Report of the

FORAGE TASK GROUP

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I. INTRODUCTION

This report addresses progress made by the Forage Task Group (FTG) in addressing three charges, or short-term objectives, assigned by the Standing Technical Committee (STC). These charges are: (1) assemble and integrate indicators of forage status, (2) identify newly emerging sources of forage data, and (3) standardize sampling procedures. In addition, future plans of the FTG are discussed and brief descriptions of forage status are provided for each basin of Lake Erie.

II. PROGRESS IN ADDRESSING CHARGES

A) Analyze Indicator Variables

Annually monitored indicators that appear to have utility in assessment of the Lake Erie forage base include: (1) forage fish relative abundance and age composition, (2) forage fish growth rates, (3) predator growth and maturity rates, (4) piscivore diet composition, (5) yellow perch food consumption rates, (6) walleye prey-size selectivity, and (7) zooplankton size structure. Previous FTG efforts were directed at assembling summary data sets for these indicators. With much of this information now assembled, the current focus is to develop standardized data formats and collection methods, where practical, and begin integrating and analyzing trend-through-time data for a more comprehensive assessment of the forage base. The following describes continued progress made in analyzing two of these indicator variables:

Two of the seven variables identified by the FTG were examined as measures of forage status in the western basin of Lake Erie. More specificially, changes in these variables between two general time periods were used to examine effects of walleye predation on the forage fish community. The variables were relative abundance (log-transformed catch-per-hour-trawling data) and length frequency distributions that were weighted by annual relative abundance values for each species. These data were grouped into two periods: 1969-77 (low walleye density) and 1978-88 (high walleye density). Only Ohio data were used in these analyses.

Published research has shown that walleyes in western Lake Erie prefer soft-rayed over spiny-rayed forage fishes and select small (<120 mm) over large prey. We hypothesized that if walleye predation was affecting the forage base, we would detect declines in forage fish densities (primarily for soft-rayed fishes) and shifts toward large individuals (as small ones are removed via predation) in the later time period relative to the earlier period. Following is a brief synopsis of the results:

Relative Abundance. During summer (prior to most of the walleye predation that occurs in a given year), forage fish densities were not significantly different ($P>.05$) between periods, which suggests annual forage fish production has not changed over the past 20 years. By fall (after much predation has occurred), however, total fish densities were significantly lower ($P<.05$) during 1978-88 relative to the earlier period. Further, these declines were significant only for soft-rayed fishes (the preferred prey) and not for spiny-rayed fishes in general. Emerald and spottail shiners have experienced the sharpest declines.

Size Structure. Comparisons of fall length frequency data between the two periods were made for nine forage species. Of these nine, shifts toward large individuals during 1978-88 occurred for five species, shifts toward small individuals occurred for two species, and virtually no changes occurred for two species. Gizzard shad, the primary prey of walleyes in western Lake Erie, provide probably the best example of what we believe is size-selective removal by walleyes. Trout-perch serve as a control species because they are rarely eaten by walleyes; their length frequency distributions were nearly identical between periods.

In summary, this exercise suggests that walleye predation is having a major effect on fish community structure in western Lake Erie, which is not unexpected given the apparent high biomass of walleyes during the past decade. This further supports the establishment of community goals and management as opposed to the single-species models currently in use. Additionally, these results offer encouragement regarding the use of bottom trawls to measure changes in relative abundance. Despite the high variances associated with annual index values, trawl data can be very useful to examine trends in abundance over blocks of time.

B) Identify Emerging Sources of Forage Data

The zebra mussel (Dreissena polymorpha) has emerged as a rapidly colonizing benthic invertebrate that could have a potentially large impact to Lake Erie's food web. As such, the FTG will be particularly watchful for changes in forage indicators that may be attributable to the expansion of zebra mussels.

One currently used indicator that may have utility in assessing the effects of zebra mussels is the Zooplankton Sampling Program described in the 1989 Forage Task Group Report. Zooplankton size distribution and species composition are the principal variables monitored in this effort designed to draw inferences concerning community structure, particularly concerning zooplankton and planktivorous fish. If zebra mussels were responsible for significantly altering the apportioning of primary productivity between pelagic to benthic communities, such changes would likely be revealed in the standard Zooplankton Sampling Program.

C) Standardize Sampling Procedures

Progress in standardization occurred in the development of a draft food habits sampling protocol (Appendix A) as a companion document to the food habits coding format. Implementation of the universal coding format is underway and should facilitate pooling of information from different sources and enable interagency summaries that are compatible with other pooled data for shared stocks of piscivores, such as walleye.

In addition, computer programs for compiling standardized food habits data have been developed in SAS by FTG member, Roger Knight. This software will provide a quantitative description of the diet in terms of frequency of occurrence, percent composition by number, and percent composition by weight or volume.

III. FUTURE PLANS

Efforts in 1990 will remain focused on addressing the short-term objectives assigned by the STC. Extension of some specific assignments will include: (1) a continuation of the review of the historical USFWS data base to determine the potential for reducing variance of relative abundance estimates and (2) expand investigation of the relationships between walleye growth rates and prey-size selectivity. The principal new initiative for 1990 will be the preparation of a consolidated report of piscivore food habits data employing the recently standardized sampling protocol, coding procedures, and computer software for analysis.

IV. FORAGE STATUS

A) Eastern Basin (summarized by D. Einhouse)

Forage status in the eastern basin of Lake Erie is being monitored by independent, annual assessment programs conducted by NYSDEC, PFC, and OMNR. Forage fish relative abundance indicators are produced by each of these agencies and summarized in annual agency reports to the Lake Erie Committee. Other annually monitored forage indicators in this basin include predator growth rates, piscivore diet composition, and zooplankton size structure.

Eastern basin forage fishes that are known to comprise important components of piscivore diets include rainbow smelt, alewife, gizzard shad, white perch, spottail and emerald shiners. The relative contribution to the diet by each species varies in response to annual fluctuations in abundance.

Rainbow smelt status in the eastern basin was determined principally by three independent bottom trawl assessments conducted by OMNR, DEC and PFC. In 1989, these independent trawling efforts presented somewhat divergent views of YOY smelt abundance. Trawl indices of YOY abundance produced by OMNR suggest a moderate year class was produced in 1989. In addition, this follows what was generally believed to be a similar-sized 1988 year class. The appearance of consecutive moderate year classes in 1988 and 1989 would break the recent pattern of alternate years of strong year classes that has been characteristic of this population. This view may be tempered somewhat by PFC trawling efforts that ranked the strength of the 1989 year class weaker, relative to a good 1988 year class. NYS DEC smelt assessment efforts do not produce a YOY index, but the index of abundance for yearling and older smelt in NYS DEC trawl samples increased from 1988. This observation of increased abundance of yearling and older smelt was consistent among all three agencies.

Emerald and spottail shiner abundance in the 1980's experienced a decline relative to the previous decade (Pennsylvania Fish Commission 1988). Very large annual variability in catch rates has been observed for many years by all Lake Erie fisheries agencies (GLFC 1987) and is considered a common characteristic of these minnow populations (Scott and Crossman 1973). This characteristic continues as indicated by three ongoing eastern basin trawling programs. However, each of these three ongoing trawl assessments depicts a somewhat different trend in emerald and spottail shiner abundance in any particular year. Unacceptably large variances often associated with trawl catches of minnows may be contributing to the lack of agreement concerning recent trends in abundance. However, these various indices of abundance may very well portray the abundance trends of different local stocks who's dynamics are not in any basinwide synchrony. In very general terms, emerald and spottail shiner status during 1989 appeared to be within the broad ranges of abundance observed over this past decade.

Clupeids (YOY gizzard shad and alewife), when abundant, have been an important forage species for eastern basin predators. Stomach data from piscivores such as walleye and smallmouth bass suggest that these clupeids collectively can represent a significant component of the diet. PFC and OMNR trawl indices both characterize YOY gizzard shad production in 1989 as average, while YOY alewife production was somewhat better than an average year.

The status of eastern basin invertebrates remains less well known. Zooplankton size, species composition, and density has been monitored since 1984 in New York's portion of the eastern basin, but a summary of results is not yet available. Nevertheless, New York is planning to expand this assessment series in 1990 in efforts to identify any impacts attributable to the zebra mussel.

B) Central Basin (summarized by K. Muth)

Forage fish assessment surveys in U.S. waters of the central basin of Lake Erie were conducted monthly from May through October in 1989 by the U.S. Fish and Wildlife Service at nearshore sampling stations near Huron, Lorain, Cleveland, Fairport, and Ashtabula. Additional forage fish data were provided by the Ohio Division of Wildlife from fall samples collected at stations near Vermilion, Lorain, Fairport, and Ashtabula. Forage data from Canadian waters of the central basin were not available this year.

Sampling efforts by FWS from 33.3 hours of trawling resulted in a total catch of nearly 93,000 fish representing 20 species. White perch dominated the catch (80%), while all forage species combined constituted only 7% of the catch with rainbow smelt (5%) being the most abundant. Relative abundance indices for YOY forage species from independent fall surveys conducted by FWS and ODW confirm a 1989 decrease in reproductive success of smelt, gizzard shad, and alewife in the central basin when compared to the 1988 indices. However, the emerald shiner abundance index is higher this year, while spottail shiner and trout-perch abundance indices increased only marginally from the low 1988 values. Because smelt and clupeids are the mainstay in the diets of central basin piscivores, forage availability needed to sustain predator populations will probably decrease in 1990.

Species distribution data in 1989 tend to confirm the 1988 observation that smelt abundance in nearshore waters is generally greater in waters east of Cleveland during all sampling periods. White perch abundance was usually higher at all sampling stations during the summer and fall in 1989 than it was in 1988, but this species continued to be more prevalent in central basin waters west of Cleveland. The seasonal and geographical distributions of other forage species were more random, but there was a tendency for YOY gizzard shad to be most abundant in the Huron and Lorain samples.

Preliminary examination of forage fish growth data indicates growth in 1989 did not differ from that observed in 1988 in the central basin. Likewise, there is no evidence to indicate growth differences occur between western and central basin populations of the same forage fish species.

C) **Western Basin** (summarized by R. Knight)

Assessment of western basin forage was made from Ohio, Ontario, and USFWS data for relative abundance (bottom trawl catches), predator growth and maturity rates, diet compositions of carnivorous species, walleye prey-size selectivity, and forage fish length frequency distributions. Following is a general summary of trends in these data through 1989.

Relative abundance estimates for the six targeted forage species generally were low to moderate compared to historical data series. Trout-perch, smelt, and both shiner species appeared low historically in USFWS data, although index values for the shiners did increase from those of a year ago. This was not true in Ohio's fall index, which indicates further declines in shiner densities in 1989, in addition to low values for trout-perch and smelt. Age-0 clupeids were moderately abundant in both summer and fall surveys conducted by both agencies and during August joint surveys between Ohio and Ontario.

Predator growth and maturity trends were not available from all agencies in time for this report so only Ohio and Michigan data were examined. From Ohio data, walleye growth rates during 1989 exceeded those of 1988, but were relatively low compared to the previous 10 years. Walleyes from Michigan samples, however, were smaller at age in 1989 relative to 1988. Size at age for white bass and white perch have varied little during the 1980's, which was supported by 1989 data. Yellow perch declined in average length and weight from 1988 to 1989 and remained below historical averages. Maturity rates followed similar patterns as growth for all species.

Diet composition data for walleyes (courtesy of J. Francis, the Ohio State University) were examined for monthly changes relative to previous years. These data indicate a heavy reliance on age-0 gizzard shad by walleyes of nearly all ages, which is consistent with findings throughout the 1980's. However, walleyes also appear to be feeding on age-0 white perch during July and probably during May-June as was evident during 1988. The lack of shiners in walleye stomachs supports trawling indices that show low abundance for Notropis spp. during recent years.

Lengths of ingested prey from walleye stomachs were examined by Ohio to augment diet composition data. The basic hypothesis is that because walleyes are size-selective feeders, changes in ingested prey lengths reflect changes in forage availability. Relationships between mean shad length from stomachs and walleye growth (i.e., instantaneous growth rate) are being evaluated. Data from 1989 in conjunction with these analyses suggest that this was a year of high shad availability to walleyes, which supports observed increases in growth and maturity for this predator.

Forage fish length frequency data collected by Ohio during 1969-88 period were examined for potential effects of size-selective predation by walleyes. This was expected to show up as shifts in length frequency distributions toward large individuals in the later years (of high walleye abundance) as walleyes selectively preyed upon small fishes. Of nine species examined, five demonstrated shifts toward large individuals, two toward small individuals, and two did not change. This suggests that walleye predation is influencing size-structure of the western Lake Erie fish community. Length data from 1989 have not yet been included in this analysis, but preliminary indications are that this pattern will not change with their inclusion.

The effects of zebra mussels on forage fish populations are perceived by many as being negative (reduced planktonic food to fishes). However, moderate production of age-0 gizzard shad and extremely high production of age-0 white perch during 1989 (both of which are planktivorous) suggest that neither species was food-limited during this year in the western basin. Alternatively, zebra mussels may benefit some forage species by providing additional habitat to protect them from predation. The interactions between forage fishes and zebra mussels should receive considerable attention over the next few years.

In summary, forage fish availability in the western basin appeared moderate in 1989 compared to previous years, primarily due to relatively high clupeid production. However, low numbers of shiners in this system may equate to instability within the community, especially during years of poor clupeid hatches. Reductions in yellow perch growth may reflect low production of zoobenthos in the western basin during 1989.

APPENDIX A

STANDARDIZED FOOD HABIT DATA COLLECTION PROCEDURES

DRAFT SAMPLING PROTOCOL
STANDARDIZED FOOD HABIT DATA COLLECTION PROCEDURES

Prepared by: Mike Bur, U.S. Fish & Wildlife Service
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I. Objectives:

1. Implement standarized, interagency food habit collection and analysis procedures to examine interactions between prey and predator.

2. Use the diet information to assist in the evaluation of fish community structure and also the importance of invertebrates.

II. Rationale:

The standardization of food habit collection and analyses would facilitate the rapid and efficient comparison of data between agencies. There are several methods of collection which are utilized by the different agencies on Lake Erie. For example the U.S. Fish & Wildlife Service uses one of several trawl nets (9-m bottom trawl, 12-m bottom, 9-m rock-hopper trawl or one of two mid-water trawls) primarily, and as a supplemental collection procedure experimental gill nets are used. It would be an expensive venture to change the type of gear so that all agencies would be using the same gear. Instead there should be an understanding of the two basic types of gear - passive (gill net) and active (trawl).

There are also differences in the processing of stomachs samples such as measurement of individual food items. Frequency of occurrence, numerical, volumetric, and gravimetric are all methods of quantifying the food organisms; they may be important when used individually or collectively. It is important to understand that all of these analyses have their merit and that each agency has their own needs. The goal of this effort is to present a standard set of procedures that will enable any agency to effectively use information from another agency or agencies that will correspond with their needs.

III. Stomach Collection Procedures

1. Methods of collection. The three methods used to collect fish for stomach or gut analysis have been: 1) trawl, 2) gill net, or 3) creel samples.

Most agencies use some type of trawl to assess the fishery. The trawl is a very good method for collecting fish for food habit studies, because this is a widely used tool and the fish are immediately removed from their habitat with no delay. A positive is that you can do both a quantitative and qualitative analysis on the stomach contents. Digestion of the stomach contents is minimal if the fish has been feeding only recently. A drawback of this method is the possibility of regurgitation. The depth the trawl is fishing (>12 meters increases regurgitation) and the speed of retrieval (slow it down to reduce regurgitation) play an important role. Another drawback is that trawls seem to be selective for small fish because there is avoidance by the larger, faster swimming fish.

The gill net is used effectively to catch fish that are actively feeding, but the potential problem is that by the time you retrieve the fish the stomach contents have been digested to some extent. This precludes direct quantitative analysis because you do not know the time ingestion occurred. The time the gill net is fished will effect the digestion. The up side of this approach is that if the fish were feeding, you are able to examine the diet from a standpoint of prey (prey-size) selectivity, as does Ohio Division of Wildlife. They are interested in the prey species and size ranges consumed by specific predators. There exists the posibility of quantifying the stomach contents if the gill net is fished for a short time (<4 hours), portions of the prey are available to determine original size, and the water temperature is cool enough to allow for the first two premises.

Samples obtained from the sport fishermen are another method to analyze the food habits. This method of collection is very economical and offers a way for collecting a large sample. Caution should be taken when examining the stomach contents because these predators are actively feeding and the food items may be a result of bait consumed which may be the only food present. Regurgitation is another potential problem.

An important consideration in your sampling procedures should be to use the technique that best suits the type of species you wish to collect. As an example, do not use a bottom trawl to sample a species that would normally occupy a stratum above the bottom. Another consideration is that the sampling procedures may have been previously set up for trend analysis; so sampling techniques may be locked in. Also, the concensus (amoung the FTG members) is that active gears should be used when possible.

2. Preservation or examination of the stomach samples should occur immediately after capture to prevent any further digestion. If preserving is to be done their are two general methods practiced on Lake Erie. The first method is fast freezing, which entails placing the fish into an ice bath directly, to slow digestion while sorting through the catch and then placing the fish into the freezing medium (dry ice or fast freezing freezer) to stop digestion. The other method entails removing the stomachs and placing them into a preserving medium, such as formalin or alcohol. Making a slit in a large stomach will facilitate the preservation. The stomachs can then be returned to the laboratory for examination after preservation.

3. Sample size is an important consideration in designing your study. To be statistically significant, when assuming normal distribution, the minimum sample size should be 30. As an example, if the study calls for trawling at five locations in the central basin, a suggested sample size at each location would be 10 which would total 50 fish (n=50 allows for some empty stomachs). This is a recommendation as a minimum size; the larger the sample the more valid the statistics. Logistics plays an important role in sample size; you may not have the liberty to collect a large data set because of some constraints.

There are are other considerations in determining sample size, such as time of sampling, season, basins, depth strata, and age or size classes. The Forage Task Group needs to discuss these and ascertain how to incorporate them into the sampling protocol.

IV. Sample Processing

1. The first step is to record necessary data such as: species, sex, maturity, length, weight, capture location, date time, type of gear, and scale samples for aging. The stomach or whole fish have data associated with it for entry into your data storage device.

2. Decide what type of information you are looking for before beginning your identification process of the food items. The type of study will dictate the level of identification you need. If for example you are examining the size of prey fish that walleye consume then you may not wish to identify invertebrates beyond the category 'invertebrates'. On the other hand, if you are looking at comprehensive diets, identification down to the lowest taxonomic level is what you need. Again the study design will help you decide what identification process you will need.

3. The next step is the measurement of the identified food items. The easiest technique is the enumeration of each food item (category), simply by counting. This allows for determination of the importance of an item by its number or frequency of occurrence. As a minimum, frequency of occurrence should be calculated. Measurement of the volume of a particular food item (eg. a single prey fish) or category (eg. larval midges) by volume displacement is a very easy and rapid method of measurement. The third method is gravimetric measurement which involves the weighing of a food item either by wet weight (blotted on a towel prior to weighing) or dry weight (drying the food item at a constant temperature for a designated period of time). Weighing is more time consuming than volume displacement. As a standard minimum precision for food habits measurement volume should be .1 ml, wet weight should be .1 g, and dry weight should be at least .01 g. Also, measuring the total length of a food item, particularly prey fish when determining size-selectivity can be an important measure.

Quite possibly the easiest part to standardize is the sample processing. One of the reasons for this is that it is far easier to change the anlysis technique than to change the sampling gear and less coslty. Comparison of food habits with different gear may be obtainable when examining trends after several years of data collection.