Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Quality Assurance Procedures

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ABSTRACT

This document provides quality control procedures to check data collection and products associated with the RIC Standard *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory*. The process is carried out in three stages:

- A pre-field stage to ensure that a field project plan has been prepared and that map-based and existing data have been collected and recorded to standards;
- A field audit stage to ensure field data are collected and recorded to standards; and
- A reporting stage to ensure that final project deliverable products are provided to acceptable standards.

The procedures include a combination of manual assessments and automated data checking routines. Descriptions of procedures and forms to record results are included.

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INTRODUCTION

The British Columbia Ministry of Fisheries currently administers a large, province-wide fish and fish habitat inventory program. The inventory follows the provincial Resource Inventory Committee (RIC) standard *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures,* Version 1.1, (RIC 1998). The deliverables from these inventory projects include digital and hard copy data, reports and maps and associated products. The deliverables are produced in high volume under diverse conditions. The ministry requires complete and rigorous quality assurance (QA) methods to ensure high quality end-products.

Quality assurance is the management tool used to ensure quality. Quality control refers to the specific activities undertaken to test quality (Shampine 1993). Quality assurance includes the availability of standards and procedures, training and communication as well as quality control. The aim of quality assurance is to prevent problems before data collection begins. Early detection of errors is a critical preventative step in obtaining quality data.

This manual provides quality control procedures to check inventory data collection and products. Application of the quality control procedures will assist in early detection of errors, however, appropriate training and familiarity and experience with the inventory standards will be most important in achieving high quality surveys. Results of quality control are intended to be used by licensees and their contractors to ensure high quality data are provided to the ministry. The ministry will apply these procedures to ensure that high quality data have been received, to facilitate product acceptance.

Ministry Support

Training and support from ministry staff is critical to error prevention. If a question arises, the inventory practitioner should attempt to find an acceptable clarification by following the procedures outlined below:

- check the RIC Standards manuals and any subsequent errata sheets. These can be found on the RIC website at <http://www.for.gov.bc.ca/ric/>.
- check the frequently asked questions (FAQ) and technical information notes posted on the Fisheries Inventory link on the BC Fisheries website at <http://www.bcfisheries.gov.bc.ca>.
- contact the local regional fish/habitat inventory specialist. The regional specialist will either answer the question or, in some cases, refer the question to the appropriate authorities.
- questions of provincial significance will be brought into the FAQ or technical information note series.

This proactive approach is an attempt to deal with issues before they turn into errors.

Roles in the QA Process

The delivery of QA for fish inventory projects involves the inventory contractor, the proponent (e.g., licensee) in charge of the inventory, and the ministry. Specific responsibilities and how these relate to QA procedures outlined in this document are provided below.

Contractor

The contractor performing the inventory project is responsible for providing accurate, high quality data in the media and formats specified in the RIC standards and in their contracts. The survey must be carried out by qualified staff, very familiar with the reconnaissance inventory methodology if this goal is to be met. Internal quality control procedures are up to the individual contractor. Procedures outlined in this manual may be instructive in providing information on how the products of the inventory project will be reviewed. They may also be applied to individual project phases to detect and prevent errors as the project proceeds.

Licensee (recipient)

The proponent in charge of the inventory (e.g., the recipient of FRBC funds) is responsible for conducting QA on all deliverable products prior to submitting them to the ministry representative. This is described in clause 7 of the standard FRBC contract, Schedule A for Reconnaissance (1:20 000) Fish and Fish Habitat Inventory as follows:

> *The recipient will be responsible for ensuring that all deliverable products related to this agreement have undergone quality assurance, following ministry quality assurance procedures for fish and fish habitat inventory, prior to delivery. The recipient will maintain, and make available to the ministry representative, documentation on all quality assurance work in a format acceptable to the ministry. Options for conducting quality assurance to ministry standards must be discussed with the ministry representative.*

Ministry

The ministry is responsible for checking the quality of final deliverables and confirming that work has been done to standards. This is described in clause 46 of the standard FRBC contract, Schedule A for Reconnaissance (1:20 000) Fish and Fish Habitat Inventory as follows:

> *Prior to acceptance of services, all completed products will be checked for technical standards by the ministry representative following standard ministry quality assurance procedures for fish and fish habitat inventory. All work must be in accordance with standards and specifications outlined in this contract. Work not conducted in accordance with standards and specifications outlined in this contract will be deemed unacceptable. In this case the recipient will make the necessary changes to the deliverables at its sole expense, until the province is satisfied that the deliverables meet the specifications and standards set out in the contract.*

The ministry will perform QA on all deliverable products prior to accepting goods and services and signing the FRBC quality certificate.

Training and Qualifications

Persons responsible for conducting the inventory QA **must** be trained and experienced in the RIC standard inventory procedures. This includes thorough familiarity with all aspects of the current RIC standards relevant to fish and fish habitat inventory obtained through direct project experience. RIC training programs are available for some fish and fish habitat inventory standards through the BC Forestry Continuing Studies Network. Some training programs are under development. Knowledge and experience requirements can be obtained from the local regional inventory specialist. Suggested minimum requirements are:

- two years of direct project experience in **all** phases of RIC standard fish and fish habitat inventory as a senior project technician or project biologist;
- one year of direct project experience in **all** phases of RIC standard fish and fish habitat inventory as a senior project manager/biologist;

External expertise is required for QA of fish identifications. Fish identifications by the contractor are verified by voucher specimen collection and identification by recognized external experts. Contact the regional fisheries inventory specialist for additional information.

The number and location of reach breaks and physical reach characteristics is an important aspect of the inventory, and requires expertise in physical geography to properly conduct. QA of physical information requires similar expertise in physical geography.

QUALITY ASSURANCE PROCEDURES

This manual outlines procedures for checking the quality of work done during a fish inventory project. The QA procedures described in this manual include assessing the quality of deliverable products as well as field checking to ensure data are collected properly. Field data collection is critical to the QA process.

The following sections describe QA procedures and forms for each phase of work. These QA requirements correspond to the RIC standard reconnaissance level fish and fish habitat inventory methodologies.

General Approach

The goal of these procedures is to provide a means for determining acceptability of work to standards described in *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures*, Version 1.1 (RIC 1998). The QA procedures offer a combination of qualitative and quantitative assessment of the quality of work produced.

The QA process is carried out in three stages:

1. **Pre-field:** conducted on deliverables submitted at the end of phase 3 of the inventory project. At the end of phase 3, a "pre-field planning report" is submitted, which includes a series of deliverable and interim products. Part of the pre-field planning report is the project plan covering the field, data compilation and reporting aspects of the inventory project. The intent of QA at this stage is to ensure pre-field data have been collected properly, and to approve the project plan.
2. **Field QA:** conducted during field work to ensure that field data are collected and recorded following standards. Field audits are critical to ensuring data are collected to standards. Field visits are essential to ensure individual field crews are collecting data consistently and as intended by the standard. Errors originating in the field are difficult if not impossible to detect in many cases and, if errors originating in field data collection are detected in the review of deliverable products, are very expensive to correct. Field audits should be performed early in the field season, to ensure problems are detected and corrected before a significant amount of data are collected. Field QA includes the verification of fish identification.
3. **Reporting:** conducted on final deliverable products on project completion. Deliverables include complete databases, original data, photographs and final reports and maps. The intent of QA at this stage is to ensure all products are prepared to acceptable standards, and that all data are provided in standards formats for loading into the provincial database.

In each of the three QA stages, products are checked against the standards documented in the RIC publications. Some deliverables are checked entirely, while for others, a sample of deliverables are checked. Products and individual data elements are checked against the standard for completion, accuracy and consistency amongst products using a combination of electronic data verification and analysis by QA staff. Errors are detected when information is found that does not follow or provide the standard requirements, or is found to be inaccurate or inconsistent. For some attributes, such as those requiring estimates or judgements, some variation in results is expected, therefore some error is allowed. For other attributes, such as those critical to the integrity and consistency of the data, no error is allowed.

Data forms are provided which indicate the attributes to be checked. Space is provided for noting specific errors. General comments are also included. The tasks and details involved in the inventory program are many and thus completion of the forms requires reference knowledge of RIC inventory procedures and the tables in this guide. Forms are provided to document the QA scoring, comments and recommendations.

Sub-sampling

In order to achieve a degree of certainty that work has been carried out to an acceptable level, all attributes of deliverables provided need to be checked. As it is not possible to check every piece of data, a relatively small sample of the complete data set is selected. This sub-sampling approach is done by randomly selecting samples of the deliverable that is being checked. It is critical to the defensibility of the procedure that the samples be selected randomly. (There are many ways of generating random numbers including a random numbers table [statistics books], using the random numbers function in Excel, or other spreadsheet or statistics software.)

Where sub-sampling is appropriate, sub-sample size is determined by the project size and the number of attributes per project unit that are checked (Table 1.0). This table indicates sample intensity is relatively high for small project sizes, and relatively low for larger projects. Appropriate sample size and acceptable error rates are determined by the desired acceptance level for the data (e.g., 90% correct) and the probabilities of accepting correct or incorrect work (e.g., 95% probability of accepting work that is 90% correct or better). Explanation of the statistical rationale for sample size and acceptance levels is provided in Triton (1997).

Table 1.0. Example of sample size and acceptable error rates for different project sizes (from Triton 1997)

Project size (number of units)	Lot size (n units times data elements checked)	Sample size	Acceptable number of errors
10	100	85	10
20	200	143	17
40	400	216	26
60	600	271	33
80	800	297	36
100	1 000	321	39
150	1 500	361	44
200	2 000	385	47
300	3 000	410	50
500	5 000	434	53
1000	10 000	450	55

Each incorrect attribute in the sample is assigned one error mark; correct attributes receive no marks. It should be emphasized that the total number of errors is the sum of **all the variables** checked in the samples. An error rate of 12% in data collection is allowed—anything more fails. For consistency checks in transcription, an error rate of 5% is allowed. If greater than 5% errors were made in transcribing the data from hardcopy forms to digital forms, the work would not be approved. Other critical data elements are allowed **NO** errors.

Zero Tolerance Data

Some data elements are critical to the integrity of the data set for loading into FDIS and electronic mapping. In these cases, care must be taken to ensure no errors exist. These critical data elements are associated with ILPs, watershed codes and conversions, NIDs, UTMs and conversions. Electronic data checking routines are in place and under development to detect errors in zero tolerance data.

Electronic Data Checking

The database associated with the reconnaissance inventory is called the Field Data Information System (FDIS). This database has data entry tools with error detection built into them for many attributes. What they can detect depends upon the 'business rules,' which may change as the database changes and as more error detection rules are developed. For many attributes, the error is detected upon data entry—the database will not accept data that falls outside set bounds. For other attributes, 'batch' routines can be run on the complete data set to detect errors present.

It will be assumed in the QA procedures that electronic data checking will occur and that routine errors such as missing data or data falling outside of known ranges will be detected. Electronic error detection is unable, in all cases, to detect errors that fall within acceptable ranges.

In addition to internal FDIS QA, additional tools to assist in QA are being developed. The advantage of these electronic QA tools is that computers can check all data very quickly. For critical data elements, where zero error tolerance is required to further use the data, electronic data checking is imperative.

An ARCView QA tool is available that checks digital deliverables for mapping and some critical elements of FDIS beyond data entry business rules. These are applied at Stage 3; for discussion, see page 52.

Qualitative Checking

Because of the qualitative nature of much of the QA work, an important aspect of the QA will be in the form of comments. Where a question asks whether a task was done acceptably, adequately, properly, or by some other subjective level, the answer, yes or no, should be supplemented with an explanation if appropriate. A recommendation should be made based on these qualitative comments, and the contractor should consider the implications of the comments for acceptance. The final decision to accept the work should be left with the ministry representative.

Error Correction and Further Quality Assurance Checking

The QA check carried out through sub-sampling is not intended to detect all errors, but should identify all types of errors. All errors found during the QA process must be corrected. For products that were not approved, the entire deliverable set shall be returned and all errors must be corrected, not simply the errors identified in the sub-sample. Once the required revisions are completed, the QA check should be re-run on another independent sample of the deliverables that are affected by the changes.

The ministry shall run the QA on an independent sample to ensure all final products are acceptable and final contract payment can be made. A threshold error rate shall be set, above which products will be deemed unacceptable and returned to the proponent.

STAGE 1 QA: PRE-FIELD PLANNING

Steps in the QA of pre-field planning are listed in Table 1.1. The QA process ensures that all required deliverables have been received and that the content of the deliverables is consistent and meets the required standards. The final step is the review and approval of the project plan covering the remaining phases of the inventory.

Table 1.1. Pre-field QA steps and activities

QA step	QA activities	QA form
Deliverable checklist	Ensure all required products are provided	1A
Existing data review	Check that existing data were thoroughly sought out, reviewed and provided in FISS formats as required by contracts	1B
ILP information	Check that complete ILP information has been provided to the ministry in proper formats	1C
FDIS database	Run the FDIS QA procedure on the entire data set. Provide the FDIS QA report.	FDIS QA report
Interim maps	Check for interim map content and that existing data was transferred from FISS maps to interim maps	1D
Combined reach information check	Sub-sample reaches to ensure reaches are properly located on interim maps, that reach information is correct and that data are consistent between FDIS and the interim maps	1E
Combined lake information check	Sub-sample lakes to ensure lake information is correct and consistent between FDIS and the interim maps	1F
Over-flight and aerial video	Check format and documentation of video and ensure information is incorporated into field plan	1G
Stream sampling plan	Check that sampling design adequately covers the requirements for a reconnaissance inventory	1H
Lake sampling plan	Check that sampling design adequately covers the requirements for a reconnaissance inventory	1I
Finalize project plan	Check that the proposed project plan is complete, considers existing data and ongoing activities, and has a realistic budget	1J

It is critical to note that the checking of some pre-field data is tedious and cannot be expected to capture all data errors. This has important implications for the data compilation and reporting phase of the inventory, and is particularly important if the field and final reporting phases are carried out by a contractor other than the one who conducted the pre-field phases. Any errors in pre-field data found in the QA of final products must be addressed.

The following sections describe QA forms for checking pre-field deliverables for each inventory project. The forms are found at the end of this section. Explanations are given for the data required on each form.

Deliverable Checklist (Form 1A)

Before embarking on QA for the pre-field deliverables, a checklist for verifying the submission of the deliverables should be completed (form 1A). The deliverables are provided as the Pre-field Planning Report. The checklist is completed to establish whether all deliverables were provided with acceptable content and format.

The content and format of Pre-field Project Plan components (and overall content) are assessed as being acceptable or not at this stage. The QA team should ensure that the cover page includes appropriate project referencing and contact information, that a table of contents is provided, that a complete list of digital products is provided, and so on.

On form 1A, check off whether hardcopy and/or digital products have been received, and any relevant comments regarding the deliverables. Note some items, such as the map products, are not required in digital format at this stage. ILP maps and ILP data sheets should have been sent to the ministry for processing.

Specifications: FRIM section 2.6.2, or appendix A of the standard FRBC contract Schedule A for Reconnaissance (1:20 000) Fish and Fish Habitat Inventory.

Existing Data (Form 1B)

The intent of QA of existing data is to ensure that all relevant existing data has been used in the current inventory project. Known information can affect project needs and project planning. When new data not referenced in FISS are found, the completion of FISS maps and data forms may be required (check contract specifications).

Specifications: potential sources of information and suggested contacts are given in FRIM section 2.3.1 and appendix 1. Suggested reference or contact lists for specific areas may be available from the ministry representative.

List of contacts

A list of all individuals contacted during phase 1 work is needed to ensure that appropriate effort was made to contact key individuals to confirm that significant sources of data were not missed (e.g., regional watershed restoration specialists). The QA team should have a basic checklist of key regional contacts provided by the contract monitor. This list should be made available to the contractors at the beginning of the planning phase of the inventory.

The list of contacts is checked for acceptable format (any common format acceptable) and any known important contacts not listed are recorded. The inventory planning would be rejected if any significant contacts were missed, which in the opinion of the ministry representative, resulted in significant information sources being missed and therefore could affect the inventory project. If rejected, the pre-field products should be returned to the contractor to incorporate the important existing data.

Specifications: FRIM Section 2.3.1 or other acceptable format as used in RIC publications.

Bibliography

A list of all documents, reports, maps and project plans that are reviewed and used in the compilation of the existing information must be provided in the format of a standard bibliography.

The bibliography is checked for acceptable format (any common format acceptable) and any known important information not listed is recorded. The inventory planning would be rejected if any significant information sources were missed that, in the opinion of the ministry representative, resulted in

significant impact on the inventory project. If rejected, the pre-field products should be returned to the contractor to incorporate the important existing data.

Specifications: FRIM Section 2.3.1 or other acceptable format as used in RIC publications.

FISS information and products

Most inventory contracts require any historic information that was not available in FISS to be summarized and provided in standard FISS formats. However, some contracts may not have this requirement and some may have modified requirements. Contract specifications should be reviewed prior to this QA step.

New fish information found during the review should have been correctly recorded onto FISS data compilation forms and clean 1:50 000 NTS maps. One copy of each new information source should be submitted. Some contracts may request only the appropriate reference to the materials.

Check that FISS forms, maps, reference materials and/or references were provided as required. If not provided, the ministry representative should inform the contractor and arrange for FISS materials to be provided.

Specifications: FISS Data Compilation and Mapping Procedures. October, 1997.

Interim Locator Point Maps and Data Sheets (Form 1C)

Interim locator points (ILPs) must be assigned to every stream in the project area that does not have a watershed code. Each ILP is recorded on the map as a unique five-digit number for the ILP being described. An ILP data sheet is prepared and includes the project code, ILP map number, ILP number, and other data, including UTMs for congested areas. The contractor must send a copy of ILP maps and ILP data sheets to the ministry. The ministry will generate watershed codes for those streams and provide these to the contractor for use later. The ILP maps and ILP data sheets must be sent to the ministry as early as possible to allow timely processing and return of results.

QA of the ILP information is ultimately done by the ministry during ILP processing and watershed code generation. However, to ensure that this process is as efficient as possible, the QA team should check that ILP information is complete and in proper formats. Products received by the ministry in improper format will be returned to the contractor for correction.

Procedures to check ILP information before sending the ministry for processing are as follows:

- To check ILP coverage and consistency, it is recommended that each TRIM map be examined in detail to ensure that:
  - ILPs (up to five digits) are indicated for all streams on the ILP maps (and/or working copy TRIM maps). It is absolutely essential that all streams without watershed codes be labelled with an ILP. If some are missed, the maps must be re-visited.
  - ILPs listed on the ILP data sheet are consistent with the ILP map; any inconsistencies in ILPs on the maps and data sheets are also cause for rejection of the products
  - for congested areas, UTMs of streams must be provided on the ILP datasheet.
- The ILPs must be documented on the maps and in the ILP data sheet in the proper formats. ILPs on the maps must be ledgible, and the ILP data sheet formats must conform to Table 9 of the *User's Guide to the British Columbia Watershed/Waterbody Identifier System. Revision 2.2 April, 1998.*

Note: If ILP information is with the ministry at the time QA is being conducted, ILPs provided on interim maps are used to check data in the combined checks to follow.

Specifications: Table 9. *User's Guide to the British Columbia Watershed/Waterbody Identifier System.* Revision 2.2 April, 1998.

FDIS Database (FDIS Hardcopy QA Report)

The FDIS Database at the end of the planning stage includes the reach planning table that has information for all reaches in the project area, reach cards for those reaches to be sampled as random or discretionary sites in the field, the lakes planning table that has information for all lakes in the project area, and features. Business rules built in to the FDIS data entry screen ensure that the data entered into the FDIS database are complete and that no business rules have been violated. Only complete records with data that falls within allowable ranges are accepted by the database. When data entry is complete, an electronic QA check can be run on individual reach and lake data (from the individual data forms entry screen), or on the FDIS data set (from the administrative menu). Results of the FDIS QA test showing that no errors exist in the data set must be provided.

Specifications: FRIM section 2.4.4.3; FRIM section 2.4.5; FDIS business rules provided in the FDIS Users Guide available on the BC Fisheries website at:

<http://www.bcfisheries.gov.bc.ca>.

Interim Map (Form 1D)

Interim maps provided as part of the project plan at the end of phase 3 should include all requirements from phases 1 to 3 of the inventory. The required information includes:

Phase 1
- additional 1:20 000 streams from forest cover maps (optional)
- waterbodies referenced with ILPs and/or watershed codes and waterbody identifiers
- known existing data and features (with NIDs)
- watershed boundaries.

Phase 2
- reach breaks
- sequential reach numbering
- additional features from map/air photo analysis (with NIDs).

Phase 3
- proposed random and discretionary reach sample sites
- proposed primary and secondary lake sample sites.

The information presented on the map should be legible, using hand-drawn symbols and NIDs as appropriate.

Interim map checking is carried out in combination with checking of reach, lake and feature characteristics as reported on the FDIS reach planning table, lakes planning table, reach form, and features screen. Completed in this way, the consistency of data from the ILP map, interim map and FDIS is checked as well as the associated attribute values. Transfer of relevant FISS data is also checked. Other items required on the interim maps are checked in review of the sampling design and final project plan. An Interim Map Summary (Form 1C) is provided to confirm that all required information has been provided. This is best completed as further QA checks are being carried out.

Some projects, particularly those with contracts completing phases 1–3 only, require the interim map to be provided digitally. In this case, electronic checking of the maps using the ARCView QA Tool, as described in section 3, is appropriate.

Transfer of Existing FISS Data to Interim Maps (Form 1D)

At this step, the QA consists of checking to ensure that relevant FISS information has been transferred to the interim map. The work will be checked using form 1D.

Data transferred to interim (TRIM) maps by the recipient should be accurate, complete and use make use of proper symbols. Specifically, the interim maps must be checked against the FISS maps from which the bulk of the initial data came. There are five different types of items to be checked on each map:

1. fish distributions
2. known or potential obstructions to fish movements (e.g., falls)
3. important fish habitat locations and fisheries sensitive zones (e.g., spawning grounds must be indicated if known)
4. fish enhancement and management activity sites
5. any other information relevant to the inventory program.

The QA should check to ensure that these types of data have been correctly transferred (e.g., the map symbol used and location of information must be correct).

Check that ten relevant existing data points present on the FISS maps have been correctly transferred. This includes location of the feature and an NID. If no FISS features are present for the area, provide a comment stating this is the case.

Combined Check of Stream Reach Data (Form 1E)

Phase 2 of a fish inventory project delineates all reaches and summarizes general reach characteristics in the FDIS reach table. Preliminary reach breaks are marked on TRIM maps and preliminary reach information is characterized from maps and/or air photos and recorded in FDIS. The FDIS reach card includes information for all reaches in the project area. Additional reach information is recorded on the FDIS reach card for those reaches proposed to be sampled in the field. Features information is recorded in the features section of the FDIS reach card.

This QA step involves checking the information in the FDIS reach information against the maps and air photos. One primary concern in this step is the need to ensure consistency between the maps, air photos and data collected in FDIS. This includes ensuring that ILPs have been correctly transcribed, reach break positions are accurate, and reach numbers and key channel characteristics are all correctly identified. Another primary concern is to ensure that the data presented are correct. As much of the data collected at the pre-field stage are related to physical geography and map and air photo analysis, it is imperative that appropriate expertise be available to the QA team. Of particular importance is the positioning of reach boundaries. This has a significant impact on levels of sampling and on later data applications. Air photos must be available for the QA team to review reach boundary positioning.

The number of reach records to check depends on the size of the project and number of reaches as discussed in the introduction. Another requirement is to include both proposed sampled and non-sampled reaches in the number selected to check. An example of project size, lot size and required sample size is provided in Table 1.2. This table shows lot and sample sizes for all reaches (i.e., all reaches in the project area as listed in the reach table) and for sampled reaches (i.e., reaches proposed for sampling with additional reach data). If reach data for sampled reaches is included at this stage, select a number of reaches upon which to perform a QA check from the sampled reach list. Make up the number to be checked from the list of reaches not proposed for sampling.

For example, for a 500 reach project area with 20 sampled reaches:

- 20 reaches proposed for sampling requires checking 13 reaches
- 500 reach total project area requires checking 30 reaches
- reach QA would therefore include 13 sampled reaches and 17 non-sampled reaches.

If only reach table data are available at this stage, select them from the reach table. QA checks of additional reach data parameters for sampled reaches must be carried out at a later stage in the QA process.

Table 1.2. Number of reaches, lot size and QA sample size requirements for sampled and non-sampled reaches. For estimates of required sample size for values outside this range, see Appendix 1.

Number of reaches	Lot size*	Sample size
All reaches (Reach table)		
50	750	293 (20 reaches)
100	1 500	361 (24 reaches)
200	3 000	410 (27 reaches)
500	7 500	444 (30 reaches)
1000	15 000	450 (30 reaches)
Sampled reaches (Additional reach data)		
10	130	102 (8 reaches)
20	260	165 (13 reaches)
30	390	216 (17 reaches)
40	520	249 (19 reaches)
50	650	278 (21 reaches)
100	1 300	344 (27 reaches)

* N reaches × attributes checked.

Form 1E for streams should be used to perform the check and to record specific errors. The specific reach records that are checked are listed at the start of form 1E for future reference.

Table 1.2 lists each reach attribute that should be checked and the details of what and how to check for errors in that attribute. The data in the record must agree with the interim maps and air photos. Map symbols should be checked at this time; especially ensuring that the correct symbols for reach breaks and NIDs have been used on the maps. Record individual errors. The space for comments can be used to indicate if consistent errors are suspected in one or more attributes, and whether the recipient has agreed to revisit those particular attributes.

Many of the attributes in the FDIS reach table **must be correct** in order to use the data for further processing and application purposes. These include the presence of a watershed codes (or ILP at the planning stage), sequential reach numbering and unique feature numeric identifiers (NIDs). These zero tolerance attributes are shaded in Table 1.3 and in form 1E.

For many of the physical variables obtained from maps and air photos, interpretation is required. While many of these indicate “must be correct,” the inexact nature of the information must be considered in error rates and consequences. The intent is to have the majority of these fields correct, therefore some error is tolerable.

Table 1.3. Summary of reach attributes and quality checking requirements. Note that shading indicates zero error tolerance.

Attribute (marks)	Checking requirements
Project name	Must be consistent with contract information
Project code	Must be consistent with contract information
Interim locational point or watershed code	Either ILP or watershed code must be provided and shown on TRIM map pointing to the stream. If ILP is used the ILP map number must be correct. The ILP and ILP map # together must be unique. No errors are allowed in this field.
Reach break position	The upper reach break must be in correct position. There should be no locations where obvious reach breaks were missing. QA team should work with recipient to standardize reach break positioning.
Reach number	Reaches must be numbered sequentially in an upstream direction, starting at 1 at the downstream end. No errors are allowed in reach numbering.
Reach symbol	Mapped reach symbols must be correct
Map number	Must be correct (TRIM map if available; otherwise NTS map). No errors are allowed.
Map status	Must be correct. No errors are allowed.
Order	Must be correct
Upstream elevation	Must be accurate to within 25% of the contour interval in low relief, and 50% of contour interval in high relief areas, as measured from the TRIM map. Downstream elevation must be less than or equal to upstream elevation.
Downstream elevation	As above
Length	Must be accurate to within 10% or 1 cm, whichever is less, as measured from the TRIM map
Gradient	Not a required check as this is a calculated field
Pattern	Must be within one class
Confinement	Must be within one class
AN/BR	Must be correct
Basin type	Must be within one level of the watershed classification hierarchy
Features	
NID number	A unique numerical identifier (NID) associated with the reach feature. Must be present in FDIS and on the interim map, and must be unique to the map; no errors are allowed.
Symbols	Must use the correct symbol for each feature
Sampled reaches	
BCG zone	Must be correct
Setting	Must be correct
Open water	Must be correct
Coupling	Must be within one class
Valley flat	Must be correct
Active floodplain	Must be correct
Islands	Must be within one class

Bars	Must be correct

Table 1.3. Continued.

Attribute (marks)	Checking requirements
Disturbance indicators	Must be correct
Mass movement	Must be within one class
Riparian vegetation	Must be correct
Exposed/Eroded	Must be correct
Land use	Must be correct

Combined Check of Lake Data (Form 1F)

The lake planning table is completed for each lake in the survey area. Quality control for this group of attributes can be carried out using form 1E. For easy reference, the specific cards to be checked are listed at the beginning of form 1E. Recipients should make corrections on the forms as required. Table 1.4 below lists each attribute on the lake planning table and its checking requirements, which should be checked at this stage, along with details of what to check for that attribute. Specific errors are recorded on the form as the cards are checked.

Table 1.4. Summary of lake attributes and quality checking requirements. Note shaded attributes indicates zero error tolerance.

Attribute	Checking requirements
Watershed code	Must be correct
Waterbody identifier	Must be correct
ILP map number	Must be correct
Interim locational point	Must be unique, and must be shown on TRIM map pointing to the outlet of the lake. The ILP and ILP map # together must be unique.
NID and NID map number	Both must be correct
UTM	Must be correct
Reach number	Must be correct and must be correctly shown on the TRIM map
Basin type	Must be within one level of the watershed classification hierarchy
Group	Must be indicated
Class	Must be indicated
Genesis (1)	Must be correct at broad category level
Surface area	Must be within 5% of true surface area
Magnitude (1)	Must be correct
Biogeoclimatic zone	Must be correct
Waterbody type	Must be indicated

Aerial Overflight and Video (Form 1G)

Aerial videography may have been carried out to corroborate decisions regarding map layout, reach and barrier locations and sampling design. This inventory step is optional, and may be conducted as part of inventory phase 3 or phase 4. If done, the video record must meet standards in terms of format, referencing and content.

The format of the original video data should be supplied as Hi-8. One VHS copy must be provided.

The video should be referenced in the proper format (Project code – year – video number), and a copy of the data log sheet must be included (Figure 7 from *Aerial Photography and Videography Standards: Applications for Stream Inventory and Assessment.* 1997).

The content of the video must follow standards (FRIM appendix 4), and the quality must be acceptable (i.e., useable). The QA team should ensure that observations from the aerial flight and video are incorporated into the analysis of reach and lake characteristics, and noted on features cards if appropriate. The video needs to be run through to the end to ensure that the level of quality is consistently high throughout. The checklist on form 1F should be used while checking the aerial overflight and video.

Specifications: FRIM appendix 4; *Aerial Photography and Videography Standards: Applications for Stream Inventory and Assessment.* 1997. Figure 7.

Field Sampling Design and the Project Plan (Forms 1H, I, J)

In many cases, there will be pressure to approve field project plans in order that crews can get into the field. If this is the case, plans may be approved. However, a written agreement should be made indicating that final QA of the pre-field data has not been completed and any errors resulting from planning information must be corrected in the final deliverable products.

Stream Reach Sampling Design (Form 1H)

Reach sample sites are selected as random and as discretionary sites. The appropriate random reach sample size requirements are selected on the basis of the total number of reaches classified by gradient, size and channel pattern. Discretionary sample sites are added to address specific fish distribution questions. The stream reach sampling plan is summarized in the reach planning table of FDIS.

The automated FDIS routines should be used to select the random sites. Resulting sampling rates by reach classification should match those presented in the reconnaissance standards manual.

The QA team should ensure that the discretionary sites that have been added are added:

1. to determine fish distribution limits (e.g., above and below some barriers)
2. at major inlets and outlets of secondary lakes
3. at all inlets and outlets to primary lakes (mandatory)
4. to ensure adequate representation of all basin types in the sample design
5. in consideration of access
6. in consideration of the location of WRP fish habitat assessment projects (to avoid duplication of effort).

It is important for the sampling design to include representation of all major reach types (including reaches > 20% and higher order streams), and to ensure that site distribution covers the watersheds as well as possible. It is expected that the design will be flexible to account for existing information, logistical constraints (e.g., access), and fish species life history (e.g., timing of spawning). It is the responsibility of the QA team to make sure the sample design is developed according to standards before the contract monitor's review. Form 1H should be used while checking stream reach classification and the sampling plan.

The QA team should also check that reaches selected randomly to be sampled are shown on the TRIM maps with solid green lines, and that discretionary samples have been added and indicated using dashed green lines.

Specifications: FRIM section 2.4.4

Lake Sampling Plan (Form 1I)

The lake sampling plan is summarized in the lakes planning table. The QA team should work through a number of lake groups to ensure that lakes have been properly classified as primary or secondary. All primary lakes to be sampled should be indicated on TRIM maps with a solid green line, and those secondary lakes recommended for sampling should be indicated with a dashed green line. The QA team should check that adequate spatial coverage of secondary lakes will result from the recommended sampling design. The selection of secondary lakes will depend largely on the project budget and the similarity of lakes within basins. Selection should be made in consultation with the contract monitor.

Specifications: FRIM section 2.4.5

Finalization of Sampling Design and Project Plan (Form 1J)

Phase 3 of a fish inventory project is the last phase before field work begins, and finalizes the project plan. It is at this stage that the contract monitor will be reviewing the sample plan in detail before approving the commencement of field work. Critical elements of the plan include:

- whether existing information and other ongoing activities in the watershed have been considered
- the distribution of water samples and voucher specimens
- specific sampling methods proposed for the range of habitat types expected
- whether an adequate budget is in place to complete the project as planned.

Form 1J includes a list of items to check before the project plan is finalized.

Specifications: FRIM section 2.6

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1A DELIVERABLE CHECKLIST FOR PRE-FIELD – PAGE 1 OF 1

Check to ensure that a pre-field project planning report was received in the correct format with all the associated deliverable products.

Pre-field Project Planning Report Deliverables	Hardcopy	Digital	Acceptable Y/N	Comments
1. Cover page				
2. Table of Contents				
3. List of digital products				
4. Overview map		N/A		
5. Existing data review • FISS map				
• list of references				
• list of contacts				
• new FISS information summary and products		N/A		
6. ILP data* • ILP data sheets				
• ILP map list				
• ILP maps or status report		N/A		
7. Interim maps* • map list • maps		Optional		
8. FDIS database	N/A			
• FDIS QA Report				
9. Sampling design sheets				
10. Aerial video record (optional)	N/A			
11. Project plan				
12. Pre-field Planning Report complete	N/A	N/A		
13. Related items required to perform QA • Air photography		N/A		

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

* If ILP maps and ILP data sheets have been sent to the ministry for processing, ILPs must be shown on the interim maps to allow QA to proceed.

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Submitted by: _____

QA review by: _____ **Review date:**_____

FORM 1B **EXISTING DATA REVIEW – PAGE 1 OF 1**

Deliverable	Deliverable check	Acceptable Y/N	Comments
List of contacts	Is list of contacts provided in acceptable format?		
	Have all relevant contacts for the project area in question been pursued?		
	• If **NO**, report known important contacts not provided on list.		
Bibliography	Is bibliography provided in acceptable format?		
	Does the bibliography adequately cover the information known to be available for the project area in question?		
	• If NO, report known available information that was not provided in bibliography.		
FISS information	Has FISS update information been provided for new sources of fisheries information that were not referenced in FISS as required in the contract:		
	• FISS forms		
	• clean NTS maps		
	• a copy of each new source provided		
	• a reference to each new source provided		
	• If NO, report required information not provided.		

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1C **INTERIM LOCATIONAL POINT MAPS AND DATA SHEETS – PAGE 1 OF 1**

ILP Deliverables

		Y/N	Comments
ILP map	Provided as separate ILP maps		
	Provided as part of interim maps		
	Maps and ILPs legible		
ILP data sheet	Complete/consistent with TRIM maps		
	Tables match standard		
	UTMs provided for areas of congestion		

Are ILP deliverables acceptable (Y/N)?

Comments:

Complete ILP Coverage

	TRIM sheet	Basin reference	N streams with watershed codes	N streams with ILPs	N streams without ILP or watershed code	N inconsistencies between ILP map and ILP data sheet
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Submitted by: _____

QA review by: _____ **Review date:**_____

FORM 1D **INTERIM MAP DATA – PAGE 1 OF 1**

Interim Map Summary

Map item	Present	Legible	Comment
Watershed codes			
Waterbody identifiers			
ILPs			
Forest cover map streams (optional)			
Watershed boundaries			
Reach boundaries			
Existing features with NIDs			
New features with NIDs			
Proposed reach sample sites (random/discretionary)			
Proposed lake surveys (primary/secondary)			

Approved: ❑ **Y** ❑ **N** **Recommended actions:**

FISS Information

Randomly select and check ten features on the FISS maps to ensure correct information transfer.

	1	2	3	4	5	6	7	8	9	10
FISS map #										
Interim map #										
FISS feature										
Transferred (Y or N)										
Location correct										
Symbol correct										
NID present										
Total errors										

QA Summary

Number of marks (10 features × 4 items): 40 Maximum number of errors acceptable (12%): 5

Number of errors found: _____ Is the number of errors acceptable: ❑ Y ❑ N

Approved: ❑ **Y** ❑ **N**

Comments: **Recommended actions:**

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1E **COMBINED CHECK OF STREAM REACH DATA – PAGE 1 OF 2**

List of reaches checked (FDIS /Interim maps/air photos)

	1	2	3	4	5	6	7	8	9	10
TRIM map #										
ILP #										
WSC										
Reach #										

For all reaches	1	2	3	4	5	6	7	8	9	10	Comments
Watershed code **or** ILP # and ILP map #											
ILP sheet, FDIS, ILP (or interim) map all match											
NID # and NID map # **or** UTM (optional, but no errors allowed; do not include in marking scheme)											
TRIM map number											
Reach number											
Reach break location											
Reach map symbol											
Map status											
Order											
Upstream/Downstream elevation											
Length											
Pattern											
Confinement											
AN/BR											
Basin type											
Total errors											
Shaded cell errors											

Features	1	2	3	4	5	6	7	8	9	10	Comments
NID and NID map number											
Map symbol											
Total errors											
Shaded cell errors											

Note: Any error identified in a shaded cell constitutes a failure.

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Submitted by: _____

QA review by: _____ **Review date:**_____

FORM 1E **CONTINUED – PAGE 2 OF 2**

Reaches to be field sampled	1	2	3	4	5	6	7	8	9	10	Comments
BCG zone											
Setting											
Open water											
Coupling											
Valley flat											
Active floodplain											
Islands											
Bars											
Disturbance indicators											
Mass movement											
Riparian vegetation											
Exposed/Eroded											
Land use											
Total errors											

QA Summary

	All reaches		Features		Sampled reaches	
Number of reaches sampled						
Number of marks (N reaches sampled × attributes)	N×15		N×2		N×13	
Maximum errors acceptable (12% of marks)						
Number of errors found						
Is the number of errors acceptable (Y/N)						
Number of errors in zero-tolerance attributes						

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1F **COMBINED CHECK OF PRE-FIELD LAKE INFORMATION – PAGE 1 OF 1**

List of lakes checked (FDIS/Interim map/air photo)

	1	2	3	4	5	6	7	8	9	10
ILP # or WSC										
Reach #										
Map #										

Attribute	1	2	3	4	5	6	7	8	9	10	Comments
Official name											
Alias or local name											
WSC and waterbody identifier "**or**"											
ILP number and ILP map number											
NID # and NID map #											
UTM (optional, but no errors allowed; do not include in marking scheme)											
Reach number											
Basin type											
Group											
Class (P/S)											
Genesis											
Surface area											
Magnitude											
Biogeoclimatic zone											
Wetland											
Total errors for each lake											

Note: Any error identified in a shaded cell constitutes a failure.

QA Summary

	Lakes	
Number of lakes sampled		
Number of marks (N lakes sampled x attributes)	N×13	
Maximum errors acceptable (12% of marks)		
Number of errors found		
Is the number of errors acceptable (Y/N)		
Number of errors in zero-tolerance attributes		

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Submitted by: _____

QA review by: _____ **Review date:**_____

FORM 1G **AERIAL OVERFLIGHT AND VIDEO – PAGE 1 OF 1**

Task checked	Acceptable (Y/N)	Comments
Is video data Hi-8™ ?		
Is a VHS copy of the video provided?		
Is the video referenced properly (Project code – year – Vx)?		
Is the data log sheet provided and filled out?		
Is the quality of the video image acceptable?		
Is the video continuous along the stream network?		
Is there voice annotation of significant features?		
Is the video labelled properly?		
Are significant features cross-referenced to the map base?		
• reach break verification		
• potential barriers to fish		
• changes in the stream network that are not identified on the map		
• stream complexes that are not adequately represented on the map		
• significant habitat alterations due to resource extraction activities		
• points of access		
• other points of interest.		

Note: Any error identified in a shaded cell constitutes a failure.

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1H **STREAM SAMPLING DESIGN – PAGE 1 OF 1**

	Acceptable (Y/N)	Comment
Is the inventory watershed based (i.e., entire watershed)?		
Are **random** reaches selected for sampling based on the FDIS statistical sampling design?		
For low gradient or small/medium sized streams, is the sample size of reaches ≥ 8?		
For higher gradient (20–30%) or large sized streams, is the minimum sample size 2 and maximum 25?		
Are **discretionary** reach samples included?		
• above or below barriers		
• adjacent to identified cutblocks		
• major inlets and outlets to secondary lakes		
• of inlets and outlets to primary lakes		
• to achieve connectivity within sub-basins for fish distribution and identification of upstream limits.		
Are proposed reach sample sites shown on TRIM maps with solid and dashed green lines?		
Are planning tables complete with gear and voucher requirements indicated?		
Does the distribution of sample sites adequately represent all basin types and basin connectivities.		
Is the overall sampling rate (sample number vs total number of reaches) acceptable?		
Does the sample design adequately cover the requirements for a reconnaissance inventory?		

Note: Any error identified in a shaded cell constitutes a failure.

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Submitted by: _____

QA review by: _____ **Review date:**_____

FORM 1I **LAKES SAMPLING DESIGN – PAGE 1 OF 1**

	Acceptable (Y/N)	Comment
Is the lakes planning table complete and accurate (including classification of lakes as primary, secondary or not sampled)?		
Will all identified primary lakes be sampled?		
Is there at least one lake from each lake group identified that will be sampled?		
Will at least 20% of all identified secondary lakes be sampled?		
Is justification provided for those lakes that will not be sampled?		
Are lakes proposed for sampling outlined on TRIM maps with solid and dashed green lines?		
Are planning tables complete with gear and voucher requirements indicated?		
Does the sample design adequately cover the requirements for a reconnaissance inventory? If no, the sampling design is rejected.		

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Submitted by: _____

QA review by: _____ **Review date:** _____

FORM 1J **PROJECT PLAN – PAGE 1 OF 1**

	Acceptable (Y/N)	Comment
Does the project plan cover field inventory procedures?		
Does the project plan cover data compilation?		
Does the plan cover reporting requirements?		
Does the plan include proposed staff for field phase?		
Has existing data been considered and used in the project plan?		
Have sampling intentions of relevant WRP projects or other inventory project requirements been incorporated into the plan to avoid duplication?		
Has the plan integrated the sampling of lake and stream habitats, in particular, with any aerial over flights and sampling of lake tributaries?		
Have requirements for effective sampling methods in relation to stream reach and lake types been addressed?		
Have requirements for biological and water samples been properly considered?		
• water sampling particularly in primary lakes		
• fish voucher specimens		
• other samples.		
Does and should the plan incorporate any special fish species level inventory needs on a provincial or regional scale?		
Are budget and schedule adequate to complete the project as planned?		
If the answer to any of the above is no, is this going to have an impact on the inventory project? If so, the project plan is rejected.		

Approved: ❑ **Y** ❑ **N**

Comments:

Recommended actions:

NOTES

STAGE 2 QA: FIELD DATA COLLECTION

Phase 4 of a fish inventory project involves field sampling of stream reach sites and lakes as specified in the sampling plan. QA during the field program consists of a **field audit**. The field audit is designed to ensure that each field crew is appropriately trained, equipped and competent in the field, understands data collection techniques and standards, and is able to properly record data. General checks in the field audit include:

- Field crew is appropriate (as per contract)
- Field crew has appropriate training and permits
- Field crew is equipped to do the job. This includes ensuring that equipment is appropriate and that data forms, field maps and field guides (manuals) are available to the crew.
- Field crew can demonstrate proper use of equipment
- Field crew can complete data forms properly (that they understand what the fields and choices are, and can record properly on the form).

Up to four QA forms are used for the field audit, depending on the focus of the field inventory (Table 2.1). All field crews are checked to ensure they are appropriately staffed and that required permits are present. Each crew should have a safety plan, developed according to company procedures. Crews involved in stream inventory are checked using site card and fish collection check procedures, and crews involved in lake inventory are checked using lake survey form and fish collection check procedures.

Table 2.1. Field data collection quality assurance

Field crew	Quality assurance checked	QA form
All field crews	Crew information, permits and safety	2A
Stream inventory	Site card procedures	2B
	Fish collection procedures	2D
Lake inventory	Lake survey procedures	2C
	Fish collection procedures	2D

The field QA should be conducted for each attribute on the appropriate forms. The crew members must demonstrate their competence at performing each task. The checks on field procedures should be applied independently to each field crew. Any problems or difficulties that the crew has in carrying out the tasks should be explained on the form. If there are deficiencies in the techniques, the QA team should make sure the crew understands the correct technique. The ministry representative should discuss immediately with the contractor any problems with the work.

The field audit is critical in that it represents the only opportunity to detect and prevent potential errors in field data collection. Errors that occur in the field are difficult if not impossible to detect after the fact, and are extremely expensive to correct. It is critical that the field QA occur early in the field season (week 1) to avoid cumulative errors in the data. The QA team should arrange the field check on short notice.

Prior to conducting a field audit, the QA team should familiarize themselves with the inventory project plan and service contract.

On completion of the field audit, the QA team shall prepare and send a letter to the contract manager and the ministry representative outlining any significant concerns and other problems with field work. A copy of all field audit forms must accompany the letter.

Crew Information, Permits and Safety (Form 2A)

QA form 2A is used to check both stream site and lake inventory crews to ensure that the field crew has appropriate expertise as listed in the project plan, that the crew has the required permits, and that each crew member has the appropriate certifications and training. The QA team should ensure that the crew has a safety plan in place and that this plan is followed.

Crew information includes crew member names, general area of expertise and whether they are listed in the project plan (or contract). This also includes checking first aid and electrofishing certification (if applicable).

Permits required to conduct fish collection in the field include both provincial and federal government fish collection permits.

Safety for the worker is regulated by the Workers' Compensation Board (WCB). All crew members must be apprised of the relevant parts of the WCB *Occupational Health and Safety Regulations*. If the QA team observes any obvious contravention of WCB regulations, the employer should be notified.

If the required crew expertise, permits or certificates are not present or valid, the QA team should notify the project leader and the ministry representative.

Specifications: Workers' Compensation Board *Occupational Health and Safety Regulations*, BC Regulation 296/97.

Field Audit of Stream Inventory

The field audit for stream inventory includes checking that stream site data are collected following appropriate techniques and that the site cards are properly and completely filled out. It also includes checking that fish sampling is conducted following appropriate techniques and that the fish collection form is properly filled out.

Stream Site Inventory (Form 2B)

A field audit of crews conducting stream inventory should include site selection, whether appropriate equipment is available, calibrated and properly used, and that site card characteristics are collected and recorded properly. QA form 2B is provided to record these items.

Site Selection: The QA team should check that site selection within the reach is appropriate. The site should be representative of the reach, and should be away from disturbances such as bridge crossings. Site length should be the greater of 100 m or 10 bankful channel widths (see FRIM section 4.2.2).

Field sampling should be completed during low flow conditions. If unusually high (or low) flow conditions are encountered, impacts on fish sampling and habitat description should be noted.

Materials and Equipment: It is important to confirm that the field crew has appropriate materials and equipment to properly conduct measurements and record on the site card. Basic materials required include a supply of site cards, reference materials such as the Site Card and Fish Collection Form field guides, and appropriate field maps with stream and site referencing information. Field equipment is required to measure site characteristics such as site length, channel characteristics such as channel and wetted widths, depths and gradients and physical characteristics of the water (temperature, pH, conductivity). The equipment used is to be recorded, as is whether the equipment was properly calibrated and properly used in taking measurements.

Site Card and Data Collection: The QA team should ensure that the field crew understands the meaning of all of the attributes on the site card, and of all the codes required to complete each field. Field crews must also understand the method of collection and the recording procedure for each attribute. The QA team should ensure that site cards are *completed* in the field.

The site card procedures check form (form 2B) lists each field on the site card. Fields are grouped by general category. Details of each field are provided in the *Site Card Field Guide*. For each field, errors or problems are recorded as an X under **Technique** or **Data**. Technique refers to knowledge of each attribute and data collection procedures. The QA team must ensure that, for example, channel measurements are correctly taken at appropriate locations and intervals according to the field guide. As many of the fields require visual estimates and percentage classifications, results should be discussed with the field crew. The main focus should be on knowledge of the attributes rather than exact results. Data refers to ensuring that data are correct and recorded appropriately on the site cards. When an error is detected, make sure that details of the error are recorded in comments.

For referencing, several fields are completed in the pre-field phase (e.g., stream name, watershed code, ILP#, ILP map #, NID #, NID map #, reach #). These should be filled in on the site cards while present in the field. The remainder of referencing fields are completed while in the field following the standards.

For each group of information, an **equipment** check is given. Ensure that equipment to measure group features is available and appropriate. This is a summary of the equipment list done above.

Specifications: *Site Card Field Guide* (RIC 1999).

Field Audit for Lake Surveys (Form 2C)

The field audit for lake inventory includes checking that lake inventory data are collected following appropriate techniques and that the lake survey forms are properly and completely filled out, and that fish sampling is conducted following appropriate techniques and that the fish collection form is properly filled out.

The field audit for lake surveys covers the entire suite of activities done for a primary lake reconnaissance level survey. A subset of these activities are checked for a secondary lake survey. The field audit covers equipment and materials availability, condition and use, procedures used to collect inventory information and data recording. Form 2C is used to check field survey procedures.

Materials and Equipment: Several aspects of the lake survey have significant equipment requirements. It is important that lake inventory crews have and use equipment appropriately. The QA team should list the equipment used to conduct the survey and confirm that the equipment is functioning properly, has been calibrated and is properly used. Back-up equipment should be readily available. The QA team should carry their own meters for verifying the crew's results.

Field mapping and reference materials are important to carry in the field. These include the lake outline and other maps, and reference materials to assist in completing the lake survey form.

Lake Survey Form and Data Collection: The QA team should ensure that the field crew understands the meaning of all of the attributes on the lake survey form, and of all the codes required to complete each field. Field crews must also understand the method of collection and the recording procedure for each attribute. QA should ensure that lake survey forms are *completed* in the field.

The lake survey procedures check form (form 2C) lists each field on the lake survey form. Fields are grouped by general category. Details of each field are provided in the *Lake Survey Form Field Guide*. Equipment available for each category and important data collection techniques are also listed. For each field, errors or problems are recorded as an X under **Technique** or **Data**. Technique refers to knowledge of each attribute and data collection procedures. As many of the fields require visual estimates and percentage classifications, results should be discussed with the field crew. The main focus should be on knowledge of the attributes rather than exact results. When an error is detected, record details of the error in the comments field. Data refers to ensuring that data are correct and recorded appropriately on the site cards.

For **waterbody referencing**, many fields are completed in the pre-field phase. These should be filled in on the lake survey forms while present in the field. The remainder of the waterbody referencing fields are completed while in the field following the standards.

For each group of information, an **equipment** check is given. Ensure that equipment to measure group features is available and appropriate. This is a summary of the equipment list done above.

For **lake bathymetry**:

- The field crew must be equipped with an acceptable sounder and sounding line. A lake outline map must be available to record transect information.
- Technique is important to check and includes constant speed and direction, and techniques used to operate the sounder to achieve desired results. Transect information must be recorded on the sounding chart and on the lake outline map.

For the **limnology station**:

- Location and set up of the station should be checked. The station should be established at the deepest point of every distinct basin within a lake. The boat must be anchored.
- The required water samples must be taken at appropriate depths. For lakes < 6 m maximum depth, one sample from surface. For lakes > 6 m depth, one surface sample (at 0.5 m) and one bottom sample (1 m above bottom) are required. An additional bottom metals sample in separate container with fixative may be required (check project plan). Specifications: FRIM section 3.2.11.8.
- The water samples must be labelled appropriately.
- For profiles, temperature measurements should be done to determine the depth of the thermocline. Oxygen profiles should cover the water column. Ascending and descending recordings are required.

Specifications: *Bathymetric Standards for Lake Inventories*. Version 2.0. RIC 1999;
Ambient Freshwater and Effluent Sampling Manual. RIC 1994;
Lake Survey Form Field Guide. RIC 1999.

Field Audit for Fish Collection (Form 2D)

The field audit for fish collection includes checks to ensure appropriate effort has been applied and that sample site selection and sampling techniques have been properly done. Equipment function and use is also checked. Data collected on the fish form are also checked. Form 2D is used to check fish collection field procedures.

Equipment and Materials: The field crew must have appropriate sampling gear for the lake or stream in question.

- For **lakes**, gill nets, minnow traps and other appropriate gear is required.
- For **streams**, this includes an approved electroshocker, minnow traps and any other appropriate gear. The field crew must be equipped to conduct sampling following at least two methods.
- Ancillary fish capture equipment such as dip nets, stop nets and buckets to hold fish must also be available.
- Check the condition of all gear. In the case of the electroshocker, the field crew should demonstrate that the safety features and settings are functioning properly.

Sample Site Selection, Sampling Effort and Technique: The amount and location of sampling effort and sampling techniques should be checked. This includes techniques and equipment used for sampling.

- For **lakes**:
  - The standard reconnaissance sample normally includes two overnight gill nets plus minnow traps. Any variations to this must be justified.
  - Duration of sampling should be adequate to catch the required number of fish for the present study but should not create undo stress on the fish population. A minimum of one overnight gill net set is required for primary lakes.
- For **streams**, the standard reconnaissance sample covers 100 m of stream or 10 bankful channel widths. The site must be the same as that described on the site card. The QA team should ensure that the entire site is sampled, covering all habitat types using a variety of appropriate techniques. If only one methodology is employed, this should be justified (e.g., all habitats can be effectively sampled using a single technique). If sampling does not cover the standard stream length, the shorter sample must be justified (e.g., excessive fish captures).
- Ensure that the electrofisher is functional by checking the switches and outputs.
- Electrofishing technique should be checked to ensure that:
  - The electrofisher is operated safely
  - All habitats are covered in the site
  - Effective fish capture technique is evident. This includes anode and dip net operation, electrofisher settings (e.g., voltage, pulse width)
  - Impacts on fish are minimized (e.g., burn marks, recovery and mortality).

Fish Collection Form and Data Collection: The QA team should ensure that the field crew understands the meaning of all of the attributes on the fish collection form and of all the codes required to complete each field. Field crews must also understand the method of collection and the recording procedure for each attribute. The QA team should ensure that fish collection forms are *completed* in the field.

The fish collection procedures check form (form 2D) lists each field on the fish collection form. Details of each field are provided in the *Fish Collection Form Field Guide*. For each field, errors or problems are recorded as an X under **Technique** or **Data** as for other forms

Field Audit for Individual Fish Data

Information about individual fish captured is collected in both lake and stream sampling. The QA team should check that the field crew has appropriate equipment to process the fish. Processing includes measuring and recording fish data on the individual fish data card and also includes collecting, recording and labelling any samples (e.g., voucher, aging, genetic materials). Results are recorded on QA form 2D.

Equipment and Materials: The field crew should have fish keys available to assist in fish identification. Appropriate containers for fish processing and recovery should be available. Equipment for collecting data on individual fish includes a measuring board (or ruler) and weigh scales (optional for stream sampling). Appropriate equipment and materials for sample collection (e.g., age sampling materials such as scale envelopes and preservative, labels and containers for voucher specimens) should also be available.

Fish Handling: The QA team should check that fish are properly handled. Field crew members must know how to handle fish in order to take detailed measurements and minimize handling stress and fish mortality.

Fish Identification and Fish Samples: Correct identification of fish captured is critically important to the inventory program. QA of fish identification is checked in the field as well as through voucher specimens collected for the project area.

- The QA team should check to ensure the crew is correctly identifying fish. Verify the fish identifications of the crew in the field.
- Ensure the field crew has a fish identification key and is able to use it properly.
- Ensure that procedures are followed to deal with any fish captured which the crew cannot identify. Fish captured which the crew cannot identify certainly must be collected, labeled, preserved and sent through appropriate channels (e.g., project biologist) for expert identification.

A system of voucher specimen collection is in place to confirm fish species identification by field crews in the project team. Voucher sampling requirements are a component of the project plan. QA procedures in the field include ensuring the crew is aware of the voucher requirements set out in the project plan, and that materials are in place to collect the appropriate specimens. Any fish collection must follow appropriate techniques.

Further QA of fish identification will occur in stage 3, including reviewing evidence of voucher specimen species identification confirmation and the incorporation of fish identification into the final database, reports and maps.

Fish aging structures such as fish scales, otoliths and fin rays are routinely collected to determine fish age. All samples taken must be properly preserved, packaged and labeled. Results of fish aging must be incorporated into the final database, reports and maps, and are checked in stage 3 of the QA procedures.

Collection of fish tissue for various purposes, including analysis of genetic materials, may be part of the inventory. Requirements should be set out in the project plan. All samples taken must be properly preserved, packaged and labeled.

Individual Fish Data Form and Data Collection: The QA team should ensure that the field crew understands the meaning of all of the attributes on the individual fish collection form, and of all the codes required to complete each field. Field crews must also understand the method of collection and the recording procedure for each attribute. Ensure that individual fish collection forms are *completed* in the field.

The individual fish data procedures check form (form 2D) lists each field on the fish collection form. Details of each field are provided in the *Fish Collection Field Guide*. For each field, errors or problems are recorded as an X under **Technique** or **Data** as for other forms. It is important that individual fish data forms are linked to fish collection forms through the fish collection form number box.

The QA team should ensure that the field crew is sampling enough fish.

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Contractor: _____

Field audit by: _____ **Site identifier:**_____ **Field audit date:**_____

FORM 2A **FIELD AUDIT: CREW INFORMATION, PERMITS AND SAFETY**

Crew information

Crew members' names	Listed in contract or plan	Area of expertise (bio, geo, other)	First aid		Electrofishing	
			Level 1	Transport-ation	Crew member	Crew leader

QA comments about crew and/or certifications:

Permits and safety plan

Group	Item	Acceptable		Specify problem
		Y	N	
Permits	MELP fish collection permit			
	DFO fish collection permit			
Safety plan	Safety plan in place Is safety plan followed			

QA comments about permits and safety:

Note: If any obvious WCB regulations are contravened, the QA team must immediately inform the responsible contract manager and the ministry representative.

Field Audit Confirmation

Field audit leader: _____ For field crew: _____

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Contractor: _____

Field audit by: _____ **Site identifier:**_____ **Field audit date:**_____

FORM 2B **FIELD AUDIT FOR STREAM SURVEYS: SITE CARD PROCEDURES CHECK – PAGE 1 OF 2**

Materials present in field	Y	N	Notes
Site cards			
Field reference materials			
Field maps			

List equipment used	Calibrated (Y/N)	Proper use (Y/N)	Notes

Group	Item	Acceptable		Notes
		Tech.	Data	
Site selection	Representative site			
	Conditions appropriate			
Reference	Stream name (Gaz)			
	Alias			
	WSD code or			
	ILP # and ILP map #			
	Map NID and NID map #			
	Field UTM (and method)			
	Reach number			
	Site number			
	Site length (and method)			
	Access			
	Date, time			
	Agency			
	Crew			
	Fish form			
Channel	Equipment			
	Channel widths			
	Wetted widths			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FORM 2B **CONTINUED – PAGE 2 OF 2**

Group	Item	Acceptable		Notes
		Tech.	Data	
Channel (cont.)	Residual pool depth			
	Bankful depth			
	Gradient			
	Stage			
	NVC; Dry/Int; DW; Tribs			
Cover	Total cover			
	Cover elements • amount			
	• location			
	Crown closure			
	Large woody debris			
	• function			
	• distribution			
	Instream vegetation			
	Left and right bank shape			
	Texture			
	Riparian vegetation			
	Stage			
Morphology	Flood signs			
	Bed material			
	D95			
	D			
	Morhpology			
	Disturbance indicators			
	Channel pattern			

Group	Item	Acceptable		Notes
		Tech.	Data	
Morphology (cont.)	Islands			
	Bars			
	Coupling			
	Confinement			
Water	Equipment			
	Temperature			
	pH			
	Conductivity			
	Turbidity			
Features	NID map #, NID			
	Type			
	Height, length			
	Photo			
Habitat quality	Keywords			
	Relevant comments			
	FSZ			
Photodocu-mentation	Roll #			
	Photo #			
	Focal length			
	Direction			
	NID #, NID map #			
	UTM and method			
Wildlife	Group			
	Relevant comment			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Contractor: _____

Field audit by: _____ **Site identifier:**_____ **Field audit date:**_____

FORM 2C

FIELD AUDIT FOR LAKE SURVEYS: LAKE SURVEY PROCEDURES CHECK – PAGE 1 OF 3

Materials present in field	Y	N	Notes
Lake survey forms			
Field data reference			
Lake outline maps			
Field maps			

List equipment used and available	Calibrated (Y/N)	Proper use (Y/N)	Notes

Group	Item	Acceptable		Notes
		Tech.	Data	
Waterbody	Class of wetland or lake			
	Fish collection form			
	Lake name (Gaz, local)			
	Watershed code or			
	ILP#, ILP map #			
	Waterbody ID			
	Reach #			
	Project ID			
	NID map #, NID #			
	UTM			
	Magnitude			
	Surface area, source			
	TRIM map #, year			
	Air photo reference			
	Elevation, source			
	Biogeoclimatic zone			
Terrain characteristics	Setting			
	Aspect			
	Hillslope coupling			
	Lake basin genesis			
	Land use %			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FORM 2C **CONTINUED – PAGE 2 OF 3**

Group	Item	Acceptable		Notes
		Tech.	Data	
Shoreline characteristics	Shoreline type %			
	Cover			
	Recreational features			
Inlets/Outlets	Inlets/outlets (#)			
	Inlet spawning			
	List of inlets/outlets			
	Watershed code or			
	ILP #, ILP map #			
Survey information	Start, end dates			
	Agency			
	Crew			
Access	Mode (air/road)			
	Auto within			
	Off road and distance			
	Trail, distance			
	Closest community			
	Comments			
Aquatic flora	Emergent vegetation			
	Dominant species			
	Submergent vegetation			
	Dominant species			
	Floating algae			
	Species list			
	Voucher specimens			
Lake bathymetry	Equipment			
	Bathymetry techniques			
	Bathymetric data recording			
	Type of survey			
	Littoral area			
	Maximum depth			
	Benchmark height			
	Benchmark type/location			
	Maximum water level			
Photodocu-mentation	Roll #			
	Photo #			
	Focal length			
	Direction			
	NID #, NID map #			
	UTM and method			
Aquatic wildlife	Group			
	Species/Comments			
Weather	Visual observations			
Limnological station	Properly located			
	Equipment			
	Station no.			
	Date, time			
	UTM			
	EMS no.			
	Secchi depth			
	Water colour			
	pH (surface and bottom)			
	Ice depth			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FORM 2C **CONTINUED – PAGE 3 OF 3**

Group	Item	Acceptable		Notes
		Tech.	Data	
Water samples	Depth			
	Requisition #			
	Processing, labelling and transport to lab			
Profiles	Depth			
	Dissolved oxygen			
	Temperature			
	Conductivity			
	H_2S presence			
Equipment used				

Notes:
1.

Notes:

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Contractor: _____

Field audit by: _____ **Site identifier:**_____ **Field audit date:**_____

FORM 2D

FIELD AUDIT: FISH COLLECTION CHECK – PAGE 1 OF 3

Materials present in field	Y	N	Notes
Fish collection forms			
Individual fish data forms			
Field data reference			
Field key to freshwater fishes of BC			
Approved electroshocker			
Ancillary fish capture equipment (buckets, dip nets, stop net)			
Measuring board/ruler			
Weigh scale			
Fish samples (e.g., scale envelopes, tissue vials)			
Voucher containers, preservative, labels			

Sampling technique		Acceptable Y	Acceptable N	Notes
Lakes	Number and duration of gill nets set			
	Number and duration of minnow traps set			
	Other			
Streams	Site selection and length			
	Number and duration of minnow traps set			
	Other			
Electrofisher function	Tilt/safety switch			
	Main power switch			
	Anode deadman's switch			
	Quick release harness			
	Anode clean			
Electrofishing techniques	Safe operation and hand signals			
	Site coverage – all habitat types fished			
	Effective fish capture			
	Impact on fish			
Fish handling	Impacts on fish			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FORM 2D **CONTINUED – PAGE 2 OF 3**

Fish identification and fish samples		Acceptable		Notes
		Y	N	
Fish identification	Correct identification			
	Correct use of fish key			
	Procedure for unidentified fish			
	Knowledge of voucher sample plan			
	Voucher collection/labelling			
Fish samples	Age sampling, labelling			
	Genetic sampling/labelling			
	Other			

Fish Collection Form

Group	Item	Acceptable		Notes
		Tech.	Data	
Header	Name			
	Stream/Lake/Wetland			
	Watershed code or ILP			
	Waterbody ID			
	ILP map #			
	Project ID			
	Reach #			
	MELP fish permit #			
	Date start, end			
	Agency, crew			
	Resample			
Site/Method	Site #			
	NID map #, NID #			
	Site UTM			
	Method, method no.			
	Temp, cond., turbidity			
Fish summary	Site #			
	Method, method no.			
	Haul/Pass (H/P)			
	Species, stage, total #			
	Min. length			
	Fish activity			
Gear specifications	Site #			
	Method, method no.			
	Haul			
	Date, time in			
	Date, time out			
	Net type, length & depth			
	Mesh size			
	Set, habitat			
Electrofisher specifications	Site #			
	Method, method no.			
	Pass			
	Time in, time out			
	EF sec.			
	Length, width			
	Enclosure			
	Voltage, freq., pulse			
	Make, model			
Individual fish data	Fish collection form #			
	Site #			

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

FORM 2D **CONTINUED – PAGE 3 OF 3**

Group	Item	Acceptable		Notes
		Tech.	Data	
Individual fish data (cont.)	Method, method no.			
	Haul/Pass			
	Species			
	Length			
	Weight			
	Sex			
	Maturity			
	Age structure			
	Age sample #			
	Age			
	Voucher			
	Genetic structure			
	Genetic sample #			
	Photos			
	Number of fish sampled			

Notes:
1.

Notes:

Field Audit Confirmation:

Field audit leader: _____ For field crew: _____

NOTES

STAGE 3 QA: FINAL PROJECT DELIVERABLES

Quality assurance of final deliverables is conducted to ensure that all project requirements have been met and that all data and products are consistent and correct. This includes ensuring that the original data are received, that data are entered correctly into FDIS, that data are consistent between original data forms, FDIS, maps and reports and that individual lake and watershed reports are complete and comply with standards. A series of steps and activities to quality assure the final project deliverables are listed in Table 3.1. Checking requirements and forms follow.

Table 3.1. Quality assurance steps for final project deliverables

QA step	QA activities	QA form
Deliverable checklist	Ensure all required products are provided	3A
Over-flight and aerial video	Check format and documentation of video and ensure information is incorporated into field plan	1F
Electronic data check	Use the electronic checking capabilities of FDIS and the ARCView fish QA tool to detect errors in digital data sets.	3B
	FDIS QA – ensure that the complete FDIS database is provided, including watershed code, UTM and bathymetry updates as required. The electronic QA is run on FDIS and the QA report is provided.	
	Digital map files – run the ARCView QA Tool to files are of proper format and that data is correct and accurate.	
Data consistency	Sub-sample data to ensure that data are correct and consistent between the original data forms, FDIS and the final map and report products.	
• Reach/Site		3C
• Lake		3D
• Fish		3E, 3F
Individual lake report	Individual lake reports are checked for:	
	• content and format	3G
	• bathymetric map is checked (hardcopy and digital)	3H
	• lake outline map is checked	3I
	• annotated air photo is checked.	3J
Watershed report	The watershed report is checked for:	3K
	• content and format	
	• overview map (hardcopy and digital)	
	• project map (hardcopy and digital)	
	• interpretive map (hardcopy and digital).	
	The ARCView QA tool is used to check digital map products and related data.	
Fish identification	Ensure that fish identification QA has been done and results have been incorporated into inventory	3L

	products.
Project plan	Check that the inventory was done as proposed in the project plan.

Deliverable Checklist (Form 3A)

The first step is to determine that all required deliverables have been provided. A checklist of deliverables is provided (form 3A). If any of the appropriate deliverables are missing further QA cannot be conducted. The QA procedure then steps through each deliverable to ensure it is acceptable.

Overflight and Aerial Video (Form 1F)

Quality assurance of any aerial video record is discussed in stage 1. Form 1G (see p. 24) is used to report on the QA procedure.

Digital Data Checking (Form 3B)

There are many data elements that, unless correct, will produce errors that prevent the proper and further use of data. Generally these are errors in data such as watershed codes, sequential reach numbering or NIDs. Because **each** error is critical, all errors must be found and corrected. Exhaustive manual checking of each piece of data is extremely tedious and will almost certainly miss errors. Electronic checks and electronic data transfer procedures are the only practical way to ensure errors do not occur in these critical data elements.

Currently there are two digital data checking routines available. These work on FDIS and on digital mapping files. These digital checking routines allow the QA Team to check all data in the database. Critical data, that which must be correct in order for data processing routines to work, can also be checked. Any errors uncovered in the digital checking must be fixed.

FDIS database QA

The FDIS data entry screens ensure that only valid data are entered. Validation rules and automated database checks that are conducted within FDIS catch most errors involving invalid data. After the field program several uploading routines are run to replace interim data with final data. These include replacing ILPs with watershed codes, loading UTMs for NIDs and updating the lake bathymetry with processed data. FDIS should be checked to make sure these upload routines have been completed:

- have NIDs been replaced with UTMs
- have ILPs been replaced with watershed codes
- has bathymetry been updated.

If it was not possible to run these procedures, a different set of QA tests must be conducted to ensure these procedures will run when invoked (see below).

FDIS provides the capability to run a QA check on the entire data set. The FDIS QA is run and a list of errors is generated for each data set. Errors must be confirmed and true errors must be corrected in FDIS. The final QA report generated by FDIS showing that no true errors exist must be provided. Where identified errors are not in fact errors, an explanation is required (handwritten notes on the QA report is acceptable).

ARCView QA tool

A QA tool has been developed to check the three digital mapping files required as deliverables for each map. This tool also checks spatial accuracy of data points in relation to TRIM maps. As well as these

specific checks, more general checking of FDIS data to locate missing ILPs or watershed codes, duplicate NIDs or non-sequential reach numbering is also included. These are applied to the data and products of the data as appropriate. If errors are found, the original data (e.g., FDIS) must be corrected.

The ARCView fish QA tool has the capability to check critical data within digital mapping files and within FDIS. Deliverable digital files for the inventory include a series of tables as described in the *Standards for Fish and Fish Habitat Maps,* RIC 1998 and Errata 1999. These tables include a metadata table and a map features table (note the Map Features table as described in Errata 1999 replaces the point and attribute tables of the 1998 standard).

An ARCView fish QA tool has been developed to conduct quality assurance on these digital deliverable products. The checks include:

1. tables (metadata, map features) conform to the standard formats
2. field definitions in the tables are correct
3. cross reference NIDs between the point and attribute tables
4. correct feature codes are used
5. all features have attributes
6. missing watershed codes or ILPs.

Additional checks are included to confirm:

1. sequential reach numbering within a watershed code or ILP
2. point features are within 10 m of TRIM stream linework.

The ARCView QA tool generates a list of errors. These errors must be corrected in the digital mapping tables and in FDIS as appropriate. A final QA report indicating no errors exist must be provided as part of the QA deliverables.

For further information consult the ARCView fish QA tool documentation. The ARCView QA tool and documentation is available through the regional inventory specialist or through the BC Fisheries website at <http://www.bcfisheries.gov.bc.ca>. (Note: planning is underway to add the non-spatial data checking routines employed by the ARCView fish QA tool to the FDIS QA package.)

FHAT20 computer application model

The FHAT20 model is currently under development. The model utilizes data from FDIS and historic data to predict channel characteristics and fish distribution. The model requires that data, largely obtained from FDIS, are error free. Two critical data requirements include:

- stream reaches are sequentially numbered within a watershed code
- watershed codes must be hierarchical; all streams must have a parent (i.e., all streams flow into a stream one level up in the watershed code hierarchy).

FHAT20 uses the hierarchical watershed codes and sequential stream reaches to create the network for the project area modelling exercise. Errors in watershed codes or in stream reach numbering will cause errors in running the program, and may produce inappropriate modelling results. As FHAT20 is started, the data are initially checked. Errors are detected and error messages are provided. These errors must be corrected in order for FHAT20 to proceed. Once available, contractors should ensure FHAT20 requirements are satisfied and that all errors are corrected.

Digital mapping table production

Automated procedures are now available within FDIS to create the map features table. This will assist in data consistency. If the automated procedure is not used, consistency between FDIS and the map

features table must be checked manually. To check this, ensure that the number of reaches, sites and stream features in FDIS equals the number of reaches, sites and stream features in the related attributes table. All fish and physical information in FDIS should be in the related attributes table. Regardless of how the map features table was produced, checking procedures in the ARCView fish QA tool should be run as the final check.

ILP to watershed code conversion

One bottleneck that commonly occurs in the reconnaissance inventory program is the replacement of ILPs with watershed codes. If this has not been done, make every effort to ensure the data will be compatible when this procedure is finally run. One simple check is to ensure that the number of ILPs in FDIS matches the number of ILPs sent in the ILP data sheet, and watershed codes returned in the ILP to watershed code conversion table. It is conceivable that the generation of the watershed codes will be overlooked. When the watershed codes are uploaded, the numbers may not equate. As well, because the data entry of ILPs in FDIS and the production of the ILP to watershed code tables are independent, data entry mistakes can cause problems with the linkages.

NID to UTM conversion

A NID/UTM conversion table is created and uploaded to FDIS where the conversion is completed. The format of the table must be as described in the FDIS manual. The NIDs in the conversion table must correspond with the NIDs in FDIS. All NIDs must have a UTM.

Data Consistency

An extremely important issue for QA is consistency of the data collected in the field with that entered into FDIS and presented in final map and reporting products. The QA team must ensure that data errors have not been generated as a result of transcription errors between original field notes, field data entry into electronic databases, reporting and mapping. To do this, consistency must be checked between the original data forms, the digital database, the digital mapping data, and the hardcopy maps.

These are somewhat tedious checks and will be streamlined with the development of tools to assist in QA. New tools should be used as they come available. Until that time, the statistical approach of sub-sampling must be used.

Stream Data Consistency (Form 3C)

Quality assurance for digital stream data can be completed using form 3C. Since the first sections of the forms were checked previously (including consistency with the TRIM maps), and since the field measurements were checked in the field and cannot be checked from an office, the checking done at this time concentrates on:

- consistency between original hard copy site forms and digital data in FDIS
- consistency in attributes on the site forms with the final maps.

Any data that do not conform to standards should be detected and reported on as well.

The QA team must manually check an appropriate number and distribution of sample sites to make sure original hard copy field forms, digital data in FDIS, digital map files and final project and interpretive maps agree. As discussed in the introduction, the number of items to check varies with the project size (i.e., the number of sites in the project) and data attributes to check. Table 3.2 presents the number of site cards to check in relation to project size. The numbers are derived using the number of marks (n = 18) applied in checking data from the field site cards through to the project map

(see form 3C). Choosing a number of marks which flow through to the project maps will ensure adequate checking during the final mapping stages.

Table 3.2. Number of site cards required for consistency checking in relation to project size

Project size (n sites)	Lot size (n sites ´ 18 marks)	Required sample size	Site cards to check
			10 minimum
20	360	201	11
40	720	287	16
60	1080	326	18
80	1440	356	20
100	1800	375	21
200	3600	420	23
300	5400	435	24

The selection of sample sites must cover the entire project area (e.g., sites on all mapsheets). Specific sample sites that are checked should be listed at the start of form 3C so that they can be referred to afterwards and to show the recipient where the errors occurred.

All attributes on the site card are listed on form 3C. Consistency of the site card data with field data forms, FDIS, project maps and interpretive maps is checked. The "where to check" column lists which products the consistency check applies to for each attribute (e.g., fewer attributes are checked on the final mapping in comparison to FDIS). Any errors are recorded as an "x" for each attribute checked, and the location(s) of the error is recorded. Any data that does not conform to standards also constitutes an error. Acceptable error rates for data consistency have been set at 5% of the sample checked.

Specifications: *Site Card Field Guide*; *Standards for Fish and Fish Habitat Maps* (RIC 1998), Appendix 3.

Lake Data Consistency (Form 3D)

Quality assurance for lake data follows the same procedures as for the site card, and can be completed using form 3D. Each lake surveyed should be checked. The QA team must manually check all lake survey forms to make sure digital and hard copy forms agree, and that information is correctly transcribed to maps associated with the lake report. The maps to check include the bathymetric map, the lake outline map and the project map (e.g., lake summary symbol). Any data that do not conform to standards also constitutes an error.

Specifications: *Lake Survey Form Field Guide*; *Standards for Fish and Fish Habitat Maps* (RIC 1998), Appendix 3.

Fish Collection Data Consistency

Fish collection form (Form 3E)

Fish collection forms are checked for consistency using form 3E. Raw data recorded on field forms is compared with the data presented in FDIS and recorded on the maps. Fish data includes species information on the site data and lake summary symbols on the project maps, and the reach summary symbols on the interpretive map. Any transcription errors are recorded, as are errors in data with respect to the standards. All fish collection forms associated with the site cards and lake survey cards reviewed above are checked. Checking procedures are the same as those employed for site cards and lake survey forms. A total of 36 attributes are followed and checked.

Specifications: *Data Forms* and *User Notes* (fish collection form); *Fish Collection Form Field Guide*; *Standards for Fish and Fish Habitat Maps* (RIC 1998), Appendix 3.

Individual fish data (Form 3F)

Individual fish data associated with the each fish collection form are checked for consistency between the individual fish data forms and FDIS, and for data errors. Individual fish data is not mapped, so checking of final maps is not required. Check all data associated with each fish collection form.

Specifications: *Fish Collection Form Field Guide*.

Individual Lake Reports

Complete individual lake reports should be provided for each lake surveyed. Reports must be submitted in both hardcopy and digital formats. A series of appendices and attachments accompanies the report. The contents of each lake report is checked using forms 3G, 3H, 3I and 3J.

Report content and format (Form 3G)

Check that both hardcopy and digital reports are provided. Ensure that the digital file is in Word 6.0 (or current acceptable standard), that it can be opened and that the digital report content is the same as the hardcopy report.

The hardcopy lake report is checked to ensure it follows the standard format as provided in the *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures* and Errata 1999. An example lake report is available on the BC Fisheries website at:

<http://www.bcfisheries.gov.bc.ca>.

Detail is provided of form 3G as a means to ensure that the QA team considers content of each report section. At this time, report sections have variable detail in the QA attribute listings. Judgement is necessary to evaluate content, and should focus on determining that the content presented is correct. Data presented as tables in the report should be checked against the mapped data to ensure it has been transcribed and interpreted correctly. Appendices and attachments to the report are also checked.

The review of the lake report will result in a list of deficiencies found in the report, appendices and attachments. The deficiencies must be addressed prior to submitting the final products.

Lake bathymetric maps (Form 3H)

The five bathymetric maps corresponding to the five primary lake cards checked above should also be reviewed by the QA team using form 3H. The bathymetric map must appear the same as the standard example provided in Figure 13 of *Bathymetric Standards for Lake Inventories, Version 2.0* (RIC 1999). The map must be computer generated or drafted. If the map does not look like the standard example, the map is rejected. The content and appearance of the lake map and header block is checked. Statistics presented on the map are also checked.

A digital bathymetric map file is required, in TIFF format. This is checked off in the attachments to the lake report.

Specifications: *Bathymetric Standards for Lake Inventories, Version 2.0* (RIC 1999). Additional symbols are found in *Standards for Fish and Fish Habitat Maps* (RIC 1998).

Lake outline maps (Form 3I)

Each lake report has one or more lake outline maps associated with it. These may be presented in the aquatic vegetation, the site summary and the bathymetry reporting sections. Consistency should be checked among hardcopy maps and the attribute databases where appropriate. Using form 3I, a checklist of 18 attributes on the outline map are checked. Note the number of outline maps can vary depending on the amount of information presented (e.g., bathymetric transect map; sample site map, aquatic vegetation map).

Specifications: *Bathymetric Standards for Lake Inventories, Version 2.0* (RIC 1999). Additional symbols are found in *Standards for Fish and Fish Habitat Maps* (RIC 1998).

Air photo enlargement (Form 3J)

Each lake report has an enlarged, annotated air photo (presented as Attachment 6). Information such as benchmark location, limnological station, photograph locations and fish sampling sites are indicated on the air photo. Form 3J lists five attributes to check on the air photo.

Specifications: *Bathymetric Standards for Lake Inventories, Version 2.0* (RIC 1999). Additional symbols are found in *Standards for Fish and Fish Habitat Maps* (RIC 1998).

Watershed Project Report (Form 3K)

The complete watershed report should be provided in both hardcopy and digital formats. A series of appendices and attachments accompanies the report. The contents of the watershed report is checked to ensure that reports contain all necessary information in the required format using form 3K. Maps (Overview, Project and Interpretive), appendices and attachments are all covered in form 3K.

Report content and format

Check that both hardcopy and digital reports are provided. Ensure that the digital file is in Word 6.0 (or current acceptable standard), that it can be opened and that the digital report content is the same as the hardcopy report.

The hardcopy watershed report is checked to ensure it follows the standard format as provided in the *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures*. An example watershed report is available on the BC Fisheries website at:

<http://www.bcfisheries.gov.bc.ca>.

Detail is provided of form 3K as a means to ensure that the QA team considers content of each report section. Judgement is necessary to evaluate content, and should focus on determining that the content presented is correct. Data presented as tables in the report should be checked against the mapped data to ensure they have been transcribed and interpreted correctly. Appendices and attachments to the report are also checked.

The review of the watershed report will result in a list of deficiencies found in the report, appendices and attachments. The deficiencies must be addressed prior to submitting the final products.

Mapping Deliverables

Overview map

The overview map is presented in the location section of the report, and checked in the location section of form 3K. This is an 8.5 × 11 (or 11 × 17) map showing the TRIM aquatic layer for the entire project area with sample sites. Required features are listed in Appendix 3 of the *Standards for Fish and Fish Habitat Maps*, (RIC 1998). An example map is presented on the BC Fisheries website at:

<http://www.bcfisheries.gov.bc.ca>.

Project and interpretive maps

The project and interpretive maps are presented in Appendix 2 of the watershed report. Specifications of these maps are provided in Appendix 3 of the *Standards for Fish and Fish Habitat Maps*, (RIC 1998). Example maps are presented on the BC Fisheries website at:

<http://www.bcfisheries.gov.bc.ca>.

Hardcopy deliverables are checked on form 3K in Appendix 2. Requirements common to both maps are presented, followed by specifics for the project and the interpretive maps.

The **project map** is intended to present new information collected. Data required includes numbered reach breaks, features and obstructions, reach data symbols, site data symbols and lake summary symbols.

The **interpretive map** presents results of any interpretations (e.g., fish distribution limits, probability of fish presence) and classifications (e.g., stream classification for FPC). Reach summary symbols are required for each reach in the project area. Options are available for presenting fish distributions and stream classifications. Many features presented on the project map are incorporated into the interpretive map.

Digital Deliverables

Digital mapping deliverables are discussed in the revised Appendix 4 of the *Standards for Fish and Fish Habitat Maps*, (RIC 1998) as presented in the Errata to the *Standards for Fish and Fish Habitat Maps*, (RIC 1999). The fundamental requirement is to provide a metadata file and a map features file. These are checked using the ARCView fish QA tool (see prior discussion).

Any plot files of the hardcopy maps produced (e.g., postscript, hpgl2 files) should be provided and must plot out the same as the hardcopy provided.

Fish Identification (Form 3L)

Correct identification of fish captured is critically important to the inventory program. There are three procedures dealing with fish identification in the inventory process:

- Fish identification is checked in the field by the QA team.
- Captured fish that crew cannot accurately identify, are preserved and sent through appropriate channels for expert identification.
- A system of voucher specimen collection is in place to confirm fish species identification by the field crews in the project area. Specific project requirements are included in inventory project plans.

At the end of the project, fish identification quality is checked through a review of the results, "expert" fish identification of voucher sample collections and "problem" fish identifications. Written documentation of fish samples sent for expert identification and results confirming fish identity should be included in the inventory reports as attachments.

To ensure that fish identification quality assurance has been conducted as outlined in the project plan, the QA Team should:

- review voucher requirements in individual project plans and ensure the requirements were met;
- review evidence of voucher and "problem" specimen sampling and species identification confirmation presented as report attachments; and
- ensure that the final products (reports, maps and database) incorporate the results of expert fish identifications.

Fish aging

Scale (etc.) samples collected and results of age determination are provided as attachments to inventory reports. Some projects include a requirement to verify fish aging. Requirements for and evidence of any fish aging quality assurance should be checked.

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3A **DATA COMPILATION AND REPORTING DELIVERABLES FOR QA – PAGE 1 OF 1**

Deliverable		Hardcopy	Digital	Comments
Watershed reporting	Watershed report			
	Appendices			
	I. FDIS summary and photographs			
	II. Maps			
	Attachments			
	I. Pre-field planning document			
	II. Field notes and forms			
	III. Fish ageing structures			
	IV. Fish samples and vouchers			
	V. Photodocumentation			
	VI. Digital data			
	VII. FISS update data			
	VIII. Aerial photography			
Individual lake reporting (for each lake)	Lake report			
	Appendices			
	I. Lake survey form			
	II. Water chemistry data			
	III. Fish collection forms			
	IV. Tributary summary			
	V. Photographs			
	VI. Bathymetric map			
	Attachments			
	I. Photodocumentation			
	II. Digital data			
	III. FISS update data			
	IV. Phase completion reports			
	V. Field notes and forms			
	VI. Aerial photography			
	VII. Fish ageing structures			
	VIII. Fish samples and vouchers			

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3B **DIGITAL DATA CHECKING – PAGE 1 OF 1**

For each FDIS file provided:

FDIS filename:

	Acceptable		Comments
	Y	N	
Conversions done:			
• ILP to WSC			
• NID-UTM			
• Update bathymetry			
FDIS QA report attached			
• Acceptable error report			

For each FDIS file and digital map file set:

ARCView fish QA tool

	Filename	Acceptable		Comments
		Y	N	
Digital map files				
• Metadata table				
• Map attributes table				
FDIS data check				
• Sequential reach numbering:				
• Point locations on TRIM streams:				
Copy of ARCView fish QA tool error report attached				
• Acceptable error report				

Note: The map attributes table, introduced in 1999, replaces the point table and the attribute table from 1998 standards.

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3C

CONSISTENCY CHECK: STREAM CARDS, FDIS, PROJECT, INTERPRETIVE MAPS – PAGE 1 OF 2

	1	2	3	4	5	6	7	8	9	10
Site #										
Mapsheet #										
NID map #										
NID #										

Record errors below with an 'x.' An error occurs if there is any inconsistency among: 1) field site cards, 2) FDIS, 3) project maps and 4) interpretive maps, as specified for each attribute.

Card section	Attribute	Where to check	1	2	3	4	5	6	7	8	9	10	Error locations
Header	Stream name	1, 2, 3, 4											
	Watershed code or ILP map # and ILP #	1, 2, 3, 4											
	NID map # and NID #	1, 2											
	Reach #	1, 2, 3, 4											
	Site #	1, 2, 3, 4											
	Site length	1, 2											
	Access	1, 2											
	Survey date	1, 2, 3, 4											
	Agency conducting survey	1, 2, 3, 4											
	Time of survey	1, 2											
	Crew conducting survey	1, 2											
	Fish form completed	1, 2											
Channel	Channel width	1, 2, 3, 4											
	Wetted width	1, 2											
	Residual pool depth	1, 2											
	Site gradient	1, 2, 3											
	Reach gradient	2, 3, 4											
	Bankfull depth	1, 2											
	Stage	1, 2											
	No Vis. Ch., DW, and Dry/Int.	1, 2, 3, 4											
	Tribs	1, 2, 3, 4											
Cover	Total cover	1, 2											
	Cover elements	1, 2											
	Functional LWD (amount, distribution)	1, 2											
	Crown closure	1, 2											
	Instream vegetation	1, 2											
	Bank shape, texture, riparian vegetation	1, 2											

FORM 3C **CONTINUED – PAGE 2 OF 2**

Card section	Attribute	Where to check	1	2	3	4	5	6	7	8	9	10	Error locations
Water	EMS #	1, 2											
	Temperature, pH	1, 2											
	Water chemistry requisition #	1, 2											
	Conductivity, turbidity	1, 2											
Channel morpho-logy	Flood signs	1, 2											
	Bed material	1, 2, 3											
	D95, D	1, 2											
	Morphology	1, 2, 3											
	Disturbance indicators	1, 2, 3											
	Pattern	2, 3											
	Islands, bars, coupling	1, 2											
	Confinement	2, 3											
Features	NID map # and NID #	1, 2											
	Type, height/length	1, 2, 3, 4											
	Photo, comments	1, 2											
	UTM	1, 2											
Habitat quality	General comments	1, 2											
	Fisheries sensitive zones	1, 2, 3, 4											
Photo-documen-tation	Roll #	1, 2											
	Frame #	1, 2											
	Focal length	1, 2											
	Direction	1, 2											
	Comments	1, 2											
Wildlife	Group	1, 2											
	Observations	1, 2											
Comments	General comments	1, 2											
Total errors:													

Summary of stream site information check:

Number of marks (# cards * 52): _____ Maximum number of errors acceptable (5%): _____

Number of errors found: _____ Is the number of errors acceptable: Y N

Number of errors by location:
Site card: _____ FDIS: _____ Project map: _____ Interpretive map: _____

Comments:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3D

CONSISTENCY CHECK: LAKE CARDS, FDIS, BATHYMETRIC MAP, LAKE OUTLINE MAP AND PROJECT MAP – PAGE 1 OF 2

Lake name: _____

Watershed code: _____ **Waterbody ID:** _____

Record errors below with an 'x.' An error occurs if there is inconsistency among 1) lake cards, 2) FDIS, and/or 3) project maps, and/or 4) interpretive maps, and/or 5) lake outline maps, and/or 6) bathymetric maps as specified for each attribute.

	Attribute (max # errors)	Where to check	Errors	Error locations
Waterbody	Type of wetland or lake	1, 2, 3		
	Fish collection form	1, 2		
	Lake name	1, 2, 5, 6		
	WSC or ILP map # and ILP #	1, 2, 3, 4, 5, 6		
	Reach #	1, 2		
	Air photo reference	1, 2, 5, 6		
	Waterbody ID	1, 2, 3, 4, 5, 6		
	Project ID	1, 2, 3, 4		
	Magnitude	1, 2		
	NID map # and NID #	1, 2		
	UTM	1, 2, 6		
	Surface area	1, 2, 3, 6		
	Elevation	1, 2, 6		
	Biogeoclimatic zone	1, 2		
Terrain characteristics	Setting, aspect	1, 2		
	Coupling, genesis	1, 2		
Shoreline characteristics	Shoreline type %	1, 2		
	Land use %	1, 2		
	Cover	1, 2		
	Recreational features	1, 2, 5		
Inlets/Outlets	# Inlets/Outlets	1, 2, 5, 6		
	Spawning present (2°)	1, 2, 5		
	WSC or ILP map # and ILP #	1, 2, 5		
Survey information	Start date	1, 2, 5, 6		
	End date	1, 2		
	Agency, crew	1, 2, 5, 6		
Access	Mode (Air/Road/Off road/Trail)	1, 2		
	Auto within	1, 2		
	Distance from road	1, 2		
	Closest community, comments	1, 2		

FORM 3D **CONTINUED – PAGE 2 OF 2**

	Attribute (max # errors)	Where to check	Errors	Error locations
Aquatic flora	Emergent and submergent	1, 2, 5		
	Dominant species	1, 2		
	Floating algae	1, 2, 5		
	Species list	1, 2		
Lake bathymetry	Type of survey	1, 2		
	Littoral area (%)	1, 2, 3, 6		
	Maximum depth	1, 2, 3, 6		
	Benchmark height	1, 2, 6		
	Benchmark type/location	1, 2		
	Maximum water level	1, 2		
Photo documentation	Roll #, frame #, direction	1, 2, 5		
	Focal length	1, 2		
	NID map # and NID #	1, 2		
	UTM	1, 2		
Aquatic wildlife observations	Group	1, 2		
	Species/Comments	1, 2		
Water quality	Station no., UTM	1, 2		
	Date, time	1, 2		
	EMS no.	1, 2		
	Secchi depth, colour	1, 2		
	pH (surface and bottom)	1, 2, 3		
Water sample	Depth	1, 2		
	Requisition #	1, 2		
Dissolved oxygen, temperature, and conductivity profiles	Depth	1, 2		
	Dissolved oxygen, temp.	1, 2		
	Conductivity	1, 2, 3		
	Descend and ascend	1, 2		
	H_2S presence	1, 2		
Equipment	Equipment class	1, 2		
Total errors:				

Summary of lake information check:

Number of marks (# cards * 59): _____ Maximum number of errors acceptable (5%):

Number of errors found: _____ Is the number of errors acceptable: Y N

Number of errors by location: Lake survey form: _____ FDIS: _____ Project map: _____
Interpretive map: _____ Lake outline map: _____
Bathymetric map: _____

Comments:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3E

CONSISTENCY CHECK: FISH COLLECTION FORM, FDIS, PROJECT MAP, INTERPRETIVE MAP, LAKE OUTLINE MAP – PAGE 1 OF 2

	1	2	3	4	5	6	7	8	9	10
Site #										
Mapsheet #.										
NID map #										
NID #										

Record errors below with an 'x'. An error occurs if there is inconsistency among 1) fish collection forms, 2) FDIS, 3) project maps, and 4) interpretive maps, and/or 5) lake outline maps, as specified for each attribute.

Group	Item	Where to check	1	2	3	4	5	6	7	8	9	10	Error locations
Header	Name	1, 2, 3, 4, 5											
	Stream/Lake/Wetland	1, 2, 3											
	Watershed code or ILP	1, 2, 3, 4, 5											
	Waterbody ID	1, 2, 3, 4, 5											
	ILP map #	1, 2											
	Reach #	1, 2, 3, 4, 5											
	MELP fish permit #	1, 2											
	Date start, end	1, 2											
	Agency, crew	1, 2											
	Resample	1, 2											
Site/Method	Site #	1, 2, 3, 4, 5											
	NID map #, NID #	1, 2											
	Site UTM	1, 2											
	Method, method no.	1, 2											
	Temp, turbidity	1, 2											
	Conductivity	1, 2											
Fish summary	Method, method no.	1, 2											
	Haul/Pass (H/P)	1, 2											
	Species	1, 2, 3, 4											
	Stage, total #	1, 2											
	Min. length	1, 2											
	Fish activity	1, 2											

FORM 3E **CONTINUED – PAGE 2 OF 2**

Group	Item	Where to check	1	2	3	4	5	6	7	8	9	10	Error locations
Gear specifications	Method, method no.	1, 2											
	Haul	1, 2											
	Date, time in/out	1, 2											
	Net type, lgth, dpth	1, 2											
	Mesh size	1, 2											
	Set, habitat	1, 2											
Electrofisher specifications	Method, method no.	1, 2											
	Pass	1, 2											
	Time in, time out	1, 2											
	EF sec.	1, 2											
	Length, width	1, 2											
	Enclosure	1, 2											
	Voltage, freq., pulse	1, 2											
	Make, model	1, 2											

Number of marks (# cards * 36): _____ Maximum number of errors acceptable (5%): _____

Number of errors found: _____ Is the number of errors acceptable: Y N

Number of errors by location: Fish collection form: _____ FDIS: _____ Project map: _____
Interpretive map: _____ Lake outline map: _____

Comments:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3F **CONSISTENCY CHECK: INDIVIDUAL FISH DATA CARD, FDIS – PAGE 1 OF 1**

	1	2	3	4	5	6	7	8	9	10
Site #										
Mapsheet #.										
NID map #										
NID #										

Record errors below with an 'x'. An error occurs if there is inconsistency among 1) individual fish data cards and 2) FDIS, as specified for each attribute.

Group	Item	Where to check	1	2	3	4	5	6	7	8	9	10	Error locations
Individual fish data	Site #	1, 2											
	Method, method no.	1, 2											
	Haul/Pass	1, 2											
	Species	1, 2											
	Length	1, 2											
	Weight	1, 2											
	Sex	1, 2											
	Maturity	1, 2											
	Age structure	1, 2											
	Age sample #	1, 2											
	Age	1, 2											
	Voucher	1, 2											
	Genetic structure	1, 2											
	Genetic sample #	1, 2											
	Photos	1, 2											

Number of marks (# cards * 15): _____ Maximum number of errors acceptable (5%): _____

Number of errors found: _____ Is the number of errors acceptable: Y N

Number of errors by location: Fish collection form: _____ FDIS: _____ Project map: _____
Interpretive map: _____ Lake outline map: _____

Comments:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3G **INDIVIDUAL LAKE REPORT – PAGE 1 OF 3**

Report section	Attribute	Accept. (/x)	Notes
Title page	Proper title		
	Watershed code below title		
	Prepared for…		
	Prepared by…		
	Signature of R.P.Bio		
Reference information	Project reference information		
	Watershed information		
	Lake sampling summary		
	Contractor information		
Disclaimer	Standard wording disclaimer		
Acknowledgements			
Table of contents	Page numbering correct		
	Report outline follows standard		
Lists	List of Tables		
	List of Figures		
	List of Appendices		
	List of Attachments		

Report section	Attribute	Accept. (/x)	Notes
Introduction			
Project scope/objectives			
Location	Description; map		
Access	Detailed description		
Resource Information	First Nations		
	Land use, logging, recreation, …		
	Impacts and uses by wildlife		
	Existing water quality data		
	Previous fish presence		
Methods	Reference to RECCE standards		
	Reference to project plan		
	Deviations from RECCE standards		
	Deviations from project plan		
	List of sampling equip. used		

Lake Report Format

Report section	Attribute	Accept. (/x)	Notes
Results and Discussion			
Logistics	Problems encountered		
Immediate shoreline			
Terrain			
Aquatic flora			
Site summary	Lake outline map; description		
Bathymetry	Table of statistics; map		
Limnological sampling	Table of results; T/O_2 profile		
Inlets, outlets			
Fish age, size and life history	Fish sampling summary		
	Fish capture summary		
	Summary of life stages, life history, etc		
	Length-frequency histograms		
	Table: Summary of Length-at-age…		
	Data presented by species		
	Age classes appear correct		
Significant features and fisheries observations	Fish and fish habitat		
	Critical habitats		
	Special populations		
	Wild stocks		
	Rare stocks or species		
	High value sport fishing		
	NO management recommendations		
	Habitat concerns		
Wildlife observations			

Report section	Attribute	Accept. (/x)	Notes
References	All sources in report listed		
	According to CBE style manual		

Lake Report Appendices

Report section	Attribute	Accept. (/x)	Notes
Appendix I. Lake survey form			
Appendix II. Water chemistry summary			
Appendix III. Fish data collection form			
Appendix IV. FDIS tributary summary	In ascending order by WSC		
	Grouped by site		
	FDIS reach card printouts		
	FDIS site card printouts		
	Fish data collection form		
	Photos (min. 1, max. 4)		
	All photos entered in FDIS		
	Explanatory photo captions		
	Photos in colour (final only)		
Appendix V. Photographs			
Appendix VI. Bathymetric map	Proper size (“C” or “D” size)		
	Folded in pocket in report		

Lake Report Attachments

Report section	Attribute	Accept. (/x)	Notes
Attachment I. Photodocumentation	Table: Photo summary report		
	Colour thumbnail reference		
	Photo CD		
	CD image #s match digital		
	Negatives in plastic sleeves		
	Negatives labelled		
	Negative #s match digital		
	Prints in plastic sleeves		
	Prints labelled		
Attachment II. Digital data	Budget breakdown by phase		
	Project sampling design		
	References, contacts list		
	Table of vouchers collected		
	Table of DNA collected		
	Photo summary report		
	Report tables, figures		
	Report text		
	FDISDAT.MDB		
	Bathymetric map file (TIFF format)		
Attachment III. Reference material	FISS data forms and maps		
	Copies of reference material		
	Data on forms match FDIS		
Attachment IV. Phase completion reports	Hardcopy contract phase completion reports		

Report section	Attribute	Accept. (/x)	Notes
Attachment V. Field notes	Field book or facsimile		
	Lake survey forms		
	Fish collection forms		
	Individual fish data forms		
	Field working maps		
	Site cards		
Attachment VI. Aerial photography	Purchased aerial photos		
	Aerial video tape		
Attachment VII. Fish ageing structures	Actual ageing structures		
	Labelled photocopies		
	Age data is correct		
Attachment VIII. Voucher and DNA samples	Table: Vouchers collected		
	Table: DNA collected		

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3H **BATHYMETRIC MAP CHECK – PAGE 1 OF 1**

Lake name:_____

Watershed code:_____ **Waterbody ID:** _____

Section	Attribute	Errors	Notes
Map	Standard appearance		
	All contour line depths are labelled		
	All contours are closed		
	Measurements in metres		
	6 m contour included in heavier line		
	North symbol of 'fish' is right way		
	Inlet/outlet streams and direction of flow		
	Benchmark location		
	All symbols as outlined in 'bathymetric standards'		
	Max depth within each deepest contour		
	Location map		
Statistics	Elevation		
	Surface area		
	Volume		
	Estimated annual fluctuation		
	Mean depth		
	Maximum depth		

Section	Attribute	Errors	Notes
Statistics (cont.)	Perimeter (mainshore and islands)		
	Area above 6 m contour		
	Benchmark height above water level		
Header block	Name (gazetted)		
	Watershed code number		
Waterbody identifier	UTM number to 100 m precision		
	Contour interval		
	Technical check		
	Date of completion of final map		
	Revision date		
	Approved		
	Scale bar present		
	Scale decimal based to 100s level		
	NTS number is at 1:50 000 scale		
	All NTS sheets used are recorded		
	Name of surveyor and company		
	Lake outline source		
	Date of survey (month, year, day)		

No. marks (# maps * 36): _____ Max. no. errors acceptable (5%): _____

No. errors found: _____ Is no. errors acceptable: Y N

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3I **OUTLINE MAP CHECK – PAGE 1 OF 1**

Lake name:_____

Watershed code:_____ **Waterbody ID:** _____

Section	Attribute	Errors	Notes
Map	"E" line is present		
	Sounding transects perpendicular to "E" line		
	Sounding transects agree with bathymetric map		
	Inlet/outlet streams and direction of flow agree with bathymetric map and air photo		
	Location of deepest point in each "major" basin		
	Limnological station in each "major" basin		
	Reach breaks and stream survey sites indicated		
	Significant aquatic macrophyte beds indicated		
	Prominent shoreline features		
	Benchmark location agrees with bathymetric map and air photo		
	Location, direction of lake features photos		

Section	Attribute	Errors	Notes
Map (cont.)	All symbols as outlined in 'bathymetric standards'		
	Fish sample sites		
Header block	Name of lake		
	Watershed code		
	Date of survey (month, year, day)		
	Legend with all symbols used on map		
	Bottom left-hand corner, contractor/organization producing the map		

No. marks (# maps * 18): _____ Max. no. errors acceptable (5%): _____

No. errors found: _____ Is no. errors acceptable: Y N

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3J **ANNOTATED AIR PHOTO CHECK – PAGE 1 OF 1**

Lake name:_____

Watershed code:_____ **Waterbody ID:** _____

Attribute	Errors	Notes
Benchmark location agrees with bathymetric map and outline map		
High water mark		
Limnological station in each "major" basin		
Fish sampling sites		
Inlet/outlet streams and direction of flow agree with bathymetric map and outline map		

No. marks (# maps * 5): _____ Max. no. errors acceptable (5%): _____

No. errors found: _____ Is no. errors acceptable: Y N

Notes:
1.

Notes:

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:** _____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3K **WATERSHED REPORT – PAGE 1 OF 5**

Report section	Attribute	Accept. (/x)	Notes
Title page	Proper title		
	Watershed code below title		
	Prepared for…		
	Prepared by…		
	Signature of R.P.Bio		
Reference information	Project reference information		
	Watershed information		
	Sampling design summary		
	Contractor information		
Disclaimer	Standard wording disclaimer		
Acknowledgements			
Table of contents	Page numbering correct		
	Report outline follows standard		
Lists	List of Tables		
	List of Figures		
	List of Attachments		
	List of Appendices		

Report section	Attribute	Accept. (/x)	Notes
Introduction			
Project scope, objectives	1:20 000, 1:5000, lakes, etc.		
Location	Description		
Overview map	8.5 × 11" or 11 × 17"		
	Outline of entire study area		
	Inset map showing relation to BC		
	Sample site locations		
	1:20 000 map grid		
	Major communities/roads		
	TRIM/FC aquatic features		
Access	Description		
Resource Information	First Nations		
	Land use, logging, recreation, etc.		
	Impacts and uses by wildlife		
	Existing water quality data		
	Previous fish presence (and ref.)		
Methods	Reference to RECCE standards		
	Reference to project plan		
	Deviations from RECCE standards		
	Deviations from project plan		
	List of sampling equipment used		

FISH INVENTORY QUALITY ASSURANCE CHECK FORM

Project name: _____

FRBC project number: _____ **MELP project number:**_____

Contractor: _____

QA review by: _____ **Review date:** _____

FORM 3K **WATERSHED REPORT – PAGE 1 OF 5**

Report section	Attribute	Accept. (✓/x)	Notes
Title page	Proper title		
	Watershed code below title		
	Prepared for…		
	Prepared by…		
	Signature of R.P.Bio		
Reference information	Project reference information		
	Watershed information		
	Sampling design summary		
	Contractor information		
Disclaimer	Standard wording disclaimer		
Acknowledgements			
Table of contents	Page numbering correct		
	Report outline follows standard		
Lists	List of Tables		
	List of Figures		
	List of Attachments		
	List of Appendices		

Report section	Attribute	Accept. (✓/x)	Notes
Introduction			
Project scope, objectives	1:20 000, 1:5000, lakes, etc.		
Location	Description		
Overview map	8.5 × 11" or 11 × 17"		
	Outline of entire study area		
	Inset map showing relation to BC		
	Sample site locations		
	1:20 000 map grid		
	Major communities/roads		
	TRIM/FC aquatic features		
Access	Description		
Resource Information	First Nations		
	Land use, logging, recreation, etc.		
	Impacts and uses by wildlife		
	Existing water quality data		
	Previous fish presence (and ref.)		
Methods	Reference to RECCE standards		
	Reference to project plan		
	Deviations from RECCE standards		
	Deviations from project plan		
	List of sampling equipment used		

Report section	Attribute	Accept. (✓/x)	Notes
Results and Discussion			
Logistics	Problems encountered (e.g., weather, access, water levels)		
	How were problems addressed?		
	How were results affected?		
Summary of sub-basin biophysical information (optional)	Table of information defining each sub-drainage		
Habitat and fish distribution	Characteristics of fish habitats		
	Pattern of fish distribution		
	Location of significant fish populations		
	Lakes treated as a reach of the stream		
	Upstream limits of species presence		
	Obstructions that influenced fish presence		
	Table of all barriers present		
Fish age, size and life history	Summary of life stages, life history, etc.		
	Length-frequency histograms		
	Table: Summary of length-at-age…		
	Data presented by species		
	Data presented by sub-drainage		
	Age classes appear correct		

Report section	Attribute	Accept. (✓/x)	Notes
Significant features and fisheries observations	Fish and fish habitat		
	Critical habitats		
	Special populations (rare, etc.)		
	Wild stocks		
	High value sport fishing		
	NO management recommendations		
	Habitat protection concerns		
	Fisheries sensitive zones		
	Fish above 20% gradients		
	Restoration opportunities		
	Problem culverts		
	Unstable slopes		
Fish bearing status	Brief narrative section		
	Table: Summary of fish bearing reaches…		
Fish bearing status (cont.)	Table: Summary of non-fish bearing reaches		
	Table: Follow-up sampling required		
References	All sources in report listed		
	According to CBE style manual		

Stream Report Appendices

Report section	Attribute	Accept. (✓/x)	Notes
Appendix I. FDIS summary and photographs	In ascending order by WSC		
	Grouped by site		
	FDIS reach card printouts		
	FDIS site card printouts		
	Fish data collection form		
	Photos (min. 1, max. 4)		
	All photos entered in FDIS		
	Explanatory photo captions		
	Photos in colour (final only)		
Appendix II. Hardcopy maps – Fisheries project map	"E" size plots		
	Folded in pocket in report		
	UTM projection		
	1:20 000 map grid		
	1:20 000 scale		
	Complete title box		
	Complete legend box		
	Source information box		
	Inset map box		
	Fish species box		
	Contour lines (thinned as approp.)		
	Disclaimer		
	Lake and stream annotation		

Report section	Attribute	Accept. (✓/x)	Notes
Appendix II. Hardcopy maps – Fisheries project map (cont.)	WSCs or ILPs for all sampled streams		
	WSCs or ILPs for all 3rd order or higher streams		
	WSCs or ILPs for every other 1st and 2nd order stream		
	WBIDs for all lakes		
	Sample site locations/numbers		
	All site data symbols attached to sites		
	Lake summary symbols		
	Reach data symbols on all reaches <30% gradient and all reaches containing sites		
	Features, obstructions and symbols		
	Reach breaks and numbers		

Stream Report Appendices

Report section	Attribute	Accept. (✓/x)	Notes
Appendix II. Hardcopy maps – Fisheries interpretive map	"E" size plots		
	Folded in pocket in report		
	UTM projection		
	1:20 000 map grid		
	1:20 000 scale		
	Complete title box		
	Complete legend box		
	Source information box		
	Inset map box		
	Fish species box		
	Contour lines (thinned as approp.)		
	Disclaimer		
	Lake and stream annotation		
	WSCs or ILPs for all sampled streams		
	WSCs or ILPs for all 3rd order or higher streams		
	WSCs or ILPs for every other 1st and 2nd order stream		
	WBIDs for all lakes		
	Sample site locations/numbers		
	Reach breaks and numbers		
	Reach summary symbols for all reaches in the project area		

Report section	Attribute	Accept. (✓/x)	Notes
Appendix II. Hardcopy maps – Fisheries interpretive map (cont.)	Features, obstructions and symbols (optional)		
	Fisheries sensitive zones		
	Fish distribution limits		
	Red/blue, solid/dashed lines to illustrate fish stream class (optional)		
	Roads/communities (optional)		

Notes:

Stream Report Attachments

Report section	Attribute	Accept. (✓/x)	Notes
Attachment I. Planning document	Budget breakdown by phase		
	Project sampling design		
	Process of site selection		
	Reach table		
	Lake table		
	Random sample table		
	References, contacts list		
Attachment II. Field notes	Field book or facsimile		
	Site cards		
	Fish collection forms		
	Individual fish data forms		
	Field working maps		
Attachment III. Fish ageing structures	Actual ageing structures		
	Labelled photocopies		
	Annuli identified with red		
	Age data are correct		
Attachment IV. Voucher, DNA samples	Table: Vouchers collected		
	Table: DNA collected		
Attachment V. Photodocumentation	Table: Photo summary report		
	Colour thumbnail reference		
	Photo CD		
	CD Image #s match digital		
	Negatives in plastic sleeves		
	Negatives labelled		

Report section	Attribute	Accept. (✓/x)	Notes
Attachment V. Photodocumentation (cont.)	Negative #s match digital		
	Prints in plastic sleeves		
	Prints labelled		
Attachment VI. Digital data	Budget breakdown by phase		
	Project sampling design		
	References, contacts list		
	Table of vouchers collected		
	Table of DNA collected		
	Photo summary report		
	Report tables, figures		
	Report text		
	FDISDAT.MDB		
	Mapping files (plot files)		
	Mapping files (metadata and map features files)		
Attachment VII. FISS update data	FISS data forms and maps		
	Copies of reference material		
	Data on forms match FDIS		
Attachment VIII. Aerial photography	Purchased aerial photos		
	Aerial video tape		

FORM 3L **FISH IDENTIFICATION AND AGING – PAGE 1 OF 1**

Fish Identification

	Y/N	Comments
Voucer requirements described in project plan met?		
Evidence of: • voucher samples collected		
• problem fish as necessary		
• results of expert Ids		
Final fish identifications incorporated: • FDIS		
• reports		
• maps		

Fish Aging

	Y/N	Comments
Fish aging QA requirements described in project plan met?		
Evidence of: • aging QA		
Final fish ages incorporated: • FDIS		
• reports		
• maps		

LITERATURE CITED

Omule, S.A.Y., C.A. Zala, R.E. Odeh and D.G. Kilshaw. 1992. How to conduct quality control for stand delineation and description. *In* Proc. of Stand Inventory Technologies: an International Multiple Resource Conference. Portland, OR. pp. 107–114.

Shampine, W.J. 1993. Quality assurance and quality control in monitoring programs. Environ. Monitoring and Assess. 26:143–151.

Triton Environmental Consultants Ltd. 1997. Development of a quality assurance plan for British Columbia's fish and fish habitat inventory program. B.C. Min. Environ., Lands and Parks, Victoria, BC. Draft rep.

APPENDIX 1: ESTIMATING SAMPLE SIZE FOR QUALITY ASSURANCE

The graph that follows can be used to estimate the quality control sample size required on the basis of project size.

Lot size = total number of marks, or the number of units checked times the number of attributes to check (e.g., total number of reaches in the project area times 15 reach table attributes).

Sample size = required number of marks that must be checked. The sample size can be converted to the number of data cards to check by dividing by the number of marks per card (e.g., divide by 15 for reach table attributes).

Data on the graph is from "Guidelines to Quality Control Forest Classification," B.C. Ministry of Forests. The data relates to risk levels of 95% certainty, so that work above 90% will be rejected and work below 85% will be accepted. For further discussion see Triton 1997 and Omule *et al*. 1992.

Graph of lot size and sample size for estimation of sample size requirements for quality assurance