What types of Great Lakes fish do you pursue (choose top THREE in order)?

1. Yellow perch (14%)
2. Chinook salmon (83%)
3. Coho salmon (34%)
4. Lake trout (36%)
5. Brown trout (17%)
6. Steelhead (61%)
7. Walleye (9%)
8. Bass (largemouth or smallmouth) (3%)
9. Whitefish (lake or menominee) (8%)
10. Others (1%)

Survey results from meeting minutes of a regional fisheries workshop on January 7, 2012, Ludington, MI.

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(Report considered as draft because it has not been fully reviewed by Salmonid Working Group or the Lake Michigan Technical Committee)
**Introduction**

The Fish Community Objective (FCO) for Lake Michigan salmonines specifies establishment of a diverse salmonine community capable of sustaining an annual harvest of 2.7 to 6.8 million kg, of which 20-25% is lake trout *Salvelinus namaycush*. Inherent in this objective is the desire to maintain a salmonine community that has abundant levels of Chinook salmon *Oncorhynchus tshawytscha* (i.e., target annual yield of 3.1 million kg) sufficient to suppress alewife *Alosa pseudoharengus* populations but not beyond levels where predator consumption would threaten food web integrity.

The Salmonine and Planktivore Objectives are based on the understanding that large populations of exotic forage fishes, such as alewife and rainbow smelt *Osmerus mordax*, negatively impact recruitment of native fishes, and that controlling exotic prey fishes presents an opportunity to create new, diverse fishing opportunities. Therefore, progress toward these objectives is evaluated by determining the relative balance between predator and prey (e.g., Chinook salmon and alewife interactions) rather than suppression of alewife through extreme top-down predation.

Through the Lake Michigan Technical Committee (LMTC) process, a Salmonid Working Group (SWG) was established to cooperatively collect and disseminate knowledge regarding Lake Michigan salmonines and to assess the status of pelagic salmonines and their prey (Terms of Reference for the Salmonid Working Group 2008).

The SWG's main goal is to evaluate progress toward achieving the Salmonine FCO, and is accomplished by implementing a science-based approach for annually evaluating measurable indices of the salmonine and planktivore populations (i.e., Red Flags). This evaluation, along with consultation with managers and constituents, has resulted in two (1999 and 2006; Figure 1) coordinated lakewide stocking reductions.

Since the implementation of the Red Flags Analysis (RFA), the SWG has evaluated progress toward meeting the Salmonine FCO based on an *a priori* set of criteria and benchmarks (see “Methods” section and Claramunt et al 2010). A management recommendation section to the Lake Michigan Committee would then either come from the SWG (thru 2008) or the LMTC (since then). However, in light of anticipated changes to the Red Flags evaluation protocols based upon the current review of the RFA (R. Clark 2012 *in prep*) and the Stocking Decision Analysis (M. Jones *personal communication*) currently in progress, no recommendation will be made in 2012 as a result of the 2011 index values. Consequently, no formal analysis will be presented in this report with respect to the Red Flags triggers or percentiles, as in past reports. Only current values and trends of Red Flags indicators will be presented and discussed herein.
Methods

The SWG uses a set of criteria to measure the health of the Chinook salmon population and identify potential threats to predator-prey populations. The biological criteria utilize all currently available data from ongoing assessments, including: estimates of abundance from creel and fishery-independent surveys, stocking records and estimates of natural reproduction, estimates of salmonine size-at-age and growth, trends in prey fish abundance, and indices of fish health and system integrity. For each biological category, we have several indices available for analysis. However, we have selected only a few representative parameters from each category to present here.

The data included in this report are provided by several agency and university sources. Members of the SWG assist in the collection and/or consolidation of such data by providing summary statistics in a lakewide time-series table. The data in the table cover 1985-present and are used herein to evaluate the overall predator-prey balance necessary to achieve the Lake Michigan Salmonine Objective.

Results and Discussion

Abundance: Charter fishery catch rates, predicted abundance of age-1 fish, and weir returns were utilized to evaluate trends in Chinook salmon abundance in 2011. Chinook salmon are used as the indicator of overall predator abundance because of the availability of data and because of the demand placed on the prey population due to their high consumption rate. Lakewide harvest of Chinook salmon was highest in the late 1980s, declined substantially during 1989-1994, increased steadily from 1995-2005 and remained high through 2007. Harvest dropped substantially in 2008 and continued to decline thru 2010; although it rebounded slightly in 2011 (Figure 1).

Similarly, catch rates in the recreational fishery, using Michigan DNR charter CPE as an index, declined in the late 1980s, were low during 1992-1994, but rose starting in 1995 and peaked around 2006-2007. (Figure 2). Charter catch rates declined from 29.7 fish per 100 hours in 2007 to 24.7 in 2009, but appear to have generally stabilized since then. The average catch rate over the entire time series is 15.0±1.7 and ranged from 4.0 – 30.0 fish per 100 hours of fishing. Even though catch rates declined since 2007, they have still been well above the long-term average. Over the past 3 years harvest rates have averaged 24.8 fish per 100 hrs of fishing. Previous SWG reports predicted the observed decline because recreational catch rates had been at all-time high levels during 2006-2007 (30 fish and 16.0 fish per 100 hours for the charter and non-charter fisheries, respectively; Claramunt et al. 2008, 2009).
The abundance of age-1 Chinook salmon can be predicted from the abundance of age-0 alewives in the previous year (Warner et al. 2008). Based on that relationship, we used the abundance of age-1 Chinook salmon as an index of future salmon abundance because fishery-independent survey collections have not been available since 2008. The abundance of age-1 Chinook salmon showed an increasing trend in the early part of the time series (1992-1996; Figure 3). Since 2005, however, the predicted abundance of age-1 Chinook salmon indicates a decreasing trend. In 2011, the predicted number of age-1 Chinook salmon was well below the average of 1,940,957 ± 228,166 fish and the lowest in the time series at 383,035 fish.

Reproduction: Recruitment of naturally-produced Chinook salmon smolts has increased since their introduction in 1967. Natural reproduction has been estimated periodically throughout the period 1985-2009. Estimates in the early 1990s from oxytetracycline (OTC) studies suggested that natural recruitment accounted for 29-35% of lakewide adult stocks when stocking levels were near their highest (6-7 million smolts; Figure 1 and 5).

Estimates for 2001-2003 from OTC-marked fish collected in 2004 and, more recently, estimates from the lakewide OTC evaluation starting with the 2006 year-class (Claramunt et al. 2007), indicate that natural recruitment has increased such that natural recruits now account for over 50% of the lake population on average. The percentage of wild Chinook salmon for the 2006-2009 (2010 data not available) year (Figure 4). However, weir returns increased to 41,410 fish in 2011; more than twice the return level in 2009. This strong return appears to support the large predicted age-1 Chinook salmon estimate in 2010. This increase in weir returns may also be due to increased survival as a result of a reduction in Chinook harvest during the 2011 fishing season in some portions of Lake Michigan.
classes ranged from 53.5 to 57.7%. These values have all been adjusted for marking error. Although smolt production dropped somewhat in 2008, the level rebounded in 2009 to an approximate total of 7 million, which includes stocked fish (Figure 5). The decline in overall production in 2008 was primarily due to reduced stocking levels.

Growth: Several weight-at-age indices suggest that growth conditions have changed over time, presumably from changes in Chinook salmon abundance, forage levels, and environmental factors. For this report, we selected Chinook salmon weight-at-age 2 from the Michigan DNRE creel survey (male and female combined; Figure 6), weight-at-age 3 (females only) from Strawberry Creek (WI) weir returns (Figures 7), and the standard weight index (again from the Strawberry Creek weir; Figure 8) to assess changes in growth.

Most of the data sources indicate that weight-at-age peaked in 2000-2001, following the production of an abundant year-class of alewife in 1998, and declined from 2002 through 2007. Since 2007, however, the creel survey weight-at-age trend has increased for age-2 to a high of 4,695 grams (g) in 2011. This is an increase of 1895 g from 2,800 g in 2008. Average weight-at-age 2 from the creel was 3,256±153 g and ranged from 1,842-5,021 g throughout the time series (Figure 6).

In 2011, weight of age-3 Chinook salmon increased substantially at the Strawberry Creek weir (7,541 g) compared to 2010 (5,930 g) (Figure 7). With respect to the long term average, weight-at-age 3 in 2011 was slightly higher than the average of 7,524±274 g. Also, the standard weight index in 2011 (4,304 g) increased from 2010 (4,055 g), exceeding the average for the time series of 4,191±49 g (Figure 8). Weight-at-age
indicators improved considerably in 2011, continuing their generally increasing trends since bottoming out in 2007.

**Prey fish abundance:** Estimates of forage fish biomass are reported in kilotonnes (kt; 1 kt = 1,000 metric tons) of age-1 and older alewife from bottom trawl surveys and in kt of total alewife biomass from acoustic surveys (Figure 9). Average biomass from bottom trawl surveys is 16.8 ±1.9 kt, ranging from 6.0-47.6 kt during 1985-2011 (Madenjian et al. 2012). Alewife biomass estimated from the bottom trawl increased from 4.7 kt in 2010 to 6.1 kt in 2011. Alewife biomass in 2011 was the third lowest value in the time series (1985-2011).

Alewife biomass estimated from acoustic surveys in 2011 was 18.5 kt, below the long-term average of 74.5 ±19.5 kt (1992-1996 and 2001 – 2011; Figure 9). The acoustic estimate of alewife biomass in 2011 is the second lowest in the series history and remains well below values recommended in the Planktivore FCO (Warner et al. 2012).

The bottom trawl data indicate that alewife biomass continues at low levels and also suggests a lack of recruitment to larger size classes. The results from the acoustic survey, which is very efficient at sampling younger ages of alewives (ages 0-2), suggests that the abundance of young alewives in 2011 was low and that the survival of the large 2010 year class may have been poor (Warner et al. 2012).

In previous reports, we used alewife abundance in predator diets as another indicator of changes in prey abundance. Unfortunately, long-term trends of predator diet samples (grams of total prey in stomach) are no longer available. As a replacement for an index of diet conditions, we used the average length of a jack coho salmon (age-1 males) returning to Michigan weirs because their growth represents prey availability in one growing season only. Changes in the length of a coho jack should be closely related to changes in alewife abundance, or at least juvenile alewife abundance. Similar to previously reported results for trends in Chinook salmon diets/ration, coho lengths were low in the mid 1990s, peaked following the strong 1998 year-class of alewife, declined, but then recovered following increases in production of alewives starting with the 2002 year-class (Figure 10). Average length of a coho jack for 1991-2011 was 375 ±3.2 mm and ranged from 350 to 398 mm.
Coho length may also be impacted by reduced competition with Chinook salmon (Chinook salmon recruitment has been low), which will indirectly affect the predator-prey ratios for coho salmon. In 2010, the average length of a coho jack decreased considerably suggesting a lack of alewife production in 2009. The increased growth in 2011 (380 mm) from 2010 (375 mm) levels supports estimates of the large 2010 alewife year class. However, considering the abundance of age-1 alewife in 2011, coho growth rates would have been expected to be greater.

**Fish health:** Fish health has been monitored using several tests (e.g., visual signs, FELISA, QELISA, DFAT) for the presence of *Renibacterium salmoninarum*, the causative agent for bacterial kidney disease (BKD). Stress-mediated diseases such as BKD can have strong regulatory influences on Chinook salmon populations. Additionally, using consistent methods, gross clinical (visual) signs of disease have been recorded for fish captured in the open-water survey and for weir returns. Critical information from the fishery-independent survey is no longer available. Just over 1.0% of the weir-returning Chinook salmon showed any sign of disease in 2011 (Figure 11).

**System Integrity:** In 2008, the SWG was asked by the Lake Michigan Committee to incorporate additional indicators for other salmonines such as brown trout, coho salmon, steelhead, and lake trout. With the additional indicators, the red flags analysis could be expanded to evaluate the objective to maintain diversity in the predator-prey complex with the view of promoting ecosystem integrity. In response to the LMC request, we used the proportion of the harvest that was comprised of the other (not Chinook salmon) salmonines. The recommended composition in the Salmonine Objective (interpreted from the recommendations for total harvest by salmonine) is 50% Chinook salmon and 20-25% lake trout. The average percent of the harvest over the 1985-20011 time series that is comprised of salmonines other than Chinook salmon is 42.1±3.5%. Although the percentage of non-Chinook salmonine harvest has generally remained much lower than target levels in the last decade, the percent composition has increased in recent years and 2011 (37.5%) is the highest the level has been since 2001 (41.2%; Figure 12).
Summary

Chinook salmon harvest in 2004-2007 was above the established reference level set forth in the Salmonine Objective for Lake Michigan (3.1 million kg / 6.8 million pounds; Figure 1), but dropped substantially to within the Salmonine Objective range in 2008. This observation was expected based on our analysis of the 2007 Red Flag parameters, from which the SWG concluded that the previous harvest levels were not sustainable and declines in fishery catch rates and harvest levels in the near future were inevitable. Indicators of salmon abundance suggested that the decline starting in 2008 would continue in 2009 and likely into the 2010 fishing season. Harvest values did decline in 2010 and maintained this approximate level in 2011.

The current Chinook salmon population is dependent upon a more limited age class distribution of alewife than it has historically. Large alewife year classes have occurred recently (e.g., 2010) though survival appears to be poor thereby truncating the overall age distribution. Size at age of Chinooks improved dramatically between 2010 and 2011 as the 2010 alewife year class was well assimilated into the Chinook population. This suggests the current predator-prey ratios are more in balance. However, the dependence on limited alewife age classes with poor survival suggests a precarious situation for Chinook growth and survival in the upcoming years.

Chinook salmon stocking rates were adjusted in 1999 and 2006, through a cooperative process, in an attempt to minimize the risk of a lakewide salmon population crash and its effects on the fishery. These stocking reductions were based on a review of biological indicators including the RFA by the SWG and reflected the consensus of fisheries managers from each agency. However, concerns have arisen with respect to the application and use of the RFA prompting a thorough review and revision (R. Clark 2012 in prep). Upon completion of the RF Review study report, the SWG will evaluate the suggestions and determine how the recommendations will be assimilated into the current RFA. The 2013 SWG report will reflect the changes made to the RFA based upon the Clark review. Furthermore, the anticipated completion of the Stocking Decision Analysis and subsequent interstate workshops in 2012 will further preclude the need to conduct a RFA in 2012 to assist with Chinook management decisions.
References


