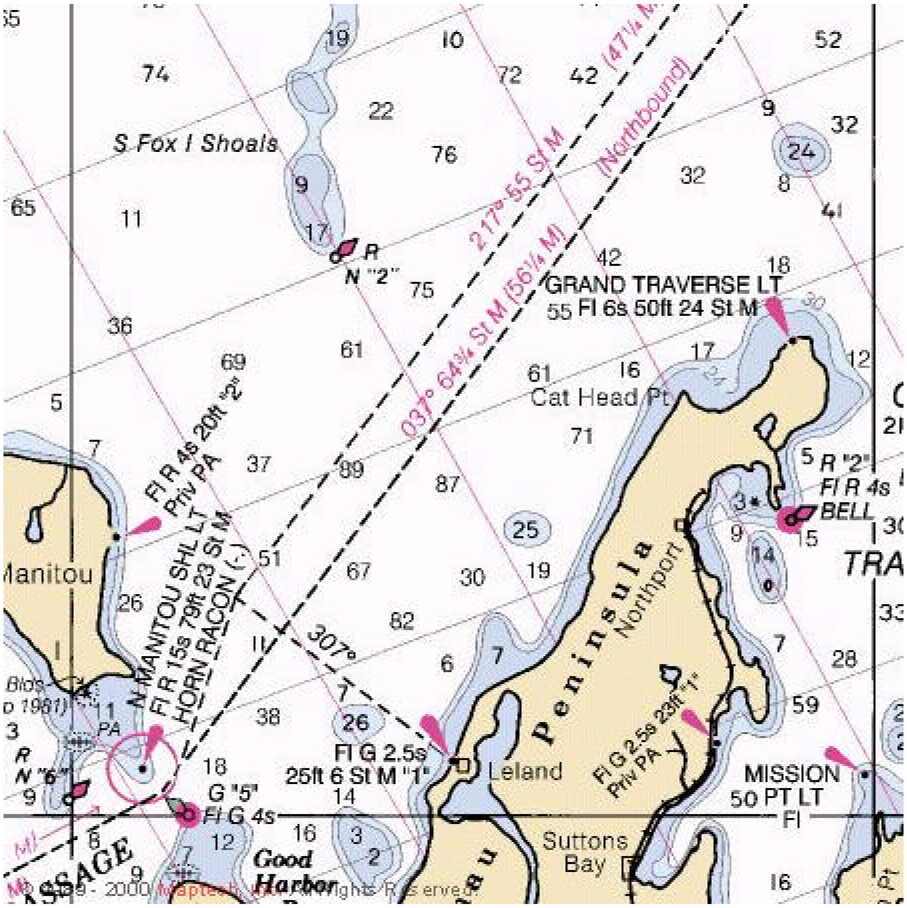

Figure 7. Lake Michigan map (scale = 1:500,000) near Leland, MI. Area shown is centered at Latitude 45° 09' 29'' N and Longitude 85° 45' 38'' W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

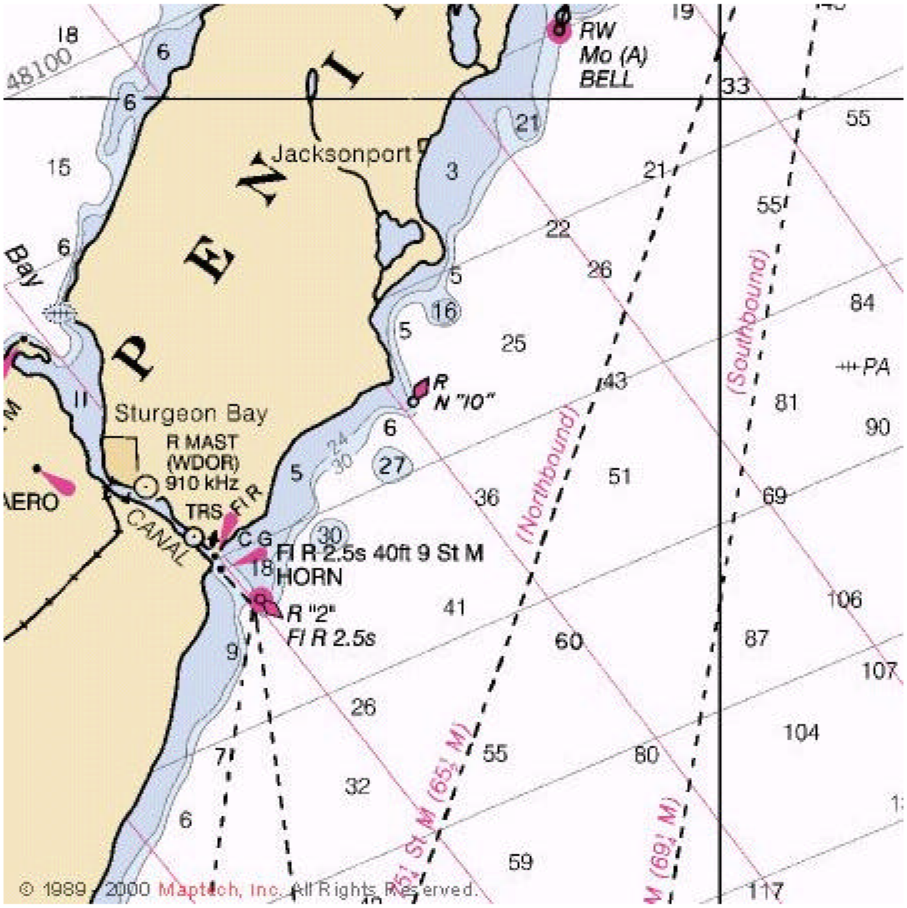

Figure 8. Lake Michigan map (scale = 1:500,000) near Sturgeon Bay, WI. Area shown is centered at Latitude 44° 50' 30" N and Longitude 87° 09' 59" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

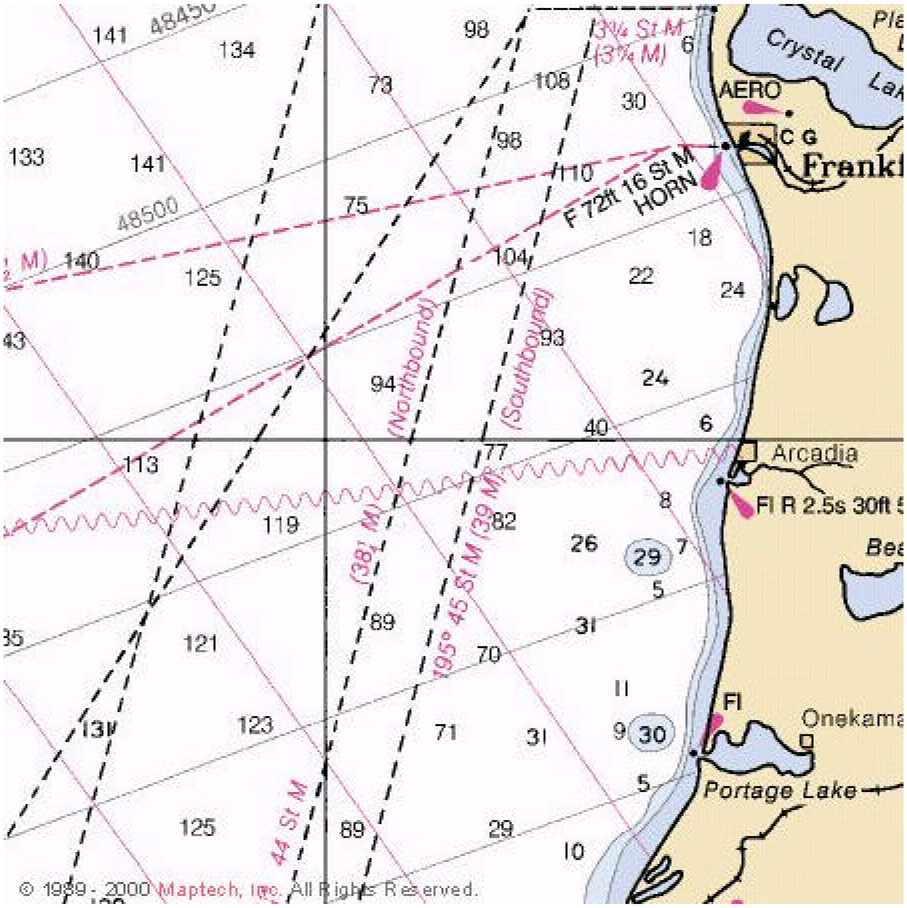

Figure 9. Lake Michigan map (scale = 1:500,000) near Arcadia, MI. Area shown is centered at Latitude 44° 29' 35'' N and Longitude 86° 25' 14'' W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

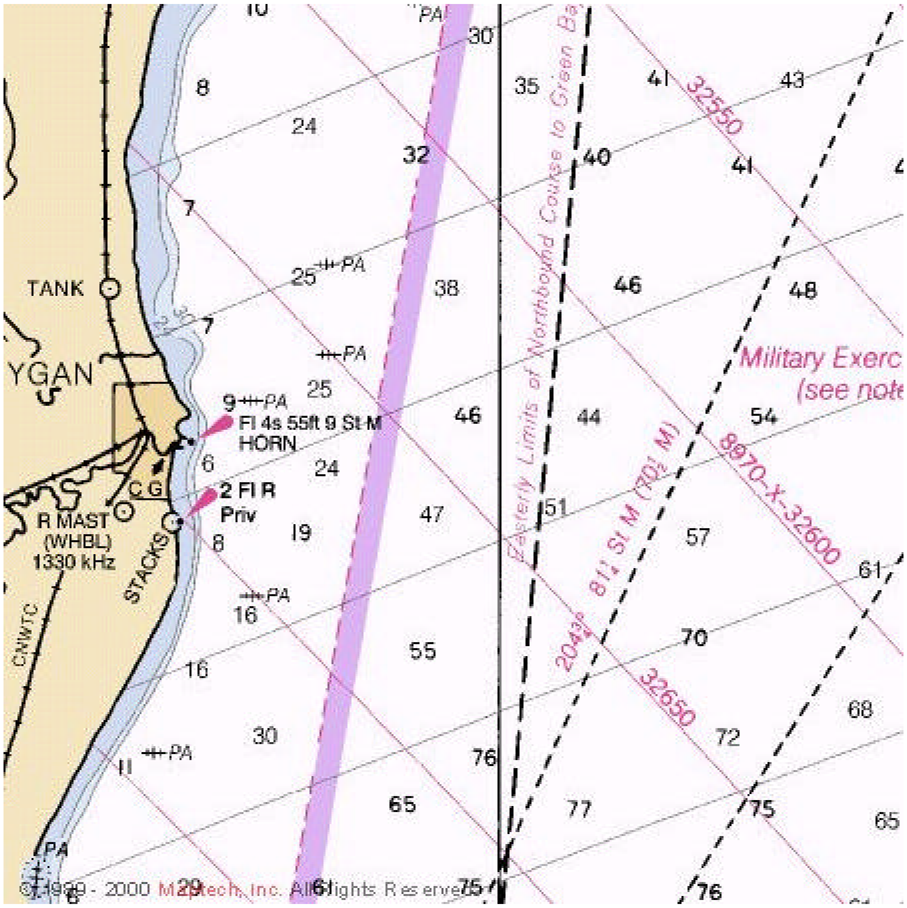

Figure 10. Lake Michigan map (scale = 1:500,000) near Sheboygan, WI. Area shown is centered at Latitude 43° 44' 42" N and Longitude 87° 31' 43" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

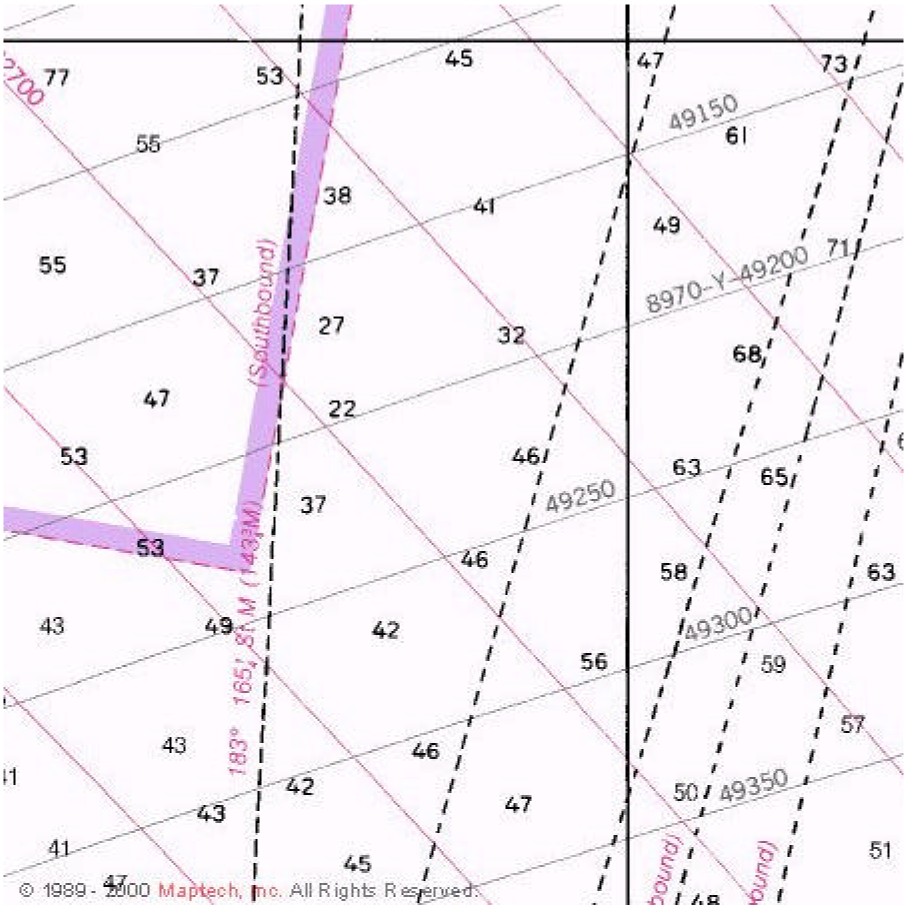

Figure 11. Lake Michigan map (scale = 1:500,000) near the Midlake Refuge (Sheboygan Reef). Area shown is centered at Latitude 43° 18' 42" N and Longitude 87° 06' 30" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

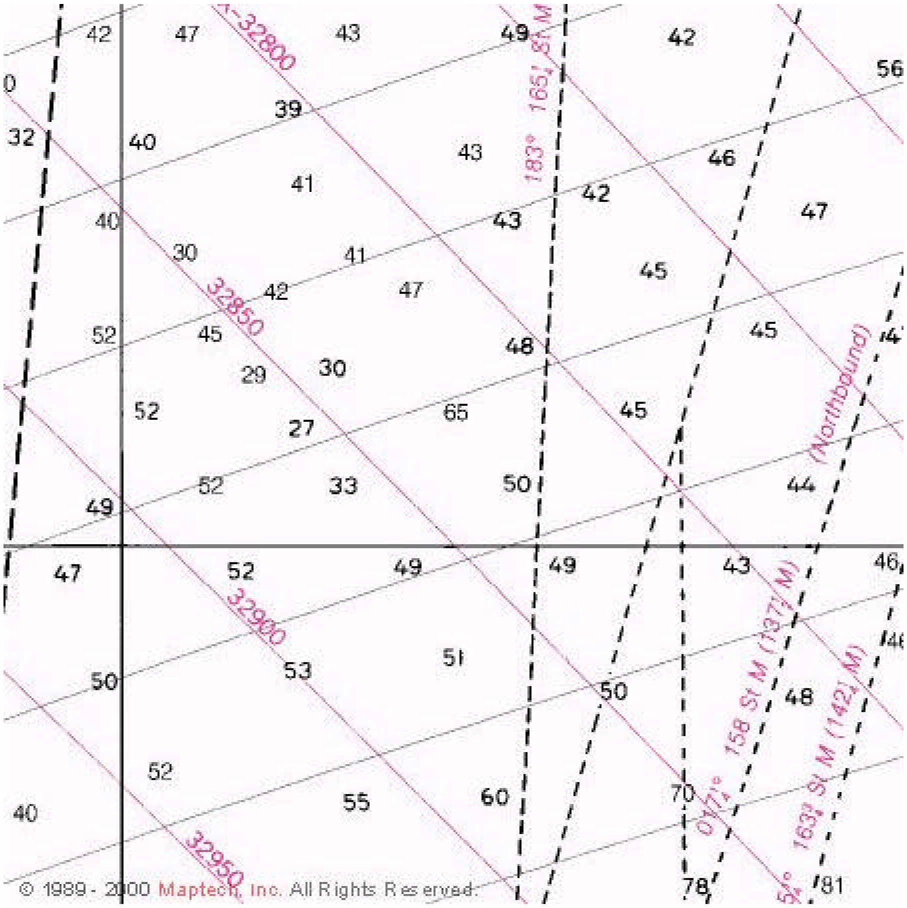

Figure 12. Lake Michigan map (scale = 1:500,000) near the Midlake Refuge (East Reef). Area shown is centered at Latitude 43° 02' 30" N and Longitude 87° 17' 36" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

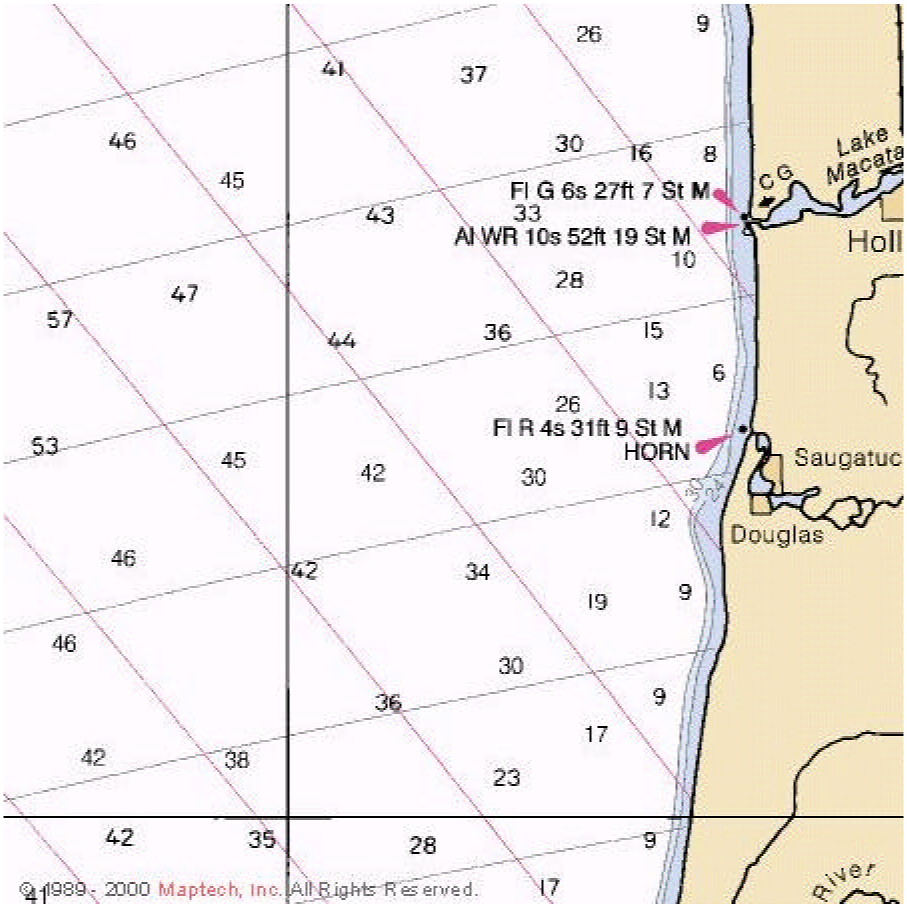

Figure 13. Lake Michigan map (scale = 1:500,000) near Saugatuck, MI. Area shown is centered at Latitude 42° 40' 01" N and Longitude 86° 23' 48" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

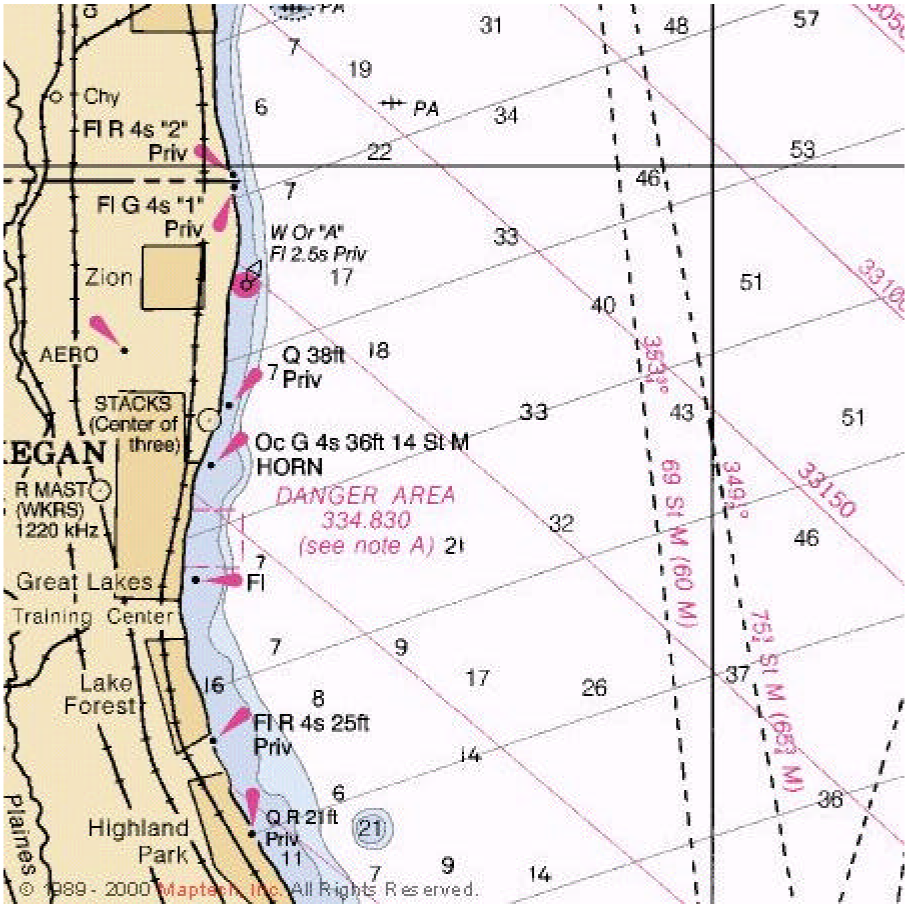

Figure 14. Lake Michigan map (scale = 1:500,000) near Waukegan, IL. Area shown is centered at Latitude 42° 22' 00" N and Longitude 87° 39' 37" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

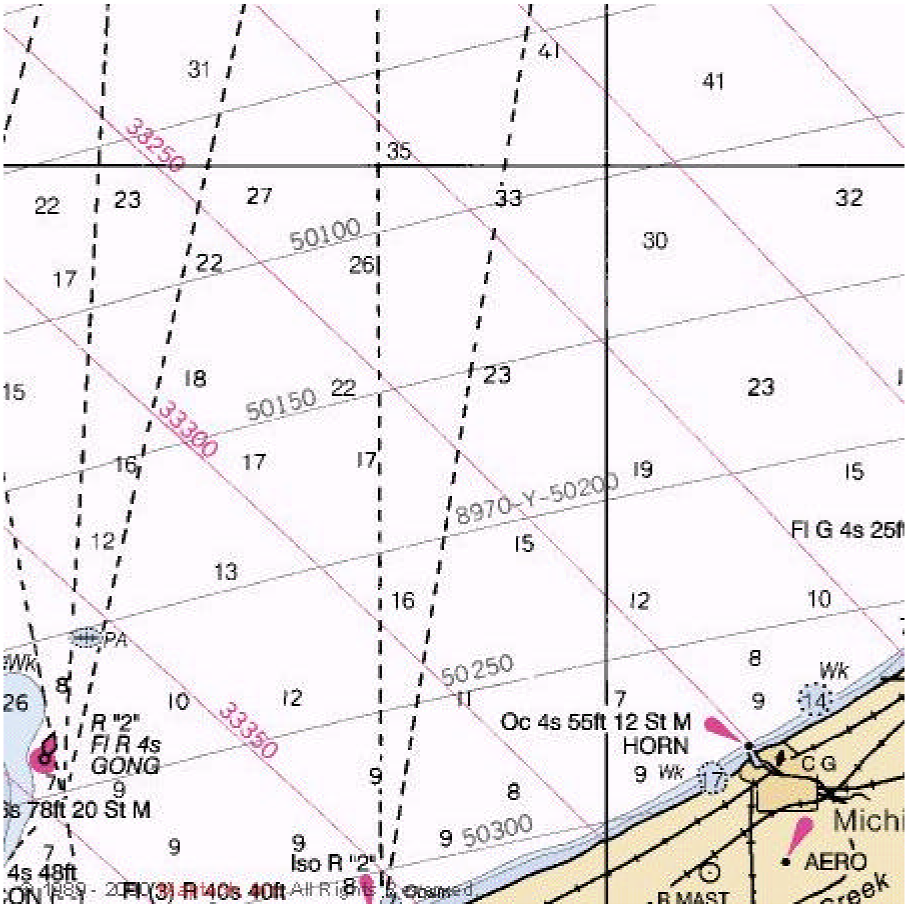

Figure 15. Lake Michigan map (scale = 1:500,000) near Michigan City, IN. Area shown is centered at Latitude 41° 51' 54" N and Longitude 87° 05' 41" W. Map image used with permission from Maptech ® Inc. (http://www.maptech.com).

Appendix 2

Sampling Design for Chinook Salmon and Steelhead Trout Assessment

Design of Suspended Gill Nets:
Monofilament surface and suspended gill nets will be used to sample chinook salmon and steelhead trout populations in Lake Michigan (Table 1). All nets are 9-m (30-ft) deep and each mesh size represents a 30-m (100-ft) panel. Mesh is strung with #18 nylon thread on 10-mm (0.4-in) braided poly rope. Floats are #200 plastic (Canadian) and leads are 227 g (8 oz) split. Surface nets are suspended with Scanmarin 229- and 406-mm (9- and 16-in) inflatable buoys tied between each section. Buoys are orange in color to increase visibility of the net on the surface. A gill-net gang consists of four 244-m (800-ft) sections of net (976 m [3,200 ft] total). Each 244-m section is composed of single panels from each of the eight mesh sizes arranged from smallest to largest. Because the nets are bulky, gill net drums similar to those used in commercial marine fisheries are used to lift the gear. Due to navigational hazards associated with surface nets, the vessel tends nets by remaining attached to the surface end of the net.

Table 1. Net specifications for assessment of chinook salmon in Michigan waters of Lake Michigan.

Mesh size (stretched)	76 mm (3.0 in)	89 mm (3.5 in)	102 mm (4.0 in)	114 mm (4.5 in)	127 mm (5.0 in)	140 mm (5.5 in)	152 mm (6.0 in)	178 mm (7.0 in)
Thread size (monofilament)	#3	#4	#4	#6	#6	#6	#6	#8
Meshes deep	144	120	108	90	86	80	72	60
No. floats-leads/net	12	12	13	12	13	12	12	12
Len. of tie btwn float-lead	203 mm (8 in)	241 mm (9.5 in)	229 mm (9 in)	203 mm (8 in)	229 mm (9 in)	254 mm (10 in)	203 mm (8 in)	241 mm (9.5 in)
No. ties between float-lead	12	10	10	12	10	10	12	10
No. meshes hung/tie btwn float-lead	6	6	5	4	4	4	3	3
Len. of float-lead tie	114 mm (4.5 in)	127 mm (5 in)	102 mm (4 in)	114 mm (4.5 in)	127 mm (5 in)	127 mm (5 in)	114 mm (4.5 in)	114 mm (4.5 in)
No. meshes hung/float-lead tie	3	3	2	2	2	2	1	1
Cross bridle:								
Len. of tie	254 mm (10 in)	305 mm (12 in)	254 mm (10 in)	305 mm (12 in)	213 mm (8.4 in)	229 mm (9.0 in)	254 mm (10 in)	305 mm (12 in)
No. of ties	36	30	36	30	43	40	36	30
No. of mesh/tie	4	4	3	3	2	2	2	2

Schedule of Sample Collection:
To obtain quantitative information on fish movements we will sample the length (south to north) of the lake twice, once in the spring and once in the summer (Table 2). Nets will be set at random inshore and offshore locations within specified statistical districts.

Selection of Random Sampling Sites:
Sampling locations will be selected by assigning numbers to latitudinal sections of grids within each statistical district. A random number generating program will be used to determine 4 random sampling locations (10 minute interval latitudes) within each statistical district. Random sites will be assigned to Table 2 in the order drawn. The order of sampling will be determined based on convenience of travel between sites within a statistical district. The boat will travel away from shore within the randomly selected latitudinal section and nets will be set at the specified depth/distance strata for that sample.

Evaluation of Thermal Preferences of Chinook Salmon and Steelhead Trout:
There are four panels of each mesh size within each gang. Two panels will be set at the surface, while the other two will be set at depths to include preferred temperatures of chinook salmon. The bottom of the deep net section should be set at the depth where water temperatures drop below 13°C (55°F). The deeper net will always be set at a depth of at least 9 m (30 ft) (top of net), to avoid overlap with the surface net. The following decision criteria will be used for selecting the depth of the bottom net:

a). Is the warmest temperature in the profile 13°C (55°F) or less?
   Yes - Surface net=0-9 m (0-30 ft), Suspended net=9-18 m (30-60 ft).
   No - Go to b).

b). Is water temperature at 18 m (60 ft) greater than 13°C (55°F)?
   Yes - Bottom of suspended net at nearest depth where T<13°C (55°F).
   No - Bottom of suspended net at 18 m (60 ft).

Sample Standardization:
In order to remove possible sources of variance around estimates of catch per unit effort (CPUE), the time of day and duration of the net sets should be as constant as possible. Nets should be set one hour prior to sunset and should be left in the water for a period of 4 hours (from the time the first buoy enters the water to the time the first buoy is removed from the water).

Collection of Data:
Note: Record information from the top and bottom nets on separate data sheets.

<u>Physical Data: (Card #1)</u>

1) Record the ID number (start with 1001, use a T for the top net, a B for the bottom net, and an F for the forage net in the effort section of Card #1 and on Cards #2 and #3; i.e., 1001T, 1001B, 1001F for the first net set), lake, date, data type (assessment), statistical district, grid number, and location (name nearest port) on the Card #1 data sheet. On the Temperature Profile Data Sheet record whether a thermal bar is present or not and whether the net is ON-BAR or OFF-BAR and if OFF-BAR, whether it is in- or out-side of the bar. Presence or absence of, and position relative to, thermal bars should be determined based on satellite temperature maps and temperature measurements across the length of the gill net.

2) Record the latitude and longitude of the net on Card #1, indicate coordinates at the beginning and end of the set.

3) Record the site depth as the total water depth of the site represented by the range of depths across which the net is set (i.e., net fished over 70-73 m [230-240 ft] of water).

4) Record the gear type (see list below for possible gear types), width, length, material (nylon, mono, etc.), minimum mesh size and maximum mesh size (stretched mesh, inches) on the Card #1 data sheet.

SGN=Surface gill nets
SPN=Suspended gill nets
BGN=Bottom gill nets
VGN=Vertical gill nets (forage assessment)

5) Record the temperature at the start and end of each net set on the Temperature Profile Data Sheet. Record temperatures at 3-m (10-ft) intervals.

6) Record the fishing depth on the temperature profile data sheet by placing an "X" at the depth of the top and the bottom of the nets (i.e., if the net is set in 0-9 m [0-30 ft] and 9-18 m [30-60 ft] of water, record an "X" in the space for the 0-, 9-, and 18-m [0-, 30-, 30-, and 60-ft] depths).

7) In the space provided on the Card #1 for "Effort" record the ID number, the time the first buoy enters the water, the time the last buoy goes into the water as well as the time the first buoy leaves the water and the time when the last buoy leaves the water for each net type (Top, Bottom, and Forage). Use military time. Keeping records of all time variables involved with setting nets will enable us to determine variability among net sets and give us flexibility in determining the best methods for calculating CPUE. In the space labeled GN-Type mark the gear type (SGN, SPN, BGN, or VGN).

8) In the section entitled Weather Data on Card #1, record information on wind direction, wind speed, cloud cover, moon phase, air temperature, time of day, wave height, and current direction when the net is initially set. When the net is lifted, record how far it drifted and in the space provided for other observations record any major weather changes that may have occurred during the set.

Biological Data:

1) The total number and group weight of each species caught will be recorded on the Card #2. Obtain group weights only on non-target species (Table 3 lists species on which to obtain more specific information).

2) For trout, salmon, and burbot, lengths, weights, and additional information will be recorded on Card #3. Length frequencies of fish sampled in forage nets will be recorded on Card #2.

3) Collect stomachs from 10 fish from each 100 mm group of fish collected (use tally sheet to keep track of numbers). Try to distribute samples between the top and bottom nets. Collect stomachs from a random sample of 5 burbot and lake whitefish from each 100 mm size group on each sampling day. Freeze stomachs individually in labeled plastic bags. Check the Stomach column (Card #3) when stomachs are taken.

4) Collect scale samples from all salmonids and place in labeled scale envelopes. Collect otoliths from burbot from which stomach samples were collected and store in labeled scale envelopes. Check the respective Otolith or Scales column (Card #3) when scales and/or otoliths are taken.

5) On Card #3 record the mesh size if separate panels of net are being evaluated (one time per statistical district).

5) Evaluate prevalence of BKD (FELISA) on the numbers and species of fish shown in the biological data collection schedule (Table 3). Record that BKD samples were taken on the scale envelopes and on Card #3. Visually identify whether the fish has BKD and note positive or negative result and any comments on the scale envelope. Identification of visual symptoms of BKD is based on criteria developed by personnel of the United States Fish and Wildlife Service (Lasee 1995).

6) Record the finclips according to the nomenclature on handouts.

7) Record lamprey wounding rates by assigning wounds to categories defined by King and Edsall (1979) (A1, A2, A3, B1, B2/B3, and A4/B4) and record total number of each on the scale envelope and Card 3.

8) Record the sex and maturity of the fish. Maturity should be assigned according to the criteria listed below. Numbers greater than 2 will only be used in spawning reef assessments.

I=Immature
M=Mature
G=Gravid (Eggs formed but still hard)
R=Ripe (Eggs being expelled)
P=Partly spent
S=Spent
U=Unknown

Potential Outcomes and Duration of Sampling:
The sampling outline discussed above should be considered a long-term means of monitoring the status of salmonid populations in Lake Michigan. The information will provide us with the means of evaluating population trends, shifts in diet, incidence of high mortality or disease, age and size structure of populations, as well as allowing comparisons both within and among species to determine differences in survival and behavior in the lake environment. It is commonly believed that chinook salmon and steelhead are more abundant in spring in the southern part of the lake and move north throughout the summer as the water warms. Sampling the length of the lake over two time periods will allow us to investigate current assumptions concerning fish movement throughout the lake. By fishing nets at both the surface and the thermocline we will be better able to determine the most appropriate way to sample target fish populations.

Table 2. Summary of proposed sampling schedule for lakewide assessment of chinook salmon and steelhead trout in Lake Michigan.

		Statistical District			
ID Number	Depth / Distance Strata	Western Lake Michigan	Eastern Lake Michigan	Time	Replicate
1	INSHORE	IN/IL/WM6	IN/MM8	SPRING	1
2	INSHORE	IN/IL/WM6	IN/MM8	SPRING	2
3	INSHORE	IN/IL/WM6	IN/MM8	SPRING	3
4	INSHORE	IN/IL/WM6	IN/MM8	SPRING	4
5	OFFSHORE	IN/IL/WM6	IN/MM8	SPRING	1
6	OFFSHORE	IN/IL/WM6	IN/MM8	SPRING	2
7	OFFSHORE	IN/IL/WM6	IN/MM8	SPRING	3
8	INSHORE	WM4	MM6	SPRING	1
9	INSHORE	WM4	MM6	SPRING	2
10	INSHORE	WM4	MM6	SPRING	3
11	INSHORE	WM4	MM6	SPRING	4
12	OFFSHORE	WM4	MM6	SPRING	1
13	OFFSHORE	WM4	MM6	SPRING	2
14	OFFSHORE	WM4	MM6	SPRING	3
15	INSHORE	WM1/WM2/MM1	MM4	SPRING	1
16	INSHORE	WM1/WM2/MM1	MM4	SPRING	2
17	OFFSHORE	WM1/WM2/MM1	MM4	SPRING	1
18	OFFSHORE	WM1/WM2/MM1	MM4	SPRING	2
19	INSHORE	MM2	MM3	SPRING	1
20	INSHORE	MM2	MM3	SPRING	2
21	INSHORE	MM2	MM3	SPRING	3
22	OFFSHORE	MM2	MM3	SPRING	1
23	OFFSHORE	MM2	MM3	SPRING	2
24	INSHORE	IN/IL/WM6	IN/MM8	SUMMER	1
25	INSHORE	IN/IL/WM6	IN/MM8	SUMMER	2
26	INSHORE	IN/IL/WM6	IN/MM8	SUMMER	3
27	INSHORE	IN/IL/WM6	IN/MM8	SUMMER	4
28	OFFSHORE	IN/IL/WM6	IN/MM8	SUMMER	1
29	OFFSHORE	IN/IL/WM6	IN/MM8	SUMMER	2
30	OFFSHORE	IN/IL/WM6	IN/MM8	SUMMER	3
31	INSHORE	WM4	MM6	SUMMER	1
32	INSHORE	WM4	MM6	SUMMER	2
33	INSHORE	WM4	MM6	SUMMER	3
34	INSHORE	WM4	MM6	SUMMER	4
35	OFFSHORE	WM4	MM6	SUMMER	1
36	OFFSHORE	WM4	MM6	SUMMER	2
37	OFFSHORE	WM4	MM6	SUMMER	3

Table 2. continued.

		Statistical District			
ID Number	Depth / Distance Strata	Western Lake Michigan	Eastern Lake Michigan	Time	Replicate
38	INSHORE	WM1/WM2/MM1	MM4	SUMMER	1
39	INSHORE	WM1/WM2/MM1	MM4	SUMMER	2
40	OFFSHORE	WM1/WM2/MM1	MM4	SUMMER	1
41	OFFSHORE	WM1/WM2/MM1	MM4	SUMMER	2
42	INSHORE	MM2	MM3	SUMMER	1
43	INSHORE	MM2	MM3	SUMMER	2
44	INSHORE	MM2	MM3	SUMMER	3
45	OFFSHORE	MM2	MM3	SUMMER	1
46	OFFSHORE	MM2	MM3	SUMMER	2

Definition of Terms:

1) ID number: On data sheets 1000 is added to this number to avoid overlap with scale sample numbers.

2) Depth / Distance Strata:

INSHORE -- Sites located inshore; water depth <46 m (150 ft) or within 1.6 km (1 mi) of shore.
OFFSHORE -- Sites located offshore; water depth 92 m (300 ft) or >9.6 km (6 mi) from shore.

3) Statistical District: Statistical districts where sampling will occur on the eastern and western sides of Lake Michigan.

4) Time:

SPRING- May 1 to June 30

SUMMER- July 1 to August 31

5) Replicate: Two to four replicates will be performed for each depth / distance strata , within each statistical district during each time period.

Table 3. Biological data collection schedule. An “**X**” indicates that the information should be obtained from all fish of a designated species. In some cases we will sub-sample the total catch. Numbers indicate the maximum number of fish that should be evaluated per set.

SPP	TOTAL #	GROUP WT	TL	WT	CLIP	CWT	OTC	LAMPREY	SEX	MATUR-ITY	SCALES	OTOLITHS	STOMACH	VISUAL BKD	FELISA
CHS (301)	X		X	X	X	X	X	X	X	X	X		10 per 100-mm group	X	X
COH (310)	X		X	X	X	X		X	X	X	X		10 per 100-mm group	X	X
RBT (303)	X		X	X	X	X		X	X	X	X		10 per 100-mm group	X	X
LAT (307)	X		X	X	X	X		X	X	X	X		10 per 100-mm group	10 per 100-mm group	10 per 100-mm group
BNT (305)	X		X	X	X			X	X	X	X		10 per 100-mm group	X	X
ATS (304)	X		X	X	X	X		X	X	X	X		10 per 100-mm group	X	X
BUR (127)	X	X	X	X				5 per100mm group	5 per100mm group			5 per100mm group All>300mm	5 per 100-mm group	5 per 100-mm group	5 per 100-mm group
LWF (203)	X	X	X	X				5 per100mm group	5 per100mm group		X		5 per 100-mm group	5 per 100-mm group	5 per 100-mm group
LHR (202)	X	X	X	X					X		X			X	X
ALL OTHER (By SPP)	X	X													

Appendix 3. Lakewide assessment data forms.

LAKEWIDE ASSESSMENT - Gill Net Data Form

Coll #	Date	Vessel	Port	Grid	Fishing depth From	Fishing depth To	Loran-C or Lat-Long coordinates From	Loran-C or Lat-Long coordinates To	Moon phase

	Time	Temperature (°C) Top	Temperature (°C) Mid	Temperature (°C) Bot	Temperature (°C) Air	% cloud	Wave ht. (m)	Wind Speed (km/h)	Wind Dir	PPT (Y/N)	Secchi (m)
Set											
Lift											

Species	Number	Group weight (nearest 50 g)	Length range (mm) Minimum	Length range (mm) Maximum

Notes:

LAKEWIDE ASSESSMENT - Trawl Data Form

Coll #	Date	Vessel	Grid #	Stat. Dist.

Temperature (°C)						Wind			
Top	Mid	Bot	Air	% cloud	Wave ht. (m)	Speed (km/h)	Dir	PPT (Y/N)	Secchi (m)

Tow #								
Direction								
	Start	Stop	Start	Stop	Start	Stop	Start	Stop
Time								
Coordin-ates								
Depth (m)								

Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				
Number				
Group wt*				
Species				

Number				
Group wt*				
Species				
Number				
Group wt*				

* Nearest 50 g
Notes:

LAKEWIDE ASSESSMENT – Lake Trout, Burbot, Chinook Salmon Biological Data Form

Coll. #	Date	Port	Grid

								Lam-prey			Fish Health (NL=no lesions, AB=abnormal, NX=not examined)												
Species code	Fish ID #	Length (mm)	Weight (g)	Sex	Maturity*	OT, Scale, CWT	Clip	Fresh	Healed	Saved stomach? (Y/N)	General body	Skin	Gills	Eyes	Abdominal cavity	Heart	Digestive tract	Spleen	Liver	Kidney	Gonad	% Mesenteric fat	Carotene (wheel)		

*Maturity Code: I=Immature; M=Mature; U=Unknown
Notes:

LAKEWIDE ASSESSMENT – Diet Data Form

Coll. #	Date	Port	Grid

		Diet											
Species code	Fish ID number	Total weight of stomach contents (g)	Prey category	Category wt. (g)	Category count	Item length (mm)	Item weight (g)	Item length (mm)	Item weight (g)	Item length (mm)	Item weight (g)	Item length (mm)	Item weight (g)

Notes:

Date:____________________________ SAMPLE ID#:_______________________________

CARD #1: Gear/Weather/Climate/Time Information-SV Steelhead

LAKE: Michigan 2 Superior 1 Huron 3 St. Clair 4 Erie 5

DATA TYPE:Commercial 1 Assessment 2 Index 3 Other ________________

STAT DIST. ___________ FIRST BOUY: LAT. _____ _____ _____ LAST BOUY: LAT. _____ _____ _____

GRID: ________________ LONG. _____ _____ _____ LONG. _____ _____ _____

LOCATION: ____

SITE DEPTH (m): From _____ To

GEAR TYPE:_________ WIDTH: ______ LENGTH: ______ MATERIAL(Gill Net):__________

MIN MESH:_________ MAX MESH: __________ COD/POT MESH(Trawl/Trap Net): _____________

VESSEL SPEED (Trawl): _____________ TOW TIME: ____________

EFFORT:
Time of set (in military time, if greater than 24 h give date and time):

ID NUMBER	NET TYPE	GN-Type	IN	OUT
	Trap/Pound/Fyke			
	Gill Net:First Buoy			
	Gill Net:Last Buoy			
	Gill Net:First Buoy			
	Gill Net:Last Buoy			
	Gill Net:First Buoy			
	Gill Net:Last Buoy			

Weather Data

Wind Direction (circle one): N NE NW S SE SW E W

Wind Speed (km/hr): ________ Sky (circle one): Clear Cloudy (% Cover ___) Overcast

Moon Phase: ______________ Air Temperature (°C): ______ Time of Day:

Wave Height (m):_____ Current Direction:______ Drift (How Far?):

Other Observations: ____

CARD #2: AGGREGATE CATCH AND LENGTH FREQUENCY DATA

PAGE _______ OF _______

ID NUMBER __________ DATE __________

MESH ____________________ DEPTH ____________________

SPECIES						
TOTAL NUMBER						
TOTAL WEIGHT (GRAMS)						
SUBSAMPLE NUMBER (1)						
SUBSAMPLE WEIGHT (1)						
SUBSAMPLE NUMBER (2)						
SUBSAMPLE WEIGHT (2)						

C	MESH	DEPTH	N						
O									
M									
M									
E									
N			5						
T									
S									
			10						
			15						
			20						
			25						
			30						
			35						
			40						
			45						
			50						

LAKEWIDE ASSESSMENT – Card #3. Biological Data Sheet Page___ of ___

Date	ID #

						Lamprey									Biological samples						
Species code	Fish ID #	Length (mm)	Weight (g)	Clip	Tag number	No. A1	No. A2	No. A3	No. B1	No. B2/B3	No. A4/b4	Sex	Maturity*	Visual BKD?	BKD swab?	Head?	Tail?	Stomach?	Scales?	Otoliths?	Dest.

Maturity Code: I=Immature; M=Mature; G=Gravid; R=Ripe; P=Partly spent; S=Spent; U=Unknown

Temperature Profile Data Sheet

ID #: ______________________ DATE: ______________________

THERMAL BAR ? Yes No

Site Information: ONBAR OFFBAR IN / OUT OFFSHORE

Depth in m (ft)	Temperature °C Start	Temperature °C End	Depth of nets in m (ft.)
0			
3 (10)			
6 (20)			
9 (30)			
12 (40)			
15 (50)			
18 (60)			
21 (70)			
24 (80)			
27 (90)			
30 (100)			
34 (110)			
37 (120)			
40 (130)			
43 (140)			
46 (150)			
49 (160)			
52 (170)			
55 (180)			
58 (190)			
61 (200)			
64 (210)			
67 (220)			
70 (230)			

Appendix 4

Fish Species Codes For Use In Lakewide Fisheries Databases For Lake Michigan

The intent of this appendix is to provide standard fish species codes that will be used by all agencies and organizations that participate with the Lake Michigan lakewide assessment plan. Codes were developed to: 1) be applied in the field without exhaustive memorization; 2) handle a large and growing list of fish species without altering existing codes; 3) have intuitive links with common names of fish; 4) be applied consistently without numerous exceptions; and 5) be compatible with easy data entry, data manipulation, and database use.

Rules for selecting 3-letter abbreviations codes for fish species: (in precedence order)

General Rules

1. Keep abbreviation methods consistent for related or similarly named species. This should over-ride other rules.
2. To prevent duplicate codes, consider all fish species likely to be coded.

One Word Common Names

3. Use first two letters and last letter of common name (walleye = WAE, alewife = ALE, carp = CAP), unless:
4. If a compound name, use first two letters and first letter of second word (bluegill = BLG, stonecat = STC).
5. If combinations of both the above produce duplicates, use the first three letters (bloater = BLO).

Two Word Common Names

6. Use first two letters of first word and first letter of second word (lake trout = LAT, chinook salmon = CHS), unless:
7. If one or both words are compound words, use the first letter of the first three individual words, regardless of whether compounded or not (smallmouth bass = SMB, lake whitefish = LWF, ninespine stickleback = NSS).
8. If combinations of rule 6 or 7 produce duplicates, use the first and last letter of the first word and the first letter of the second word for both fish (brook trout and brown trout become BKT and BNT instead of BRT).

Three Word Common Names

9. Use first letter of each word (american brook lamprey = ABL, northern redbelly dace = NRD)

Rules and Examples for Resolving Duplication

The above process can often result in two fish having the same code. Following are rules for resolving duplications (in precedence order) and some examples that illustrate the decision-making process for assigning codes.

1. Codes that follow a pattern for several similar fish takes precedence (see rule 1 above).
2. Codes for fish with a multiple word names take precedence over shorter or single word names.
3. Codes that have been commonly used for commonly encountered fish take precedence over rarely encountered fish.

Example 1: All redhorse suckers use two letters from the first name rather than the RH from "redhorse" because some of the redhorse suckers have compounded first names such as shorthead redhorse. In addition, if RH were used, both silver and shorthead redhorse would have the same code.

Example 2: BLR is applicable to both black redhorse and bloater. Because bloater is a shorter name, and because there is an established pattern for naming redhorse suckers, bloater becomes BLO (see rule 5 above).

Example 3: SMB is applicable to both smallmouth buffalo and smallmouth bass using rules 6 and 7. Smallmouth bass are more commonly encountered and have traditionally been coded with SMB. The code for smallmouth buffalo then becomes SLB following rule 8. It then follows that all buffalo should follow the same pattern. While bigmouth buffalo could be BMB (rule 6), using BGB follows the same pattern as SLB. In addition, if BLB were chosen for black buffalo, it would conflict with black bullhead, a common species. Thus, BKB becomes the appropriate code for black buffalo (rule 8), and for consistency (rule 1), SLB and BGB become the codes for smallmouth and bigmouth buffalo.

FISH SPECIES ABBREVIATION CODES

(ordered by common name)

CODE	COMMON NAME	GENUS SPECIES	FAMILY
ALE	Alewife	*Alosa pseudoharengus*	CLUPEIDAE
ABL	American Brook Lamprey	*Lampetra appendix*	PETROMYZONTIDAE
AME	American Eel	*Anguilla rostrata*	ANGUILLIDAE
AMS	American Shad	*Alosa sapidissima*	CLUPEIDAE
ARG	Arctic Grayling	*Thymallus arcticus*	SALMONIDAE
ATS	Atlantic Salmon	*Salmo salar*	SALMONIDAE
BAK	Banded Killifish	*Fundulus diaphanus*	FUNDULIDAE
BGB	Bigmouth Buffalo	*Ictiobus cyprinellus*	CATOSTOMIDAE
BKB	Black Buffalo	*Ictiobus niger*	CATOSTOMIDAE
BLB	Black Bullhead	*Ameiurus melas*	ICTALURIDAE
BLC	Black Crappie	*Pomoxis nigromaculatus*	CENTRARCHIDAE
BLR	Black Redhorse	*Moxostoma duquesnei*	CATOSTOMIDAE
BCS	Blackchin Shiner	*Notropis heterodon*	CYPRINIDAE
BND	Blacknose Dace	*Rhinichthys atratulus*	CYPRINIDAE
BNS	Blacknose Shiner	*Notropis heterolepis*	CYPRINIDAE
BLO	Bloater	*Coregonus hoyi*	SALMONIDAE
BLG	Bluegill	*Lepomis macrochirus*	CENTRARCHIDAE
BNM	Bluntnose Minnow	*Pimephales notatus*	CYPRINIDAE
BON	Bowfin	*Amia calva*	AMIIDAE
BRM	Brassy Minnow	*Hybognathus hankinsoni*	CYPRINIDAE
BSS	Brook Silverside	*Labidesthes sicculus*	ATHERINIDAE
BRS	Brook Stickleback	*Culaea inconstans*	GASTEROSTEIDAE
BKT	Brook Trout	*Salvelinus fontinalis*	SALMONIDAE
BRB	Brown Bullhead	*Ameiurus nebulosus*	ICTALURIDAE
BNT	Brown Trout	*Salmo trutta*	SALMONIDAE
BUH	Bullhead (general)		ICTALURIDAE
BUT	Burbot	*Lota lota*	LOTIDAE
CAP	Carp	*Cyprinus carpio*	CYPRINIDAE
CMM	Central Mudminnow	*Umbra limi*	UMBRIDAE
CES	Central Stoneroller	*Campostoma anomalum*	CYPRINIDAE
CHP	Chain Pickerel	*Esox niger*	ESOCIDAE
CHC	Channel Catfish	*Ictalurus punctatus*	ICTALURIDAE
CHL	Chestnut Lamprey	*Ichthyomyzon castaneus*	PETROMYZONTIDAE
CHS	Chinook Salmon	*Oncorhynchus tshawytscha*	SALMONIDAE
COS	Coho Salmon	*Oncorhynchus kisutch*	SALMONIDAE
CNS	Common Shiner	*Luxilus cornutus*	CYPRINIDAE
CRC	Creek Chub	*Semotilus atromaculatus*	CYPRINIDAE

CCS	Creek Chubsucker	*Erimyzon oblongus*	CATOSTOMIDAE
DAR	Darter (general)		PERCIDAE
DWS	Deepwater Sculpin	*Myoxocephalus thompsoni*	COTTIDAE
EMS	Emerald Shiner	*Notropis atherinoides*	CYPRINIDAE
FHM	Fathead Minnow	*Pimephales promelas*	CYPRINIDAE
FSD	Finescale Dace	*Chrosomus neogaeus*	CYPRINIDAE
FHC	Flathead Catfish	*Pylodictis olivaris*	ICTALURIDAE
FSS	Fourspine Stickleback	*Apeltes quadracus*	GASTEROSTEIDAE
FWD	Freshwater Drum	*Aplodinotus grunniens*	SCIAENIDAE
GIS	Gizzard Shad	*Dorosoma cepedianum*	CLUPEIDAE
GOR	Golden Redhorse	*Moxostoma erythrurum*	CATOSTOMIDAE
GOS	Golden Shiner	*Notemigonus crysoleucas*	CYPRINIDAE
GOF	Goldfish	*Carassius auratus*	CYPRINIDAE
GRC	Grass Carp	*Ctenopharyngodon idella*	CYPRINIDAE
GRP	Grass Pickerel	*Esox americanus*	ESOCIDAE
GRS	Green Sunfish	*Lepomis cyanellus*	CENTRARCHIDAE
HHC	Hornyhead Chub	*Nocomis biguttatus*	CYPRINIDAE
IOD	Iowa Darter	*Etheostoma exile*	PERCIDAE
JOD	Johnny Darter	*Etheostoma nigrum*	PERCIDAE
KII	Kiyi	*Coregonus kiyi*	SALMONIDAE
LAC	Lake Chub	*Couesius plumbeus*	CYPRINIDAE
LCS	Lake Chubsucker	*Erimyzon sucetta*	CATOSTOMIDAE
LAH	Lake Herring	*Coregonus artedi*	SALMONIDAE
LAS	Lake Sturgeon	*Acipenser fulvescens*	ACIPENSERIDAE
LAT	Lake Trout	*Salvelinus namaycush*	SALMONIDAE
LWF	Lake Whitefish	*Coregonus clupeaformis*	SALMONIDAE
LAY	Lamprey (general)		PETROMYZONTIDAE
LMB	Largemouth Bass	*Micropterus salmoides*	CENTRARCHIDAE
LSS	Large-scale Stoneroller	*Campostoma oligolepis*	CYPRINIDAE
LOP	Logperch	*Percina caprodes*	PERCIDAE
LES	Longear Sunfish	*Lepomis megalotis*	CENTRARCHIDAE
LND	Longnose Dace	*Rhinichthys cataractae*	CYPRINIDAE
LNG	Longnose Gar	*Lepisosteus osseus*	LEPISOSTEIDAE
LNS	Longnose Sucker	*Catostomus catostomus*	CATOSTOMIDAE
MIS	Mimic Shiner	*Notropis volucellus*	CYPRINIDAE
MOE	Mooneye	*Hiodon tergisus*	HIODONTIDAE
MOS	Mottled Sculpin	*Cottus bairdi*	COTTIDAE
MUE	Muskellunge	*Esox masquinongy*	ESOCIDAE
NSS	Ninespine Stickleback	*Pungitius pungitius*	GASTEROSTEIDAE
NBL	Northern Brook Lamprey	*Ichthyomyzon fossor*	PETROMYZONTIDAE
NHS	Northern Hog Sucker	*Hypentelium nigricans*	CATOSTOMIDAE
NOP	Northern Pike	*Esox lucius*	ESOCIDAE

NRD	Northern Redbelly Dace	*Chrosomus eos*	CYPRINIDAE
PAF	Paddlefish	*Polyodon spathula*	POLYODONTIDAE
PED	Pearl Dace	*Margariscus margarita*	CYPRINIDAE
PKS	Pink Salmon	*Oncorhynhus gorbusha*	SALMONIDAE
PIP	Pirate perch	*Aphredoderus sayanus*	APHREDODERIDAE
PNM	Pugnose Minnow	*Opsopoeodus emiliae*	CYPRINIDAE
PUS	Pumpkinseed	*Lepomis gibbosus*	CENTRARCHIDAE
PWF	Pygmy Whitefish	*Prosopium coulteri*	SALMONIDAE
QUB	Quillback	*Carpiodes cyprinus*	CATOSTOMIDAE
RAD	Rainbow Darter	*Etheostoma caeruleum*	PERCIDAE
RAS	Rainbow Smelt	*Osmerus mordax*	OSMERIDAE
RBT	Rainbow Trout	*Oncorhynchus mykiss*	SALMONIDAE
RES	Redear Sunfish	*Lepomis megalotis*	CENTRARCHIDAE
RIR	River Redhorse	*Moxostoma carinatum*	CATOSTOMIDAE
ROB	Rock Bass	*Ambloplites rupestris*	CENTRARCHIDAE
RFS	Rosyface Shiner	*Notropis rubellus*	CYPRINIDAE
ROG	Round Goby	*Neogobius melanostomus*	GOBIIDAE
RWF	Round Whitefish	*Prosopium cylindraceum*	SALMONIDAE
RUE	Ruffe	*Gymnocephalus cernuus*	PERCIDAE
SAS	Sand Shiner	*Notropis stramineus*	CYPRINIDAE
SAR	Sauger	*Stizostedion canadense*	PERCIDAE
SAE	Saugeye	*Stizostedion vitreum X canidense*	PERCIDAE
SCL	Sculpin (general)		COTTIDAE
SEL	Sea Lamprey	*Petromyzon marinus*	PETROMYZONTIDAE
SHR	Shorthead Redhorse	*Moxostoma macrolepidotum*	CATOSTOMIDAE
SJC	Shortjaw Cisco	*Coregonus zenithicus*	SALMONIDAE
SNC	Shortnose Cisco	*Coregonus reighardi*	SALMONIDAE
SNG	Shortnose Gar	*Lepisosteus platostomus*	LEPISOSTEIDAE
SIL	Silver Lamprey	*Ichthyomyzon unicuspis*	PETROMYZONTIDAE
SIR	Silver Redhorse	*Moxostoma anisurum*	CATOSTOMIDAE
SLS	Slimy Sculpin	*Cottus cognatus*	COTTIDAE
SMB	Smallmouth Bass	*Micropterus dolomieu*	CENTRARCHIDAE
SLB	Smallmouth Buffalo	*Ictiobus bubalus*	CATOSTOMIDAE
SOS	Sockeye Salmon (Kokanee)	*Oncorhynchus nerka*	SALMONIDAE
SPE	Splake	*Salvelinus namaycush X fontinalis*	SALMONIDAE
SHS	Spoonhead Sculpin	*Cottus ricei*	COTTIDAE
STS	Spottail Shiner	*Notropis hudsonius*	CYPRINIDAE
SPG	Spotted Gar	*Lepisosteus oculatus*	LEPISOSTEIDAE
SPS	Spotted Sucker	*Minytrema melanops*	CATOSTOMIDAE
STB	Stickleback (general)		GASTEROSTEIDAE
STC	Stonecat	*Noturus flavus*	ICTALURIDAE
STN	Sturgeon (general)		ACIPENSERIDAE

SFH	Sunfish Hybrid	*Lepomis*	CENTRARCHIDAE
TPM	Tadpole Madtom	*Noturus gyrinus*	ICTALURIDAE
TSS	Threespine Stickleback	*Gasterosteus aculeatus*	GASTEROSTEIDAE
TIM	Tiger Muskellunge	*Esox masquinongy X lucius*	ESOCIDAE
TRT	Tiger trout	*Salvelinus fontinalis X Salmo trutta*	SALMONIDAE
TRP	Trout-perch	*Percopsis omiscomaycus*	PERCOPSIDAE
TNG	Tubenose Goby	*Proterorhinus marmoratus*	GOBIIDAE
XXX	Unknown fish		
WAE	Walleye	*Stizostedion vitreum*	PERCIDAE
WAM	Warmouth	*Lepomis gulosus*	CENTRARCHIDAE
WHB	White Bass	*Morone chrysops*	MORONIDAE
WHC	White Crappie	*Pomoxis annularis*	CENTRARCHIDAE
WHP	White Perch	*Morone americana*	MORONIDAE
WHS	White Sucker	*Catostomus commersoni*	CATOSTOMIDAE
YEB	Yellow Bullhead	*Ameiurus natalis*	ICTALURIDAE
YEP	Yellow Perch	*Perca flavescens*	PERCIDAE

(ordered by family, genus, and species)

CODE	COMMON NAME	GENUS SPECIES	FAMILY
LAY	Lamprey (general)		PETROMYZONTIDAE
CHL	Chestnut Lamprey	*Ichthyomyzon castaneus*	PETROMYZONTIDAE
NBL	Northern Brook Lamprey	*Ichthyomyzon fossor*	PETROMYZONTIDAE
SIL	Silver Lamprey	*Ichthyomyzon unicuspis*	PETROMYZONTIDAE
ABL	American Brook Lamprey	*Lampetra appendix*	PETROMYZONTIDAE
SEL	Sea Lamprey	*Petromyzon marinus*	PETROMYZONTIDAE
STN	Sturgeon (general)		ACIPENSERIDAE
LAS	Lake Sturgeon	*Acipenser fulvescens*	ACIPENSERIDAE
PAF	Paddlefish	*Polyodon spathula*	POLYODONTIDAE
SPG	Spotted Gar	*Lepisosteus oculatus*	LEPISOSTEIDAE
LNG	Longnose Gar	*Lepisosteus osseus*	LEPISOSTEIDAE
SNG	Shortnose Gar	*Lepisosteus platostomus*	LEPISOSTEIDAE
BON	Bowfin	*Amia calva*	AMIIDAE
MOE	Mooneye	*Hiodon tergisus*	HIODONTIDAE
AME	American Eel	*Anguilla rostrata*	ANGUILLIDAE
ALE	Alewife	*Alosa pseudoharengus*	CLUPEIDAE
AMS	American Shad	*Alosa sapidissima*	CLUPEIDAE
GIS	Gizzard Shad	*Dorosoma cepedianum*	CLUPEIDAE
CES	Central Stoneroller	*Campostoma anomalum*	CYPRINIDAE
LSS	Large-scale Stoneroller	*Campostoma oligolepis*	CYPRINIDAE
GOF	Goldfish	*Carassius auratus*	CYPRINIDAE
NRD	Northern Redbelly Dace	*Chrosomus eos*	CYPRINIDAE
FSD	Finescale Dace	*Chrosomus neogaeus*	CYPRINIDAE
LAC	Lake Chub	*Couesius plumbeus*	CYPRINIDAE
GRC	Grass Carp	*Ctenopharyngodon idella*	CYPRINIDAE
CAP	Carp	*Cyprinus carpio*	CYPRINIDAE
BRM	Brassy Minnow	*Hybognathus hankinsoni*	CYPRINIDAE
CNS	Common Shiner	*Luxilus cornutus*	CYPRINIDAE
PED	Pearl Dace	*Margariscus margarita*	CYPRINIDAE

HHC	Hornyhead Chub	*Nocomis biguttatus*	CYPRINIDAE
GOS	Golden Shiner	*Notemigonus crysoleucas*	CYPRINIDAE
EMS	Emerald Shiner	*Notropis atherinoides*	CYPRINIDAE
BCS	Blackchin Shiner	*Notropis heterodon*	CYPRINIDAE
BNS	Blacknose Shiner	*Notropis heterolepis*	CYPRINIDAE
STS	Spottail Shiner	*Notropis hudsonius*	CYPRINIDAE
RFS	Rosyface Shiner	*Notropis rubellus*	CYPRINIDAE
SAS	Sand Shiner	*Notropis stramineus*	CYPRINIDAE
MIS	Mimic Shiner	*Notropis volucellus*	CYPRINIDAE
PNM	Pugnose Minnow	*Opsopoeodus emiliae*	CYPRINIDAE
BNM	Bluntnose Minnow	*Pimephales notatus*	CYPRINIDAE
FHM	Fathead Minnow	*Pimephales promelas*	CYPRINIDAE
BND	Blacknose Dace	*Rhinichthys atratulus*	CYPRINIDAE
LND	Longnose Dace	*Rhinichthys cataractae*	CYPRINIDAE
CRC	Creek Chub	*Semotilus atromaculatus*	CYPRINIDAE
QUB	Quillback	*Carpiodes cyprinus*	CATOSTOMIDAE
LNS	Longnose Sucker	*Catostomus catostomus*	CATOSTOMIDAE
WHS	White Sucker	*Catostomus commersoni*	CATOSTOMIDAE
CCS	Creek Chubsucker	*Erimyzon oblongus*	CATOSTOMIDAE
LCS	Lake Chubsucker	*Erimyzon sucetta*	CATOSTOMIDAE
NHS	Northern Hog Sucker	*Hypentelium nigricans*	CATOSTOMIDAE
SLB	Smallmouth Buffalo	*Ictiobus bubalus*	CATOSTOMIDAE
BGB	Bigmouth Buffalo	*Ictiobus cyprinellus*	CATOSTOMIDAE
BKB	Black Buffalo	*Ictiobus niger*	CATOSTOMIDAE
SPS	Spotted Sucker	*Minytrema melanops*	CATOSTOMIDAE
SIR	Silver Redhorse	*Moxostoma anisurum*	CATOSTOMIDAE
RIR	River Redhorse	*Moxostoma carinatum*	CATOSTOMIDAE
BLR	Black Redhorse	*Moxostoma duquesnei*	CATOSTOMIDAE
GOR	Golden Redhorse	*Moxostoma erythrurum*	CATOSTOMIDAE
SHR	Shorthead Redhorse	*Moxostoma macrolepidotum*	CATOSTOMIDAE
BUH	Bullhead (general)		ICTALURIDAE
BLB	Black Bullhead	*Ameiurus melas*	ICTALURIDAE
YEB	Yellow Bullhead	*Ameiurus natalis*	ICTALURIDAE
BRB	Brown Bullhead	*Ameiurus nebulosus*	ICTALURIDAE
CHC	Channel Catfish	*Ictalurus punctatus*	ICTALURIDAE
STC	Stonecat	*Noturus flavus*	ICTALURIDAE
TPM	Tadpole Madtom	*Noturus gyrinus*	ICTALURIDAE
FHC	Flathead Catfish	*Pylodictis olivaris*	ICTALURIDAE
GRP	Grass Pickerel	*Esox americanus*	ESOCIDAE

NOP	Northern Pike	*Esox lucius*	ESOCIDAE
MUE	Muskellunge	*Esox masquinongy*	ESOCIDAE
TIM	Tiger Muskellunge	*Esox masquinongy X lucius*	ESOCIDAE
CHP	Chain Pickerel	*Esox niger*	ESOCIDAE
CMM	Central Mudminnow	*Umbra limi*	UMBRIDAE
RAS	Rainbow Smelt	*Osmerus mordax*	OSMERIDAE
LAH	Lake Herring	*Coregonus artedi*	SALMONIDAE
LWF	Lake Whitefish	*Coregonus clupeaformis*	SALMONIDAE
BLO	Bloater	*Coregonus hoyi*	SALMONIDAE
KII	Kiyi	*Coregonus kiyi*	SALMONIDAE
SNC	Shortnose Cisco	*Coregonus reighardi*	SALMONIDAE
SJC	Shortjaw Cisco	*Coregonus zenithicus*	SALMONIDAE
PKS	Pink Salmon	*Oncorhynhus gorbusha*	SALMONIDAE
COS	Coho Salmon	*Oncorhynchus kisutch*	SALMONIDAE
RBT	Rainbow Trout	*Oncorhynchus mykiss*	SALMONIDAE
SOS	Sockeye Salmon (Kokanee)	*Oncorhynchus nerka*	SALMONIDAE
CHS	Chinook Salmon	*Oncorhynchus tshawytscha*	SALMONIDAE
PWF	Pygmy Whitefish	*Prosopium coulteri*	SALMONIDAE
RWF	Round Whitefish	*Prosopium cylindraceum*	SALMONIDAE
ATS	Atlantic Salmon	*Salmo salar*	SALMONIDAE
BNT	Brown Trout	*Salmo trutta*	SALMONIDAE
BKT	Brook Trout	*Salvelinus fontinalis*	SALMONIDAE
TRT	Tiger trout	*Salvelinus fontinalis X Salmo trutta*	SALMONIDAE
LAT	Lake Trout	*Salvelinus namaycush*	SALMONIDAE
SPE	Splake	*Salvelinus namaycush X fontinalis*	SALMONIDAE
ARG	Arctic Grayling	*Thymallus arcticus*	SALMONIDAE
TRP	Trout-perch	*Percopsis omiscomaycus*	PERCOPSIDAE
PIP	Pirate perch	*Aphredoderus sayanus*	APHREDODERIDAE
BUT	Burbot	*Lota lota*	LOTIDAE
BAK	Banded Killifish	*Fundulus diaphanus*	FUNDULIDAE
BSS	Brook Silverside	*Labidesthes sicculus*	ATHERINIDAE
STB	Stickleback (general)		GASTEROSTEIDAE
FSS	Fourspine Stickleback	*Apeltes quadracus*	GASTEROSTEIDAE

BRS	Brook Stickleback	*Culaea inconstans*	GASTEROSTEIDAE
TSS	Threespine Stickleback	*Gasterosteus aculeatus*	GASTEROSTEIDAE
NSS	Ninespine Stickleback	*Pungitius pungitius*	GASTEROSTEIDAE
SCL	Sculpin (general)		COTTIDAE
MOS	Mottled Sculpin	*Cottus bairdi*	COTTIDAE
SLS	Slimy Sculpin	*Cottus cognatus*	COTTIDAE
SHS	Spoonhead Sculpin	*Cottus ricei*	COTTIDAE
DWS	Deepwater Sculpin	*Myoxocephalus thompsoni*	COTTIDAE
WHP	White Perch	*Morone americana*	MORONIDAE
WHB	White Bass	*Morone chrysops*	MORONIDAE
ROB	Rock Bass	*Ambloplites rupestris*	CENTRARCHIDAE
SFH	Sunfish Hybrid	*Lepomis*	CENTRARCHIDAE
GRS	Green Sunfish	*Lepomis cyanellus*	CENTRARCHIDAE
PUS	Pumpkinseed	*Lepomis gibbosus*	CENTRARCHIDAE
WAM	Warmouth	*Lepomis gulosus*	CENTRARCHIDAE
BLG	Bluegill	*Lepomis macrochirus*	CENTRARCHIDAE
LES	Longear Sunfish	*Lepomis megalotis*	CENTRARCHIDAE
RES	Redear Sunfish	*Lepomis megalotis*	CENTRARCHIDAE
SMB	Smallmouth Bass	*Micropterus dolomieu*	CENTRARCHIDAE
LMB	Largemouth Bass	*Micropterus salmoides*	CENTRARCHIDAE
WHC	White Crappie	*Pomoxis annularis*	CENTRARCHIDAE
BLC	Black Crappie	*Pomoxis nigromaculatus*	CENTRARCHIDAE
DAR	Darter (general)		PERCIDAE
RAD	Rainbow Darter	*Etheostoma caeruleum*	PERCIDAE
IOD	Iowa Darter	*Etheostoma exile*	PERCIDAE
JOD	Johnny Darter	*Etheostoma nigrum*	PERCIDAE
RUE	Ruffe	*Gymnocephalus cernuus*	PERCIDAE
YEP	Yellow Perch	*Perca flavescens*	PERCIDAE
LOP	Logperch	*Percina caprodes*	PERCIDAE
SAR	Sauger	*Stizostedion canadense*	PERCIDAE
WAE	Walleye	*Stizostedion vitreum*	PERCIDAE
SAE	Saugeye	*Stizostedion vitreum X canidense*	PERCIDAE
FWD	Freshwater Drum	*Aplodinotus grunniens*	SCIAENIDAE
ROG	Round Goby	*Neogobius melanostomus*	GOBIIDAE
TNG	Tubenose Goby	*Proterorhinus marmoratus*	GOBIIDAE

XXX	Unknown fish

Appendix 5

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