**CREEL SURVEY OF THE WISCONSIN WATERS OF LAKE MICHIGAN**

**Geographic area**

Wisconsin's share of Lake Michigan is second only to Michigan and encompasses 495 miles of shoreline and 25 tributaries. The Wisconsin waters of Lake Michigan include Green Bay and portions of two distinct lake basins (northern and southern).

Green Bay is northernmost and more eutrophic than the lake proper and because of warmer temperatures during the summer, the majority of the salmonid fishery is limited to the northern section of the bay. Major access points include Marinette, Peshtigo and Oconto on the bay's west shore and Sturgeon Bay, Egg Harbor, Fish Creek and Ellison Bay on the east shore. A significant number of boats and anglers also fish from Green Bay, primarily for yellow perch and walleyes. Major tributaries include the Menominee, Little, Peshtigo, Oconto and Fox Rivers.

The northern basin extends from the tip of Door County to midway between Manitowoc and Sheboygan. The shoreline is generally rocky and irregular in the north and sandier and less broken in the south. The lake bottom slopes steeply to a maximum depth of 923 feet. Major access points include Gills Rock, Baileys Harbor, Sturgeon Bay, Algoma, Kewaunee, Two Rivers and Manitowoc. Major tributaries include the Ahnapee, Kewaunee, East and West Twin and Manitowoc Rivers.

The southern basin includes all waters from Sheboygan south. The shoreline is unbroken and the lake bottom slopes gently to a maximum depth of 558 feet. Major access points include Sheboygan, Port Washington, Milwaukee, Racine and Kenosha. Major tributaries include the Sheboygan, Milwaukee and Root Rivers.

**Creel sampling dates**

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| --- | --- | --- |
| Year | Lake Michigan/ Green Bay Creel | Tributary Creel |
| 2013 | March 15 - October 31 | March 1 - May 15  September 1 - December 31 |
| 2012 | March 15 - October 31 | March 1 - May 15  September 1 - December 31 |
| 2011 | March 15 - October 31 | January 1 - May 15  September 1 - December 31 |
| 2010 | March 15 - October 31 | March 1 - May 15  September 1 - December 31 |
| 2009 | March 15 - October 31 | February 1 - May 15  September 1 - November 15 |
| 2008 | March 15 - October 31 | March 15 - May 15  September 1 - December 31 |
| 2007 | March 15 - October 31 | March 15 - May 15  September 1 - December 31 |

**Fishery types**

The creel survey is conducted at ramp, pier and breakwater, shore and stream sites along Lake Michigan and Green Bay. Moored boat anglers are surveyed using a voluntary mail survey.

**Creel survey sampling design**

The open water creel survey was conducted using a modified access point design called the Wisconsin Hybrid design. It differs from a true access point design in that creel clerks visit several sites per site group. The fishing season for the creel survey is stratified by statistical management unit (SMU) (i.e. counties), fishery types (i.e. ramp, pier, shore and stream), statistical survey periods (i.e. months or groups of months) and day type (i.e. weekday, weekend/holiday).

Surveys were conducted on every weekend day and holiday and on either two or three days during the week, depending on the month. Each workday was comprised of two shifts, and am and pm shift. Combined together, the two shifts covered the entire angling day. The clerk worked one shift per workday. The shifts were equal in duration, did not overlap and were sampled with equal probability. An example is shown below.

Statistical Management Units (SMU) were assigned based primarily on county lines and include units like Kenosha, Racine, Milwaukee, etc. Survey sites within each SMU were placed into site groups. There may be one or several site groups in each SMU based on the time of year and size of each SMU. Site groups were selected randomly on a daily basis without replacement and survey sites within a site group were visited randomly.

For example, during an am shift, typically from 05:00 to 13:00 the clerk would be responsible for sampling two site groups (Milwaukee north and Milwaukee south). The clerk would spend half the shift in one group and the second half in the other group with the order determined randomly. A random count time would then be assigned to each group. The clerk would make instantaneous counts of all anglers or trailers at all sites in the site group. This means that only one count per site per day is made.

EXAMPLE

Statistical Management Unit MILWAUKEE

Site Groups MILWAUKEE SOUTH MILWAUKEE NORTH

Survey Sites South Shore Ramps McKinley Ramps

South Shore Pier McKinley Pier

Oak Creek Milwaukee River

Grant Park Shoreline Riverfront Ramp

South Metro Pier North City Shoreline

**Angler contact methodology**

Three types of data were collected for each site sampled: angler, boat trailer or car counts for effort, angler or party interviews for catch rates and biological information on harvested fish. Instantaneous counts were made by creel clerks at all sites in the survey. The type of count was dependent on the type of fishery. At most ramp sites, boat trailers were counted. At most pier, shore and stream sites, anglers were counted. However, due to poor access points on some tributaries, car counts were used and were corrected by the number of anglers in the car from interview data. The time the count was completed and count per site were recorded on the activity count form.

Angler or angler parties were interviewed at the completion of their fishing trips. Anglers were asked if they were state residents, what time they started their fishing trip, what they fished for and the number of caught and harvested fish. These data were recorded on the angler interview form. If the angler indicated that they had harvested fish, biological information such as species, length, weight, finclip and tag numbers were collected.

**Data collected**

Data are collected on effort, targeted effort, harvest and catch. Fish are identified, weighed, measured and checked for finclips and tags. The biological data are summarized and presented in an annual creel report as follows: length and weight frequencies by species and SMU, mean, standard deviation, and range by species and SMU, and finclips by species, SMU and fishery type.

**Effort, catch, CPUE and variance calculations**

*Fishing effort*

Fishing effort estimates (expressed in angler hours) were derived from instantaneous counts of anglers at pier, breakwater, shore and stream sites and from counts of boat trailers at boat ramps and from counts of cars at stream sites. Counts were made at randomly computed times at each site during each visit. We estimated angler effort and its variance within each stratum (SMU, fishery type, month and day type). The variance of angler effort involves variability among days and variability within days. Formulas for two stage surveys were used to calculate variance.

The goal was to calculate total effort for a stratum (e.g. SMU, fishery type, month and day type) and its variance. First convert angler counts to angler hours by multiplying by the hours in the angling day. This requires that shifts were equal in duration, did not overlap and were sampled with equal probability.

n = number of days sampled

N = total number of days in stratum

m = number of instantaneous counts done per shift

M = number of instantaneous counts possible per shift

yij = angler hours for jth count on ith day

Calculate mean angler hours per day,

and mean angler hours per stratum, (that is the mean of the daily means)

calculate the pooled variance within days,

R =

and the variance among daily means,

var(R) =

Using the symbols sb2 and sw2, we can write the formula for the variance of the mean daily angler hours within a stratum. Note that the following formula assumes that m << M (the number of instantaneous counts done was much less than the number that could potentially be done - this will usually be the case).

var( =

If n/N is small, then we have

var( =

Finally, total effort and variance within a stratum are

Effort = N

and

var(effort) = n2 var(

*Harvest and catch*

Harvest and catch estimates were derived from interviews at anglers at all sites. For each interview, the number of fish harvested and the hours fished were determine. The harvest and hours fished were summed over all interviews in a stratum, the ratio of the sum and the variance of the ratio were then calculated.

i - indexes interviews

k = number of interviews

fi  = fish harvested, interview i

hi = hours fished, interview i

R = harvest rate, fish harvested per hour fished

R =

And

var(R) =

where is mean fish harvested per interview, is mean hours fished per interview and var(f), var(h) and cov(f,h) are the variance of fish harvested the variance of hours fished and the covariance between fish and hours respectively.

The harvest was then calculated as the product of effort in angler hours and harvest in fish harvested per hour. Variance was estimated as the variance of a product.

Y = estimated effort in angler hours

R = estimated harvest per hour

H = estimated total harvest

H = YR

And

Var(h) = Y2 var(R) + R2 var(Y) – var(R) var(Y)

This assumes that effort and harvest rate were independent. Notice that the population formula (appropriate if all values are known, not estimated) involves a + (sum) where the above formula involves a - (difference). The above formula is correct when the terms in the product are estimated.

**Moored boat survey design**

Anglers who moored their boat on Lake Michigan and Green Bay but were not charter boat captains were surveyed by questionnaire beginning in 1988. The earlier surveys (1982-1985) were based on voluntary information from moored-boat owners who received their survey form from sport fishing clubs. However, in 1988, creel clerks were asked to compile a list of boat registration numbers of moored-boats present on Lake Michigan during a day of bad weather. These numbers were used to develop a list of boat owners from the Wisconsin Department of Natural Resources master file of registered boats. Beginning in 1988, a mail survey was sent to all moored-boat owners to obtain information on 1) whether they moored their boat on Lake Michigan or Green Bay; 2) the port of call; 3) whether the boat was used for fishing during that week; 4) the number of days fished; 5) number of anglers in the fishing party; 6) number of hours fished; and 7) the number of each species caught on each day during the past seven day period.

**Effort, catch, CPUE and variance calculations**

*Fishing effort*

Fishing effort was calculated by harbor by month for each month of the survey. Party size and number of hours fished on each trip were multiplied, summed for each month and harbor, and divided by the number of responses received for the month. This total was multiplied by the boat count and the number of days in the month to obtain estimated angler hours for the entire moored-boat population.

n = number of responses

pi = party size, response i

hi  = hours fished, response i

C = number of boats counted

N = number of days in stratum

Effort =

and the variance,

var(effort) = (C \* N)2 \* (s)2 \*

*Harvest*

Harvest estimates were calculated by harbor by month for each species based on catch per boat day using the following formula:

H = harvest

i - indexes responses

fi = fish harvested, response i

n = number of responses

C = number of boats counted

N = total number of days in stratum

s = standard deviation

H =

and the variance

var(H) = (C \* N)2 \* (s)2 \*

*Harvest rate*

Catch rate, the number of fish caught per angler hour, was obtained by dividing the monthly reported catch of each species by the total fishing effort for that month for each harbor.

and the variance,

catch rate =

fi = fish harvest, response i

ftotal = summed harvest by stratum

hi = angler hours, response i

htotal = summed angler hours by stratum

var(catch rate) =

This type of survey is biased because only those interested and successful anglers tend to mail back the survey form. Therefore, the harvest will tend to be an overestimate of the actual number but should be comparable among years and locations.

**Evaluation of methods and estimates**

The Wisconsin hybrid design has been used in Wisconsin for many years. Last year a Creel Survey Workshop was organized by the Bureau of Fish Management. As part of this workshop, a research statistician used creel data from Escanaba Lake in Wisconsin to show how the creel calculations were performed. These calculations were based on an inland creel program. I obtained this sample data set from this workshop and applied it to the Lake Michigan program. I calculated total effort and its variance, harvest and its variance, catch and its variance and harvest rates. In all cases the results were identical to the results obtained during the workshop.

**Quality control**

No regular scheduled checks were made on clerks prior to the 1995 fishing season. Starting in 1995, a separate clerk will check on the creel clerks to insure that they are on station and preforming their duties. This will be complemented with checks made by other field personnel who are engaged in field activities. Prior to 1995, creel clerks were checked on average 2 or 3 times per month by either permanent staff from Plymouth or Milwaukee. These checks were made both covertly and overtly. Several clerks were dismissed based on these checks in the last three years.

The clerks are initially trained by either a permanent fisheries technician or a former creel clerk. They spend 2 or 3 days at the start of the survey going over all the aspects of the creel survey. A check of the clerk is then made several weeks into the season to insure that all the correct information is being collected. Any problems that are noted during this visit or on data sheets are corrected at this time.

The data is entered by either the creel clerk or data entry personnel. The data entry program contains error checks so that all errors are detected before going into the permanent database.

**Creel survey contact personnel**

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