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Riverine Index Netting
Manual of Instructions

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Riverine Index Netting Manual of Instruction
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Abstract

This manual represents the provincial standard for assessing fish populations and communities in medium to large non-wadable rivers in Ontario. There are many reasons why you might want to use the Riverine Index Netting protocol and each will have its own experimental design independent of the net function. At a minimum it is important to understand that Riverine Index Netting (RIN) nets and this manual have been developed to efficiently catch small, large, and extra-large fishes in rivers. This instruction manual assumes that the user has sound knowledge and field experience in netting and sampling fishes. The manual is subdivided into sections on: gear description, pre-field activities, field procedures, post field activities, and data management. We also provide a hypothetical case study to illustrate how the Riverine Index Netting method can be employed at a hydropower development. Lastly, we provide appendices on bathymetry mapping, aging structures, contaminant analysis, field forms, equipment list, and fish species codes. Few methods exist for non-wadeable rivers in the world. As a result, we generally have a poor understanding of fishes in flowing waters and how they are influenced by disturbance. This manual represents just the beginning of method development for rivers in Ontario. We hope this manual is proven to be useful in environmental impact assessments and resource reporting.

Résumé

Le présent manuel représente la norme nationale d'évaluation des populations et des communautés de poissions dans des rivières moyennes à larges non traversables à gué de l'Ontario. C'est pour plusieurs raisons que vous auriez peut-être intérêt à vous servir du protocole de décompte des prises d'espèces fluviales et chacune d'entre elles aura sa propre conception expérimentale indépendante de la fonction du filet. Au minimum, il est important de comprendre que les filets de décompte des prises d'espèces fluviales et le présent manuel ont été conçus pour capturer efficacement des poissons, qu'ils soient petits, grands ou très grands, dans des rivières. Dans le présent manuel d'instructions, on suppose que l'utilisateur possède une solide connaissance et de l'expérience sur le terrain en prise au filet et échantillonnage de poissons. Le manuel est subdivisé en parties traitant des sujets suivants : description de l'équipement, activités préalables aux activités sur le terrain, procédures applicables sur le terrain, activités ultérieures aux activités sur le terrain, et gestion de données. Nous fournissons également l'étude d'un cas hypothétique pour illustrer le mode d'emploi de la méthode de décompte des prises d'espèces fluviales à une centrale hydroélectrique. En dernier lieu, nous avons fourni des annexes sur la cartographie bathymétrique, le vieillissement des structures, l'analyse des contaminants, des formulaires pour le travail de terrain, des listes d'équipement, et des codes des espèces de poissons. Les méthodes applicables aux rivières non traversables du monde sont peu nombreuses. Par conséquent, en général, on comprend mal les poissons des cours d'eau et l'influence des perturbations sur eux. Le présent manuel n'est que le commencement de l'élaboration de méthodes pour les rivières de l'Ontario. Nous espérons que ce manuel s'avérera utile lors des évaluations des incidences environnementales et de la déclaration des ressources.

Contents

1.0 Introduction

This manual represents the provincial standard for assessing small, large, and extra-large-bodied fish populations and communities in non-wadable rivers in Ontario. The nets can be used singly or in combination to gather fish community information. The main objective of an index netting survey is to assess the relative abundance of fishes and provide other biological measures or indicators of the community's status. In the past, survey methods in Ontario have varied over time and among watersheds. This lack of standardization has resulted is fishery data that is not directly comparable and is less useful for synthesis or management purposes (Willox and Lester 1994). This problem can be avoided by standardized sampling. Adherence to a high degree of standardization is necessary to make sure that the catch probability does not vary from population to population or among sampling events. Just as important is that your data is archived in Fishnet. Entering your data is easy and allows for regional comparison of rivers in Ontario.

The Riverine Index Netting (RIN) protocol was borne out of a need to assess fish populations in rivers for the Ontario Ministry of Natural Resources. The development of this method used the Fall Walleye Index Netting (FWIN) protocol (Morgan 2002) as an initial net design as it is expected to have the highest probability of success for capturing juvenile lake sturgeon (NESI 2005). During a subsequent workshop on Methods for Sampling Fishes and Their Habitats in Flowing Waters it was agreed that developing a netting protocol would have the greatest impact because netting is not constrained by conductivity, turbidity, or depth, and thus would be applicable across many river types in Ontario (Jones and Kim 2005; Jones, Mandrak and Kim 2005). After three years of testing and workshops, the FWIN nets were modified for use in rivers and the methodology was adjusted based on field crews' experiences netting in rivers.

There are many reasons why you might want to use the RIN protocol and each will have its own experimental design independent of the net function. At a minimum, it is important to understand that RIN nets and this manual have been developed to efficiently catch fishes in rivers. This instruction manual assumes that the user has sound knowledge of and field experience in netting and sampling fishes.

2.0 Gear Description

This manual describes the use of three nets for assessing small, large, and extra large-bodied fish populations in rivers. Large mesh nets target large-bodied fishes sought by commercial and recreational anglers. Small mesh nets capture small-bodied fishes such as young-of-the-year and juvenile sport fish, and forage fishes of interest to large-bodied fishes. The extra large mesh net is designed to target adult sturgeon.

Table 1. Summary of small, large, and extra-large mesh gillnet construction.

Small Mesh Gillnet					
Stretch measure (in)	0.50	0.75	1.00	1.25	1.50
Stretch measure (mm)	13	19	25	32	38
Mono diameter (mm)	0.10	0.13	0.13	0.15	0.15
Series Order	4	2	5	1	3
Panel length (m)	2.5	2.5	2.5	2.5	2.5
Panel length (ft)	8.2	8.2	8.2	8.2	8.2
Panel height (m)	0.9	0.9	0.9	0.9	0.9
Panel height (ft)	3.0	3.0	3.0	3.0	3.0
Monofilament	Clear, double knotted except 13-25 mm are single knot				
Float line	10 mm (3/8 in)				
Lead line	no. 30 (15lbs/300ft)				
Mesh labels	yes (mm)				

Large Mesh Gillnet								
Stretch measure (in)	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00
Stretch measure (mm)	38	51	64	76	89	102	114	127
Mono diameter (mm)	0.28	0.28	0.28	0.33	0.33	0.33	0.40	0.40
Series Order	5	3	7	1	4	8	2	6
Panel length (m)	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Panel length (ft)	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Panel height (m)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Panel height (ft)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Monofilament	Clear, double knotted							
Float line	13 mm (1/2 in)							
Lead line	no. 27 (27lbs/300ft)							
Mesh labels	yes (mm)							

Extra-Large Mesh Gillnet				
Stretch measure (in)	8	9	10	12
Stretch measure (mm)	204	230	255	306
Twine size	210/12	210/12	210/12	210/12
Series Order	3	1	4	2
Panel length (m)	6.2	6.2	6.2	6.2
Panel length (ft)	20.3	20.3	20.3	20.3
Panel height (m)	2.13	2.13	2.13	2.13
Panel height (ft)	7	7	7	7
Line	Green twine, double knotted, multifilament nylon			
Float line	13 mm (1/2 in)			
Lead line	no. 27 (27lbs/300ft)			
Mesh labels	yes (mm)			

In addition to the design standards described below, you will also require two 3 m (9.8 feet) bridles and two lengths of 6 mm (1/4 inch) diameter or smaller polypropylene rope appropriate for the depth of the river. The end of each panel is clearly labelled with a corresponding mesh size (mm) on a metal band and the division identified with a distinctive colour mark. Tying the net off to shore is preferred over anchoring. Anchors should be heavy enough to prevent movement of the net but not heavy enough to distort the net thereby reducing catchability. Please note that large amounts of excess rope on a spool or board will pull the top of the net downstream and decrease catchability. Use only the amount of rope needed and use small floats to reduce drag. All floats should be marked with agency name and contact number and should include a caution that it is attached to scientific equipment and lifting and/or removal is prohibited.

If required, two or more nets can be joined together. Panels on either side of the join should not be the same mesh size. It is important that on receiving a new order of nets from the manufacturer that they are closely inspected to ensure they meet the specifications outlined in the table above. A large-mesh RIN net is 24.8-m long and 0.9-m deep. This is essentially the AFS North American standard net but at one-half the height. The small mesh net is the same as the small mesh net used in the Ontario Ministry of Natural Resources' Broad-scale Monitoring Program, but again, is one-half the height. Recommended panel order, a quasi-random order, was used to minimize capture bias based on direction of fish movement upon encountering the net.

Table 2. Summary of the Riverine Index Netting methodology.

Criteria	Target
Fish size	Small-bodied fishes e.g., cyprinids, to extra large-bodied fishes e.g., adult sturgeon, depending on net used.
Season	July 1st – October 1st
Set Duration	Eighteen hours (+/- two hours). 13:00-17:00 (set) and 8:00-11:00 (lift). Fished overnight.
Gear	Three types of gillnet: small, large, and extra-large mesh.
Set orientation	Perpendicular to flow or angled less than 45° downstream
Water velocity	Less than 0.5 meters per second
River width	Greater than 30 m
Depth	Water deeper than 0.9 meters. No depth stratification.
Spatial Stratification	May be required depending on reason for netting (i.e. above/below dam)

3.0 Pre-Field Activities

3.1 Sampling Methods

RIN netting should occur the period of July 1st to October 1st to avoid the autumn increases in flow, leaf fall, and macrophyte die-off. Field crews in southern Ontario may decide to start netting earlier and end later than this date, whereas those in the north may decide to start netting later and end earlier. There are no criteria for water temperature or depth.

The nets are set perpendicular to shore and flow, however, if the river is too narrow the nets can be angled to shore up to an angle of 45°. Avoid setting nets in areas where the water velocity exceeds 0.5 metres per second. The target soak time of each set is 18 hours; however, a range of 16 to 20 hours is acceptable. Typical nets are set around 13:00-17:00 hrs and lifted 8:00-11:00 hrs. The number of sites that can be sampled in a day will depend on catch size, travel time to the waterbody, distance from launch to sites, and crew experience; but, a target of 10 nets is reasonable. Reduce the number of nets sampled during the first netting day if expected catches are unknown or possibly high. In very large rivers, several nets can be joined together to make a longer net.

3.2 Sample Size (Number of Nets) to Assess Abundance

We recommend that 20 to 40 net sets should be used for each river. In rivers with low numbers of fish, e.g., 1 walleye per net, 40 nets might be needed; whereas, in rivers with high numbers of fish, e.g., 6 walleye per net, only 20 nets might be needed. Higher variability is common in fish that aggregate; whereas, randomly distributed fish would provide a low degree of variation. The number of nets needed for a precision of 20% relative standard error (RSE; Equation 1) can be calculated after each day of netting if so desired and for fish species other than walleye, e.g., suckers.

Equation 1

$$RSE = \frac{SE}{\bar{x}} = \frac{s}{\sqrt{n} \times}$$

Sample size requirements can also be related to specific management objectives, independent of river size. For example, if the objective was to determine a baseline value for future comparisons or to detect if a change in abundance had occurred from a previous survey, then a target level of precision or RSE would determine your sample size. Note, a RSE of 20% is an arbitrary level; you may want slightly higher or lower levels of precision. For a more detailed examination of sample size see Wilde (1995).

Other considerations aside from good abundance estimates include reducing the impact of the netting on the fish community. An estimate of walleye abundance can be determined from a sample of 50 to 200 walleye. Netting should stop if the biological sample size is reached before the recommended number of net sets has been completed.

3.3 Sample Size (Number of Nets) to Assess Biodiversity

The assessment of biodiversity is heavily influenced by effort (number of nets), heterogeneity of habitat, and the number of gear types used. Biodiversity assessment can be done using any of the three nets, but the extra-large net will likely catch only sturgeon. Sample the variety of habitat types available (non-random targeted sampling). Species accumulation curves can be determined after each day of sampling to understand how much sampling is required. Species accumulation curves are graphs that show the total number of fish sampled from all samplings on the bottom axis (X axis) and the total number of different species from all samplings on the side axis (Y axis). As the number of samplings increases the number of species increases. The rate of increase slows as most of the species possible to sample are recorded and the probability of finding a new species approaches zero. The shape of the curve and the number of samples can be used to predict the probable number of species at a site. See RIN Support Spreadsheet.xls at: http://people.trentu.ca/nicholasjones/RIN.htm for RSE automated spreadsheet.

3.4 Defining Upstream and Downstream Limits of Netting

Unlike many lakes, rivers are open systems and their boundaries are not always clear. The section of river to be netted can be defined in several ways. For example, a lake downstream may define the downstream limit of interest. The operation of a hydropower facility might have impacts several kilometres downstream. A waterfall might serve as a good boundary limit upstream. Estimating the zone of influence from an impact is not simple. You may also need to consider a section of river for a reference condition. If there are no discernable limits then you might consider the home ranges of the target fishes. Although river fishes may make long distance migrations e.g., spawning, over-wintering, the home ranges of fishes in rivers are typically smaller than those for fishes in lakes. According in Minns (1995) the home ranges of some common fishes in rivers rarely exceed 10 km.

3.5 River Stratification

Once the upstream and downstream boundaries have been defined the river can be stratified into segments. A segment is a section of river with relatively homogenous habitat over the large-scale, e.g., backwater region, uniformity in geology or substrate, and/or sections of river split by lakes. For example, if you are assessing the effect of a dam, a design consisting of paired nets above and below the dam might be used (see Section 7.0). This stratification will help ensure that different river segments are represented and that potential variation is partitioned. There is no depth stratification in the protocol. This reflects the physical properties of rivers in that their waters generally mix, creating isothermal conditions. You may still want to stratify based on depth if you know that a river segment is deeper or shallower than other parts of the river.

3.6 Random Selection of Sample Sites

The selection of sample sites and development of the sampling schedule are completed prior to netting. We **strongly advise** that field crews familiarize/survey the sections of river targeted for netting prior to netting activities to allow for strategic use of net sets, large-scale stratification of the river into segments, and more efficient use of time (e.g., less travel time, avoid unfishable waters). The abundance estimation method requires stratified random sampling without replacement. Non-random targeted sampling in a variety of habitat types available can be used for biodiversity assessment. Ensure even spatial coverage if there is no real or preconceived knowledge of fish distribution. In large river systems, where travel times may prevent the full spatial extent of the river to be sampled each day, sites may be grouped into manageable clusters as an acceptable compromise; however, nets should be spaced at a minimum of 250 m intervals (Table 3).

Table 3. Suggested site spacing for different lengths of river.

River length (km)	Site spacing Interval (km)
5 to 20	0.25
20 to 40	0.5
40 to 80	1.0
> 80	2.0

Nets can be placed on either side of the river, i.e., right or left bank but should not be set opposite to each other unless the river is > 100 m wide. Nets can be placed in the middle of the river if the river is > 200 m wide. Avoid problem areas including snags and boulders that may entangle the net and steep drop-offs. Ensure to select alternate sites in case pre-chosen sites are unsuitable.

3.7 Preparation of Field Forms and Equipment

Field crews should have all the necessary maps of their waterbody, including sampling site locations before going into the field. If a pre-survey was completed, which is strongly recommended, directions on how to find the waterbody, boat launching sites, depths profiles and navigational hazards can also be added to the maps. See Appendix 1 on how to conduct bathymetric surveys on rivers. Prior to the first field sampling day, crews will need to prepare enough RIN forms to record their results while in the field (Appendix 4). A minimum of one RIN Sample and Species form and one Fish Sample form is required per net. Additional copies of these forms may be required if catch numbers are large.

RIN forms can be printed or copied onto waterproof paper for working in inclement weather. It is recommended that a set of waterproof forms be made available to field crews for days when such forms would be required.

3.8 License to Collect Fish for Scientific Purposes

RIN netting and other methods of capturing fish for management purposes are critical tools used by fisheries managers. Contractors are required to have a valid collector's permit to carry out a fish survey. However, due to recent changes in regulations, MNR staff are no longer required to obtain one.

In the case of index netting, the License to Collect Fish for Scientific Purposes as provided for in Section 36.1 of the Ontario Fishery Regulations (OFR) provides the appropriate authority. This license is issued under Section 34.1(1) of the Fish Licensing Regulations under the Fish and Wildlife Conservation Act (FWCA) by any of the following: Area Supervisor, Regional Operations Manager, Great Lakes Manager, and Fisheries Section Manager.

3.9 Species at Risk

If any of the sampling locations are in areas where listed species at risk are likely to be captured using the gear in question, it will be necessary to apply for appropriate permits. If the sampling activity is anticipated to cause an unacceptable level of harm to the population of a listed species, it is possible that a permit will not be issued and alternative sampling locations or methods may need to be selected.

3.10 Invasive Species Transfer

Care must be taken not to transfer invasive flora and fauna species. This may mean cleaning of nets, boat, motor, and trailer of organic debris and allowing drying between 48 and 96 hours. Subsequently, all equipment, except nets, should be sprayed with ~15% bleach solution or peroxide. It may also mean that nets are confined to an area of the province i.e., provincial zones.

3.11 Preparation of a Fish Disposal Plan

The RIN technique can result in mortality of captured fish, so it is necessary that a fish disposal plan be established (and approved) prior to conducting a RIN survey. Based on Section 36(5) of the FWCA it is illegal to abandon fish or to let its flesh spoil if it is fit for human consumption. Although the FWCA is not binding on the Crown, reasonable efforts should be made to provide local charities with any salvageable fish. Also see section 5.2 on Tissue Sampling for Contaminants.

3.12 Preparing a Public Information Notice

If working on a waterbody with cottage or tourism development, it is a good idea to prepare an information sheet to give to property owners and other members of the public when encountered near your sampling sites. Public information sheets can be left on docks or at doors of residents that appear to be away for the day. These information sheets tend to satisfy most people's curiosity and significantly reduce the occurrence of negative reactions which can lead to net tampering or unnecessary complaints. In some cases, project leaders may want to contact local interest groups (e.g., cottage associations, First Nations, angler groups) prior to conducting the field program, to inform them about the RIN program that will be taking place on the waterbody. A typical information sheet or contact letter should identify who is conducting the RIN program, why, for how long, and provide a telephone number to contact for more information.

4.0 Field Procedures

4.1 Safety and Communication

RIN surveys take place on large rivers whose flow can be deceiving and conditions can change abruptly, especially near hydro-electric dams. Contact power generation authorities to obtain information about changes in flow. Drowning caused by quickly changing flows is a real threat. Delay sampling if there are severe weather conditions. Safety and operation protocols must follow MNR Marine Safety Program Policy and should be carefully reviewed by the crew and manager prior to the field work and revisited periodically during the program. All safety equipment should be accessible and personal floatation devices must be worn while on the water. Safety of sampling crews must override all other activities and everyone participating in the RIN survey should be aware of their rights and obligation according to the Occupational Health and Safety Act. A designated person should know where the field crew is on any given day and how to contact them. The crew should report to this person at the end of the day. As an additional check-in measure, government of Ontario employees may use the Provincial Communications Centre (PCC).

4.2 Site Selection

Use the river map and sampling schedule you prepared in advance (as described in Section 3.0) to determine where and when to set each gillnet. Avoid net locations with steep drop-offs or areas with abundant aquatic vegetation. If pre-selected net locations are not suitable, use one of the alternate sites selected within the given area.

4.3 Setting the Net

To set the net, one crew member is positioned in the bow of the boat and the second member at the rear operating the motor.

1. Upon reaching the desired location, drop the marker buoy and anchor into the water, playing out rope. Once the anchor reaches bottom, shift the motor into reverse and begin to play out the net. Alternatively, tie the net to shore.

2. Make sure that the net's float line and lead line play out evenly, free from twists and tangles, with the float line handled at a higher level.

3. When the net is fully played out, shift the motor into neutral and play out enough rope for the anchor to reach bottom and the buoy to remain floating. Continue holding the marker buoy while the motor operator reverses to pull the net tight. Release the buoy. Tying the net off to shore is preferred over anchoring. Anchors should be heavy enough to prevent movement of the net. Please note that large amounts of excess rope on a spool or board will pull the top of the net downstream and decrease catchability. Use only the amount of rope needed and use small floats to reduce drag.

4. Record all relevant data as set out on the RIN Sample and Species form.

4.4 Information to Record at Set

Immediately following each set all necessary data is recorded in pencil on the RIN field form (Appendix 4). The information outlined below is the minimum requirement for entry into FISHNET 3. Record in the comment section of the form any other pertinent observations. Data regarding environmental conditions will be used to interpret catch data, not to develop fish-habitat associations.

4.5 Lifting the Net

Lift the nets the following day in the same order as they were set. The target set length is 18+/-2 hrs. The person lifting the net is in the front of the boat. Generally, the outboard motor can be stopped, but on windy days the outboard motor operator may need to control the boat's position so that the net does not get fouled as a result of wind or boat movement. To lift the net:

1. Retrieve the marker buoy at the near shore end of the net and pull in the anchor-marker line to the anchor.

2. Grasp the float line and lead line and put them both into one hand, allowing the netting to hang free. Begin pulling in the net while keeping the float and lead lines together in your hand (this will ensure the net will not tangle).

3. While pulling in the net, place it in the storage container in a spiral fashion.

4. Process fish as you lift the net (the motor operator can do this while the net is being lifted), filling out the RIN Sample and Species form for both coarse and sport fish caught and the RIN Fish Form for length values of coarse fish. Place sport fish into appropriately marked bags (RIN nets are processed by net and mesh size, so be sure to clearly label each bag accordingly). If weather conditions or volume of catch prevents processing fish on the water, retain fish in separate tubs for each mesh size lifted to be processed onshore.

5. Continue lifting the net until all fish are removed from the net and the entire net is placed into the storage container.

6. Proceed to the next net to be lifted.

4.6 Information to Record at Lift

Immediately following each lift (i.e., before going to the next lift) the following data are recorded in pencil on the RIN field form: lift date, lift time, and effort status. Also record in the comments field any additional pertinent observations. Record catch by mesh size for future comparisons.

4.7 Processing the Catch

To avoid error associated with tight confines and unstable conditions, the day's sport fish catch should not be processed in the boat. If possible, fish processing should take place on the shore and under cover. After unloading all samples, the day's catch should be sorted by sample and effort number. The first step is to identify, count, and record all fish caught in each net. Identify and record by mesh size all fish caught in each net set. This information is recorded, in pencil, on the RIN Sample and Species form. A separate form is used for each net set.

4.8 Fish Sampling

A two person crew is used to sample the fish. A number of biological attributes can be collected from the fish samples. A minimum requirement for RIN surveys is that all sport fish will be completely sampled and all other species will be sampled for length (both fork and total length). For the sport fish species, the following data are to be collected: fork length, total length, round weight, sex, and maturity. These data are recorded on the RIN Fish Sample form. In addition, a scale sample and at least one other secondary aging structure are collected. Optional data that can be collected on sport fish include: visceral fat, gonad (testes or ovary) wet weight, fecundity samples, and stomach samples. Guidelines for processing fish for this information are not covered in this manual.

1. The fish handler selects a fish, identifies the mesh size and species and places it on the measuring board.

2. Measure the fork and total lengths to the nearest 1 mm and record the fish number, fork length, and total length on the Fish Sample form. To measure the total length, compress the upper and lower lobes of the caudal fin rays to obtain the maximum length.

3. Weigh the fish using a hand-held spring-loaded weigh scale or an electronic balance (preferred). Hand-held spring-loaded scales should be calibrated every two days. If you are using a hand- held scale, do not record weights that are < 10% of the minimum scale capacity (i.e. do not use a 1 kg scale to weigh an 80 g fish, use a 100 g scale). If using an electronic balance, measure the round weight to the nearest 1 g.

4. To collect a scale sample, gently wipe away any excess mucous and dirt from the area to be sampled with the blade of your knife. Clean the knife blade carefully by wiping with a cloth or rinsing with water. With the tip of the knife, gently pull the scales from the left side of the body and place in a scale envelope. For spiny rayed fish (e.g., walleye, sauger, yellow perch, smallmouth bass) remove at least ten scales from below the lateral line and posterior to the insertion of the pectoral fin. For soft rayed fish (e.g., northern pike, salmonids, coregonids) remove at least twenty scales from above the lateral line and anterior to the dorsal fin. Make sure to clearly label each scale sample envelope with all the information available on the fish and where it was collected.

5. For any fish that is scale sampled, collect a secondary calcified ageing structure and place it in a separate scale envelope that has been labelled as above. Opercles and cleithra must be immediately cleaned and otoliths placed in small vials for storage.

6. Using a filleting knife cut the fish ventrally from the urogenital opening to the pelvic girdle and determine the sex and state of maturity. Record on RIN Fish Sample form.

7. Follow instruction in Appendix 3: Protocol for the Collection of Sport Fish for Contaminant Analyses Updated 2007: Sport Fish & Biomonitoring Unit if interested in contaminants.

5.0 Post Field Activities

5.1 Processing the Collected Fish Tissues

Scale sample envelopes should be organized before being sent for age interpretation. The flap of the scale envelope should be folded over but not tucked in. Ageing tissues from each individual fish should be stored together. Group envelopes by species before sending for aging.

5.2 Tissue Sampling for Contaminants

Fish tissue samples can be analyzed for a wide variety of organic and inorganic contaminants including mercury, PCB's, mirex, DDT, and dioxins. Mercury analyses are performed on lean, dorsal, skinless, boneless muscle tissue of the fish ~ 50 g of flesh from above the lateral line. Keep samples frozen. Typically 20-30 sport fish of various sizes are sampled. Consider collecting tissue in samples associated with hydroelectric developments. See Appendix 3 for more information on tissue sampling.

5.3 Disposing of Dead Fish

Dead fish should be disposed of according to your fish disposal plan. Dead fish (and offal) not destined for human consumption should be buried at an appropriate burial site. Do not bury or dispose of fish in areas with frequent human or bear activity.

5.4 Net Storage and Replacement

Gillnets should be dried completely following each RIN survey to avoid transporting exotic species between waterbodies (see section 3.10). Small tears in the panels should be repaired as soon as possible. Nets with large tears or damaged panels should be sent back to the manufacturer for replacement. The nets should be stored in their individually sealed containers in a dry place. Ropes, marker buoys, and anchor should be dried out and stored in their sealed container in a dry place.

5.5 Other Equipment

Other equipment should be checked for damage and serviced if necessary. Outboard motors should receive servicing at the conclusion of the field season. All metal equipment should be dried and lubricated before being stored in a dry place. Batteries should be re-charged and stored in a dry place.

6.0 Data Management

The data recorded on the RIN forms are in a format compatible with the software package FISHNET 3.0 and as such data entry can be done directly from the forms into FISHNET 3.0. At this time, FISHNET 3.0 is only available to MNR staff with access to the MNR Intranet; however, steps are currently being made to allow partners access to FISHNET 3.0.

7.0 When a River Becomes a Lake

During the course of the development of this protocol, we had several questions about comparing data from lakes and rivers, fundamentally different ecosystems. For example, biologists wanted to compare lake and river fisheries data, particularly where sections of river are slated to become a reservoir for hydropower production. In turn, the resource manager wonders if using a net designed for lakes can work in rivers, or visa versa. They see the value of using standard gears (Bonar et al. In Press). The data from rivers are not truly comparable to data from lakes. The reasoning follows two lines of thought, (1) the nets function differently in rivers than in lakes, and (2), lakes and rivers are very different environments. If a net fishes differently in the two environments then is the method standardized and is the data comparable? Not likely. As noted in this study, RIN nets are the same as the AFS core net but are half the height. The reduction in height (1.8 to 0.9 m) typically results in 13% less fish captured. The upper half of the FWIN net we tested does not catch many fish but contributes twice the drag, bending the net over and perhaps pulling it downstream. As net height increases it moves up in the water column where water velocities are higher (highest at the surface). The second point is that rivers typically harbour more fishes than lakes per unit area; however, these fishes are typically smaller in size (Randall et al. 1995). This is one explanation for rivers being more productive than lakes: small fish grow faster than large fishes. Seasonal migrations aside, fish in rivers typically move less than lake fish (Minns 1995, Gowan et al. 1994). Lastly, fish distribution in rivers is likely patchier than in lakes. In conclusion, abundance data from lakes and rivers are not readily comparable; however, other aspects of the data certainly can be used e.g., age-class structure. In striving for generality it is important to note that standardization is more than using the same gear type, but using it in particular environmental settings where the gear functions correctly.

8.0 Applying the Riverine Index Netting Protocol: Hypothetical Example

There are many reasons why you might want to use the RIN protocol and each will have its own experimental design independent of the net function. At a minimum it is important to understand that RIN nets and this manual have been developed to efficiently catch fishes in rivers in a standardized way.

Case Study

You received an application to modify the flow regime for a hydropower site on the Ward River from EcoPower Inc. EcoPower has shown that it is very interested in learning how to balance power demand and ecosystem effects. They are seen as one of the more green power companies in the province. Publicly there are concerns about the walleye fishery and about lake sturgeon that use sections of the river for spawning. Relatively little is known about the abiotic and biotic characteristics of the river; however, it is a low conductivity, clear-water but stained, northern river. It is suggested that a fisheries survey (large mesh net) be conducted along with an assessment of possible ecological impacts.

The hydropower station currently operates as a peaking facility with a base flow of 20 cubic meters per second (cms). The station will continue to operate this way for 10 years (2010-2019) after which time the base flow will be experimentally reduced to 10 cms but flushing floodplain flows (approximately 200 cms) will be added for 1 day per year with a recession of a maximum of 20 cms per day to the base flow of 10 cms. The experimental phase will last 10 years (2020-2030). Monitoring results will be reviewed in 2031 to determine future station operations. Engineers note that the backwater section is expected to expand and contract seasonally and with power generation 10 to 30 km upstream.

In preparation for RIN, work was done in the office using GIS data and aerial photography to define river segments, large pools, and possible access points. A segment was defined as a relatively homogenous section of river e.g., backwater sections, changes in geology, sections of river split by lakes. A field survey of the river was conducted that further described the river in terms of access points, backwater limits, danger zones, general habitat characteristics within river segments, and where netting will not be possible. A digital bathymetric survey was done (see Appendix 1) and a georeferenced map was created that captured this basic information and will be used to communicate plans amongst field staff and stakeholders.

The limits of the study area were set at 50 km upstream and downstream of the dam. These limits were set based on the understanding that walleye range up to 10 km (Palmer 1999) and that the influence of the dam might be noticeable up to 40 km downstream. In addition, a lake is located 50 km downstream and naturally makes a good limit. The river was stratified based on the anticipated backwater areas, and upstream and downstream of the dam creating three different segments of the Ward River. It was noted that a gradient in temperature, flow, sediment, and zooplankton abundance, all of which will influence biota, will develop after the dam/reservoir is created as a result of a lake-outlet effect. The extent of this gradient downstream ~ 3 to 10 km, however, was not known at the time. It was determined that 20 RIN nets would be placed downstream and 30 nets upstream of the proposed hydropower site. Ten nets would be used in the non-backwatered section and 20 in the backwatered section (Table 1). Nets within the three strata would be randomly allocated.

Table 1. Summary of site selection in the Ward River. Site spacing was adjusted to 1 km.

Strata	Length (km)	# Possible netting sites	# Nets desired
Downstream	50	50	20
Upstream Backwater	30	30	20
Upstream Non-backwatered	20	20	10

In the office, the river was divided into 1 km long lengths. At each kilometre, a netting site was numbered by strata i.e., 50 possible sites downstream and 50 sites upstream, 30 in the backwatered section and 20 in the non-backwatered section (Table 1). Netting sites were randomly drawn using Microsoft Excel (random number generation), but a hat could have been used.

It would take 5 days to complete the field work based on ten nets per day plus one day for a pre-netting survey and one day for office work. Sampling would occur in the last week of August. Subsequent netting e.g., 2014 … 2029 would not likely require a pre-netting survey.

Table 2. Summary of Phases, operation, and sampling years.

Period	Operation schedule	Sampling Years
Pre-experimental	2010 to 2019	2012, 2014, 2016, 2018
Experimental	2020 to 2029	2023, 2025, 2027, 2029

In consultation with the stakeholders and the proponent it was decide that a 50% reduction in walleye abundance was significant. Everyone also agreed that the consequence of a loss were large enough such that the alpha level was dropped to 0.2. Using the RIN Support Spreadsheet.xls at http://people.trentu.ca/nicholasjones/RIN.htm, it was determined that a statistical power of 92% could be achieved if the netting was done four times in each phase (Table 2). There is a time-lag in netting in Phase 2 to allow the change in flow regime to have an effect on the fish community. It was noted that a shorter time-lag could be used if the species of interest was fast growing or the fish grew faster in more productive waters. Conversely, for slow growing fish or in low productivity systems the effects of an impact may not be noticed in catch data for several years.

In this example it might be more beneficial to sample less precisely within each year (e.g., fewer nets and higher %RSE) if this means more years can be sampled. This balance will help optimize the study design. In addition to large-mesh RIN netting, other sampling may be desired such as netting for adult sturgeon (gear code 3) and small-bodied fishes (gear code 2), benthic invertebrates, river geomorphology, wetted width, and recreational use. For more information on detecting change see Minns et al. (1996) and Lester et al. (1996).

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Appendix 1: Bathymetric Automated Survey System (BASS) in Rivers

When conducting a RIN survey, it is advantageous to have detailed knowledge of the habitat and depth profile of your river. We suggest carrying out a pre-survey scouting cruise on your river. Taking a half-day to a day to complete, the pre-survey will save time when choosing netting sites and avoid unforeseen difficulties with logistics. While scouting the river, many relevant details can be gained including: access, shoreline habitat and land use, flow, and depth. While most of these parameters can be quickly and easily observed by running the river, obtaining a depth profile can be time and resource consuming. The OMNR has developed a software application to automate the process of collecting and storing location and depth data (i.e., x, y, z) called the Bathymetric Automated Survey System (BASS).

The BASS software comes with a manual of instructions that outlines the logistical and sampling design of a BASS survey. The BASS protocol was originally designed for surveying lakes and does not address surveys on large rivers. In most cases, large rivers will approximate lakes for the purposes of a bathymetric survey and the existing BASS design will be adequate. Modifications will be dictated by the amount of time allotted to the pre-survey and the level of detail required. For a very coarse observation of river morphology, one pass along the middle of a smaller river (e.g., 50 m width) or two passes one-third of the river width from both shores in larger rivers (>100 m width) will suffice. For a highly detail survey, we suggest progressing offshore by 25 metres for each pass. Depending on time constraints and level of detail desired, the amount of effort to carry out the survey can be adjusted as required. We have obtained accurate data at survey speeds over 20 km/hr on the Madawaska River; however, slower surveys (5-10 km/hr) might be needed if greater detail is desired. The transducer must be properly mounted. Identification of access points, log jams, shallow and deep areas, cottage density, etc. can be noted during the BASS survey. No changes to the current BASS protocol are required for post-survey analyses of the collected bathymetric data.

Appendix 2: Preferred Aging Structures from Various Fish Species

Table: Structures to be collected from various fish species. Structures are listed in order of ageing reliability (from Mann 2004).

Species	Alive	Dead
Walleye and other Percids	3rd dorsal spine scales	otoliths 1st three dorsal spines opercular bones scales
Lake trout and other Salmonids	1st four leading pectoral rays scales	otoliths 1st four leading pectoral rays scales
Lake whitefish and other Coregonids	1st four leading pectoral rays scales	ootoliths 1st four leading pectoral rays scales
Northern pike and muskellunge	scales	cleithrum scales
Lake sturgeon	pectoral fin ray	pectoral fin ray
Smallmouth bass and other Centrarchids	3rd dorsal spine scales	otoliths 1st three dorsal spines opercular bones scales
Burbot		otoliths
Suckers	1st four leading pectoral rays scales	otoliths 1st four leading pectoral rays scales
Bullheads	pectoral fin spine	otoliths pectoral fin spine**
Smelt	1st four leading pectoral rays scales	otoliths 1st four leading pectoral rays scales

* As a single structure, scales are very poor indicators of age for trout.
** The spine develops a medulary cavity in the centre after age 1.

Appendix 3: Protocol for the Collection of Sport Fish for Contaminant Analyses

Updated 2007: Sport Fish & Biomonitoring Unit

Fish samples, normally muscle tissue, can be analyzed for a variety of contaminants such as mercury and PCBs at the laboratories of the Ministry of the Environment situated in Toronto. The following sample procedures should be closely followed in order to ensure that data generated by these labs is both consistent and meaningful.

Sample Preparation

Sampling crews must submit fillets (rather than whole fish) for analyses. Normally the analyses are carried out on tissue from the epaxial muscle (see Figure 1) by making an incision with a clean stainless steel knife on the dorsal surface of the fish as shown (incision no. 1). The muscle is then removed by cutting from the initial incision toward the tail (incision no. 2) until a sufficient quantity of tissue is obtained. Finally, the muscle can be separated from the body by incision no. 3. The skin is then removed from the sample and wrapped as indicated (see Sample Containers). It is very important not to remove tissue from below the lateral line because of the high fat content in this region which makes PCB and organic analyses unrepresentative. The sample should be frozen immediately after filleting and should be in this condition when shipped to the laboratory. Freezing is the only acceptable preservation technique. When a collection is ready for shipment, phone André Vaillancourt at the Sport Fish & Biomonitoring Unit in Toronto at (416) 327-3466 or 1-800-820-2716.

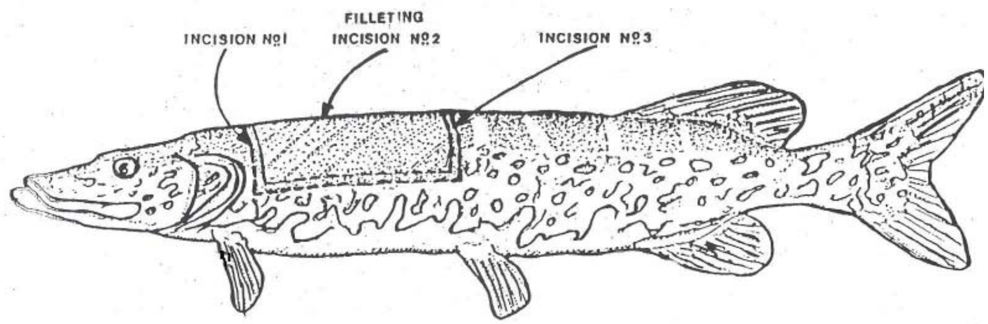

Figure 1

The absolute minimum amounts of flesh are dictated by analytical methodologies and are inflexible. The larger the sample size the better and more representative the analyses.

Table 1. The minimum and preferred quantities of tissue required for each type of analysis.

Variable	Absolute Minimum (g)	Preferred (g)
Mercury	20	50
Other Metals	50	100
PCB/Pesticides	1	100
*Dioxin	50	500

*Where Dioxins or other exotic contaminants are requested, submit a separate fillet packaged together with the fillet submitted for PCB and Pesticides.

Fish smaller than 15 centimeters in length (total length) or only 1 of a species will not be accepted. For smelt, separate the fish into groups of 10 fish of approximately the same size or only one of a species and wrap in aluminum foil, 10 fish to a package, 10 packages per location. Please report average lengths and weights for composite samples.

Sample Containers

Individual samples should be placed in small plastic bags and frozen. Preferably WHIRL-PAKS will be used, however food grade plastic bags with a zipper seal are also adequate. Clearly indicate on the outside of the plastic bag the assigned sample number or a traceable field sample number of your choosing with indelible marker. It is helpful to indicate field data such as length and weight on the bag as a failsafe against possible misidentification. All samples must then be frozen and shipped in a frozen state by utilizing ice packs, frozen bottles of water, or if available, dry ice.

Form Completion:

a) Samplers are requested to list only one species per page and when recording length to report total length (not fork length) in centimeters and weight as round weight (not gutted or dressed) in grams. Do not use decimals when recording weight. Indicate sex and age, if possible.

b) Complete submission forms neatly in black ball point pen or dark pencil as it will benefit the photocopying process (please do not use blue pen).

c) Please use assigned sample numbers sequentially by species (e.g., Smallmouth Bass [X0001-X0020], Walleye [X0021-X0040]). If assigned numbers issued to a species are not used, please discard (they cannot be used the next year or for other locations). In cases where more than 20 samples of a species are collected or incidental species are collected or any sampling related questions, please call MOE Sport Fish & Biomonitoring Unit attn: André Vaillancourt at (416) 327-3466 in Toronto.

d) Please list five largest fish in order as this will assist in assigning which fish to be tested for organic compounds.

e) It is extremely important to fill out the section for SAMPLE DATE (Year/Month/Day) as samples cannot be entered into the Laboratory Information Management System (LIMS) without one, causing unnecessary delays in analysis. List a range of sample dates or the latest sample date will suffice.

Analysis on tissue other than fish is possible, but can only be done through special arrangement. Any inquiry concerning these types of samples must be made prior to sample submission. To avoid samples sitting in a warm courier facility or truck it is wise to remember to NEVER SHIP ON A THURSDAY or FRIDAY of any given week.

Please inform, prior to shipping, any samples, the date of shipment and the mode of transport used to ship.

Sport Fish & Biomonitoring Unit, Ministry of Environment
Environmental Monitoring and Reporting Branch
125 Resources Road, Etobicoke, ON M9P 3V6
(416) 327-3466 or 1-800–820-2716.

Appendix 4: Field Forms and Variable Definitions

Waterbody	Record the official name for the waterbody in which the gillnet was set.
Effort Sample Number	Record the unique and sequential number given to each individual net set (arbitrarily chosen by you).
GPS	Record location of net netting site UTM WGS 84
Strata	Defines the strata the net was set
Site	Defines the site number within the strata
Gear Item	Record net type.
Orientation	Defines whether the net was set perpendicular or angled to shore
Set Date (yyyy/mm/dd)	The date the net was set.
Set Time (hh:mm)	Record the time that the net was set (24 hour clock in hours and minutes).
Lift Date (yyyy/mm/dd)	The date the net was lifted
Lift Time (hh:mm)	The time the net was lifted
Effort Status	Defines whether there were netting problems that may have affected the catch
Mesohabitat	Record whether the net was set in a pool, run, lake mouth or tributary mouth.
Water velocity (ms)	Record approximate water velocity.
Secchi depth (m)	Record secchi depth.
Water temperature oC	Record water temperature at the netting site.
Gear Depth Start (m)	Record the depth of the near shore end of the net.
Gear Depth End (m)	Record the depth of the off shore end of the net.
Comments	Use this field to document any useful descriptions or additional information relevant to the netting event.

RIN Fish Sample Form

Waterbody Name	Sample Number	Lift Date
Net Type: Small Large Extra-large		

FISH SAMPLE

Mesh Size (mm)	Fish Species	Fish Number	Total Length (mm)	Fork Length (mm)	Round Weight (g)	Sex	Maturity	Ageing Structure

Page ___ of ___

Mesh Sizes (mm):	Sex Codes:	Maturity Codes:	Ageing Structure Codes:
38, 51, 64, 76, 89, 102 and 127	1 = male 2 = female 9 = unknown	1 = immature 2 = mature 9 = unknown	2 = scales, 4 = pectoral rays, 7 = dorsal spine, A = otolith, B = operculum, D = cleithrum

RIN SAMPLE AND SPECIES FORM

Waterbody Name	Sample Number
Net Type: Small Large Extra-large	
Field Crew:	

SAMPLE DESCRIPTION

Strata	Site	Gear	Orientation	Set Date (yy-mm-dd)	Set Time (24hhmm)	Lift Date (yy-mm-dd)	Lift Time (24hhmm)	Effort Status

Mesohabitat Type	Water Velocity (m/s)	Secchi Depth (m)	Water Temp. (°C)	Start Depth (m)	End Depth (m)

CATCH SUMMARY

Mesh Size (mm)	Fish Species	Number Caught	Number Sampled		Mesh Size (mm)	Fish Species	Number Caught	Number Sampled

Comments:

Gear:	Orientation:	Effort Status:
1 = Large mesh 2 = Small mesh 3 = Extra large mesh	1 = Perpendicular 2 = Angled	1 = Good: No problems 2 = Minor problems – catch no affected 3 = Major problems – catch affected

Page ___ of ___

Appendix 5. Equipment List

Boat/motor (and keys, chain and lock if needed)
Boat and motor repair kit
Mandatory boat safety equipment
Fuel line, gas and extra gas
Depth Sounder with Transducer (spare batteries if required)
GPS with sites loaded (spare batteries if required)
Navigational chart and Road Map
Cell or Satellite phone
First aid kit
Boat Hook
Personal gear
Remote living emergency packs

Fish sampling kit
Measuring board
Side Cutters and tweezers
Weigh scales of different sizes
Scale Envelopes, whirlpacks, vials
Knives
Pails/plastic bags for sorting fish
Thermometer

Field sheets and book
Pencils and markers

Nets and spare anchors, rope, floats
Dip Net
Large Cooler with block of ice
Net picks
Flat file for removing burs on boat

Appendix 6. Ontario Species Codes

010. PETROMYZONTIDAE - Lampreys
011. American brook lamprey - Lampetra appendix
012. northern brook lamprey - Ichthyomyzon fossor
013. silver lamprey - Ichthyomyzon unicuspis
014. sea lamprey - Petromyzon marinus
015. Ichthyomyzon sp.
016. chestnut lamprey - Icthyomyzon castaneus
020. POLYODONTIDAE - Paddlefishes
021. paddlefish - Polyodon spathula
030. ACIPENSERIDAE - Sturgeons
031. lake sturgeon - Acipenser fulvescens
032. caviar
040. LEPISOSTEIDAE - Gars
041. longnose gar - Lepisosteus osseus
042. spotted gar - Lepisosteus oculatus
043. Lepisosteus sp.
050. AMIIDAE - Bowfins
051. bowfin - Amia calva
060. CLUPEIDAE - Herrings
061. alewife - Alosa pseudoharengus
062. American shad - Alosa sapidissima
063. Gizzard shad - Dorosoma cepedianum
064. Alosa sp.
SALMONIDAE - Trouts:
070. SALMONINAE - Salmon and Trout subfamily
071. pink salmon - Oncorhynchus gorbuscha
072. chum salmon - Oncorhynchus keta
073. coho salmon - Oncorhynchus kisutch
074. sockeye salmon - Oncorhynchus nerka
075. chinook salmon - Oncorhynchus tshawytscha
076. rainbow trout - Oncorhynchus mykiss
077. Atlantic salmon - Salmo salar
078. brown trout - Salmo trutta
079. Arctic char - Salvelinus alpinus
080. brook trout - Salvelinus fontinalis
081. lake trout - Salvelinus namaycush
082. splake - Salvelinus fontinalis x Salvelinus namaycush
083. Aurora trout - Salvelinus fontinalis timagamiensis
084. Oncorhynchus sp.
085. Salmo sp.
086. Salvelinus sp.
090. COREGONINAE - Whitefish subfamily
091. lake whitefish - Coregonus clupeaformis
092. longjaw cisco - Coregonus alpenae
093. cisco (lake herring) - Coregonus artedi
094. bloater - Coregonus hoyi
095. deepwater cisco - Coregonus johannae
096. kiyi - Coregonus kiyi
097. blackfin cisco - Coregonus nigripinnis
098. Nipigon cisco - Coregonus nipigon
099. shortnose cisco - Coregonus reighardi
100. shortjaw cisco - Coregonus zenithicus
101. pygmy whitefish - Prosopium coulteri
102. round whitefish - Prosopium cylindraceum
103. chub - Coregonus sp. (Cisco species other than C. artedi)
106. Coregonus sp.
107. Prosopium sp.
120. OSMERIDAE - Smelts
121. rainbow smelt - Osmerus mordax
130. ESOCIDAE - Pikes
131. northern pike - Esox lucius
132. muskellunge - Esox masquinongy
133. grass pickerel - Esox americanus vermiculatus
134. Esox sp.
135. chain pickerel - Esox niger
140. UMBRIDAE - Mudminnows
141. central mudminnow - Umbra limi
150. HIODONTIDAE - Mooneyes
151. goldeye - Hiodon alosoides
152. mooneye - Hiodon tergisus
160. CATOSTOMIDAE - Suckers
161. quillback - Carpiodes cyprinus
162. longnose sucker - Catostomus catostomus
163. white sucker - Catostomus commersoni
164. lake chubsucker - Erimyzon sucetta
165. northern hog sucker - Hypentelium nigricans
166. bigmouth buffalo - Ictiobus cyprinellus
167. spotted sucker - Minytrema melanops
168. silver redhorse - Moxostoma anisurum
169. black redhorse - Moxostoma duquesnei
170. golden redhorse - Moxostoma erythrurum
171. shorthead redhorse - Moxostoma macrolepidotum
172. greater redhorse - Moxostoma valenciennesi
173. river redhorse - Moxostoma carinatum
174. black buffalo - Ictiobus niger
176. Catostomus sp.
177. Moxostoma sp.
178. Ictiobus sp.
180. CYPRINIDAE - Carps and Minnows
181. goldfish - Carassius auratus
182. northern redbelly dace - Phoxinus eos
183. finescale dace - Phoxinus neogaeus
184. redside dace - Clinostomus elongatus
185. lake chub - Couesius plumbeus
186. common carp - Cyprinus carpio
187. gravel chub - Erimystax x-punctatus
188. cutlips minnow - Exoglossum maxillingua
189. brassy minnow - Hybognathus hankinsoni
190. eastern silvery minnow - Hybognathus regius
191. silver chub - Macrhybopsis storeriana
192. hornyhead chub - Nocomis biguttatus
193. river chub - Nocomis micropogon
194. golden shiner - Notemigonus crysoleucas
195. pugnose shiner - Notropis anogenus
196. emerald shiner - Notropis atherinoides
197. bridle shiner - Notropis bifrenatus
198. common shiner - Luxilus cornutus
199. blackchin shiner - Notropis heterodon
200. blacknose shiner - Notropis heterolepis
201. spottail shiner - Notropis hudsonius
202. rosyface shiner - Notropis rubellus
203. spotfin shiner - Cyprinella spiloptera
204. sand shiner - Notropis stramineus
205. redfin shiner - Lythrurus umbratilis
206. mimic shiner - Notropis volucellus
207. pugnose minnow - Opsopoeodus emiliae
208. bluntnose minnow - Pimephales notatus
209. fathead minnow - Pimephales promelas
210. blacknose dace - Rhinichthys atratulus
211. longnose dace - Rhinichthys cataractae
180. CYPRINIDAE - Carps and Minnows con't
212. creek chub - Semotilus atromaculatus

213. fallfish - Semotilus corporalis
214. pearl dace - Margariscus margarita
215. silver shiner - Notropis photogenis
216. central stoneroller - Campostoma anomalum
217. striped shiner - Luxilus chrysocephalus
218. ghost shiner - Notropis buchanani
219. grass carp - Ctenopharyngodon idella
220. rudd - Scardinius erythrophthalmus
221. Phoxinus sp.
222. Hybognathus sp.
223. Nocomis sp.
224. Notropis sp.
225. Pimephales sp.
226. Rhinichthys sp.
227. Semotilus sp.
228. Hybopsis sp.
229. Luxilus sp
230. ICTALURIDAE - Bullhead Catfishes
231. black bullhead - Ameiurus melas
232. yellow bullhead - Ameiurus natalis
233. brown bullhead - Ameiurus nebulosus
234. channel catfish - Ictalurus punctatus
235. stonecat - Noturus flavus
236. tadpole madtom - Noturus gyrinus
237. brindled madtom - Noturus miurus
238. margined madtom - Noturus insignis
239. flathead catfish - Pylodictis olivaris
241. Ictalurus sp.
242. Noturus sp.
243. Ameiurus sp.
244. northern madtom - Noturus stigmosus
250. ANGUILLIDAE - Freshwater Eels
251. American eel - Anguilla rostrata
260. CYPRINODONTIDAE - Killifishes
261. banded killifish - Fundulus diaphanus
262. blackstripe topminnow - Fundulus notatus
270. GADIDAE - Cods
271. burbot - Lota lota
280. GASTEROSTEIDAE - Sticklebacks
281. brook stickleback - Culaea inconstans
282. threespine stickleback - Gasterosteus aculeatus
283. ninespine stickleback - Pungitius pungitius
284. fourspine stickleback - Apeltes quadracus
290. PERCOPSIDAE - Trout-perches
291. trout-perch - Percopsis omiscomaycus
300. PERCICHTHYIDAE - Temperate Basses
301. white perch - Morone americana
302. white bass - Morone chrysops
303. Morone sp.
310. CENTRARCHIDAE - Sunfishes
311. rock bass - Ambloplites rupestris
312. green sunfish - Lepomis cyanellus
313. pumpkinseed - Lepomis gibbosus
314. blue gill - Lepomis macrochirus
315. longear sunfish - Lepomis megalotis
316. smallmouth bass - Micropterus dolomieu
317. largemouth bass - Micropterus salmoides
318. white crappie - Pomoxis annularis
319. black crappie - Pomoxis nigromaculatus
320. Lepomis sp.
321. Micropterus sp.
322. Pomoxis sp.
323. warmouth - Lepomis gulosus
324. orangespotted sunfish - Lepomis humilis
330. PERCIDAE - Perches
331. yellow perch - Perca flavescens
332. sauger - Stizostedion canadense
333. blue pike (blue pickerel) - Stizostedion vitreum glaucum
334. walleye (yellow pickerel) - Stizostedion vitreum
335. eastern sand darter - Ammocrypta pellucida
336. greenside darter - Etheostoma blennioides
337. rainbow darter - Etheostoma caeruleum
338. Iowa darter - Etheostoma exile
339. fantail darter - Etheostoma flabellare
340. least darter - Etheostoma microperca
341. johnny darter - Etheostoma nigrum
342. logperch - Percina caprodes
343. channel darter - Percina copelandi
344. blackside darter - Percina maculata
345. river darter - Percina shumardi
346. tessellated darter - Etheostoma olmstedi
347. Stizostedion sp.
348. Etheostoma sp.
349. Percina sp.
350. ruffe - Gymnocephalus cernuus
360. ATHERINIDAE - Silversides
361. brook silverside - Labidesthes sicculus
365. GOBIIDAE - Gobies
366. round goby - Neogobius melanostomus
367. tubenose goby - Proterorhinus marmoratus
370. SCIAENIDAE - Drums
371. freshwater drum - Aplodinotus grunniens
380. COTTIDAE - Sculpins
381. mottled sculpin - Cottus bairdi
382. slimy sculpin - Cottus cognatus
383. spoonhead sculpin - Cottus ricei
384. deepwater sculpin - Myoxocephalus thompsoni
385. Cottus sp.
386. Myoxocephalus sp.
387. fourhorn sculpin - Myoxocephalus quadricornis

Appendix 7: Some Net Manufacturers

Superior Net and Twine Co
2095B Paquette Road RR 14,
Thunder Bay, ON
P7G 1M4
Canada
(807) 767-4064
http://www.superiornet.ca/

Leckies Division of Lakefish Net and Twine Limited
547 King Edward Street,
Winnipeg, MB
R3H 0N9
Canada
(204) 774-1887
http://www.lakefish.net/

Johnston Net & Twine Ltd
519 825-7218
Fax: 519-825-7892
859 Talbot Trail
Wheatley, ON
N0P2P0
sales@johnstonnetandtwine.com
http://www.johnstonnetandtwine.com/

Les Industries Fipec inc.
235, La Grande Allée Est, C.P. 92,
Grande-Rivière (Québec)
G0C 1VO
Tél.: (418) 385-3631 Fax: (418) 385-3278
http://www.fipec.qc.ca/

**Note the Ministry of Natural Resources does not endorse the use of specific companies.*

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