Larval Assessment Sampling Protocol for Non-Wadable Waters of the Great Lakes and its Tributaries

by

The Larval Assessment Task Force of
the Sea Lamprey Control Program

April 14, 2016

Contents

INTRODUCTION

This protocol describes the purpose and methodology, consistently followed by the U.S. Fish and Wildlife Service and Fisheries and Oceans, Canada, for all surveys for larval sea lampreys conducted in non-wadable waters of the Great Lakes and non-wadable waters of streams tributary to the Great Lakes. The primary goal of larval sea lamprey assessment is to guide management actions designed to minimize escapement of juvenile sea lampreys into the Great Lakes. These actions include control through the application of lampricides as well as alternative controls such as barriers.

Deviations can be made to the protocol when the Larval Assessment Task Force recommends a change based on further study. This protocol will be reviewed after the 2016 field season and refinements can be proposed at that time. The scheduled time for this review is January, 2017.

Definitions

Non-Wadable Water

These are areas that are predominantly too deep (>0.8 m) to be surveyed with backpack electrofishers (BPEF) or have low water clarity. This category includes: deep estuaries, lakes within river systems, deep water streams and lentic/offshore locations.

Biological Reach

Biological reaches have been established for all streams historically infested with sea lampreys. Reach definitions were originally established as portions of streams that contained similar densities of larval sea lampreys and could be considered an independent section of the stream for the purpose of lampricide application. Contiguous sections of larger streams have often been divided into more than one reach.

Deep Water Qualitative Technique (DWQT)

DWQT surveys are qualitative surveys used to detect, evaluate the status, or describe the distribution of larval sea lamprey. The DWQT employs measures of effort (time) and catch (number) of larval sea lampreys to provide an index of their relative abundance. Bayluscide is typically used for DWQT surveys.

Deep Water Ranking Surveys (DWRS)

DWRS is a quantitative sampling method used to estimate abundance of large larval

sea lampreys (≥ 100 mm) a deep water area will produce the year of survey. The DWRS technique uses measures of larval sea lamprey density and substrate area to estimate larval sea lamprey abundance. Larval sea lamprey density is measured with Bayluscide or deep water electrofishers and substrate is measured along transects at defined sites. Effort/application rate is consistent per unit of measured area electrofished or surveyed.

Deep Water Survey Tools

Two primary tools are available for deep water larval sea lamprey assessments:

- the deep water electrofisher (DWEF)
- granular Bayluscide (gB)

An additional tool, the mini deep water electrofisher (MDWEF) can also be used to assess deep water populations, although its use is limited. See Appendix A for specifics regarding setup and operation of the MDWEF.

Measures of sampling efficiency have been estimated for these tools.

DEEP WATER QUALITATIVE SAMPLING TECHNIQUE

Bayluscide is the primary tool used for DWQT surveys. Base effort with Bayluscide is two or more plots per reach, each with an area of 500 m^2 at an application rate of 175 kg of product/hectare, or 5.6 kg A.I./hectare

Granular Bayluscide is only applied for survey purposes when surface water temperature is 12°C or greater. The area of each plot is measured, demarcated and granules are spread evenly over the plot with a spreader or power blower. Each plot is typically surveyed for one hour by two people.

Classification of DWQT surveys

- ***Evaluation*** surveys are conducted to assess relative abundance and larval size structure and are often used to determine if a deep water area will require DWRS. Streams and lentic areas are selected for evaluation surveys when they have shown irregular infestation with sea lampreys, or have not been sampled since their last treatment.

- ***Distribution*** surveys are conducted to determine the furthest upstream point of

infestation prior to lampricide treatment or the range of infestation of a deep water area prior to conducting DWRS. Two negative plots upstream of the last positive survey are recommended to determine the distribution of deep water populations.

- ***Detection*** surveys are conducted to determine the presence or absence of sea lamprey larvae in areas with no history of infestation.

- ***Treatment Evaluation*** surveys are conducted to assess the relative abundance and size structure of larval sea lampreys that survive lampricide applications. They are often used to determine when DWRS is needed. Treatment evaluation surveys are conducted on all streams treated with lampricides and are generally conducted 2 - 12 months after treatment.

Barrier surveys are conducted to measure the effectiveness of barriers at stopping the upstream migration of spawning sea lampreys. If sea lamprey larvae are found upstream of a barrier, DWRS is conducted to rank the deep water area for potential lampricide application. Barrier surveys are conducted upstream of barriers on streams that meet any of the following criteria:

-Presence of spawners
-History of infestation
-Suspicion of barrier failure
-Not surveyed in last 10 years
-Requested by barrier coordinator

DEEP WATER RANKING SURVEY TECHNIQUE (DWRS)

Deep water areas are currently sampled using two types of sampling tools, gB and the DWEF. Somewhat different techniques are used for each of these methods, but each requires measurement of substrate area and sampling of larval sea lamprey density in measured plots. Larval sea lamprey populations are estimated by multiplying the area of suitable substrate by the mean density (number/m^2) of sea lamprey larvae. Specific instructions for setup of the DWEF boat and assessment of the St. Marys River using the DWEF can be found in the *Larval Assessment Sampling Protocol for the St. Marys River Using the Deep-Water Electrofisher (Larval Assessment Work Group 2012).*

Quantitative deepwater surveys were previously conducted using a Deepwater Quantitative Assessment Sampling Technique (DQAS). Instructions for conducting DQAS surveys are available in Appendix C.

Terms and Definitions

- ***Drop*** is one sampling event with the DWEF (0.61m²).

- ***Plot*** is the actual measured area that is sampled for larvae. When using the DWEF, four drops equals one plot (2.44m²). When using Bayluscide, plots can vary in size, but are typically 500 m^2.

- ***Site*** is an approximate location where sampling for larvae occurs. During DWEF there are four drops taken at a site.

- ***Suitable substrate*** is Type I or Type II as defined in the Substrate Sampling section below.

- ***Survey area*** is the deep water area for which a population estimate is desired. It can be an entire reach, a portion of a reach where the boundaries of the infested area are known, or a delineated lentic area.

- ***Transect*** is a line, generally perpendicular to the flow of the stream. Along each transect, measurements of substrate are made and the location of DWEF or gB plots is determined.

- ***Unsuitable substrate*** is Type III or dry (Type IV) substrate as defined in the Wadable Sampling Protocol.

Larval Sea Lamprey Density Sampling

Both gB and DWEF have been identified as the two sampling tools currently available for deep water quantitative sampling. Selection of gear type will depend on various criteria, including: water depth and velocity, time available, amount of aquatic vegetation present, location/logistics of the area to be sampled and the cost of each method. Effectiveness of both gear types is somewhat limited by depth, water velocity, and the presence of vegetation. Supervisors at each field station will choose the tool that is most practical for their particular application.

<u>Sampling with Granular Bayluscide</u>

Substrate Sampling Plan

On streams with no historic measures of substrate (i.e. new producers), substrate is quantified the first two times DWRS is conducted. Habitat is quantified in regular sea lamprey producing streams every 10 years to account for potential changes in substrate

composition. Regardless of survey technique, quantitative deep water surveys require measurement of habitat along transects in the survey area. Transects can be located using one of two techniques. In deep water reaches with adequate access sites, transects can be located by randomly selecting six access sites from a list of available sites. If access is limited, transects are located by measuring the survey area and the distance between transects with a laser range finder, or GPS unit. Transects are aligned perpendicular to flow within a river, or perpendicular to shore if in an estuary. In lentic areas, substrate may be evaluated by remote sensing following the RoxAnn Technical Operating Procedure.

Width is measured and substrate classified along 12 transects. If access sites are randomly selected, two transects are measured and classified, one upstream and one downstream of the access site. When access sites are randomly selected, each transect must be a minimum of 40 m from any unnatural structures such as bridge abutments. Otherwise, transect spacing is determined by dividing the length of the survey area by the number of transects (12) [e.g., where length of the survey area is 2,000 m, then 2000 / 12 = 167 m between transects]. The first transect begins 0.5 times the transect spacing from the lowermost point of the reach.

Substrate is classified as Type I, II, III or IV and is measured along each transect. A metric tape or laser rangefinder is used to measure each segment of substrate. Changes in substrate are measured by probing the bottom with a graduated staff or sampling with a dredge. If a dredge is used, evenly spaced samples are taken, whereby the width of the stream is divided by 10 and substrate is classified at the edge of each bank and at each of the nine measurements between, for a total of 11 measurements. Depth is recorded for each sample. If a pole is used, changes in substrate (type I, II, III or IV) are measured to the nearest 0.1m. When using a pole, mean depth of segments less than 1 m is measured as the average of the beginning and ending depths of the segment (two measurements). Mean depth of segments greater than 1 m is measured as the average of the beginning, mid-point and ending depths of the segment (three measurements).

Larval Sea Lamprey Density Sampling Plan

Mean density of larval sea lampreys is estimated by applying gB to a minimum of six, 500 m^2 plots in deep water lotic areas. Consistent with the wadable water protocol, the goal is to collect a representative sample of larval sea lamprey density and size structure. The decision to sample additional plots is made by the crew leader and is based on the number and size structure of the sea lamprey larvae collected in the first six plots (e.g. if very few sea lamprey larvae or no sea lamprey larvae ≥ 100mm have been collected in the first six plots, additional plots are unnecessary).

In lentic deep water areas known to be infested with sea lampreys and having a defined area, a graduated approach to number of plots allocated is applied. In infested lentic areas < 3 ha; two gB plots are acceptable. In those between 3 and 10 hectares; 4 gB plots are surveyed. In any area > 10 hectares, a minimum of 6 plots are required. All lentic/offshore plot sizes should be consistent with other sampling, i.e. 500m².

Random Location of Plots

Six plots are sampled in a reach. One plot is sampled at each of the six randomly selected access sites or along each of six randomly selected transects, but no more than one plot is sampled along a single transect. The procedure to determine the location and dimensions of each plot is described in Appendix B.

Plot Size

Plot size is standardized at 500 m^2 except when 500 m^2 of suitable substrate is not present, or there is reason to believe that treatment of such a large plot would lead to excessive non-target mortality. Plot size can be reduced based on either of these two criteria. The smallest dimension of any plot is 2 m^2, with a minimum area of 50 m^2.

Granular Bayluscide Application

Bayluscide is typically applied for survey purposes when surface water temperature is 12° C or greater. In the rare occasion that water temperature is < 12 °C, then the plot will be patrolled for a total of 75 minutes and any larvae collected after the one hour mark will be noted. The perimeter of each plot is measured and demarcated with a measuring tape and stakes or a laser range-finder and buoys. Additional considerations must be made for application of gB in State of Michigan waters (see Appendix D). GPS coordinates are recorded from the center of each plot. GB is spread evenly over the plot at a rate of 8.75 kg /500 m^2. The application is conducted with a spreader or blower and multiple passes over a single plot may be necessary to achieve even distribution. The Standard Operating Procedures for the Application of Granular Bayluscide describes proper methods and safety precautions for the application of gB. A gear correction factor of 0.08 (8%) is necessary; numbers of larvae can be easily adjusted by multiplying the raw catch by 12.5 to compensate for the efficiency of the sampling gear.

Collection of Larvae

An hour of collection time per person is spent on each plot (2 people per plot) following gB application. Sampling time begins immediately after the plot has been completely sprayed. Both people may collect from the boat or in shallower water one may collect from the boat while the other works from shore. To maximize visibility and capture

rates, when it is safe to do so, collectors should stand during plot monitoring, and polarized glasses should be worn. All larvae observed are collected, identified and sea lamprey larvae are measured. Predation of lamprey larvae by birds or other animals during the collection is noted. When young-of-the-year sea lampreys are encountered they are counted, measured and recorded, but are not included in the measure of density. Note that in plots with high velocity, some collection time may be spent immediately downstream of the plot markers if larvae are likely to be carried out of the plot by the current.

Sampling with the Deep Water Electrofisher

Substrate Sampling Plan

Width is measured and substrate classified along a minimum of 16 and maximum of 40 transects spaced throughout the survey area. The exact number of transects is determined by the width of the survey area and is listed in Table 1. Transect spacing is determined by dividing the length of the survey area by the number of transects [e.g., If the survey area is 2,000 m long and 60 m wide, 16 transects would be measured 125 m apart (2000 / 16 = 125 m)]. The first transect begins 0.5 times the transect spacing from the beginning of the reach.

Substrate is classified as Type I, II, III or IV and is measured along each transect as described in the Substrate Sampling Plan section above. At each location selected for density sampling, a dredge is dropped and substrate suitability is described. When Type III substrate is encountered, larval sea lamprey density sampling is not conducted and the crew moves to the next sampling site.

Table 1. Number of transects to sample and the number of DWEF drops in deep water areas when using the DWEF.

Mean Width of Survey Area	Number of Sites and Drops per Transect	Number of Transects
30 m or greater	5 sites/20 drops	16
24 to 29 m	4 sites/16 drops	20
18 to 28 m	3 sites/12 drops*	27
12 to 27 m	2 sites/8 drops	40

* Only 2 sites (8 drops) are sampled along one randomly selected transect [(3 X 26) + (2 X 1) = 80 sites].

Substrate Classification

- ***Type I*** substrate: Consists primarily of silt, with sand and detritus as secondary components. The sand fraction is mainly comprised of very fine, fine, and medium sands. Coarse sands, gravel or rubble may be present, but their contribution is minor. Surface cover is often provided by woody debris or aquatic macrophytes. Type I substrates are indicative of depositional hydraulic environments that exist in back eddies, on the inside bends of streams, or behind large permanent or semi-permanent objects, such as boulders, logs, and bridge abutments, where stream velocities are usually < 5cm/s. Type I substrates should be disregarded if they are < 2.54 cm in depth.

- ***Type II*** substrate: Consists primarily of sand, with particle sizes mostly in the range of medium and coarse sands. Compared with Type I, mean values for silt and detritus decline, while those for gravel and rubble rise. Amounts of woody debris are similar to those for Type I, however macrophytes are few, likely as a consequence of the low organic content in Type II substrates. Type II substrates are found in transitional environments where velocity ranges approximately from 5 to 10cm/s, and is largely unimpeded by frictional forces associated with stream banks, bends in the stream, or upstream objects.

- ***Type III*** substrate: Consists primarily of hard substrates that deter burrowing, such

as gravel, rubble, hardpan clay, or bedrock. Interstices in Type III substrates that contain Type I or Type II material may occasionally harbor sea lamprey larvae, however, these areas will be dismissed if the length (along the transect) is less than the minimum recordable measure (0.1 m). Type III substrates are found in erosional hydraulic environments, such as in riffle areas or in the thalweg of the stream, where velocity (>10cm/s) and bottom characteristics restrict the deposition of fine particles.

- ***Type IV*** substrate: Unsuitable habitat consisting of dry land.

- ***Spawning*** substrate consists of substrates of suitable gravel (> 9.0 mm in diameter) with a steady, unidirectional flow and satisfactory velocities (0.5-1.5 m/s). Sand exists as a minor component among interstitial spaces in the gravel.

Larval Sea Lamprey Density Sampling

Larval sea lamprey density sampling with the DWEF is achieved by electrofishing at sites spaced equidistantly along transects. Four drops are made at each of 80 sites resulting in a total of 320 drops (4 drops X 80 sites) in each survey area. Additional sites may be sampled at the discretion of the crew leader based on the number and size structure of sea lamprey larvae collected in the first 320 drops. When necessary, additional sites are sampled along new transects placed midway between two randomly selected previously sampled transects. A gear correction in the form of a logistic regression is applied to the number of sea lamprey larvae collected to compensate for the efficiency of the sampling gear.

Site Selection

The number of sites sampled along a transect is a function of the width of the survey area (Table 1). The first sampling site is located a minimum of 3 m and maximum of 6 m from shore. Remaining sites are equally spaced across the width of the river. The minimum distance between each site is 6m. Thus, transects with two sampling sites are a minimum of 12 m long and transects with five sampling sites are a minimum of 30 m long. On transects greater than 30 m long, sites are spaced equidistantly after the initial site has been sampled.

Plot Size

Plot size is standardized by the area sampled by the hood of the DWEF (0.61 m^2). Since four plots are sampled at each site, the area sampled by the DWEF at each site equals 2.44 m^2 (4 X .61). Care must be taken not to overlap plots on successive drops at a site.

DWEF Operation

After a transect is measured, the DWEF boat is navigated to the first sampling location. The vessel is anchored, substrate is classified, and the following procedures are followed:

1. The DWEF is lowered by one of the two crew members and energized for 30 seconds during each of the four drops. Each time the DWEF is energized the voltage gradient in the bell is adjusted to 0.7 volts/cm as measured on a digital display on a volt meter attached to the AbP-2 electrofisher. The catch of sea lamprey larvae for the plot is recorded as the sum of the four drops.

2. GPS coordinates are recorded and the vessel moves to the next sampling location along the transect.

Surveys using the DWEF will be conducted using the settings listed in Table 2. These settings will be used without exception until the Assessment Task Force recommends a change based on further study. Settings for the MDWEF are described in Appendix A.

Table 2. Standardized Deep Water Electrofisher Settings

Slow Pulse		**Burst**	**Volt Range**
Rate	**Duty Cycle**		
3pps	10%	2:2	To achieve 0.6 to 0.8 V/cm

Interpretation and Analysis

For deep water areas, average larval sea lamprey density is calculated for the entire survey area (minus Type III and IV substrate) and is multiplied by the total substrate area of larval habitat to estimate larval sea lamprey abundance. An appropriate gear correction factor for gB (0.08) and the DWEF (logistic regression) is applied to the number of sea lamprey larvae collected to compensate for the efficiency of the sampling gear.

After larval sea lamprey abundance has been estimated, the methods for estimating large larvae abundance are the same as those outlined in the wadable waters protocol.

SELECTION AND SCHEDULING OF DEEP WATER AREAS FOR LARVAL SEA LAMPREY ASSESSMENT

The selection of non-wadable waters for survey is determined by their potential for treatment the following year. Deep water areas are prioritized for survey based on the treatment cycle (if any) for the given location, the current timing or placement within that cycle and/or the location's potential for production of large (>100mm) larvae. Survey priority may be altered based on reports regarding potential new infestations or improvements in water quality or changes to dams or water diversion devices. Generally, deep water areas are prioritized for survey from 1-4 using the following criteria (1 ranks highest):

1) Deep water areas within or offshore from streams that are candidates for lampricide application the following year (e.g. streams which are scheduled for ranking surveys with backpack electrofishers) or any deep water area that currently harbors sea lampreys that are likely to be ≥100 mm the following year.

2) Deep water areas within or offshore from streams that are candidates for lampricide application in two years (e.g. streams which will be scheduled for ranking surveys with backpack electrofishers in two years) or any deep water area that currently harbors sea lampreys that are likely to exceed 100mm in two years.

3) Deep water areas with a history of sea lamprey infestation that have not been surveyed in three or more years.

4) Deep water areas that have no history of sea lamprey infestation.

Priority 1 areas are scheduled for DWRS the field season prior to the year they are likely to produce large larvae and/or the expected year of lampricide treatment (stream list found in annual work plans). Distribution surveys usually accompany ranking surveys.

Priority 2 and 3 areas are sampled using evaluation surveys no more frequently than once every three years. If a population is detected and requires DWRS, the DWRS is scheduled one year prior to the year lamprey are expected to reach 100 mm (based on the size structure of larvae collected from the population during the evaluation survey).

Priority 4 areas are typically sampled once every 10 years using detection surveys. Sites are selected in areas where there is a high probability of collecting sea lamprey larvae. If a population is detected that warrants DWRS, the area is scheduled for DWRS at the appropriate time based on the size structure of larvae. If DWRS is conducted and the deep water area does not rank for treatment, the area is reevaluated for larval survey the following year. Table 3 provides a summary of survey

classification, technique and frequency based on the present and/or past status of sea lampreys in a deep water area.

Table 3. Survey technique, classification and schedule for larval assessment based on the present and/or past status of larval population.

Present and/or Past Status of Larval Population	Survey Technique	Survey Classification	Survey Schedule
May contain sea lamprey larvae that will be ≥ 100 mm in two years. Previously infested.	DWQT (DWRS as needed)	Evaluation	Following year
Contains larval sea lamprey population that are ≥ 100 mm	DWQT and DWRS	Distribution	Current year
Any treated deep water area that contains residual sea lamprey larvae.	DWQT or DWRS	Treatment Evaluation	Conducted on all treatments 2-12 months post-treatment.
No history of infestation.	DWQT (DWRS as needed)	Detection	Once every 10 years
Stream with a barrier with unknown larval sea lamprey status.	DWQT	Barrier	As needed or requested by Barrier Unit

APPENDIX A – Conducting Larval Assessments using the Mini Deepwater Electrofisher

Non-wadable waters can be assessed for larval sea lamprey with the mini deepwater electrofisher (MDWEF). Measures of habitat are conducted as described in the Larval Assessment Sampling Protocol using the AbP-2 Backpack Electrofisher in Great Lakes Streams.

Sampling with the MDWEF

Larval density sampling

Based on measures of efficiency developed for the MDWEF and the AbP-2, we estimate that 42 drops of the MDWEF is equivalent to sampling 15 m^2 with the BPEF. Thus, 42 drops of the MDWEF equals one plot of backpack electrofishing.

The method for determining how larval density sampling plots are distributed from an access site is dictated by the way the transects are placed: if transects are measured at each of 6 randomly selected access locations, density sampling is achieved by electrofishing 84 drops (2 plots) at each of the 6 sites (504 drops, 42 upstream and 42 downstream of each access site) and if habitat transects are placed equidistantly throughout the reach, an equal number of drops is made upstream and downstream from each of 12 transects (e.g. for 12 transects - 504 drops/12=42 drops, 21 upstream and 21 downstream, or one plot at each transect). If more than 12 transects are measured, 12 transects are randomly selected to conduct DWEF sampling.

Type I habitat is sampled as it is encountered beginning with the first available habitat upstream or downstream of the starting point. Drops are spaced a minimum of 0.5 m apart and continue across the transect until all available Type 1 habitat has been sampled (minus the 0.5 m buffer areas). Type I habitat is sampled across the river, parallel to the transect, moving upstream or downstream until the appropriate number of drops is completed. Consistent with the BPEF Protocol, our goal is to collect a representative sample of larval sea lamprey density and size structure, generally thought to be a collection of 100 sea lampreys age 1 and older. Additional plots may be sampled (until the goal of 100 larvae is obtained) at the discretion of the crew leader based on the number and size structure of larvae collected in the first 504 drops (12 plots).

Streams surveyed with BPEF gear that contain deep water areas may also be subsampled with the MDWEF. In these cases, a minimum of 12 RS plots are sampled with a BPEF and additional sampling is conducted in deep water areas with the MDWEF at a rate of 42 drops (1 plot) per access site (21 drops upstream and 21 drops

downstream).

MDWEF operation

After the transect is measured, the bell of the MDWEF is placed over the first available Type I habitat up or downstream of the transect. The electrofisher is energized and the voltage gradient in the bell is adjusted to 2.5-3.0 volts/cm as measured on the digital display of the volt meter. After the voltage gradient equals 2.5-3.0 volts/cm, the MDWEF is fished for 30 seconds over the plot. Prior to moving the bell and sampling the next drop, the pump is allowed to clear the hose. After 42 drops have been made the cod end is emptied and larvae are identified, measured and recorded as 1 plot.

MDWEF surveys are conducted using the settings listed in Table 4. These settings will be used without exception until the Larval Assessment Task Force recommends a change based on further study (note, these values differ from those of the DWEF).

Table 4. Standardized Mini Deep Water Electrofisher Settings

Slow Pulse		**Burst**	**Volt Range**
Rate	**Duty Cycle**		
3pps	10%	2:2	To achieve 2.5 to 3.0 V/cm

Interpretation and Analysis

Average larval sea lamprey density is calculated for the entire survey area (minus Type III and IV substrate) and is multiplied by the total substrate area of larval habitat to estimate larval sea lamprey abundance. An appropriate gear correction factor for the MDWEF (logistic regression) is applied to the number of sea lamprey larvae collected to compensate for the efficiency of the sampling gear.

After larval sea lamprey abundance has been estimated, the methods for estimating large larvae abundance are the same as those outlined in the wadable waters protocol.

APPENDIX B – Determining Bayluscide Plot Location and Dimensions

Procedure to determine Bayluscide plot location and dimensions

1. At randomly selected access sites, flip a coin to decide whether the plot will be located upstream of the upstream transect or downstream of the downstream transect. At locations where transects are spaced equidistantly, flip a coin to decide whether the plot will be upstream or downstream of the transect.

2. Divide the width of the deep water area (transect length) by two and flip a coin to decide which side of deep water area the plot will be measured.

3. Move towards the middle of the plot along the transect and measure the width of suitable substrate. If no larval substrate is present, move upstream or downstream from the transect (depending on results of step # 1), until suitable substrate is located.

4. Measure width of suitable substrate and move upstream or downstream the distance necessary to complete the 500 m^2 plot (500/width).

5. Demarcate four corners of plot and apply Bayluscide using Standard Operating Procedures.

APPENDIX C – Conducting Deepwater Quantitative Assessment Surveys with Granular Bayluscide

Habitat sampling plan

Regardless of survey technique, quantitative deep water surveys require measurement of habitat along transects in the survey area. Transects can be located using one of two techniques. In deep water reaches with adequate access sites, transects can be located by randomly selecting 6 access sites from a list of available sites. If access is limited or the reach is located in a lentic area, transects are located by measuring the survey area and the distance between transects with a hip chain, electronic range finder or with a GPS unit. Transects are aligned perpendicular to the shoreline of the river, estuary, or lentic area.

Width is measured and habitat classified along 12 transects. If access sites are randomly selected, two habitat transects are measured and classified, one upstream and one downstream of the access site. When access sites are randomly selected, each transect must be a minimum of 40 m from any man-made structures such as bridge abutments. Otherwise, transect spacing is determined by dividing the length of the survey area by the number of transects (12) [e.g., where length of the survey area is 2,000 m, then 2000 / 12 = 167 m between transects]. The first transect begins 0.5 times the transect spacing from the beginning of the reach. These methods will ensure that transects are equally spaced.

Larval habitat is classified as Type I, II, or III and is measured along each transect. A metric tape or an electronic or laser distance measuring device is used to measure each segment of habitat. Changes in habitat are measured by probing the bottom with a pole or dropping a dredge. If a dredge is used, the width of the stream is divided by 10 and habitat is classified at the edge of each bank and at each of the 9 measurements between, for a total of 11 measurements. If a pole is used, changes in habitat (type I, II, III, spawning) are measured to the nearest 0.1 m. Regardless of method, measurements of stream width, mean depth and habitat type are recorded. Mean depth of segments less than 1 m is measured as the average of the beginning and ending depths of the segment (2 measurements). Mean depth of segments greater than 1 m is measured as the average of the beginning, mid-point and ending depths of the segment (3 measurements).

Larval density sampling plan

Mean density of larval sea lampreys is estimated by applying Bayluscide to a minimum of six, 500 m^2 plots of larval habitat in the survey area. Consistent with the BPEF Protocol, our goal is to collect a total of at least 100 sea lampreys age 1 and older. The

decision to sample additional plots is made by the crew leader and is based on the number and size structure of the larvae collected in the first six plots (e.g. if very few larvae or no larvae of transformable size have been collected in the first six plots, additional plots are unnecessary).

Random location of plots

Six plots are sampled in a survey area. One plot is sampled at each of the six randomly selected access sites or along each of six randomly selected transects, but no more than one plot is sampled along a transect. The procedure to determine the location and dimensions of each plot are described in Appendix B.

Plot size

Plot size is standardized at 500 m^2 except when 500 m^2 of larval habitat is not present, or there is reason to believe that treatment of such a large plot would lead to excessive non-target mortality. Plot size can be reduced based on either of these two criteria. The smallest dimension of any plot is two meters, with a minimum area of 50 m^2.

Bayluscide application

Bayluscide is typically applied when water temperature exceeds 12 °C. In the rare occasion that water temperature is < 12 °C, then the plot will be patrolled for a total of 75 minutes and any larvae collected after the 60 minute mark will be noted. The perimeter of each plot is measured and demarcated with a measuring tape and stakes or buoys. A centroid waypoint is taken using a GPS. Granular Bayluscide is spread evenly over the plot at a rate of 8.7 kg /500 m^2. The application is conducted with a spreader or blower. In order to achieve an even spread, it may be necessary to make multiple passes over the plot. The Standard Operating Procedures for the Application of granular Bayluscide describe proper methods and safety precautions for the application of granular Bayluscide.

Collection of larvae

Each plot is collected for one hour following the Bayluscide application by two persons (2 nets) working out of one boat, or two persons working from shore. Collecting begins immediately after the plot has been completely sprayed. All larvae observed are captured, identified and measured. Predation by birds or other animals during the collection should be noted. When young-of-the-year larvae are encountered they are counted, measured to length, and recorded, but are not included in the measure of density.

Interpretation and Analysis

Average larval density is calculated for the entire survey area (minus Type III habitat) and is multiplied by the total habitat area to estimate larval abundance. An appropriate gear correction factor for Bayluscide (0.08) is applied to the number of larvae collected to compensate for the efficiency of the sampling gear.

After larval abundance has been estimated, the methods for estimating transformer production are the same as those outlined in the wadable waters protocol.

APPENDIX D – Additional Requirements for Application of Granular Bayluscide in State of Michigan Jurisdictional Waters

Following an Administrative Consent Order (ACO) issued in 2015, the Michigan Department of Environmental Quality now requires the following prior to and following application of Granular Bayluscide in Michigan jurisdictional waters:

1) If aquatic vegetation is present and determined to be too dense, the application of gB will be deferred.

2) Municipalities and agricultural irrigators in the vicinity of the application shall be notified of the application area and approximate time.

3) If non-target organisms are seen congregated in the application area or if their movement from the area may be restricted and dispersal cannot be achieved, then the plot will be moved to an alternate location or postponed.

4) Temperature and dissolved oxygen readings shall be conducted prior to starting application under all circumstances.

5) Application shall be performed beginning from the land side of the plot and progress away from shore, unless conditions such as wind or obstruction within the plot require a different direction.

MEMBERS OF THE LARVAL ASSESSMENT TASK FORCE

Current

Fraser Neave (Interim Chair) - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
Mike Steeves - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
Kevin Tallon - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
Aaron Jubar - Ludington Biological Station, Ludington, MI
Brian Stephens - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
Jean Adams - Great Lakes Science Center, Ann Arbor, MI
Chris Holbrook - Hammond Bay Biological Station, Hammond Bay, MI
Travis Brenden – Michigan State University, East Lansing, MI
Bob Frank – Marquette Biological Station, Marquette, MI
Dale Burkett – Great Lakes Fishery Commission, Ann Arbor, MI
Pete Hrodey – Great Lakes Fishery Commission, Ann Arbor, MI

Past Members of Larval Assessment Work Group/Larval Assessment Task Force

Glenn Barner - Marquette Biological Station, Marquette, MI
Doug Cuddy - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
Jacob Cunha - Marquette Biological Station, Marquette, MI
Amy DeWeerd – Ludington Biological Station, Ludington, MI
Mike Fodale – Marquette Biological Station, Marquette, MI
Joe Genovese - Marquette Biological Station, Marquette, MI
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Dave Keffer - Ludington Biological Station, Ludington, MI
Geraldine Larson – Amherst Field Office, Amherst, NY
Sidney Morkert - Ludington Biological Station, Ludington, MI
Shawn Nowicki – Marquette Biological Station, Marquette, MI
Dale Ollila - Marquette Biological Station, Marquette, MI
Henry Quinlan - Marquette Biological Station, currently at Fish & Wildlife Conservation Office, Ashland, WI.
Jeff Slade – Ludington Biological Station, Ludington, MI
Paul Sullivan - Sea Lamprey Control Centre, Sault Ste. Marie, ONT
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