

Standard Operating Procedures for *Fish River*

Version 1.2

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Contact Details

For Contractual and Administrative details:

Ms Mariann Fee
Chief Executive Officer
UoM Commercial Ltd
The University of Melbourne
442 Auburn Road
Hawthorn VIC 3122

Phone: +61 3 9810 3254
Fax: +61 3 9810 3149
Email: mfee@unimelb.edu.au

For Technical Details:

Dr Wayne Koster
Arthur Rylah Institute for Environmental Research
Department of Environment and Primary Industries
Heidelberg VIC 3084

Phone: +61 3 94508766
Mobile: +61 400 558 261
Email: wayne.koster@depi.vic.gov.au

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Introduction

The Standard Operating Procedure (SOP) for Fish (River) describes the purpose of the annual adult fish surveys in the lower Goulburn River, how the monitoring will be conducted, who is responsible for specific tasks and how the collected data will be analysed and reported. The document is intended to be taken in the field during any adult fish surveys for the LTIM and should be updated throughout the life of the Long Term Intervention Monitoring Program to reflect any agreed changes to method or procedure.

Objectives and hypotheses

This monitoring protocol for Fish River addresses the following Basin scale evaluation questions:

Long-term (five year) questions:

- What did Commonwealth environmental water contribute to native fish populations?
- What did Commonwealth environmental water contribute to species diversity?

Short-term (one year) questions:

- What did Commonwealth environmental water contribute to fish community resilience?
- What did Commonwealth environmental water contribute to native fish survival?
- What did Commonwealth environmental water contribute to native fish reproduction?
- What did Commonwealth environmental water contribute to native fish growth rates?

The Area Specific evaluation questions to consider are:

Long-term (five year) questions:

- What did Commonwealth environmental water contribute to the recruitment of Golden Perch in the adult population in the lower Goulburn River?

Short-term (one year) questions:

- What did Commonwealth environmental water contribute to the survival of Golden Perch larvae in the lower Goulburn River?

In particular, we expect that spring-summer freshes will trigger spawning and subsequent recruitment, particularly for Golden Perch, resulting in a broader range of age classes in the population (currently the Golden Perch population comprises only large, old fish) and an increase in abundance. Increased baseflows in late summer/early autumn are expected to promote subsequent survival and recruitment into the adult Golden Perch population. Spring-summer freshes and increased baseflows are also likely to benefit other native fish species and therefore increase overall fish diversity, survival and growth rates.

Indicators

Fish River is a Category I monitoring indicator for the LTIM Program. It requires annual surveys of adult fish populations at 10 sites in each nominated zone. The surveys will use a combination of boat-mounted electrofishing and fine mesh fyke nets to catch fish from each site. Fish collected will be identified, counted and measured to assess the relative abundance and size class distributions of fish populations in each zone. Otoliths will be taken from selected fish to more accurately determine population age structures of large-bodied fish and, where possible, to link spawning to specific past flow events through micro-chemical analyses.

Locations for monitoring

Monitoring will be conducted in Zone 2 (Shepparton to Murray junction). This zone was selected largely on the basis that it is where we would most likely expect to detect a response (e.g. recruitment, abundance) to flow events, particularly as previous monitoring has shown that spawning activity by Golden Perch is concentrated in this part of the lower Goulburn River (Koster unpublished data). The proposed sites are shown in Table 1 (subject to change depending on site access).



Table 1: Name and location of proposed fish monitoring sites for the lower Goulburn River. Most of the sites have been used in previous monitoring studies as shown.

Site	Lat	Long	Existing ARI site	Existing VEFMAP site	New site
Shepparton Causeway	-36.381	145.394	✓		
Zeerust	-36.254	145.353			✓
Loch Garry	-36.242	145.287		✓	
Pogues Road Undera	-36.203	145.268		✓	
Kotupna	-36.164	145.222	✓		
McCoys Bridge	-36.177	145.123		✓	
Murrumbidgee Road Pederick	-36.156	145.035		✓	
Yambuna	-36.131	145.003	✓	✓	
Murphy Road/Sun Valley Road Kanyapella	-36.095	144.925		✓	
Stewarts Bridge	-36.103	144.850			✓

Extra surveys to collect otoliths of large-bodied fish will be conducted throughout Zone 2. These sites will be selected to represent those that support relative large populations of large-bodied species such as Murray Cod and Golden Perch to increase efficiency of sample collection. These sites will be located near the sites listed above, but outside (e.g. at least 0.5 km away) of the immediate sampling area. Several sites within Zone 1 (see Table 2) that are known to support large populations of large-bodied species will also be targeted. As per the standard methods, samples can be obtained from the broader monitoring area.

Table 2: Additional monitoring sites in Zone 1 for otolith samples.

Site	Lat	Long	Existing ARI site	Existing VEFMAP site
Cable Hole	-36.69	145.230	✓	
Cemetery Bend	-36.516	145.322	✓	✓
Pyke Road	-36.427	145.357	✓	✓

Establishing sites

Site placement.

A site is defined as:

- An 800 m reach of channel within a zone.
- Site location for channel sampling should be fixed throughout the LTIM program.
- Each site should be accessible and be representative of the zone.
- Ideally, each site will coincide with a pre-existing discharge and river height gauging station.
- Each site should not be within 1 km of a significant tributary and/or distributary.
- Ten channel sites should be located within the zone targeted for Basin-scale monitoring/analysis.
- All ten sites for Basin-scale data should be located on a single channel.
- These sites should be distributed randomly throughout the zone selected for Basin-scale data collection, such that the samples collected are representative of that zone. However, they should not be spread over a distance farther than 100 km.

Timing and frequency of sampling

Sampling will be conducted annually between March-May at each site over the five year program. The timing of sampling will be chosen to coincide with relatively low river flows and low turbidity to maximise sampling efficiency. High flows (e.g. due to rainfall or environmental water releases) will be avoided, where possible, as these may increase turbidity and reduce sampling efficiency.



Responsibilities – identifying key staff

Field program

Wayne Koster and David Dawson from the Arthur Rylah Institute will be responsible for overseeing the planned monitoring, conducting the field surveys and any relevant training, and preparing safety plans. Other experienced staff from ARI may also participate in the surveys at times where needed. Angus Webb from Melbourne University will conduct data analysis. Wayne Koster and David Dawson will be responsible for collating, checking and uploading collected data.

Laboratory requirements (if any)

For aging of large-bodied fish, otoliths will be sent via post to Fish Ageing Services, Tasmania, at the end of the surveys for processing. The officer in charge of the otolith aging is Mr Kyne Krusic-Golub. Fish Ageing Services is a world class, independent fish ageing laboratory. All otolith data will be entered in excel and sent electronically to ARI after processing. After processing all samples will be returned and stored in the fish laboratory at ARI.

For microchemical analyses, otoliths will be transported in a car to the School of Earth Sciences at University of Melbourne for determination of strontium isotope ratios within the different bone layers of the otoliths. The officer in charge of the otolith micro-chemistry is Jon Woodhead. The School of Earth Sciences offer a world class, independent laboratory. All otolith data will be entered in excel and sent electronically to ARI after processing. After processing all samples will be returned and stored in the fish laboratory at ARI.

Procedure for transferring knowledge to new team members

The discipline lead (Wayne Koster) will be responsible for ensuring new team members have a sound understanding of the program and are able to competently undertake required tasks. The discipline lead will undertake the following steps to facilitate this process

1. Discuss the overall program to the new staff member and introduce to team members.
2. Outline and document the roles and responsibilities of the new staff member
3. Explain and provide access to relevant program documents
4. Explain and discuss the standard operating procedure
5. Explain and discuss the project risk assessment and the required safety measures
6. Demonstrate sampling methods to staff in the field and supervise staff undertaking these methods until satisfactory competency is demonstrated.
7. Explain and demonstrate data collation, analysis, uploading procedures and assist staff in performing these tasks as required

Any new staff undertaking electrofishing will be required to complete the U.S. Fish and Wildlife Service's Principles and Techniques of Electrofishing Program. No formal accreditation is required to undertake fyke net surveys. However, any new inexperienced staff involved in fyke net surveys will only work with other staff who have at least 2-3 years' experience. Staff must hold a valid Victorian drivers licences and boating licence. A Coxswains certificate will also be required from mid-2015. Staff must also have completed accredited 4WD training and First Aid (Level 2) training. David Dawson will be the senior field technical officer within the field team. David will liaise regularly with Wayne Koster and will train any new staff required throughout the duration of the project. Wayne Koster will convene (face to face) regular debriefs with the field team after field trips to identify any issues of concern. Scheduled debriefings will occur after each field trip for the duration of the project. Any significant matters will be dealt with immediately rather than waiting for a scheduled debrief.



Monitoring methods

Field methods

Equipment

Electrofishing boat
Double wing fine (2 mm) mesh fyke nets, chains and floats
GPS
Measuring boards
Scales
Datasheets and/or field computer
Dip net
Sample containers for otoliths

Sample placement within sites

- A sampling grid will be established within each site to ensure individual samples can be randomly sampled from that site, and are therefore representative of that site as a whole. Sampling should be random with respect to the environment to avoid temporal and spatial biases.
- Each 800m site is subdivided by fixed transects spaced 50 m apart. Points of intersection between the transects and the river bank define the sampling grid.
- The sample design specified defines two key sampling locations: electrofishing (EF) units (16 in total), and passive-gear sample (PS) waypoints (34 in total) (see Figure 1).
- To establish the PS grid, providers should save each PS waypoint in a GPS. A GPS can be used to locate each PS waypoint in subsequent visits throughout the LTIM.

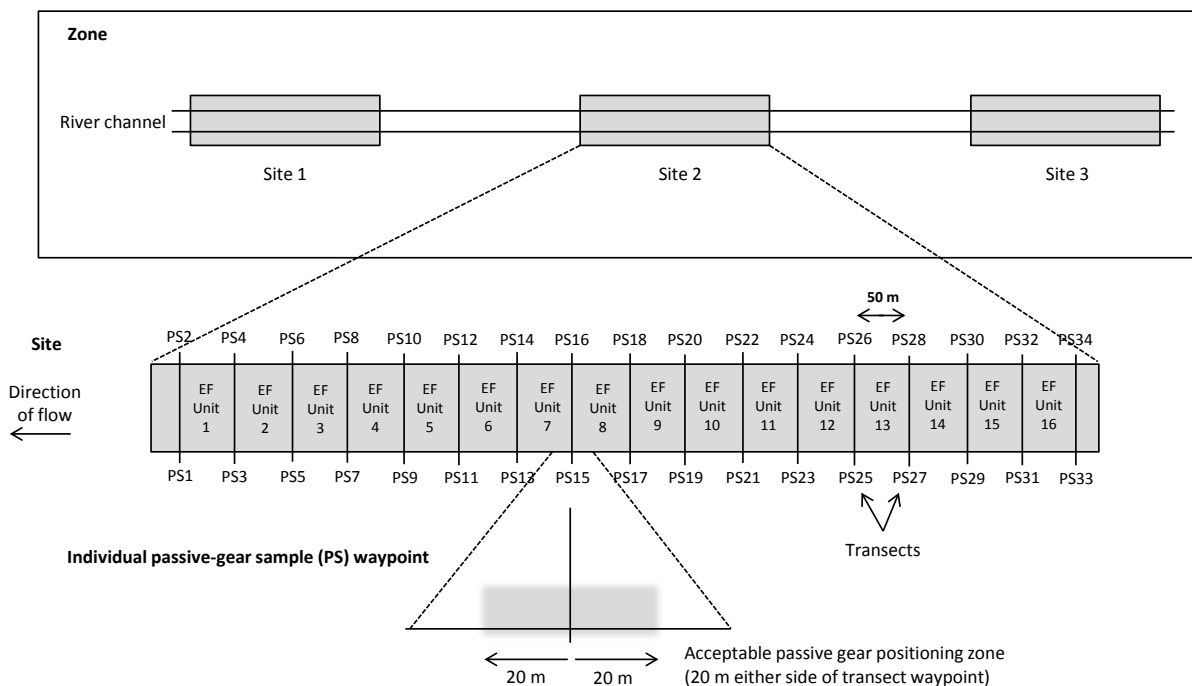


Figure 1: Diagram of hierarchical sample design illustrating zones, sites and sample locations

Life-history guilds

- Providers must identify six target species, two from each guild (Equilibrium, Periodic, Opportunistic).
- Across all Selected Areas the equilibrium species targeted will be Murray Cod. The second equilibrium species proposed for the Goulburn River will be River Blackfish. River Blackfish are relatively uncommon

in the Goulburn River, but the only other equilibrium species (Trout Cod, Catfish) are threatened and even less common.

- Across all Selected Areas the periodic life-history species targeted will be Golden Perch. The second periodic species proposed for the Goulburn River will be Silver Perch, on the basis that it is one of only two flow-dependent spawners (along with Golden Perch) in the Goulburn River.
- Across all Selected Areas the opportunistic life-history species targeted will be Carp Gudgeon. The second opportunistic species proposed for the Goulburn River will be Australian Smelt, on the basis that it is abundant in the Goulburn River and growth rates of the species have been shown to respond to flows.

Sampling protocol

Electrofishing (large-bodied species)

- Large-bodied species will be sampled using boat electrofishing
- Do not collect small-bodied species for processing using electrofishing
- The entire 800m site will be electrofished. Within each electrofishing unit of a site two 'shots' of 90 s 'on-time' should be carried out. This results in a total of 2880 s (48 min on-time) for each site. No more than 180 s of shocking should be allocated to each EF unit, such that electrofishing effort is spread out across the entire site, thus giving a more random sample with respect to the (site's) environment. Note that, within EF units the location of shots is left to the discretion of the service provider.
- For every individual belonging to a target large-bodied (equilibrium and periodic) species, the following should be obtained or implemented: identified to species; total length (TL; round or square caudal fin species) OR fork length (FL; fork-tailed species) in millimetres (mm); mass in grams (g) (use scales that have been recently calibrated);
- Record catch data separately for each 90 s shot
- If > 20 individuals for a species are obtained within a 90 s shot, record the above information on the first 20 individuals caught during a 90 s shot..
- Identify and enumerate non-target species; there is no need to record length or mass of these non-target species.
- Return all individuals (including alien species) to the water.
- In addition, in years 1 and 2, additional information will be collected to ensure that the data are compatible with standard data collection for adult fish under the Victorian Environmental Flows Monitoring and Assessment program. Refer to the existing standard methods for that program for extra information to be collected. However, in brief, the extra requirements are:
 - Need to catch and process small-bodied fish during electrofishing
 - 'Processing' implies a need to count, measure (and weigh – if large enough i.e. > about 80 mm) first 50 individuals of each species caught across the three sampling methods.

Fyke netting (Small-bodied species)

- Small-bodied species will be sampled using fyke nets
- Fine-mesh fyke nets (2 mm mesh) with a double wing (each wing: 2.5 m × 1.2 m) should be used. The first supporting hoop must be covered by a plastic grid (5 cm x 5 cm) to keep large aquatic vertebrates out of the trap.
- A random number generator should be used to randomly select a subset of 10 PS waypoints from the total of 34. A waypoint encompasses a total of 40 m of bank (20 m either side of specific waypoint), so providers should endeavour to find the point on the bank as close to the exact waypoint as possible. The purpose of this system is to ensure sampling is random with respect to the environment, so providers should not simply ignore a waypoint if setting of a net is not as leisurely as they would like. If it is impossible (in the strict sense, not just inconvenient) to set a fyke net at a certain waypoint (current is too fast; bank is far too steep; water too deep; too many emergent macrophytes to be an effective fish sample), then an adjacent, unoccupied waypoint should be used.
- Fine-mesh fyke nets should be set in the afternoon and retrieved the following morning. Set and retrieval times should be recorded for each individual net/trap, so that abundances can be expressed as rates.
- Fine-mesh fyke nets should be set with the cod end facing the current, so that water velocity is deflected around the net and wings. For the net to be effective both wings and the cod end need to be anchored to the bottom very well using, say, steel stakes. So that sampling effort is held constant across nets, the wings should have an aperture of 1 m.



- Total length (mm) should be measured for the first ten Carp Gudgeon caught in each net and fork length (mm) should be measured for the first 10 Australian Smelt caught in each net. The first ten individuals of each species may be obtained by tipping all fish caught in the net into a bucket with water and using an aquarium net to blindly sub-sample a portion. If more than 10 Carp Gudgeon or Australian Smelt are caught in a net, the additional animals only need to be counted and identified. All non-target species caught should be identified and counted. Length and weight are not required for non-target species.
- In addition, in years 1 and 2, additional information will be collected to ensure that the data are compatible with standard data collection for adult fish under the Victorian Environmental Flows Monitoring and Assessment program. Refer to the existing standard methods for that program for extra information to be collected.
 - Need to count, measure (and weigh – if large enough i.e. > about 80 mm) first 50 individuals of each species caught across the three sampling methods.

Extra sampling in years 1 and 2 to ensure data are compatible with data collected in VEFMAP

- Need to set 10 bait traps (unbaited) overnight at each site
 - Need to count, measure (and weigh – if large enough i.e. > about 80 mm) first 50 individuals of each species caught across the three sampling methods.

Otolith collection and analysis

Opportunistic species (Carp Gudgeon and Australian Smelt)

- Otolith analysis was dropped for opportunistic species for Y2 of the program onwards.

Periodic (Golden Perch and Silver Perch) and Equilibrium (Murray Cod and River Blackfish) species

- Two comprehensive otolith samples from these target species should be conducted over the course of the 5-year program; one at the beginning of the program (Year 1) and one at the end of the program (the winter of Year 5, following autumn censuses). We will seek permission to use dead fish that were collected after the 2016/17 blackwater event to partly/fully offset the need for lethal sampling of adult fish in year 5.
- Up to five days sampling effort has been allowed for each sampling event. Only 50 individuals need to be collected from each target species and sampling can cease once 50 individuals have been collected. Samples should aim to represent the full range of lengths within the population (ideally), and approximately equal numbers of individuals within each length-class. Five days should be sufficient to collect 50 individuals from the more abundant target species. For less common species, the aim will be to collect as many individuals as possible in five days. Obtain otolith samples from within the zone targeted for Basin-scale data collection, but not at the same 10 sites selected for annual censuses. If that zone does not yield an appropriate sample, sample from within the broader monitoring area, but note location of capture.
- Boat electrofishing will be the main sampling method for otolith collection, but other methods may be used as needed.
- The collected otoliths will be analysed in the laboratory to determine the age (in years) of each captured fish. The daily age of YOY Golden Perch and Silver Perch (flow cued spawners) will also be determined. Microchemical analyses of Golden Perch and Murray Cod will be used to determine whether fish collected in the Goulburn River were spawned locally, or have immigrated into the system from elsewhere.

Laboratory methods

- Otoliths will be removed in the field, stored in plastic vials and sent via post to Fish Ageing Services, Tasmania, at the end of the surveys for processing. All otolith data will be entered in excel and sent electronically to ARI after processing. After processing all samples will be returned and stored in the fish laboratory at ARI. Otoliths will be mounted and read by Fish Ageing Services using standard methods (e.g. Secor et al. 1992).
- For microchemical analyses, otoliths will be transported to the School of Earth Sciences at University of Melbourne for determination of strontium isotope ratios within the different bone layers of the otoliths. All



otolith data will be entered in excel and sent electronically to ARI after processing. After processing all samples will be returned and stored in the fish laboratory at ARI. Microchemical analyses will be conducted according to the methods of Schmidt et al. (2014).

Data analysis and reporting

Relative abundance

- Abundance data should be reported as 'catch-per-unit-effort' (CPUE). Raw data for target species should be structured by individual 'samples', which are individual net hauls, or abundances within discrete electrofishing shots. Passive trap CPUE units will be number of individuals per net per hour.
- This data will be provided in an excel spreadsheet and presented in a table.

Population structure (for target species only)

- Population structure data should be reported as total length or fork length (mm) for each individual.
- Raw length-age data should also be provided (year 1 and 5 data sets for periodic and equilibrium species) for each individual.
- The species, weight (grams), site and date of capture for each of these individuals will also be reported.
- This data will be provided in an excel spreadsheet and presented using histograms.

Community data

- CPUE data should be reported at the level of the site (species by site matrices) corresponding to each sampling method:
 1. Electrofishing (large-bodied species; target + non-target);
 2. Fine-mesh fyke nets (small-bodied species; target + non-target)
- CPUE data will be collated at the level of the site by summing the total number of individuals collected (for each species separately) divided by the total sampling effort (either total electrofishing time or total net soak time) per site.
- This data will be presented in an excel spreadsheet.

A report will be produced that will describe the relative abundance and size class distributions of fish populations, as well as population age structures. The size distribution of target samples collected will be assessed using length-frequency histograms to investigate population size ranges and the extent of recruitment (young-of-year fish) and how recruitment rates correlate with river flow in different years. We expect stronger recruitment of Golden Perch after years that have high flow events in spring. Otolith measurements will be used to determine the age-frequency distribution for equilibrium and periodic target species. Correlations between dominant year classes and flow histories will be highlighted and discussed. The daily age of YOY Golden Perch and Silver Perch (flow cued spawners) will also be back-calculated from daily growth increments in otoliths to confirm the timing of spawning and the environmental conditions associated with spawning. Whether fish collected in the Goulburn River were spawned locally, or have immigrated into the system from elsewhere will also be reported.

Detailed statistical analysis for the Selected Area evaluation will be conducted by or under the direction of Dr Angus Webb at the University of Melbourne.

Additional data for VEFMAP

- As part of the co-investment agreement with the Victorian Department of Environment and Primary Industries, in years 1 and 2, data will also be entered into Victorian Environmental Flows Monitoring and Assessment Program standard data sheets, and ready for upload to that program's online database.
 - Fill in VEFMAP datasheets using VEFMAP site codes,
 - Fill in VEFMAP habitat assessment field sheet at each site on each occasion,
 - Record basic water quality parameters - EC, water temperature, dissolved oxygen, turbidity and pH at time of survey,
 - Upload the data to the VEFMAP database.



Quality Assurance/Quality Control

- All persons conducting electrofishing will be required to complete the U.S. Fish and Wildlife Service's Principles and Techniques of Electrofishing Program.
- The electrofishing boat will be serviced annually by Berry Rewind Electrical (BRE). BRE is an electrical engineering, contracting and electric motor company currently employing an experienced team of industrial A grade electricians. The boat and motor will also be serviced annually by Barry Lawrence Marine. All service certificates will be stored in a filing cabinet in the maintenance department at ARI.
- Fyke nets will be checked for holes in either wing- or cod-ends prior to every field trip, and also upon completion of sampling at each site. Any net with a hole will be repaired or replaced immediately using a repair kit that is taken on site.
- The monitoring will be conducted under an existing Victorian Flora and Fauna Guarantee Permit (expires Aug 2014 but is renewed annually) and Fisheries Victoria Research Permit (expires Aug 2014 but is renewed annually) and ethics permit 13-10 (Arthur Rylah Institute Animal Ethics Committee) (expiry 31/12/2017 but will be renewed prior to expiry). Permits will be carried while sampling. Prior notification to Fisheries for any sampling will be made as per permit conditions.
- As per permit conditions, all electrofishing operations will be undertaken in accordance with the Australian Code of Electrofishing Practice. All nets will be set with the cod end at least 200 mm above the water surface, and will be clearly marked with the permit holders name and permit number. Permit reports will be lodged annually with the relevant body as per permit conditions.
- All data provided for this indicator must conform to the data structure defined in the LTIM Data Standard (Brooks and Wealands 2013) and provided in Attachment 1. The data standard provides a means of collating consistent data that can be managed within the LTIM Monitoring Data Management System (MDMS).
- Data will be entered into an excel spreadsheet that follows the prescribed template outlined in the standard methods. Each cell of data will be cross-checked visually against data sheets for accuracy by David Dawson. Data sheets will be stored in a filing cabinet in David Dawson's office at ARI. All data sheets will be photocopied and stored in a separate filing cabinet in Wayne Koster's office at ARI.
- Data will be stored electronically at ARI on a computer network that is backed-up daily to an external server. Data will be sent by David Dawson via email to Melbourne University to be loaded onto a central database.

References

- Brooks, S. and Wealands, S. (2013) LTIM Data Standard v0.2. Draft Report prepared for the Commonwealth Environmental Water Office by The Murray-Darling Freshwater Research Centre, MDFRC Publication 29.3/2013 November, 29pp.
- Schmidt, D.J., Crook, D.A., Macdonald, J.I., Huey, J.A., Zampatti, B.P., Chilcott, S., Raadik, T.A., and Hughes, J.M. 2014. Migration history and stock structure of two putatively diadromous teleost fishes, as determined by genetic and otolith chemistry analyses. *Freshwater Science*. 33. 193-206.
- Secor, D.H., Dean, J.M., and Laban, E.H. 1992. Otolith removal and preparation for microstructural examination. In *Otolith Microstructure Examination and Analysis*. Edited by D.K. Stevensen and S.E. Campana. Canadian Special Publication in Fisheries and Aquatic Science. 117. pp. 19-57.



Attachment 1 LTIM Data Standard requirements

Attachment 1.1 Standard Data format for individual fish to be submitted to the CEWO.

Variable	Description	Type	Req	Range
assessmentUnitId	The site, which may be a length of stream of an area of wetland(s) that meets the criteria defined in the standard method	string	Y	
dateStart	Start date (inclusive) that these measures were observed	dateTime	Y	
dateEnd	End date (exclusive) that these measures were observed	dateTime	Y	
sampleNumber	Arbitrary name/number that identifies the net, trap or electrofishing unit within the assessment unit	string	Y	
speciesName	Latin name for species of fish	string	Y	LookupList
totalLength	Total length (in mm), where necessary	number (1 decimal)	N	[0,+]
forkLength	Fork length (in mm), where necessary	number (1 decimal)	N	[0,+]
weight	Mass (in grams)	number (2 decimal)	N	[0,+]
sampleType	Sampling equipment used	category	N	CourseFyke FineFyke
ageAdult	Age determined by examination of otolith (years)	integer	N	[0,+]
ageLarvae	Age determined by examination of otolith (days)	integer	N	[0,+]

Attachment 1.2 Standard Data format for adult fish survey results to be submitted to the CEWO.

Variable	Description	Type	Req	Range
assessmentUnitId	The site, which may be a length of stream of an area of wetland(s) that meets the criteria defined in the standard method	string	Y	



Variable	Description	Type	Req	Range
dateStart	Start date (inclusive) that these measures were observed	dateTime	Y	
dateEnd	End date (exclusive) that these measures were observed	dateTime	Y	
speciesName	Latin name for species of fish	string	Y	Lookup list
coarseFykeCatch	Mean of catch per unit effort	number (8 decimals)	N	
fineFykeCatch	Mean of catch per unit effort	number (8 decimals)	N	
electroCatch	Mean of catch per unit effort	number (8 decimals)	N	

