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Chapter 30: A Relative Abundance Sampling Protocol for Northern Pike in Michigan Inland Lakes

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For decades, the Michigan Department of Natural Resources Fisheries Division (MDNR) has used a variety of survey techniques to target Northern Pike in inland lakes. However, these survey techniques provide highly variable data based on inconsistent timing of spawning, varying habitats where gear are fished, inconsistent gear types used, varied sampling effort, and a lack of randomness. As a result, it is difficult to use these data to assess Northern Pike populations and compare them between or among other populations within a region or across the State.

To help standardize surveys and reduce variability in Northern Pike sampling, MDNR Fisheries Division Management Team charged the Esocidae Committee with establishing a standardized sampling protocol for Northern Pike (Godby et al. 2023). Data collected using this protocol will be used to help managers evaluate adult Northern Pike populations and propose regulations that improve or expand recreational fishing opportunities. In addition, the standardized protocol allows for statewide analysis of Northern Pike populations and provides evaluation criteria based on catch rates generated from 20-years of surveys conducted statewide. However, there are limitations as expected with the adoption of any statewide protocol. For example, survey timing and effort required by the Godby et al. (2023) protocol conflicts with sampling periods prioritized for other species and limits the number of evaluations that can be completed each year, respectively.

This experimental gill net protocol balances the need to collect Northern Pike data from many inland lakes, with the need of conducting statistically robust surveys during a time that workplans allow. This Northern Pike experimental gill net protocol will provide information pertaining to relative abundance, age and growth, and sex-specific population metrics. Relative abundance as well as age and growth data are currently needed to evaluate target reference points within the Northern Pike management plan (Smith et al. 2016). The Management Plan for Northern Pike in Michigan (Smith et al. 2016) is used to guide management of Northern Pike populations.

30.1 Survey Planning and Prioritization

Selection of inland lakes for targeted Northern Pike sampling is done at the discretion of local management units. Collecting adequate data on Northern Pike populations to make informed decisions is one of the goals listed in the Northern Pike management plan (Smith et al. 2016). Northern Pike populations may be sampled 1) in response to requests by stakeholders interested in an evaluation of current regulations and 2) following a random Status and Trends inland lake survey to build a regional- and state-wide database for Northern Pike.

30.2 Survey Procedures

30.2.1 Evaluating Relative Abundance and Growth

Objective: To provide a sampling protocol that expands survey opportunities, reduces effort and increases the availability of baseline information needed to effectively manage populations of Northern Pike in Michigan's inland lakes.

30.2.2 ***Timing***- A relative abundance experimental gill net survey would occur during time periods when a waterbody is not thermally stratified (e.g., fall, winter, spring). Sampling an unstratified lake increases the likelihood that Northern Pike may be more distributed throughout the lake and within the water column. Sampling results may be biased during stratified periods since Northern Pike are more closely associated with the lake thermocline, compared to where bottom-oriented sampling gear are deployed. Water temperature and dissolved oxygen are important factors to consider when timing a survey using experimental gill nets. Stress-induced mortality may be reduced considerably if the maximum water temperature is below 62°F. Fall, winter, and early spring surveys fall within a time that meets these criteria to minimize mortality and allow sampling at a time of year that management unit work plans allow.

30.2.3 ***Sampling Gear***- Standard experimental gill nets will consist of five monofilament panels of 1.5-, 2.0-, 2.5-, 3.0-, and 4.0-inch stretch mesh, each 25 feet in length and 6 feet in depth. The nets will be affixed with floats and a float line for the upper line, and lead core line for the lower line. The nets will be positioned on the lake bottom when deployed. Gill nets will be fished overnight and moved each sampling day to new, randomly selected locations.

30.2.4 ***Sampling Effort***- The minimum sampling effort required to evaluate an inland lake Northern Pike population is based on the initial need to collect enough (≥5) age structures from 3-, 4-, or 5-year-old Northern Pike (Schneider et al. 2000, Chapter 9 pp 6). Assigned ages and mean total length data are ultimately what are used to evaluate target reference points outlined in the Management Plan for Northern Pike in Michigan (Table 2, Smith et al. 2016). Since Northern Pike ages are unknown at the time of capture, preliminary survey data were needed to determine the mean number of fish captured for each age category. The mean number of Northern Pike captured per age group was then used to estimate the appropriate sample size (or sampling effort) needed to assess a population.

From 2017 to 2024, preliminary Northern Pike surveys (N = 28) were mostly conducted in Upper Peninsula inland lakes using experimental gill nets. The mean number of age 3-, 4-, and 5-year-old Northern Pike captured during these surveys was 14, 12, and 8 fish, respectively. Data also collected from these preliminary surveys included the mean catch rate for age 3-, 4-, and 5-year-old Northern Pike (0.86, 0.73, and 0.50 fish per net night, respectively). These data are then used to perform a sample size analysis (Equation 1) to determine the minimum sampling effort required to collect enough age structures from Northern Pike.

Equation 1

$$N = \frac{\left(Z_\beta + Z_\alpha\right)^2 * \sigma^2}{\Delta^2},$$

Where:

N: required amount of experimental gill net effort needed to collect enough age structures (e.g., from age 3 Northern Pike) to evaluate target reference points.

Z_β: The corresponding z-score for the desired statistical power (or $1 - \beta$). The desired power is 80% and the corresponding z-score is 0.84.

Z_α: The corresponding z-score for the significance level (α). The desired significant level is 95% and the corresponding z-score is 1.96.

σ^2: The variance in catch rate (e.g., for age 3 = 0.50).

Δ: The minimum acceptable difference in mean catch rate. As an example, the mean number of age-3 Northern Pike captured was 14.4. We are willing to accept a deviation of 0.71, or 71% in the number of Northern Pike captured since this will provide at least 5 age structures for evaluating target reference points. The mean catch rate for age 3 Northern Pike was 0.86 fish per net night (0.86 * 0.71 = 0.61).

For example, using the values listed above:

$$N = \frac{(0.84 + 1.96)^2 * 0.50}{0.61^2}$$

$$N = 11\ net\ nights$$

Based on the equation presented above, a minimum of 11 net nights are needed using experimental gill nets to capture enough age 3 Northern Pike. Managers may use discretion when assigning the minimum sampling effort to an inland lake to gather enough Northern Pike age structures. Should managers desire to be more conservative, with the goal of collecting additional age structure samples (>5), they may adjust (i.e., reduce) the percent deviation to calculate the minimum sampling effort needed or refer to the sample size analysis curve represented in Figure 1.

30.2.5 ***Sample Locations***- Prior to the deployment of any sampling gear, a limnological profile will be collected from the lake's deepest basin, and at sample-depth intervals corresponding to maximum lake depth (Table 1). Inland lakes with multiple basins may require that additional limnology profiles are collected. All depth areas that can be surveyed effectively using an experimental gill net will be included for sampling, excluding areas with insufficient dissolved oxygen (<4.0 mg/L). Hypolimnetic hypoxia occurs most often during the winter sampling period, highlighting the need for a limnological profile prior to sampling. Professional judgement should be used when deciding whether to set gill nets in a lake.

The placement of nets will be randomly determined by using a lake map with a numbered grid overlay. The number of grids available will be approximately three times the minimum recommended total effort. For example, if the minimum recommended total effort is equal to 11 net nights, then the total number of grids used for determining net locations will be equal to 33 cells. All sample locations will be assigned without replication. Only grids with depths that contain a minimum dissolved oxygen of 4.0 mg/L will be sampled. All grids expected to contain hypoxic waters (i.e., <4.0 mg/L) will be eliminated from sample selection. For winter sampling, no more than 5 nets may be set per day, per three-person sample crew, due to logistical constraints (e.g., daytime/daylight hours). Unless a second crew is available, under the ice surveys using experimental gill nets may be unfeasible given the minimum effort requested by managers.

30.2.6 ***Data Collection***- For each individual gill net, record date and time of set (lift), water temperature, weather, net number, latitude and longitude of start and end, habitat type (i.e., substrate, vegetation, or structure), water depth at net start and end location, length data per Northern Pike collected and for all bycatch. For each Northern Pike captured, perform and record (on envelope) all the following: sex determination (or unknown), total length (tenths of inches), and presence of lesions and any abnormalities. Fish should be aggregated into a total of five categories including Female (F), Male (M), Suspected Female-No Gametes (F?), Suspected Male-No Gametes (M?), or Unknown (UNK).

Determine sex of Northern Pike based on external characteristics in accordance with Casselman (1974). During a fall 2023 relative abundance survey conducted on Thunder Lake (Schoolcraft County), sex was correctly assigned to approximately 96 percent of Northern Pike, confirmed by dissection. Non-target species should be identified, measured to the nearest inch, and released. All live fish should be released away from net locations. Mortalities will be minimized to the extent possible, within the constraints of survey design. In some cases, fish mortalities will occur and will be dispatched in accordance with Fisheries Division policy and procedure (MDNR 2014). Northern Pike mortalities should be utilized to perform on-site visual sex-determination self-training. For example, by using methods described by Casselman (1974), staff can assign a sex to each Northern Pike sample and later confirm/correct their assignment using dissection and visual identification of the gonads.

30.2.7 ***Age Structure Collection***- For all Northern Pike captured, clip the first 3 to 5 dorsal fin rays, cutting close to the body. Collect a minimum of 10 age structures per inch group, per sex (total of 20 per inch group) unless instructed otherwise by local management unit staff. All structures should be placed in a sample envelope marked with data including date, waterbody name, species, total length, and sex. After each sampling day, position all sample envelopes to ensure proper drying. All Northern Pike age structures should be aged.

30.2.8 ***Data Analysis***- Catch per unit effort (CPUE) will be calculated taking the total number of Northern Pike captured divided by the total number of net nights. A total of 28 targeted Northern Pike surveys were conducted using experimental gill nets between 2017 and 2024. The CPUE data have inherent limitations and biases since most surveys were mostly conducted in Michigan's Upper Peninsula in waterbodies that were not randomly selected. The existing CPUE data should be used with caution due to these limitations that may introduce bias to interpreters. These data can, however, be useful as a starting point until a robust dataset of targeted survey catch rates is developed. Stratification of the current dataset by month, region, or lake size and depth may help to minimize those biases and may make those comparisons more accurate in the future.

30.2.9 ***Evaluation***- Data collected from targeted Northern Pike surveys will be entered into Fish Collection System. The survey type should be listed as "Species Evaluation", and the notes should include the statement referencing the use of standard protocols. The new FISH system will have a checkbox/dropdown menu where you can specify the specific protocol used. All surveys that targeted Northern Pike using this protocol should be reported during annual requests issued by the Esocidae Committee to document targeted surveys. The Esocidae Committee will maintain a table of Northern Pike surveys to be used for creating updated evaluation criteria from surveys conducted according to a standardized protocol. Special notation should be assigned to surveys conducted using this protocol 1) in response to angler requests, or 2) as an 'add on' to random Status and Trends inland lake sampling.

30.3 *Future Considerations*

Preliminary surveys conducted from 2017 to 2024 were largely comprised of lakes selected in response to anglers' request for regulation changes. There is additional utility of this protocol if it were to be applied as an 'add on' to random Status and Trends inland lake surveys. For example, a waterbody randomly selected for a Status and Trends survey could also have a Northern Pike experimental gill net survey scheduled in the fall following spring Status and Trends sampling. The value in conducting an additional survey consistent with this protocol on Status and Trends lakes would be that the dataset would begin to incorporate 'randomness'. Baseline information that incorporates more 'randomness' may be more applicable when trying to make regional or statewide comparisons relative to Northern Pike populations in Michigan's inland lakes. Lastly, as a baseline dataset continues to build, annual review of this protocol and catch rate summaries will be required.

Table 1. Lake depth in feet (ft.) and the limnology sample depth interval. For example, a lake with a maximum depth (ft.) of 18 feet would need a limnology sample recorded every foot.

Lake Depth (ft.)	Limnology Sample Interval
0 to 20	Every 1 foot
21 to 40	Every 3 feet
41 to 100	Every 5 feet

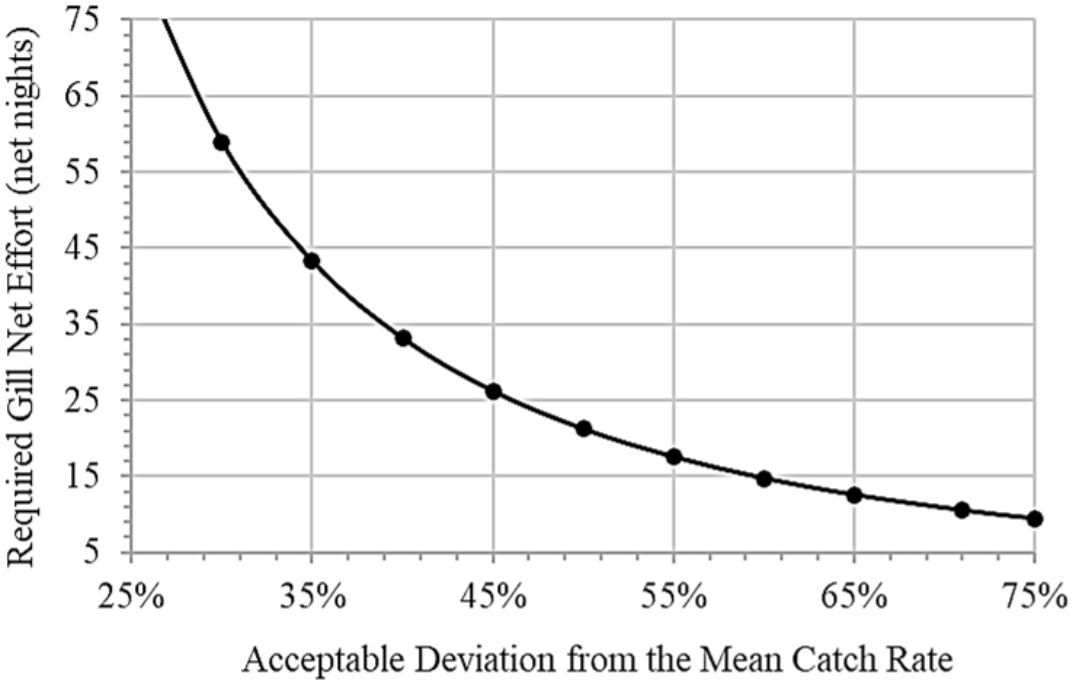

Figure 1. The minimum required sampling effort (y-axis) needed using experiment gill nets, according to the acceptable degree of deviation from the mean catch rate (x-axis). Data used here in this example is based on the capture of age 3 Northern Pike.

30.4 References

Casselman, J. M. 1974. External sex determination of Northern Pike, *Esox lucius* Linnaeus. Transaction of the American Fisheries Society 103 (2) 343-347.

Godby, N. A., C. K. Kovacs, M. J. Diana, and J. T. Francis. 2023. Northern Pike sampling protocol. Chapter 28 *in* J. C. Schneider (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

MDNR. 2014. Fish disposal following division fish survey activities. Fisheries Division Policy and Procedure 04.03.002.

Schneider, J. C., P. W. Laarman, and H. Gowing. 2000. Age and growth methods and state averages. Chapter 9 *in* J. C. Schneider (ed.) 2000. Manual of fisheries survey methods II: with periodic updates. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Smith, K. M., C. K. Kovacs, M. V. Thomas, and J. S. Diana. 2016. Management plan for Northern Pike in Michigan. Michigan Department of Natural Resources, Fisheries Report 15, Lansing.