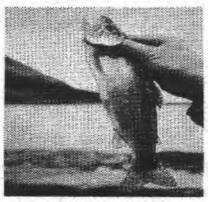
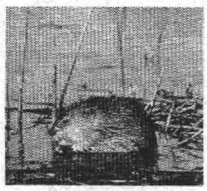
Canada Alberta Northwest Territories

Northern River Basins Study



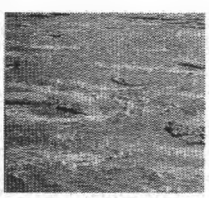




NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 142

A DATABASE OF ENVIRONMENTAL SAMPLES COLLECTED AND ANALYSED FOR THE NORTHERN RIVER BASINS STUDY






DATE DUE

Prepared for the
Northern River Basins Study
under Project 5121-D1 and 5121-E1

by

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NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 142

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
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Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

F. J. Wrona — 14 May 96
(Dr. Fred J. Wrona, Science Director) (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

P. A. Larkin — 24 May/96
(Dr. P. A. Larkin, Ph.D., Chair) (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

Lucille Partington — May 29/96
(Lucille Partington, Co-chair) (Date)

Robert McLeod — May 21/96
(Robert McLeod, Co-chair) (Date)

A DATABASE OF ENVIRONMENTAL SAMPLES COLLECTED AND ANALYSED FOR THE NORTHERN RIVER BASINS STUDY

STUDY PERSPECTIVE

Related Study Questions	
15)	*How can the Study results be communicated most effectively?*

One of the objectives contained in the Northern River Basins Study (NRBS) agreement was to provide a scientifically sound information base for planning and management of the water and aquatic environment of the study area so as to enable its long-term protection, improvement and wise use. An important component of this study was the original data resulting from the collection and analysis of environmental samples. Samples were collected, stored and analysed by a number of difference agencies. The compilation of an inventory of samples obtained by NRBS and results data into a single electronic database was undertaken to ensure future ease of access to original data.

This report describes the data contained in the database, the methods used to compile the database, the media and nature of the samples, the collection site and the data collected. Information is provided on which analyses were conducted on samples as well as providing the values of various parameters measured for the samples. All the files and the data fields that comprise the database are described in a Users Guide, which is part of this report.

The availability of original data in a single electronic database facilitates future research access to NRBS data. Without the database, interested researchers would have to undertake a significant cross referencing and data entry effort. It increases the probability that NRBS data will be incorporated into other studies and that some additional interpretations will occur. The database enables regulatory resource managers to convert NRBS data into their management databases.

REPORT SUMMARY

A database was constructed containing information about the environmental samples collected and analysed for the NRBS. The purpose of the database was to contribute to fulfilling one of the three specific objectives contained in the Northern River Basins Study agreement:

> "to provide a scientifically sound information base for planning and management of the water and aquatic environment of the study area so as to enable its long-term protection, improvement and wise use;"

The database contained records identifying 26,780 original samples. The database described samples taken in various forms; liquid, sediment, benthos, fish, mammals, birds and vegetation. The majority of these samples were fish, even when fish handled and released (with or without tags) are subtracted out. The database consisted of two major sets of dBASE IV (.DBF) files; one set described the samples and another set provided the values for parameters measured.

Recommendations were made for any future project that intends to collect and analyse environmental samples:

1. Use gps technology to obtain all georeferencing of sites where samples are collected.
2. Start database compilation early and resource it sufficiently to keep pace with data availability and management needs.
3. Require manifest reporting whenever the custodial agents of a sample changes.
4. Implement a formal data quality assurance process.
5. Require laboratories supplying data to provide electronic copies that satisfy a definitive specification as to the format and content conventions.

This report contains a Database Users Guide in Appendix B and provides the database files on a disk contained in a sleeve in the back of the document.

ACKNOWLEDGEMENTS

The Science Directors of the Northern River Basins Study (NRBS), Fred Wrona, William Gummer and Ken Crutchfield, must be thanked for their encouragement and their recognition of the pivotal value of the database.

William Gummer also arranged for the contribution of Environment Canada through the efforts of Randy Schimnoski, who compiled the data about fish, and Cam Teichroeb, who compiled analytical results from non-commercial laboratories. Dr. Stephen Gabos, Human Health Monitoring Program, funded the efforts of Loraine Hornsby and Dietrich Wittkowski, who converted analytical results from the commercial laboratories.

The four commercial laboratories, AXYS Analytical Services Ltd., Chemex Labs Alberta Ltd., Envirotest Laboratories and Zenon Environmental Laboratories, made sincere and notable efforts to satisfy the NRBS needs for electronic copies of analytical results.

To those NRBS scientists and contractors that indulged various questions regarding particular details of collections and analyses, we extend our gratitude for their patience, candor and articulateness.

Finally, as the project leader, I am greatly appreciative of the opportunity to contribute this work on behalf of Alberta Environmental Protection who seconded my position wholly to the NRBS.

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1.0 INTRODUCTION

The Northern River Basins Study (NRBS) was enabled by an agreement executed on September 21, 1991. The agreement stated three specific objectives, one of which was particularly pertinent to this project:

> "to provide a scientifically sound information base for planning and management of the water and aquatic environment of the study area so as to enable its long-term protection, improvement and wise use;"

The establishment of an appropriate information base was also identified in the NRBS Board's guiding vision statement of February, 1996, as one necessary component of success. NRBS management believed that an electronic database of environmental samples collected and analysed would be an important part of the legacy information base.

The commitment to a database for environmental samples was made to initially achieve one objective:

> *To establish and document complete and correct referencing for samples.*

Samples handling was a highly dispersed matter; samples were collected by many different researchers, shipped to and stored in a variety of different locations and analysed by several different laboratories. The locations were distributed all over the country and the agreements enabling the work were struck with many different agencies. The legacy benefit of achieving this objective would be that future researchers would have a central inventory of samples; this would save them time during reviews of NRBS documents and might save the expense of collecting new samples where the NRBS information was adequate.

In early December, 1992, D.A.Westworth was contracted to develop a prototype database for storing inventory information about samples collected and analysed by the NRBS (project 5121-B1). The prototype was delivered at the end of January, 1993, and proved the feasibility of developing a dBASE IV database for maintaining an inventory of samples.

After internal review, the NRBS Office decided to implement an inventory database. In addition to achieving the legacy objective the implementation was expected to serve three operational goals;

1. To provide current, accurate data on sample locations for mapping using the NRBS geographical information system (GIS).
2. To assist in planning continuing sample collection and analysis by recording which samples were subjected to particular analyses and if sample material is still in storage and thus available for further testing.

3. To assist in the legacy decision at the end of the NRBS about whether to discard stored samples or to transfer ownership to other agencies.

The implementation project (5121-C1) was initiated in April, 1994 and completed in May, 1995. During this time information was compiled into a modified database structure for the backlog of samples collected and analysed prior to the implementation, as well as for samples from projects conducted concurrent with the implementation. Compilation of the data for fish was conducted at Environment Canada in Regina, while all other samples were compiled in the NRBS Office in Edmonton.

In May, 1995, the decision was made to extend the database to include analytical results and to prepare the database for publishing (project 5121-E1). The commitment to include analytical results in the database was made to achieve the additional objective:

To provide easy access to analytical results.

The NRBS analysed samples for a great number of parameters which included physical metrics, chemical contaminants and physiological indicators. Proper statistical assessment of this data to investigate temporal and geographic trends and correlations between parameters involved the use of computer tools. The legacy benefit of achieving this objective would be that future researchers would have a central electronic copy of parameter values; this would allow them to move quickly into analysis using computer tools, saving them the time of data entry and of compiling a variety of results into one repository.

Through the last year of the NRBS compilation of analytical results from commercial laboratories was conducted in the NRBS Office while the compilation of non-commercial laboratories was conducted at Environment Canada in Regina. As collection and analysis results were received the database was kept up to date. As the NRBS neared completion the fish inventory data was retrieved from Regina, reviewed and merged with the other samples inventory data in the NRBS Office.

Finally, this project report was prepared to describe the method undertaken to compile the samples database, to present the scope of the data contained in the database and to provide the detailed documentation needed to effectively use the database.

2.0 METHODS

Several general principles were applied to the implementation of the database:

1. The prototype was used as a starting point for the implementation.
2. Special interfaces to tailor access were not constructed; a necessary requirement of using the database was familiarity with dBASE IV.

3. The top priority was to compile data needed to inventory environmental samples taken for contaminant analysis; other sampling would be included as time and resources permitted.

Five tasks were involved in implementing the samples database:
1. Designing the data structures for inventory information.
2. Converting inventory data into the database files.
3. Designing data structures for analytical results.
4. Converting analytical results into the database files.
5. Linking analytical results to inventory data.

2.1 DESIGNING INVENTORY DATA STRUCTURES

The data structures defined in the prototype database were mostly representative of the data fields of interest to the NRBS. The central file which contained information common to samples from all media was revised to accommodate both original samples and subsamples as well as to utilize some coded entries while relegating longer descriptive text to reference files.

For the purposes of the database "environmental sample" was defined as material removed from the natural environment with the objective of subsequent analysis, usually in a laboratory setting. This definition purposively excluded continuous in-situ measurements of such parameters as streamflow or dissolved oxygen, and controlled laboratory experiments intended to determine mathematical relationships between variables. An "original sample" was the original material extracted from the environment while "subsample" was any part of the original sample whether split off immediately in the field or later in the lab.

The data structure for the file containing central common information was reviewed each time conversion began on data from a particular media. Each time a new media was begun, the prototype data structure for the file about collection details particular to that media was tested and revised if necessary.

The details of the database structures are documented in Appendix B, Database Users Guide. "Appendix B: Database Users Guide" contains the names of the data fields in each file plus the meaning and the form of the data contained in each field.

2.2 CONVERTING INVENTORY DATA

The conversion of data into the database followed an iterative process whereby each collection project within a media was reviewed one at a time. In the NRBS Office,

mammals were done first followed by sediment, benthos, liquid and birds. The data for fish was compiled in parallel to the other media.

2.2.1 Auditing Prototype Data About Collections

For a project already contained in the prototype database the collection information was reviewed by comparison with the documentation on file. Specific samples were identified and described in draft or final project reports or in field notes submitted by the collector.

The revised data structure positioned some fields in files different from the prototype. This required a conversion from the prototype database into the new target files. This conversion was accomplished using the "update query" function provided through the Control Centre of the dBASE menu system.

The prototype was developed largely from electronic files that collectors were required to provide with the reports therefore some data fields were empty; this was true of most projects. In addition, the revised data structure required some data for fields additional to those in the prototype. On occasion errors were found in the prototype. In these cases data was corrected and added using manual data entry and update queries.

2.2.2 Converting New Data About Collections

When a project not already in the database had a final project report published, the author's report content was also available in electronic form; this included not only the text of the report, but any data listings provided in appendices. In such a case the update query function could be used to convert most of the data needed into the target files. On occasion small utility programs were written to reduce the effort involved in iterative repetitious actions.

For projects that were still in progress data was manually entered from draft project reports, field notes or correspondence on file. On occasion, certain data was not yet documented and an enquiry was sent to the collector. In such cases a unique code was entered into the data field(s) in question and a log was kept of the codes in order to revisit and resolve the case later.

For two major basin wide collections conducted in the fall of 1994, one for fish and one for sediment, the target file definitions were supplied to the collector in advance. The submittal of the collection data in the required format notably reduced the effort involved in conversion.

On regular occasions, extra work was needed to determine latitudes and longitudes for the samples. If site coordinates were provided in Dominion Land Survey form or in Universal Transverse Mercator form, it was necessary to use the GIS to convert them to latitudes and longitudes. If site coordinates were not provided, but detailed site maps

were used to report locations, then estimates were derived by interpolation with respect to other known points, or by positioning against base map features contained in the GIS. When site coordinates were provided as latitudes and longitudes in the form of degrees, minutes and seconds, it was necessary to convert them into decimal degrees to satisfy GIS requirements; this was done with a spreadsheet.

Near the end of the NRBS, latitudes and longitudes were provided to the GIS for the computation of river kilometres which were then added to the database. In the case of the NRBS river kilometres started at zero at the mouth of the Mackenzie River; river kilometres on this basis were also entered into the database for major confluences in the MacKenzie basin so that river-specific kilometres could be computed when needed.

2.2.3 Converting Data About Samples Analysis

When the NRBS Component Leaders and Science Directors decided that specific samples were to be analysed for particular parameters, the NRBS Office prepared a form called a "Laboratory Analysis Approval" (LAA). The LAA form described the specific samples and the analyses to be performed. It was sent to the laboratory as a directive to conduct the analyses. A copy was also sent to the custodian of the stored samples as a confirmation to ensure that the samples were sent to the laboratory. In due course the commercial laboratories reported the analytical results in the customary printed form. The printed results were distributed within the NRBS for both quality assurance review and for subsequent interpretive work, as well as being filed in the NRBS Office. Several sets of all commercial laboratory analysis reports were compiled as a reference supplement to this report; they were bound separately and placed in several locations where they could be accessed by the public. These locations are identified in "Appendix C: Legacy Locations for Printed Analytical Results".

After collection data was entered for a project the information from all the LAAs referring to original samples from that collection was added to the database. This was done using the update query function and manual data entry.

Analysis information was represented in the database by adding a subsample record to the central common file for each separate analysis performed on each original sample. The analysis report submitted by the laboratory was used to confirm the subsamples analysed; this ensured that laboratory duplicates were included in the database as an analysed subsample. At this point the necessary effort was invested to match the information reported by the laboratory with the existing inventory information and the laboratory's unique identifier was entered against the subsample to confirm and maintain a validated link between the database and the printed laboratory analysis report. However, in the case of fish data the laboratory unique identifier was not entered against the subsample at this time.

2.3 DESIGNING ANALYTICAL DATA STRUCTURES

In response to scientists needing electronic copies of contaminant concentrations the four commercial laboratories were requested to supply electronic files on disks in addition to their printed reports. A procedure was implemented in the NRBS Office to back up and catalogue the disks and to provide copies to individual scientists. Due to the initial variability among laboratories in reporting formats and conventions, a format specification was developed for the four commercial laboratories.

When the decision was made to extend the database to include analytical results the laboratory format specification was reviewed and revised to obtain the final definitions of the needed contaminant target files. The review process involved confirming data fields existed for every parameter reported by every laboratory for a particular contaminant test set. On occasion variations in parameter naming were reviewed with the laboratories in order to correctly assign parameters to the same fields or to different fields. The information needed about each parameter was an indicator of detection, the value of the detected concentration, the units of measurement, the significant decimal places, the value of the detection limit and for certain parameters the method of analysis.

For physical metrics and physiological indicators a similar process was followed. Project documents where scientists reported results of various analyses were reviewed in order to compile a list of the parameters measured and to gather the parameters into logically related test sets. Data fields were then defined for the parameters.

The details of the database structures are documented in Appendix B, Database Users Guide. Appendix B contains the names of data fields in each file plus the meaning and the form of the data contained in each field.

2.4 CONVERTING ANALYTICAL DATA

The commercial laboratories submitted many data files on disk in order to provide electronic copies of analytical results. Because some files were provided before a specification was written and since different laboratories responded differently to the specification, a notable variety of formats existed from the four different sources. In order to convert data from the source files into target files a computer program was written to match source parameter identifiers to target ones and to copy results into the appropriate fields.

A copy of the conversion program was revised for each different target contaminant parameter set. Every time a source file format changed within a parameter set the conversion program was revised. Every time a source file was processed the program was tested and the conversion was validated.

Much of the data provided from non-commercial laboratories was from NRBS researchers doing work of a particular topical focus. Since the data was most often reported in project reports that were yet in draft form and therefore did not yet have electronic copies from the authors, much of the parameters data was entered manually.

2.5 LINKING ANALYTICAL DATA TO INVENTORY DATA

The data structures for the analytical results files were designed to accommodate linking to the inventory files. A computer program was written to confirm cases where the unique laboratory identifier available in the electronic copy of the analytical results matched the unique laboratory identifier entered into the inventory file from the laboratory printed results; the program updated the files with additional fields for matched records. This process provided a check on the completeness of the laboratory electronic copies by comparison to the printed reports. Other processes in the NRBS Office had checked on a continuous basis whether a particular laboratory had submitted all the printed reports required of it.

On occasion the form of the unique laboratory identifier in the analytical results file differed from the one entered to the inventory from a printed report. In such a case the difference was resolved by viewing both identifier fields and judging whether the difference was merely a formatting one or whether additional fields had to be viewed to confirm or deny if a match existed. In the case of fish, several fields had to be viewed to judge matching because the unique laboratory identifier was not entered into the inventory.

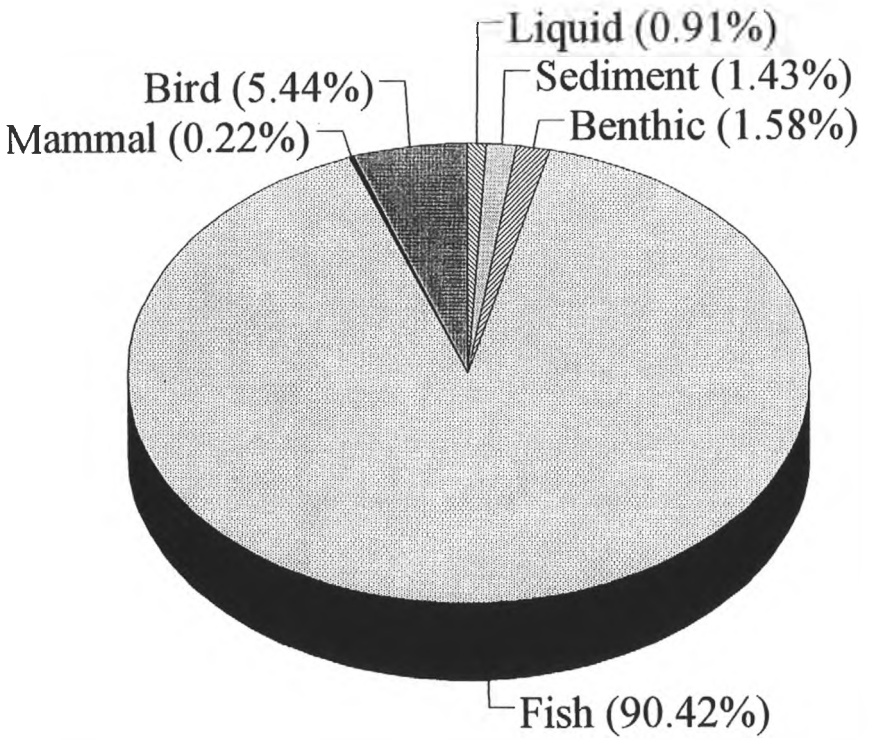
Although no effort was directed at reviewing the results values compared to the paper, an odd value was noticed on rare occasions. In these cases the printed laboratory results were checked because they were viewed as the authority. Although the laboratories provided accurate electronic copies to the best of their abilities, there was no contractual obligation to guarantee completely accurate electronic copies.

For data from non-commercial laboratories, the matching to the inventory was done at the same time as the conversion of the data, by reviewing all available fields and documentation.

3.0 RESULTS

The database contained entries describing a total of 26,780 original samples. "Figure 1: Original Samples by Media" shows that a significant number of the original samples were fish.

Figure 1
Original Samples by Media



However, many of fish original samples were fish handled and released in order to record observations and in some cases to affix tags. In addition a notable number of birds were observed, but not captured. When consideration is given only to the samples actually captured and subjected to analysis or preserved for subsequent analytical processing, fish still represent a significant majority of the samples. "Figure 2: Original Samples for Analysis" displays the portion of the 3537 original samples actually taken from each media; liquid (243), sediment (382), benthos (424), fish (2,392), mammals (59) and birds (37). The rest of this section of the report provides details contained in the database regarding the samples taken from each different media.

The database contained a total of 1440 distinct sites related to the handling of samples. "Figure 3: Collection Sites: All Original Samples for Analysis" displays the geographic extent of material actually taken from the environment.

The earliest sample contained in the database was collected on 28 September, 1988, while the latest sample was collected on 12 May, 1995. The early sample date is prior to the commencement of the NRBS because some sediment samples archived by Alberta Environmental Protection (AEP) were donated to the NRBS (refer to section 3.2). The NRBS collected and analysed some samples more recently than the latest samples in the database; the documentation related to these most recent projects was not received in time for inclusion in the database. The rest of this section of the report identifies these recent projects for each different media.

The database contained a record of many original samples and subsamples that were documented as being in storage. At the completion of the NRBS samples material in storage had ownership transferred to other agencies. The disposition of remaining NRBS samples material is not dealt with in this report.

The data files that constitute the database are provided on a 3.5 inch disk in the sleeve in the back of this report. Details related to the installation of the database on a microcomputer are provided in section B.6 of "Appendix B: Database Users Guide".

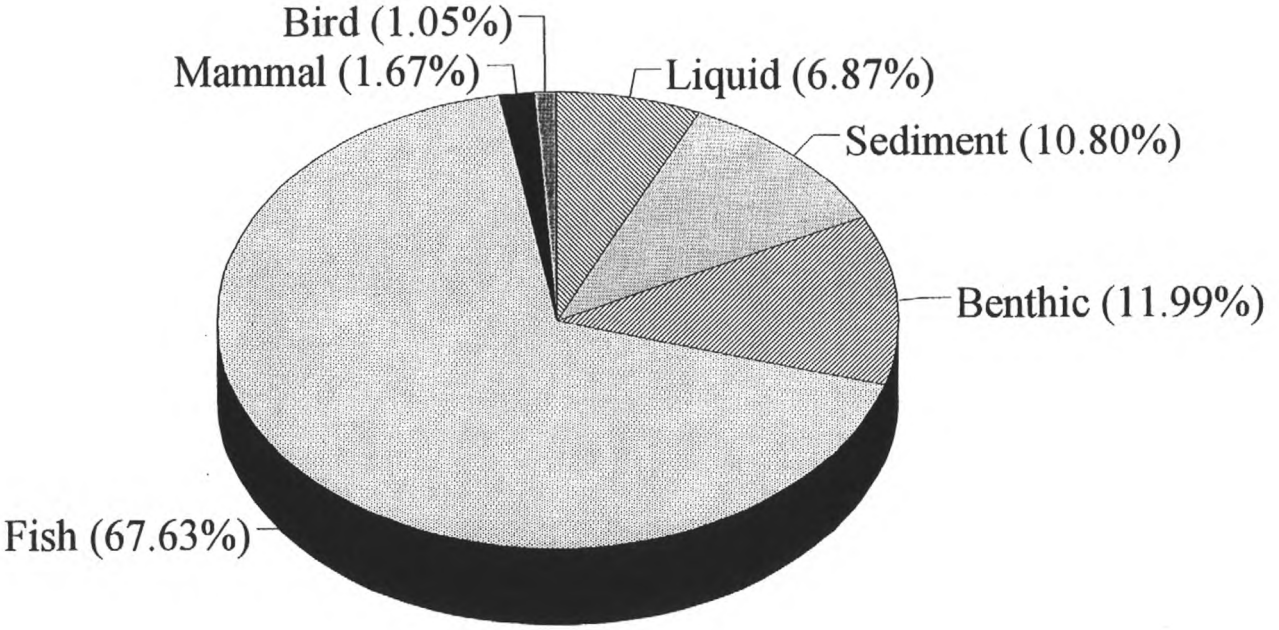
3.1 LIQUID SAMPLES

The database contained a total of 243 original samples that were collected in liquid form. "Figure 4: Nature of Liquid Samples" displays the proportion of liquid samples of each nature; ambient water (190), effluent (49) and treated water (4). "Figure 5: Collection Sites: Liquid Samples" displays the geographic distribution of the 122 sites where original liquid samples were collected.

3.1.1 Collection of Liquid Samples

"Table 1: Projects That Collected Liquid Samples" references the NRBS projects that collected liquid samples for various objectives.

Figure 2
Original Samples for Analysis



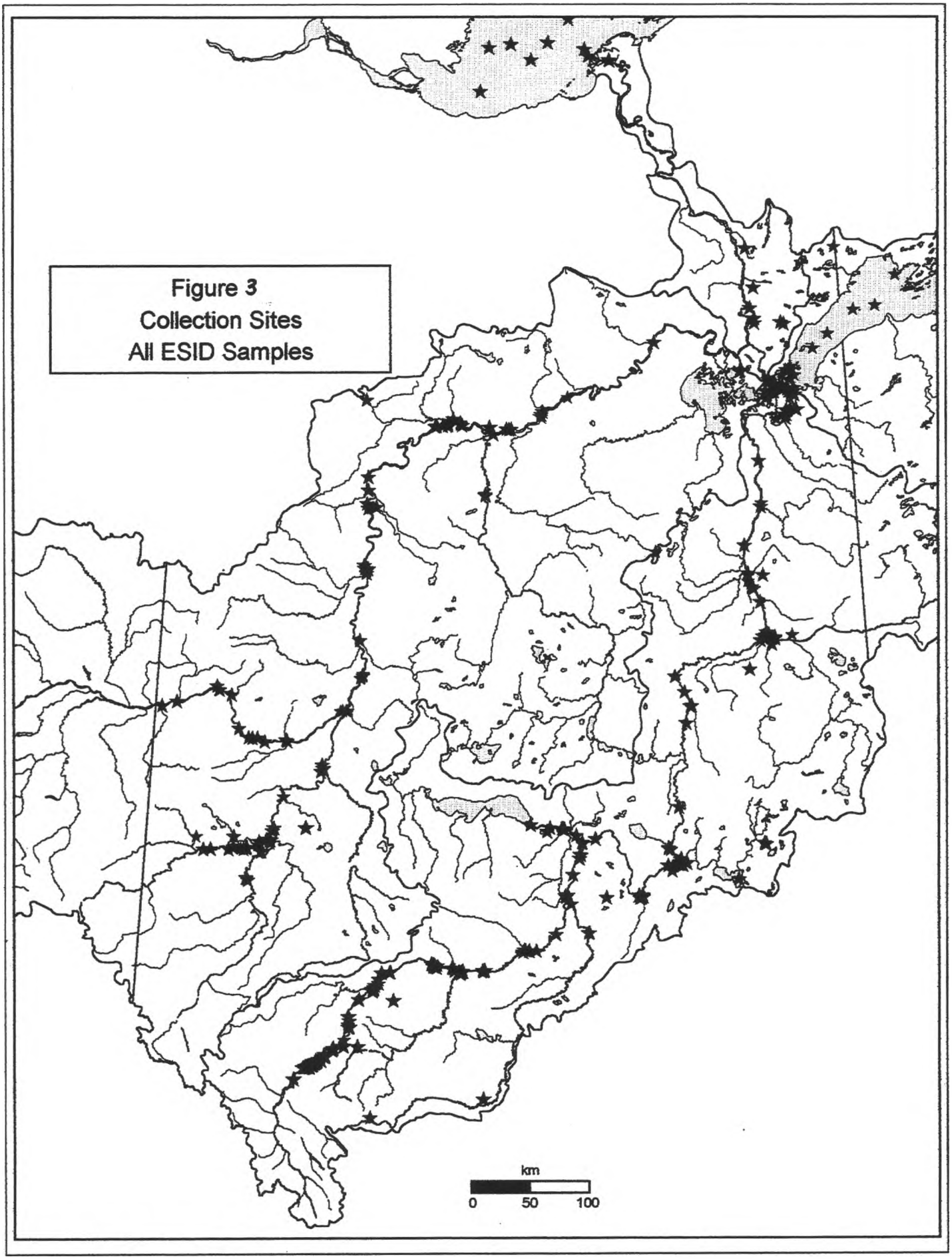
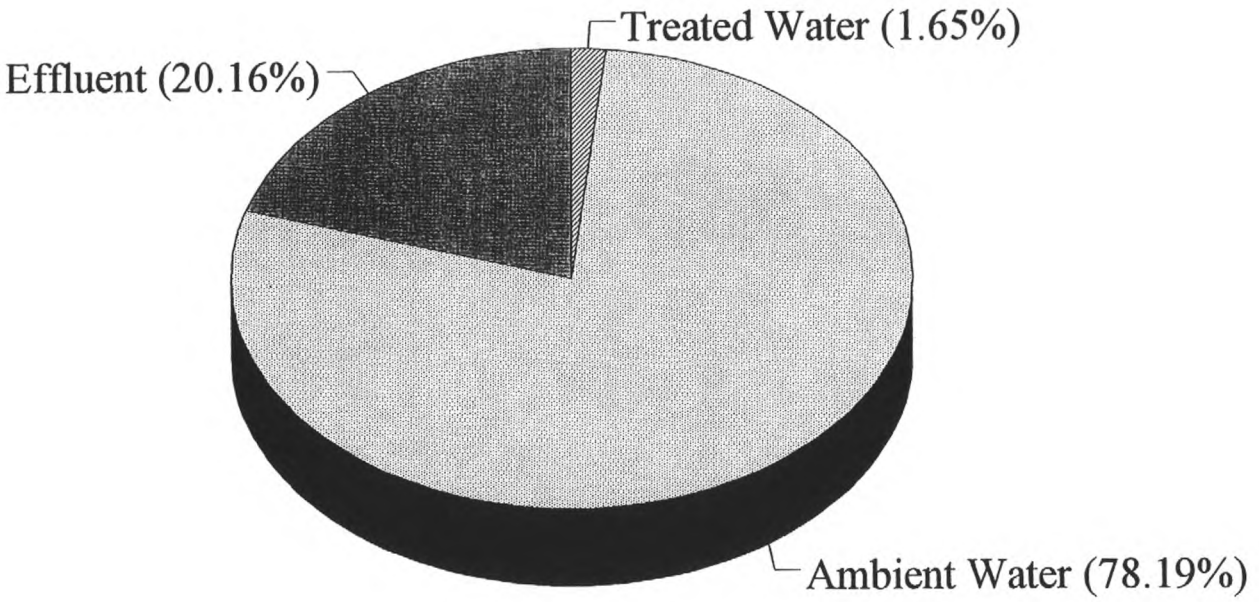


Figure 3
Collection Sites
All ESID Samples
km
0
50
100

Figure 4
Nature of Liquid Samples



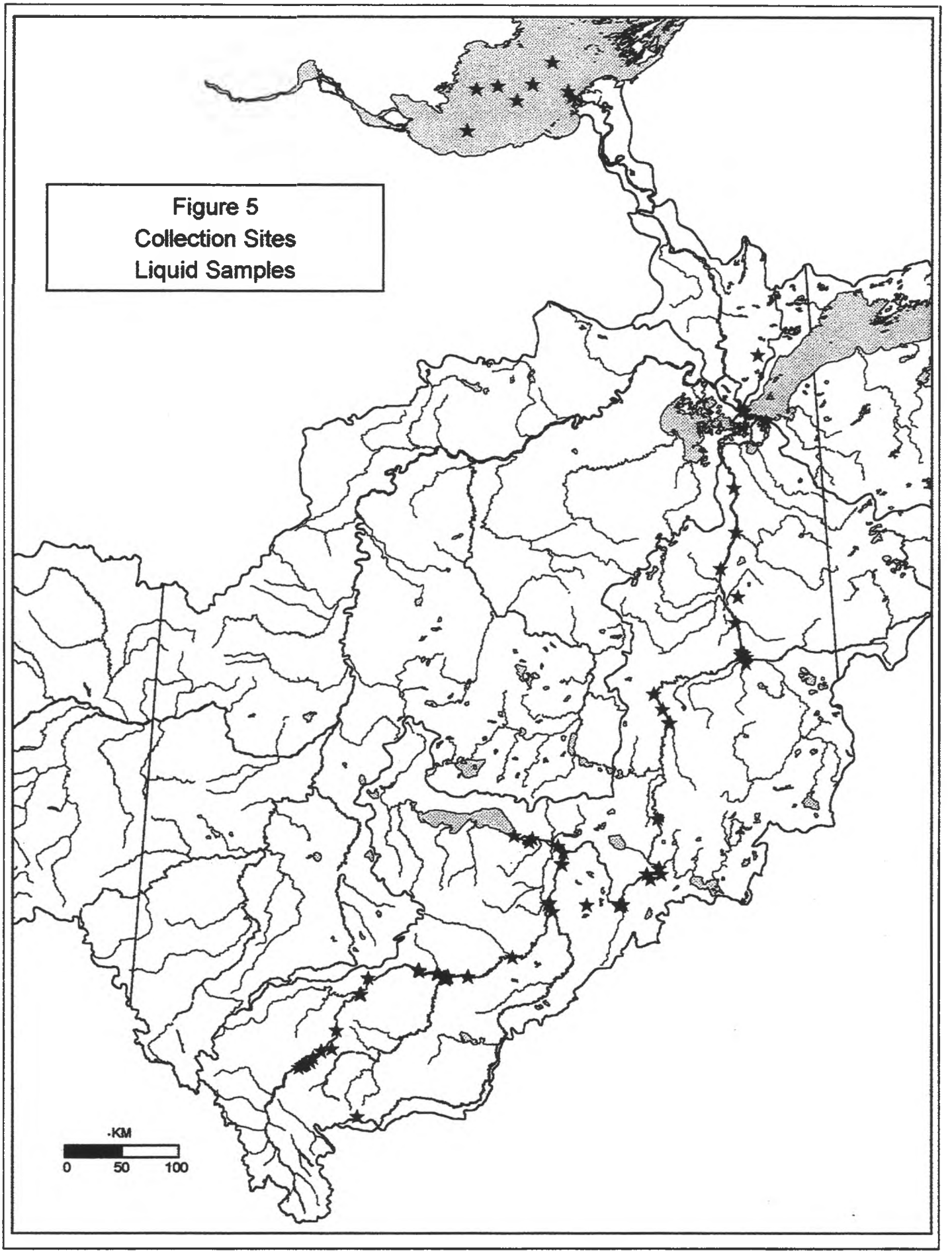


Figure 5
Collection Sites
Liquid Samples
KM
0
50
100

Table 1: Projects That Collected Liquid Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2121B1	To determine contaminants in grab and centrifuged effluent in conjunction with suspended sediment for RSS sites	Athabasca R (Hinton)	4	02-APR-92	21-MAY-92	NRBS No. 108 [14]
2122B1	To determine contaminants in centrifuged effluent while sampling suspended sediment synchronous with winter synoptic survey	Athabasca R	24	11-FEB-93	12-MAR-93	NRBS No. 130 [15]
2211A1	To obtain ultimate Biochemical Oxygen Demand (BOD/u) for use in DO models	Athabasca R	21	29-JAN-92	26-FEB-92	AEP Report [43]
2212C1	To determine inputs of DO, organic matter and nutrients to the mainstem from tributaries	McLeod R & Pembina R	10	17-JAN-94	24-MAR-94	AEP Report [42]
2221A1	To determine water column DO in conjunction with SOD	Athabasca R	13	29-JAN-92	24-MAR-92	NRBS No. 3 [40]
2312B1	To determine contaminants in grab and centrifuged water in conjunction with suspended sediment for RSS sites	Athabasca R	39	01-APR-92	26-MAY-92	NRBS No. 108 [14]
2313B1	To determine contaminants in centrifuged water while sampling suspended sediment synchronous with winter synoptic survey	Athabasca R	48	12-FEB-93	17-MAR-93	NRBS No. 130 [15]
2333C1	To determine water column characteristics in conjunction with deep coring	Great Slave L	20	21-MAR-94	28-MAR-94	NRBS No. 131 [23]
2391B1	To assess contaminants in all media in the Peace-Athabasca delta	L Athabasca (Flour Bay)	1	26-AUG-92	26-AUG-92	file correspondence
4411B1	To determine potential for off-flavour tainting of water in the Athabasca R prior to startup of the Alberta-Pacific mill	Athabasca R	31	11-FEB-93	17-MAR-93	NRBS No. 42 [33]
4413C1	To determine potential for off-flavour tainting of water in the Athabasca R after startup of the Alberta-Pacific mill	Athabasca R	32	10-FEB-94	15-MAR-94	NRBS No. 114 [34]
	TOTAL		243			

In April and May, 1992, as a contribution in kind, R. Crosley of Environment Canada, Calgary, collected liquid and sediment samples from the Athabasca River and from the Hinton combined effluent (projects 2121B1, 2312B1 and 2324B1). In February and March, 1993, R. Crosley collected liquid and sediment samples synchronous with the synoptic survey conducted by Alberta Environmental Protection (projects 2122B1, 2313B1 and 2323B1).

Contributions in kind were made by Alberta Environmental Protection (AEP). Two projects were conducted under the guidance of L. Noton; one to determine ultimate Biochemical Oxygen Demand (project 2211-A1) and one to determine dissolved Oxygen contributions from certain tributaries to the Athabasca River (project 2212-C1). L. Noton also directed the collection of high volume (4 and 20 litre) liquid samples during synoptic surveys in 1993 and 1994 for flavour panel analysis (projects 4411-B1 and 4413-C1).

3.1.2 Analysis of Liquid Samples

The database contained 324 records for liquid subsamples subjected to various analyses. "Figure 6: Analyses Conducted on Liquid" shows the number of liquid subsamples subjected to each different analysis.

3.1.3 Additional Data for Liquid

At the time of writing four projects that intended to collect and analyse liquid samples were yet to be reported to the NRBS Office; the database does not include data from these projects. Scrimgeour, Chambers, Culp and Podemski (1995) [57] subsequently reported some water chemistry measurements in the Athabasca River related to their determinations of nutrient limitations using in-situ nutrient diffusing substrate (NDS) (project 2614-C1). Scrimgeour and Chambers (1996) [56] also reported some water chemistry parameters for the Wapiti, Smoky and Athabasca Rivers related to further work with NDS (project 2614-D1). Armstrong, Stanley and Smith (1996) [1] subsequently collected samples from non-conventional sources of drinking water at several locations in northern Alberta and analysed them for microbial parameters (project 4423-D1). Johnson, Urson and Geleta (1996) [32] reported broad spectrum analysis on samples taken from the Athabasca River in July, 1994, February, 1995 and August, 1995, and from the Wapiti and Smoky Rivers in February, 1995 (project 2921-D1).

3.2 SEDIMENT SAMPLES

The database contained a total of 382 original sediment samples that were collected. "Figure 7: Nature of Sediment Samples" displays the number of sediment samples of each nature; suspended sediment (37), bottom sediment (300) and sediment cores (45). "Figure 8: Collection Sites: Sediment Samples" displays the geographic distribution of the 194 sites where original sediment samples were collected.

Figure 6
Analyses Conducted on Liquid

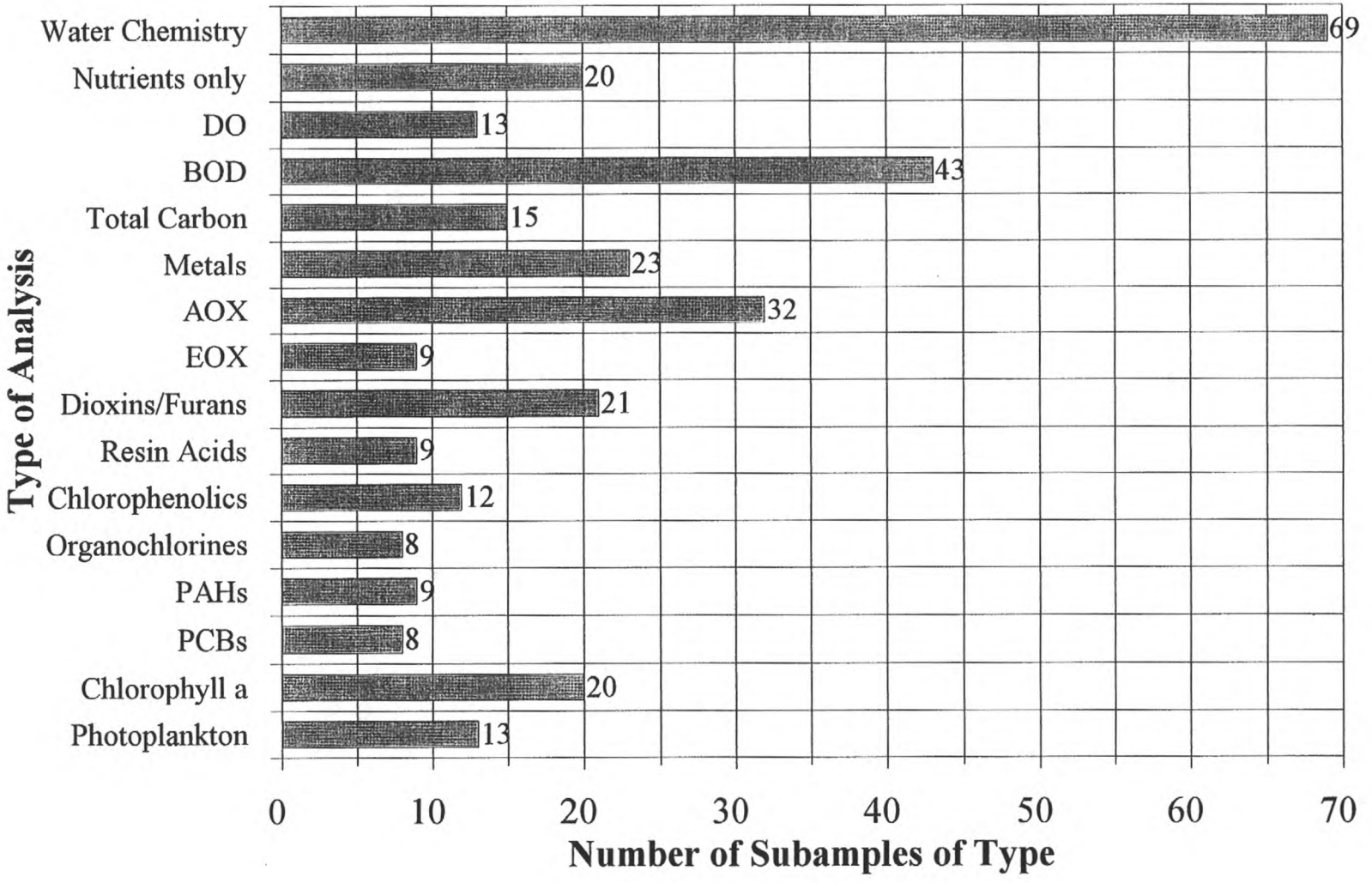
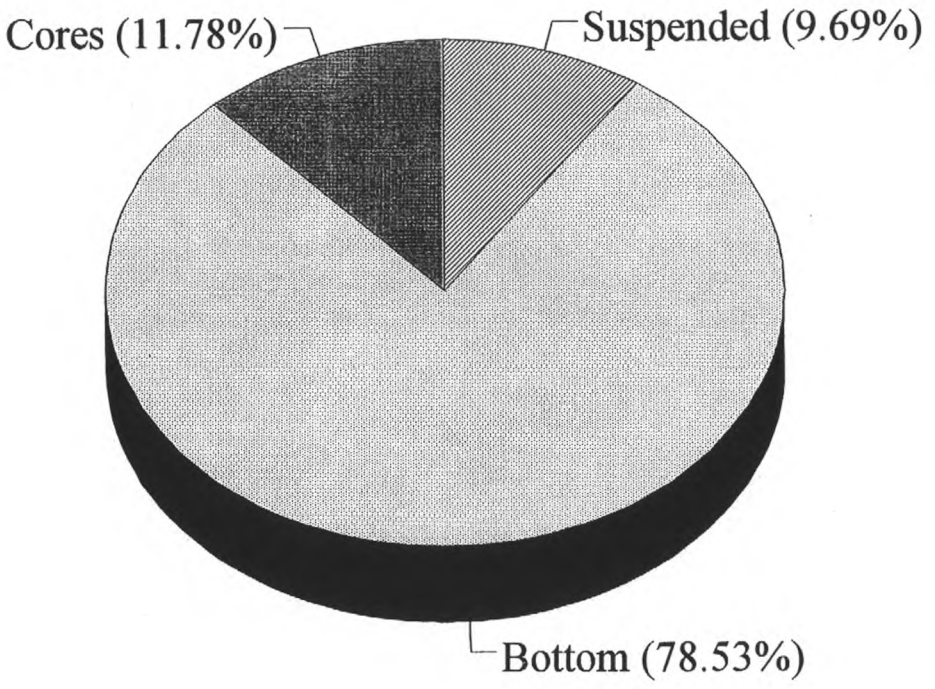


Figure 7
Nature of Sediment Samples



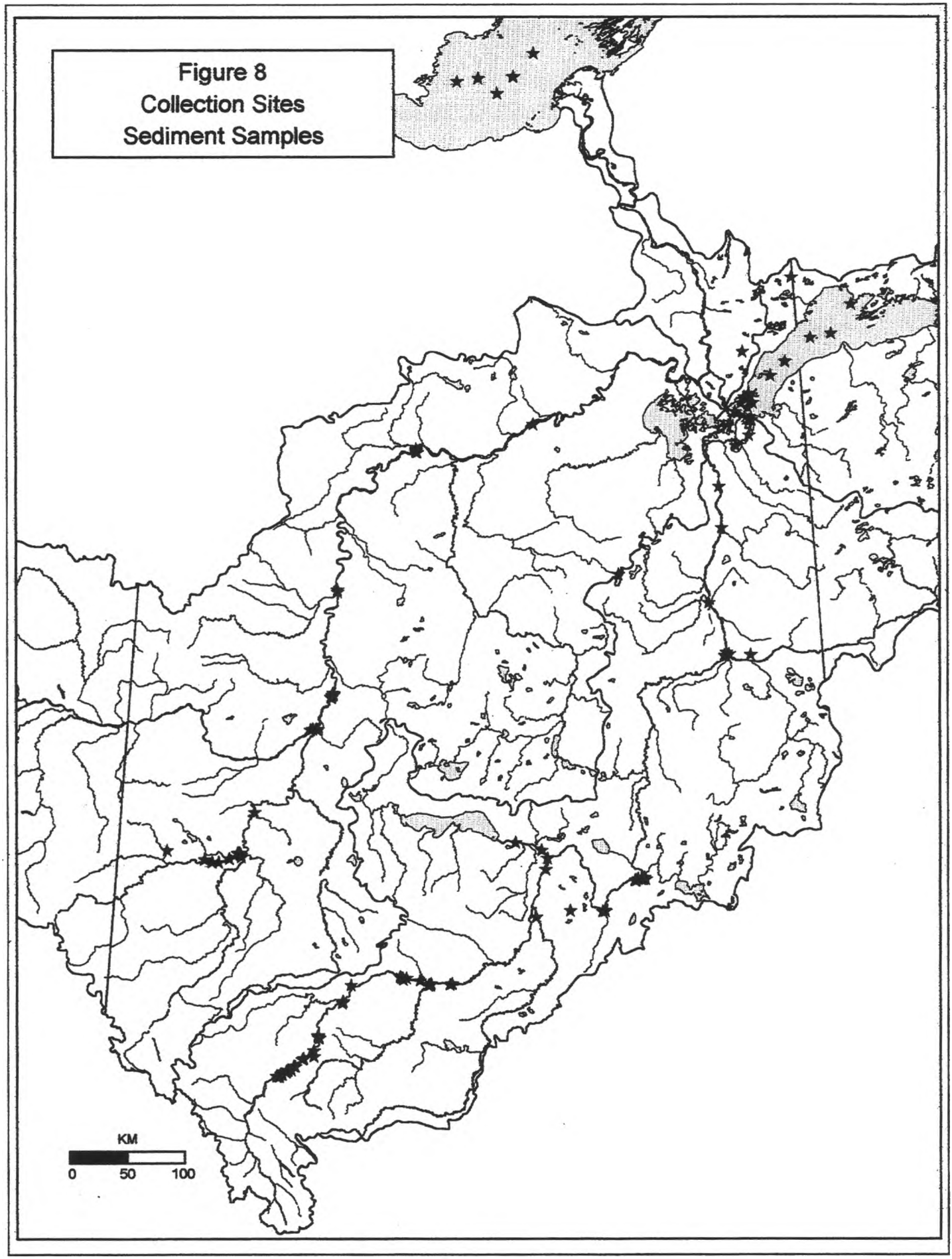


Figure 8
Collection Sites
Sediment Samples
KM
0
50
100

Table 2: Projects That Collected Sediment Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2113B1	To obtain sediment cores from lakes not influenced by waterborne inputs, to estimate atmospheric contributions	Legend L & Weeks L	11	23-MAR-93	25-MAR-93	NRBS No. 71 [6]
2121B1	To characterize effluents for RSS sites on the Athabasca R	Hinton	2	02-APR-92	21-MAY-92	NRBS No. 108 [14]
2122B1	To characterize effluents on the Athabasca R	Athabasca R	7	11-FEB-93	10-MAR-93	NRBS No. 130 [15]
2221A1	To determine SOD on the Athabasca R	Athabasca R	59	29-JAN-92	24-MAR-92	NRBS No. 3 [40]
2321A1	To prepare for analysis archived bottom sediments collected by Alberta Environment	Peace R & Athabasca R	20	28-SEP-88	18-APR-90	file correspondence
2322D1	To survey bottom sediments for spatial distribution of contaminants and to assess within-zone variability	Peace R & Athabasca R	19	08-OCT-94	11-OCT-94	NRBS No. 106 [13]
2322E1	To survey bottom sediment to assess within-zone variability in contamination	Peace R & Athabasca R	50	08-MAY-95	12-MAY-95	NRBS No. 106 [13]
2323B1	To survey suspended and bottom sediments synchronous with Alberta Environment winter synoptic survey	Athabasca R	61	11-FEB-93	07-MAY-93	NRBS No. 130 [15]
2324B1	To survey suspended sediments for RSS sites on Athabasca R	Athabasca R	12	31-MAR-92	26-MAY-92	NRBS No. 108 [14]
2325B1	To survey bottom sediments for RSS sites on the Athabasca R	Athabasca R	24	08-APR-92	14-MAY-92	NRBS No. 2 [48]
2326C1	To collect bottom sediments for RSS sites for toxicity testing portion of a triad study	Athabasca R	35	26-OCT-93	27-OCT-93	NRBS No. 59 [17]
2328C1	To collect bottom sediments for RSS sites for chemical contaminant analysis portion of a triad study	Athabasca R	35	15-SEP-93	17-SEP-93	NRBS No. 59 [17]
2332A1	To obtain a historical record of contaminant deposition by deep coring undisturbed lake bottom	L Athabasca	25	09-MAR-92	24-MAR-93	NRBS No. 72 [7]
2333C1	To obtain a historical record of contaminant deposition by deep coring undisturbed lake bottom	Great Slave L	18	21-MAR-94	28-MAR-94	NRBS No. 99 [22]
2391B1	To assess contaminants in all media in the Peace-Athabasca delta	Killers L & L Athabasca	2	25-AUG-92	26-AUG-92	file correspondence
2912D1	To prepare sediment reference material for laboratory quality assurance	Hinton & Wapiti R	2	n/a	08-OCT-94	n/a
	TOTAL		382			

3.2.1 Collection of Sediment Samples

"Table 2: Projects That Collected Sediment Samples" references the NRBS projects that collected sediment samples for various objectives.

The majority of suspended and bottom sediment collected for the NRBS was done as a contribution in kind by R. Crosley of Environment Canada, Calgary, including;

1. liquid and sediment sampling from the Athabasca River in April and May of 1992 (projects 2121-B1, 2312-B1 and 2324-B1),
2. liquid, sediment and benthic sampling in the Athabasca River in February, March and May of 1993 (projects 2122-B1, 2313-B1 and 2323-B1),
3. bottom sediment sampling in the Athabasca River in October of 1993 (projects 2326-C1 and 2328-C1),
4. bottom sediment sampling basin wide in October of 1994 (project 2322-D1),
5. bottom sediment sampling basin wide in May of 1995 (project 2322-E1).

Alberta Environmental Protection donated selected archived bottom sediment samples that had been collected basin wide during the years 1988 to 1990 (project 2321-A1). Bottom sediments as well as benthos were collected in the Athabasca River by R.L. & L Environmental Services Ltd. in April and May of 1992 (project 2325-B1).

Deep coring to determine the long term history of sediment deposition and contaminant levels was conducted in Lake Athabasca (project 2332-A1) and in Great Slave Lake (project 2333-C1). To evaluate atmospheric contributions to historic contaminant levels Legend Lake and Weekes Lake were cored as reference sites (project 2113-B1). In the case of sediment cores a single complete core is described as one original sample; subsequent core slices taken for analyses are described as subsamples split from the original.

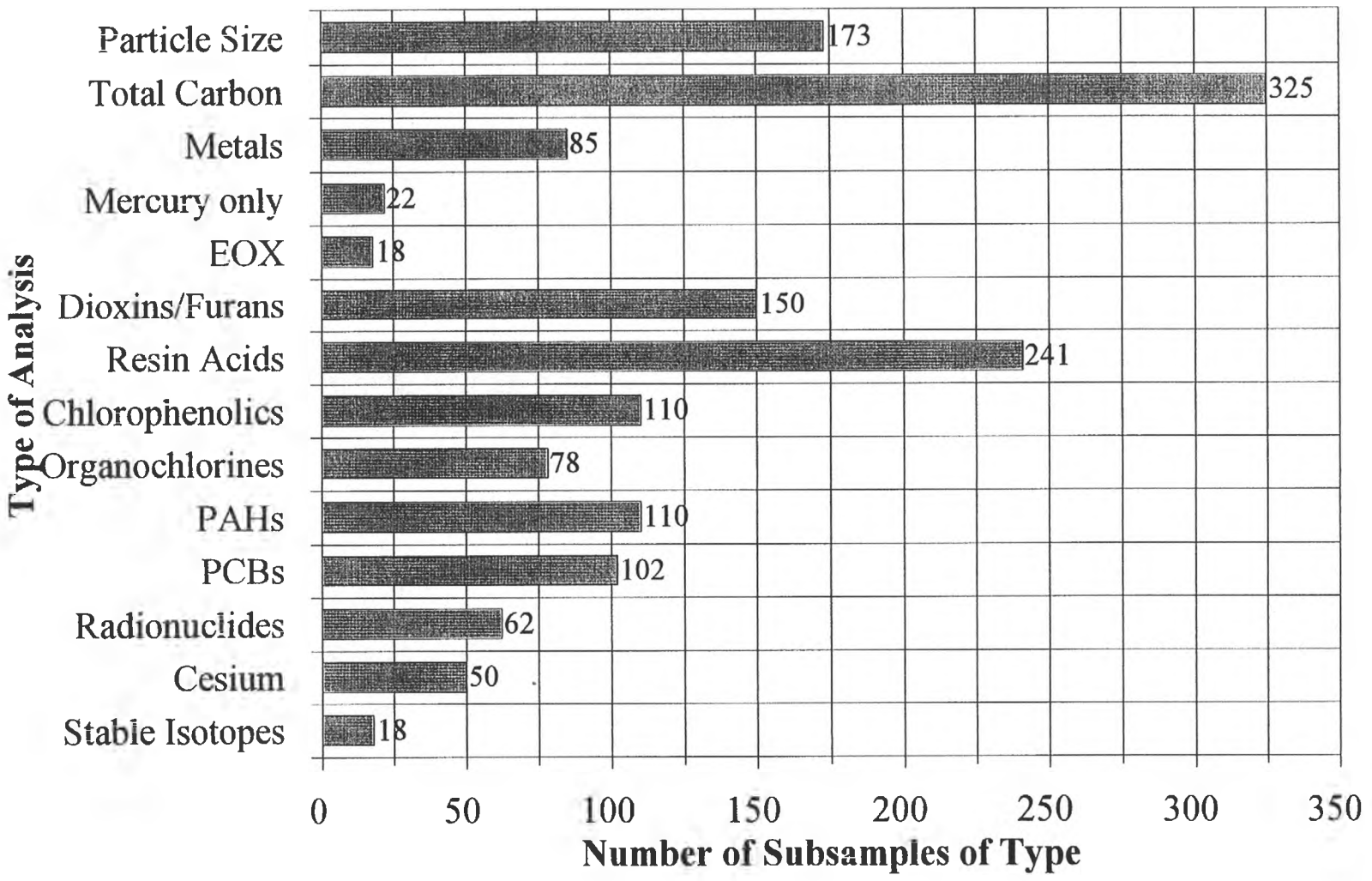
3.2.2 Analysis of Sediment Samples

The database contained 1544 records for sediment subsamples subjected to various analyses. "Figure 9: Analyses Conducted on Sediment" shows the number of sediment subsamples subjected to each different analysis.

In addition to analyses for chemical contaminants by the commercial laboratories, sediment was also subjected to particle size analysis by the National Water Research Institute. Bourbonniere, Telford and Kemper (1996b) [7] reported radionuclide measures for cores from Lake Athabasca. Hesslein and Ramlal (1993) [27] reported stable isotopes for sediment collected from the Athabasca River (project 3131-B1).

Figure 9

Analyses Conducted on Sediment



3.2.3 Additional Data for Sediment

At the time of writing two projects that intended to collect and analyse sediment samples were yet to be reported to the NRBS Office; the database does not include data from these projects. Noton (1996) [41] subsequently reported a survey of streambed oxygen demand (SOD) from October, 1994 to March, 1995, on the Athabasca River from upstream of Hinton to the Calling River area (project 2222-D1). Dobson, Day and Reynoldson (1996) subsequently reported samples of bottom and suspended sediment collected from various sites in the Athabasca, Smoky and Peace Rivers in June, 1995, for chronic bioassay testing with four species of benthic invertebrates (project 2326-E1).

3.3 BENTHIC SAMPLES

The database contained a total of 424 samples of benthic material that were collected. "Figure 10: Nature of Benthic Samples" displays the number of benthic samples of each nature; Plecoptera (22), Tricoptera (21), Ephemeroptera (21), Macroinvertebrate community (238) and Epilithon (122). "Figure 11: Collection Sites: Benthic Samples" displays the geographic distribution of the 195 sites where original benthic samples were collected.

3.3.1 Collection of Benthic Samples

"Table 3: Projects That Collected Benthic Samples" references the NRBS projects that collected benthic samples for various objectives.

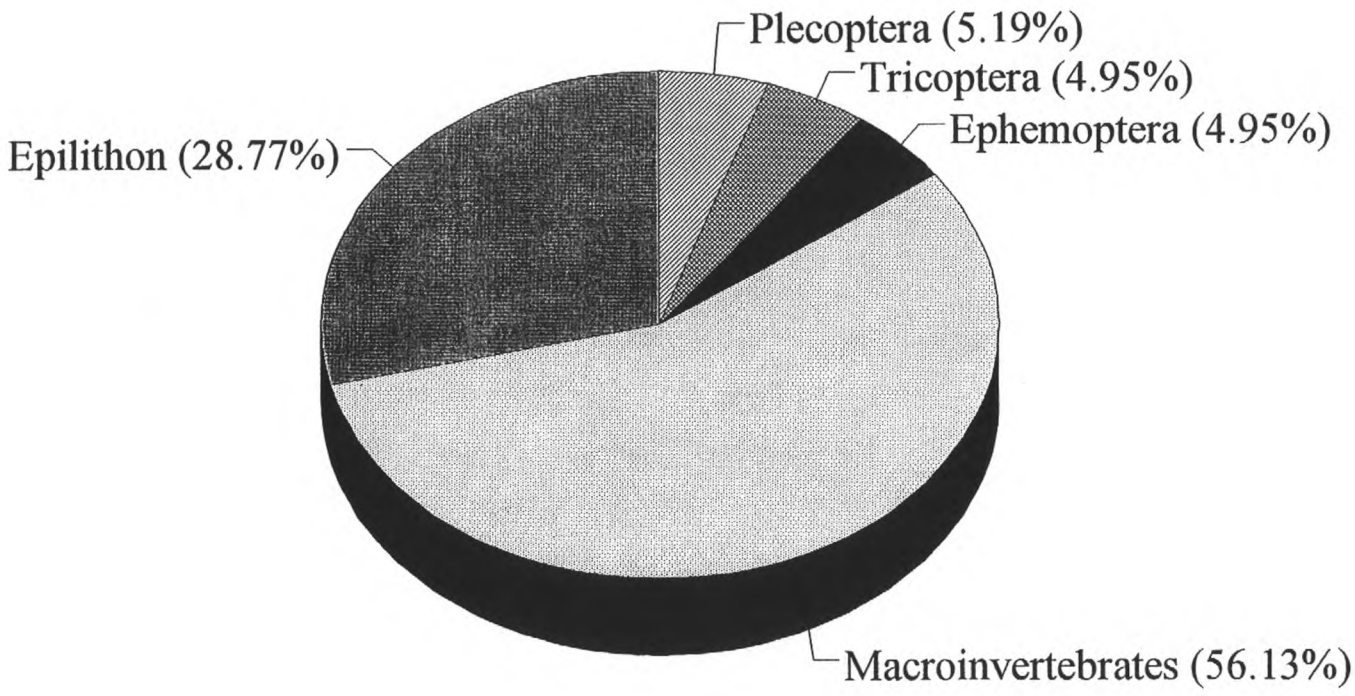
As a contribution in kind, R. Crosley of Environment Canada, Calgary, made benthic collections in conjunction with sediment collections on the Athabasca River in May, 1993 (project 2323-B1). R. Crosley also collected benthic material from the Athabasca River in September, 1993, in support of a triad study (project 2327-C1).

Collections of benthic material were also made by R.L. & L Environmental Services in April of 1992 in the reach specific study area (project 2371-B1) and in February and March of 1993 in conjunction with the synoptic survey on the Athabasca River (project 2371-B2). In September, 1993, a collection of emergent insects was made using light traps (project 2375-C1).

3.3.2 Analysis of Benthic Samples

The database contained 602 records for benthic subsamples subjected to various analyses. "Figure 12: Analyses Conducted on Benthos" shows the number of benthic subsamples subjected to each different analysis.

Figure 10
Nature of Benthic Samples



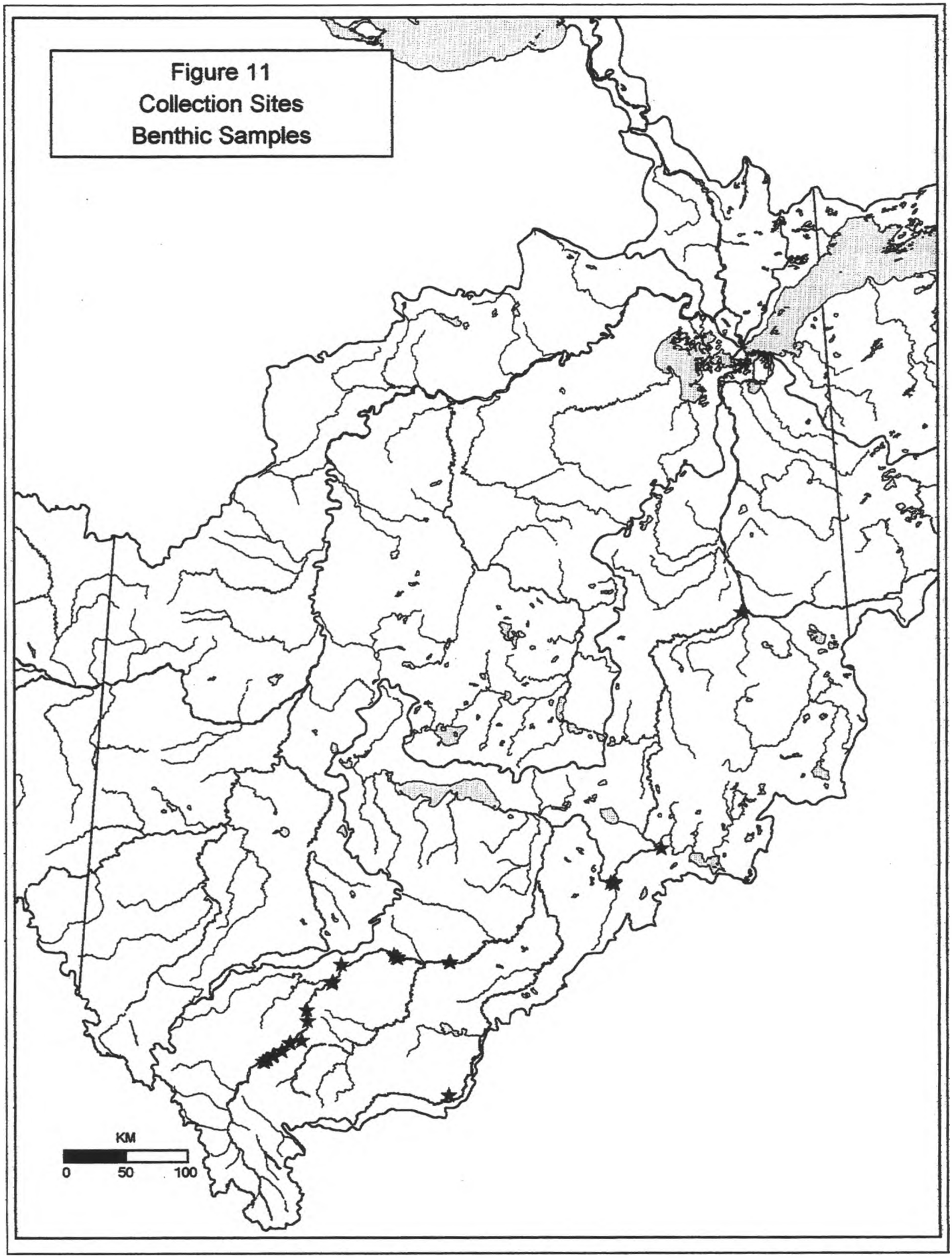


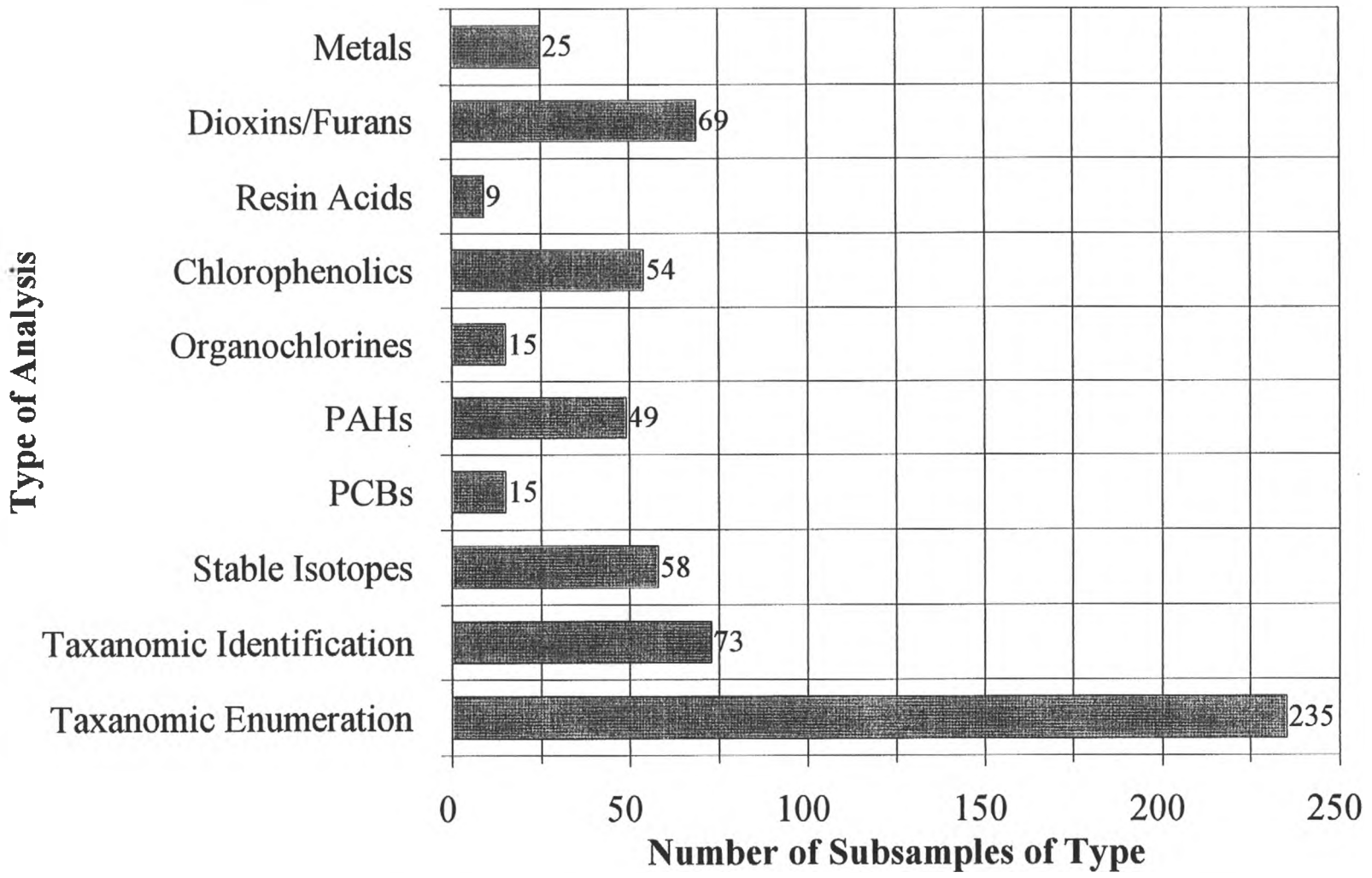
Figure 11
Collection Sites
Benthic Samples
KM
0
50
100

Table 3: Projects That Collected Benthic Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2323B1	To survey sediments and benthos synchronous with Alberta Environment winter synoptic survey	Athabasca R	40	05-MAY-93	07-MAY-93	NRBS No. 50 [53]
2327C1	To collect bottom benthic organisms for RSS sites for community composition portion of a triad study	Athabasca R	35	15-SEP-93	17-SEP-93	file correspondence
2371B1	To determine contaminants in benthic organisms and benthic community structure for RSS sites	Athabasca R	88	08-APR-92	14-APR-92	NRBS No. 2 [48]
2371B2	To determine contaminants in benthic organisms and benthic community structure for Athabasca R	Athabasca R	256	24-FEB-93	27-MAR-93	NRBS No. 21 [21]
2375C1	To sample emergent insects with light traps for contaminant analysis	Athabasca R Obed Mtn Br	5	02-SEP-93	03-SEP_93	NRBS No. 35 [20]
	TOTAL		424			

Figure 12

Analyses Conducted on Benthos



In relation to macroinvertebrates collected for contaminant analysis, taxonomic sorting was done in the field for some projects (2371-B1, 2371-B2 and 2375-C1) and the containers labelled for the target analyses. The database treated these collections as being one original sample at each site with subsequent splitting to subsamples for the various analyses.

In addition to analyses to determine contaminant concentrations, benthic material was analysed to determine stable isotopes and community structure. Hesslein and Ramlal (1993) [27] and (1996) [28] reported stable isotopes for benthic material collected from the Athabasca River (projects 3131-B1 and 3131-C1).

Community structure was reported by several researchers for the Athabasca River; R.L. & L. Environmental Services Ltd. (1993b) [49] and Dunnigan (1993) [19] reported taxonomic identifications and enumerations on the April and May, 1992 collection; Saunders and Dratnal (1994) [54] reported identifications and enumerations on the February and March, 1993 under-ice collection; and Saffran (1995) [53] reported the same for collections in May, 1993 and September, 1993. Analytical results for taxonomic enumeration was not included in the database due to significant work of this nature completed by others; Scrimgeour et al (1995) [55]; Cash, Ouellett, Wrona and Wagner (1996) [11]; and Ouellett and Cash (1996) [44].

3.4 FISH SAMPLES

The database contained 24,214 original samples identified as original fish collected. In addition to collecting fish for contaminant analysis the NRBS also handled many fish in order to examine them for species, age, sex and general health and to measure length and weight before releasing them. On numerous occasions individual fish were fixed with a tag before release; on occasion information about individual tag returns was supplied to the NRBS by AEP. This original fish data including tag details and subsequent return information was all entered into the database. Some small number of fish were unable to survive the trauma of handling and these are recorded as sacrificed.

"Figure 13: Status of Fish Handled" displays the number of original fish handled in different ways; captured and retained for contaminant analysis (2,392), handled and released (15,029), handled and tagged and released (6,646), handled and sacrificed (147). "Figure 14: Fish Species Captured for Analysis" shows the number of fish taken of each species. "Figure 15: Collection Sites: Fish Samples" displays the geographic distribution of the original fish samples collected.

3.4.1 Collection of Fish Samples

"Table 4: Projects That Collected Fish Samples" references the NRBS projects that collected fish samples for various objectives.

Figure 13
Status of Fish Handled

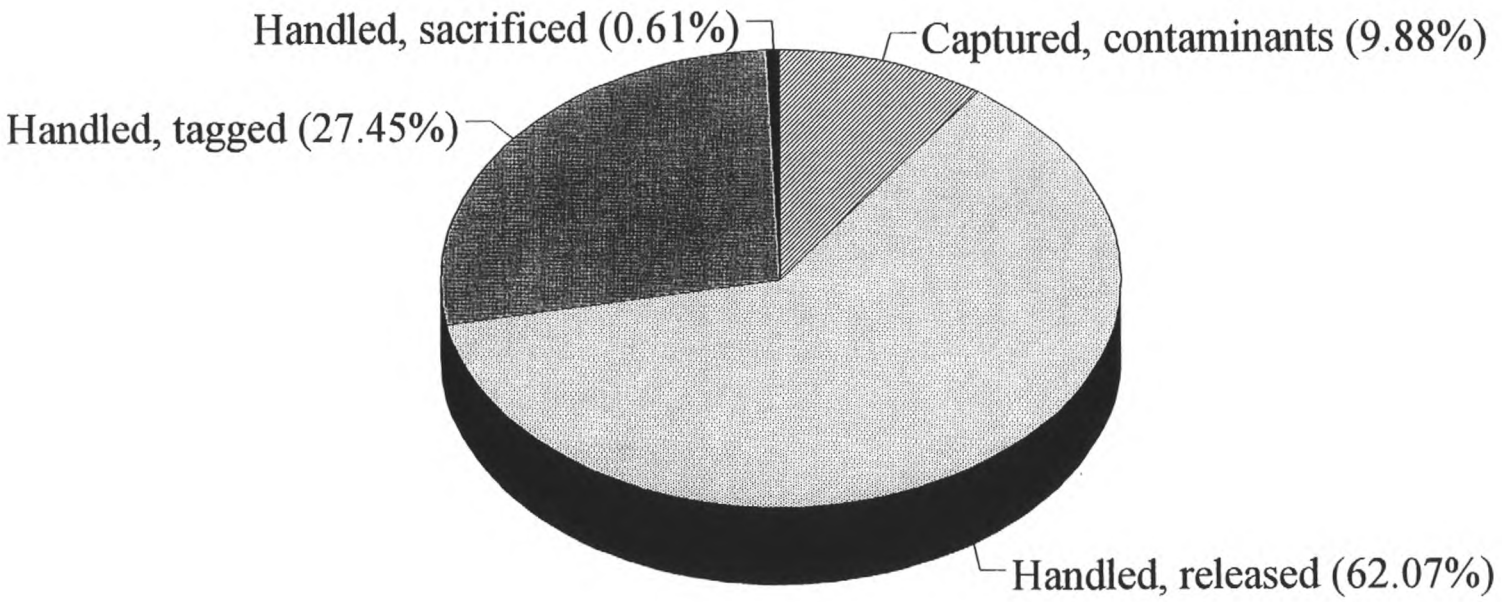
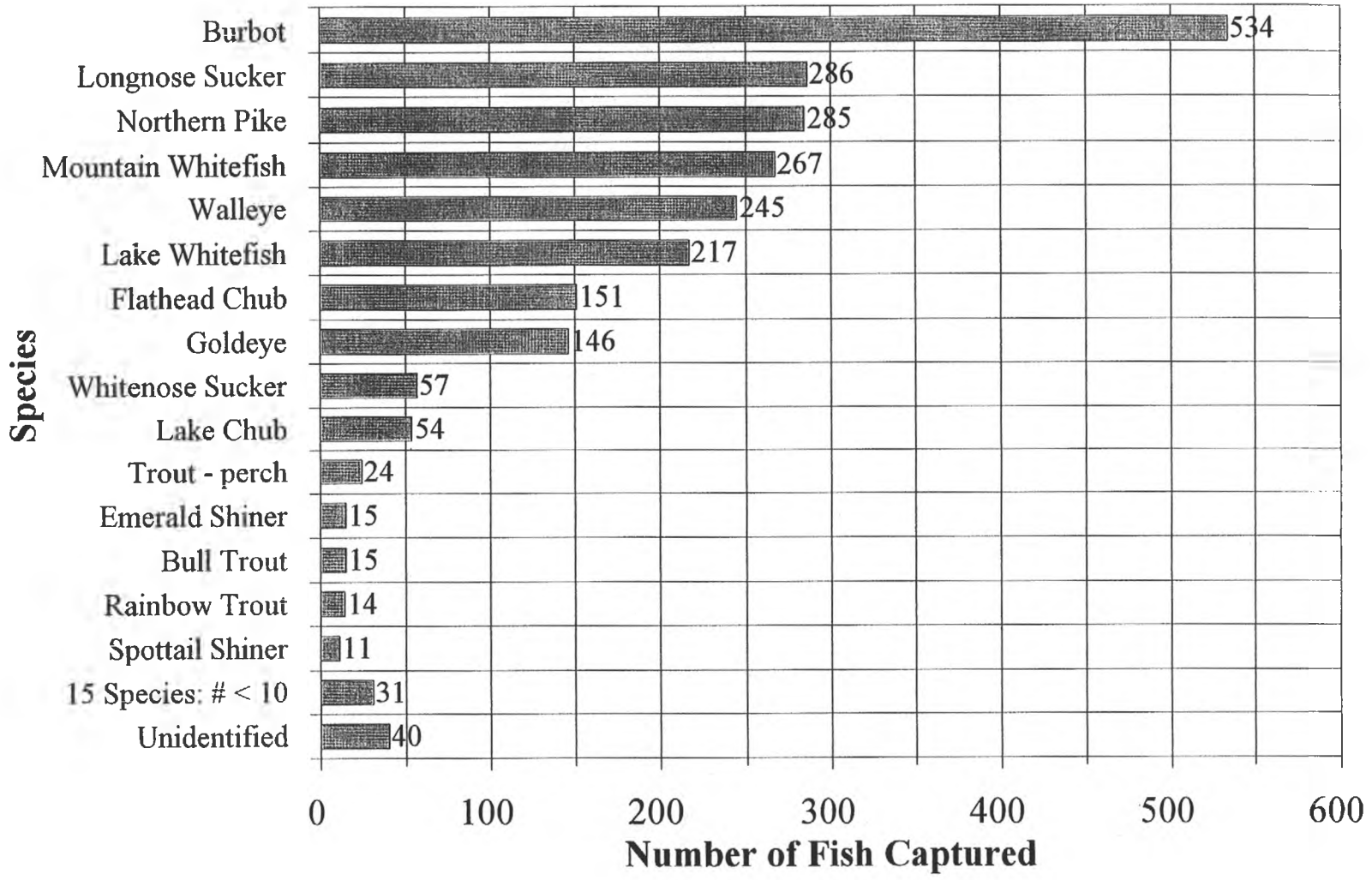


Figure 14

Fish Species Captured for Analysis



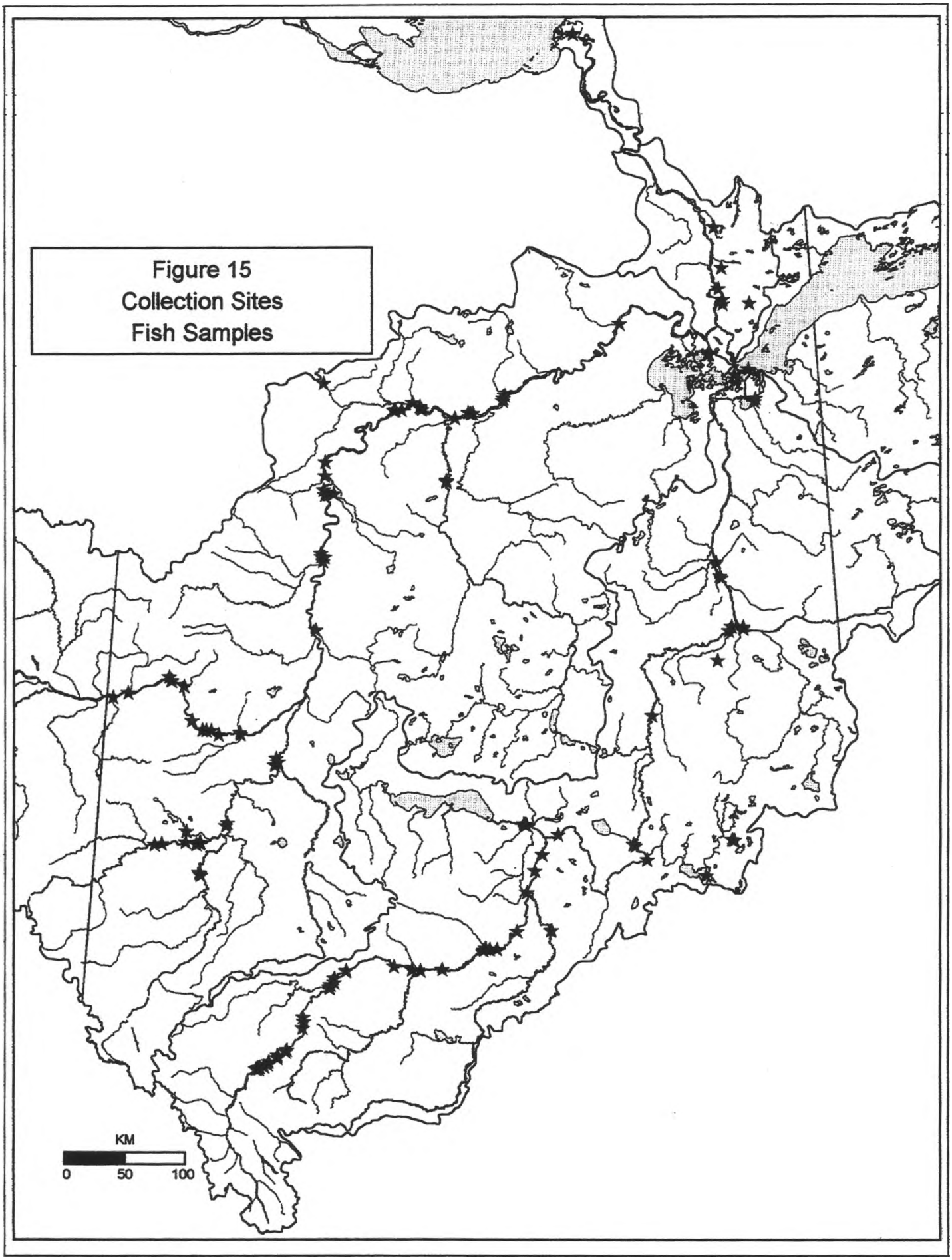


Figure 15
Collection Sites
Fish Samples
KM
0
50
100

Table 4: Projects That Collected Fish Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2371B2	To determine contaminants in benthic organisms & fish	Athabasca R	46	24-FEB-93	08-MAR-93	NRBS No. 21 [21]
2391B1	To assess contaminants in all media in the Peace-Athabasca delta	Jackfish Vill.& L Athabasca	40	25-AUG-92	26-AUG-92	file correspondence
3117B1	To conduct a baseline fish & fish habitat inventory & to collect fish for contaminant analysis	Athabasca R	4754	22-APR-92	18-JUN-92	NRBS No. 32 [50]
3117B2	To conduct a baseline fish & fish habitat inventory & to collect fish for contaminant analysis, BC bdry to Vermilion Chutes	Peace R	6263	19-APR-92	05-JUN-92	NRBS No. 9 [5]
3117B3	To conduct a baseline fish & fish habitat inventory & to collect fish for contaminant analysis, d/s Vermilion Chutes to NWT	Peace R & Slave R	incl.-3117B2	19-APR-92	05-JUN-92	NRBS No. 9 [5]
3117B7	To investigate LKWH spawning site d/s Vermilion Chutes	Peace R	297	11-OCT-92	24-OCT-92	NRBS No. 23 [46]
3117B8	To inventory critical overwintering areas	Peace R	22	16-OCT-92	21-OCT-92	NRBS No. 24 [47]
3118B1	To collect Burbot for contaminant analysis	Peace R	185	24-OCT-92	11-NOV-92	NRBS No. 12 [30]
3118B2	To collect fish species commonly caught & used for human consumption at traditional winter harvest sites in the PAD	L Athabasca	249	10-FEB-93	16-FEB-93	NRBS No. 20 [2]
3119B1	To collect fish for contaminant analysis & fish health studies for a reach specific study program	Athabasca R	91	07-MAY-92	18-MAY-92	NRBS No. 8 [3]
3119B2	To collect fish for contaminant analysis & fish health studies for a reach specific study program	Athabasca R	168	25-SEP-92	15-OCT-92	NRBS No. 10 [4]
3125C1	To conduct a fish, fish habitat, inventory u/s Athabasca Town & in headwater tributaries and to collect MNWH eggs	Athabasca R	5220	01-OCT-93	21-OCT-93	NRBS No. 40 [51]
3126C1	To tag fish and estimate populations near Whitecourt	Athabasca R	2561	10-OCT-93	19-OCT-93	NRBS No. 41 [25]
3141D1	To investigate the occurrence & abundance of fish species	Athabasca R	3687	10-MAY-94	22-MAY-94	NRBS No. 53 [52]
3144D1	To collect fish for contaminant analysis & fish physiological investigations	Peace R & Athabasca R	529	11-SEP-94	21-DEC-94	NRBS No. 61 [31]
3145D1	To collect fish species commonly caught & used for human consumption at traditional winter harvest sites in the PAD	L Athabasca PAD delta	102	16-DEC-94	04-JAN-95	file correspondence
	TOTAL		24214			

Several projects handled fish primarily to capture them for subsequent contaminant analysis. In the Peace-Athabasca delta fish were acquired from the subsistence fishery as part of the multi-media collection in August, 1992, (project 2391-B1) and as a supplemental winter subsistence collection in February, 1993 (project 3118-B2). On the Athabasca River, fish were collected from reach specific study (RSS) sites in the spring and fall, 1992, (projects 3119-B1 and 3119-B2) and under ice in conjunction with the synoptic survey in February and March, 1993 (project 2371-B2). A major collection on the Peace River in October and November, 1992 (project 3118-B1) focussed on capturing Burbot. While inventorying critical overwintering areas on the Peace River in October, 1992 (project 3117-B8), the contractor was able to acquire some fish for contaminant analysis. Finally a basin-wide contaminant collection was conducted in fall, 1994 (project 3144-D1).

Several projects collected fish for contaminant analysis while also inventorying habitat, tagging fish for longer term movement information and counting species for population estimates. On the Athabasca River habitat inventories were conducted in April to June, 1992 (project 3117-B1), October, 1993 (project 3125-C1) and in May, 1994 (project 3141-D1). A major tagging and population estimating effort was conducted near Whitecourt in October, 1993 (project 3126-C1). Surveys on the Peace River included a habitat inventory in April to June, 1992 (projects 3117-B2 and 3117-B3), and an investigation of Whitefish spawning sites at Vermilion Chutes in October, 1992 (project 3117-B7).

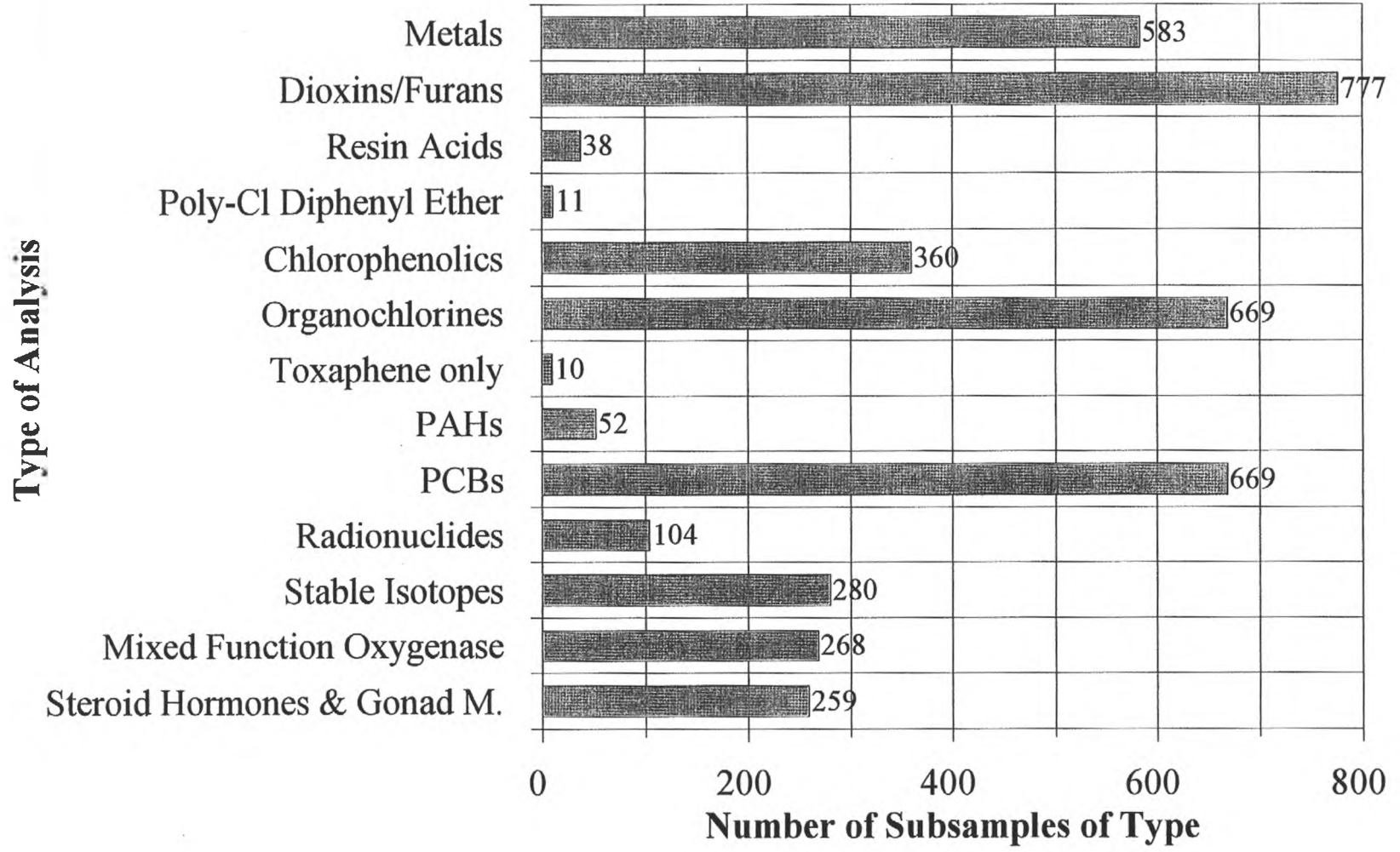
It was elected not to include radio tagged fish in the database. McLeod and Clayton (1993) [11] reported the radio tagging of 35 fish on the Athabasca River in May, 1992 (project 3121-B1). Clayton and McLeod (1994) [12] reported the radio tracked movements of these fish to March, 1993 (project 3121-B2).

3.4.2 Analysis of Fish Samples

The database contained 4,080 records for fish subsamples subjected to various analyses. "Figure 16: Analyses Conducted on Fish" shows the number of fish subsamples subjected to each different analysis. In addition to analyses for contaminant concentrations, fish subsamples were subjected to stable isotope and radionuclide measures and a variety of physiological analyses.

Hesslein and Ramlal (1993) [27] and (1996) [28] reported the values for stable isotopes in fish from several collections (projects 3131-B1 and 3131-C1). Smithson (1993) reported radionuclide values in fish from Lake Athabasca collected in February, 1993 (project 3118-B3). Lockhart et al (1996) [36] reported on mixed function oxygenase for fish collected from the reach specific study sites on the upper Athabasca River in 1992. Brown, Evans, Vandenbyllaardt and Bordeleau (1993) [8] reported on steroid hormones and gonad morphology for the same fish.

Figure 16
Analyses Conducted on Fish



3.4.3 Additional Data for Fish

At the time of writing two projects that intended to sample fish were yet to be reported to the NRBS Office; the database does not include data from these projects. Gibbons, Munkittrick and Taylor (1996) [24] subsequently reported collections and analyses of small fish species from the Athabasca River in April and May, 1994, September and October, 1994 and April, 1995; the objective was to assess the usefulness of small fish as sentinel species (projects 2353-D1 and 2353-E1). Tallman, Tonn and Howland (1996) [59] subsequently reported the sampling of inconnu and burbot on the Lower Slave River from June to November, 1994, in order to determine migrations (project 3143-D1); this work included the radio tagging of 40 fish, but did not include any captures for contaminant analysis.

At the time of writing several investigations of physiological parameters were not yet reported for the fish collected basin wide in September to December, 1994. Lockhart and Metner (1996) [37] subsequently reported analysis for liver mixed function oxygenase (project 3144-D2). Brown, Evans and Vandenbyllaardt (1996) [9] subsequently reported analyses for circulating gonadal sex steroids and gonad morphology (project 3144-D3). Brown and Vandenbyllaardt (1996) [10] reported analyses for dehydroretinol, retinol, retinyl palmitate and tocopherol (project 3144-D4). Klaverkamp and Baron (1996) [35] reported concentrations of metallothionein (project 3144-D5).

In addition, Parrott et al (1996) [45] reported the potency of extracts of semipermeable membrane devices (SPMDs) to induce mixed function oxygenase in a fish cell line (project 2354-D1); SPMDs were deployed for controlled exposure times in the Athabasca River, the Lesser Slave River and in effluents of four pulp mills and one oil sands mining and upgrading facility.

3.5 MAMMAL SAMPLES

The database contained 59 original mammals that were collected. "Figure 17: Mammal Species Captured for Analysis" displays the number of mammals taken of each species; Mink (29) and Muskrat (30). "Figure 18: Collection Sites: Mammal Samples" displays the geographic distribution of the 17 sites where original mammals were collected.

3.5.1 Collection of Mammal Samples

"Table 5: Projects That Collected Bird Samples" references the NRBS projects that collected mammals for various objectives.

During December, 1991, and January, 1992, the collection of mink for the NRBS was coordinated by Pecan Resources Inc. (Project 2361-A1). Six individual trappers provided a total of 13 mink from 9 different sites throughout the NRBS area. From November,

Figure 17
Mammal Species Captured for Analysis

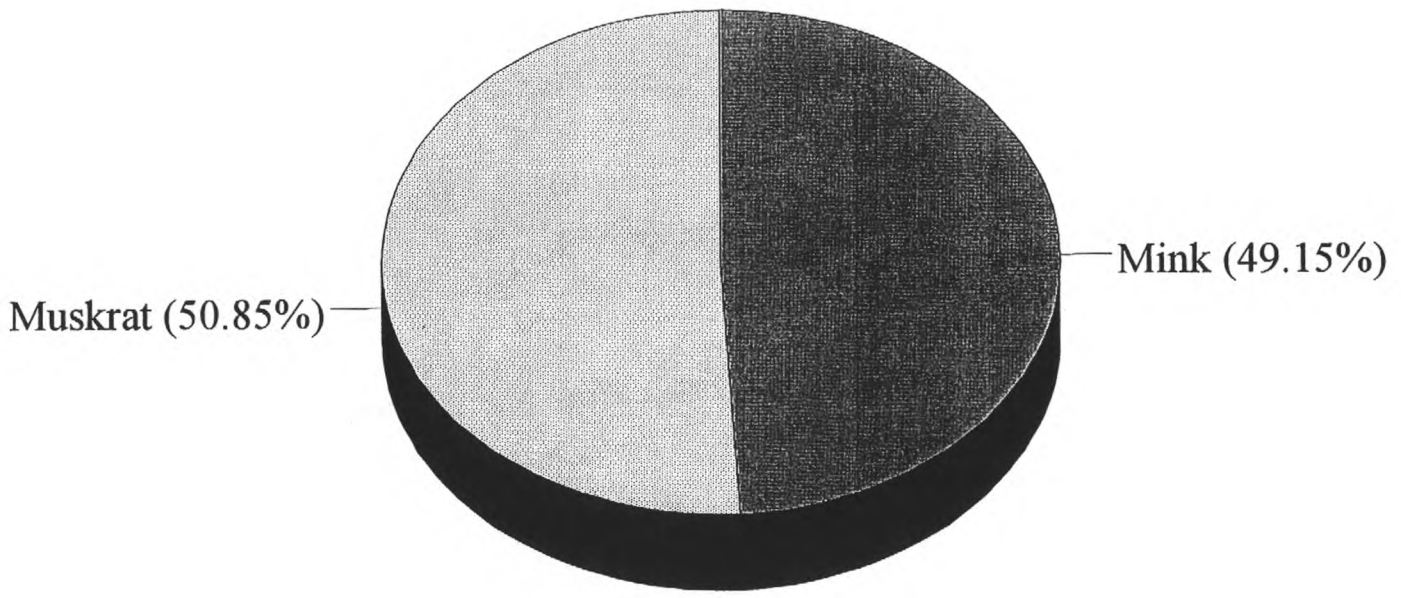



Figure 18
Collection Sites
Mammal Samples
KM
0
50
100

Table 5: Projects That Collected Mammal Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2361A1	To collect mink for contaminant analysis	various	13	12-DEC-91	31-JAN-92	NRBS No. 1 [29]
2361B2	To collect mink for contaminant analysis	various	16	01-NOV-92	25-MAR-93	file correspondence
2391B1	To assess contaminants in all media in the Peace-Athabasca delta	Athabasca R delta	30	04-DEC-92	07-DEC-92	NRBS No. 30 [26]
	TOTAL		59			

1992, to January, 1993, the collection of additional mink for the NRBS was coordinatedby the Fish and Wildlife Division of Alberta Forestry, Lands and Wildlife (Project 2361-B2). Five individual trappers provided a total of 16 mink from 8 different sites throughout the NRBS area.

Muskrat were collected from the Peace-Athabasca delta area for the NRBS as part of a multi-media collection coordinated by The Delta Environmental Management Group Ltd. (Project 2391-B1). One local trapper provided 30 muskrat from two sites; 17 muskrat were taken at Killer's Lake and 13 at Big (Johnny) Lake.

3.5.2 Analysis of Mammal Samples

The database contained 90 records for mammal subsamples subjected to various analyses. "Figure 19: Analyses Conducted on Mammals" shows the number of mammal subsamples subjected to each different analysis.

3.6 BIRD SAMPLES

The database contained a total of 1458 birds entered as original samples; 1421 of these were observations made during an aerial survey. "Figure 21: Bird Species Captured for Analysis" displays the number of birds of each species for the 37 original birds captured. "Figure 22: Collection Sites: Bird Samples" displays the geographic distribution of the 6 sites where birds were captured.

3.6.1 Collection of Birds

"Table 6: Projects That Collected Bird Samples" references the NRBS projects that collected or observed birds for various objectives.

One project (2362-B1) surveyed portions of the Wapiti River, the Peace River, the Athabasca River and the Peace-Athabasca delta for the presence of different species of birds from an aircraft. Two collections of birds were made specifically for contaminant analysis; one from the Wapiti River in August, 1992 (project 2363-B1) and one as part of the multi-media collection of the Peace-Athabasca delta in August, 1992 (project 2391-B1).

3.6.2 Analysis of Birds

The database contained 80 records for bird subsamples subjected to various analyses. "Figure 23: Analyses Conducted on Birds" shows the number of bird subsamples subjected to each different analysis.

Figure 19
Analyses Conducted on Mammals

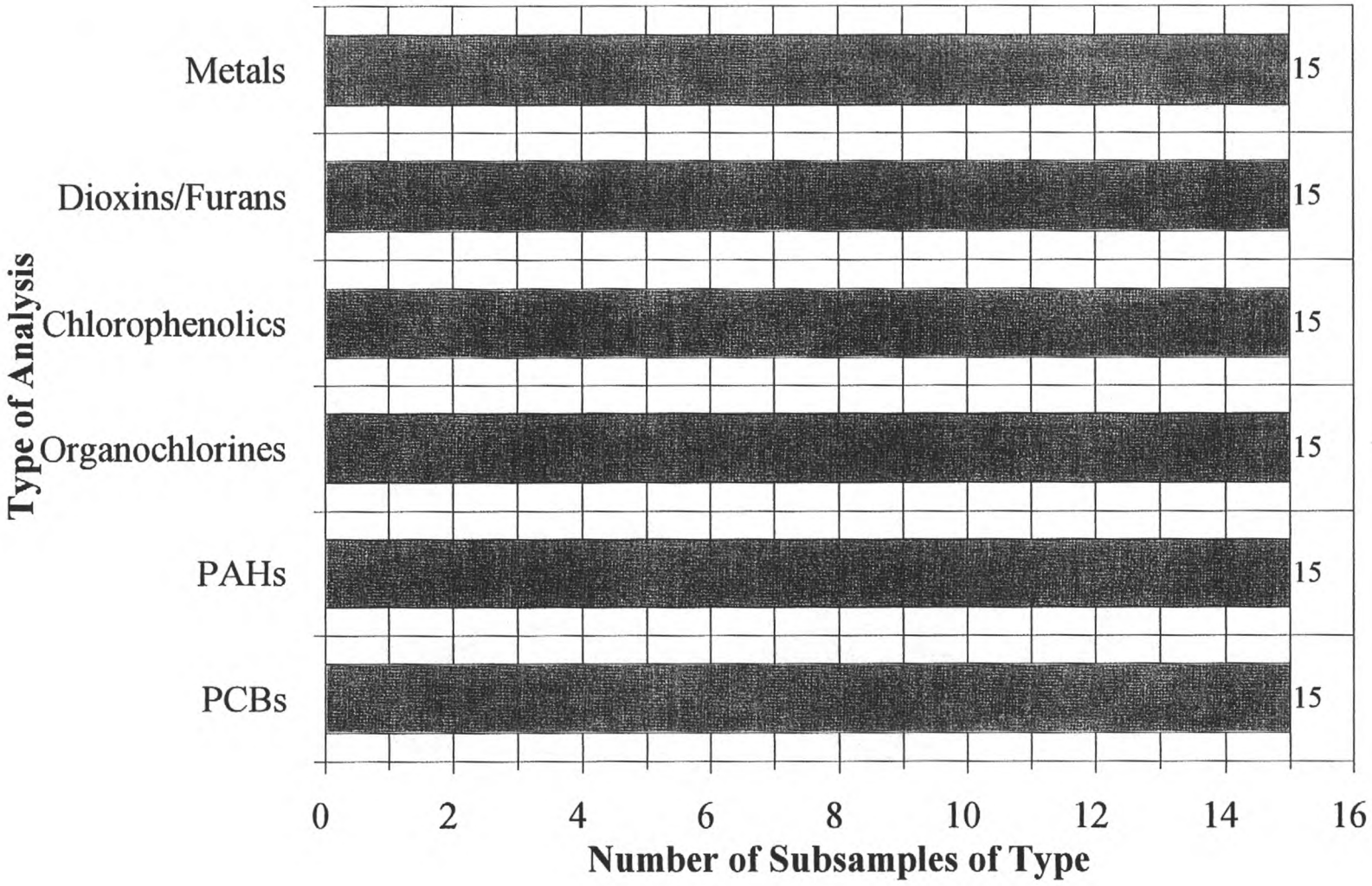
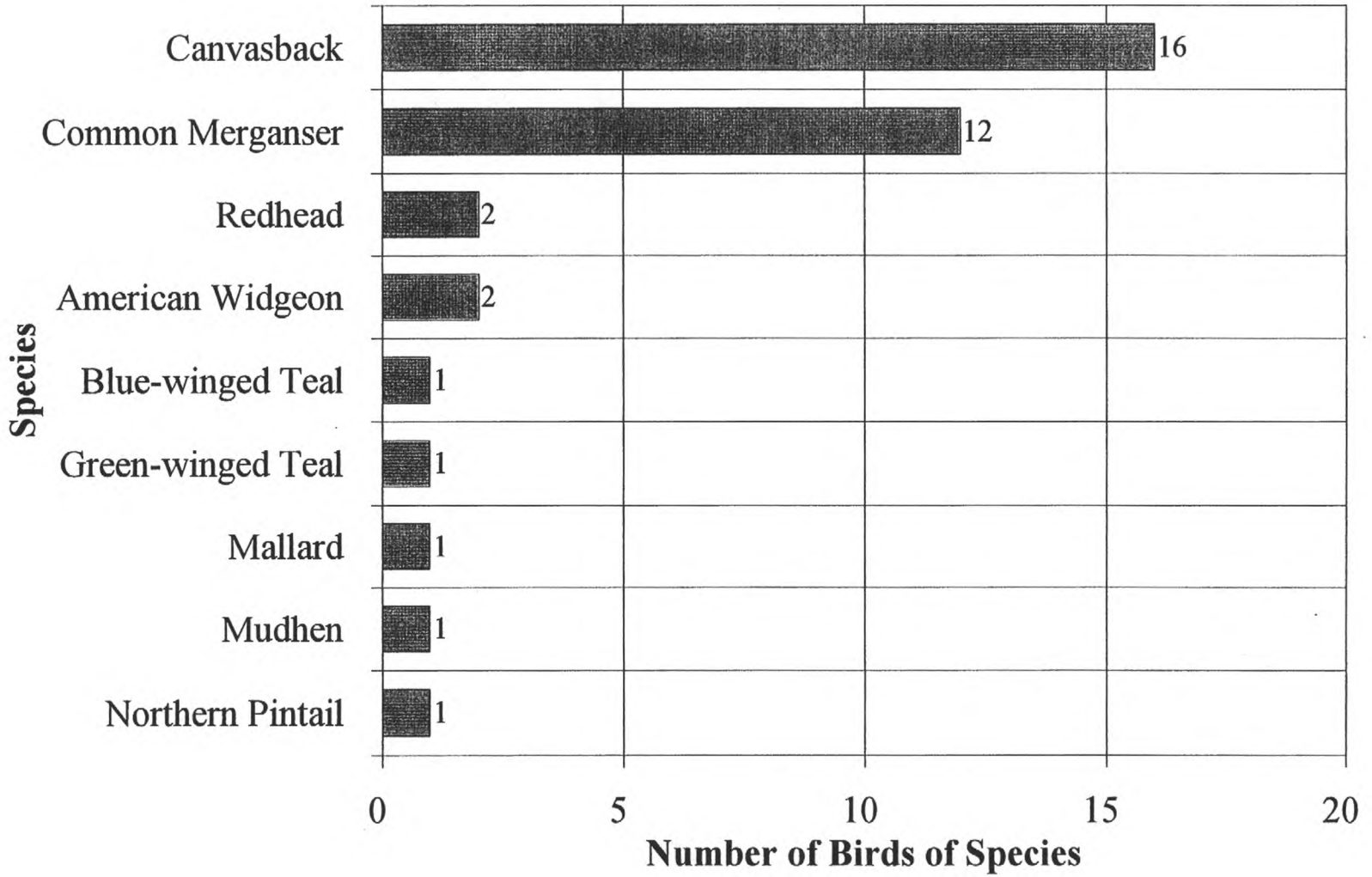


Figure 20

Bird Species Captured for Analysis



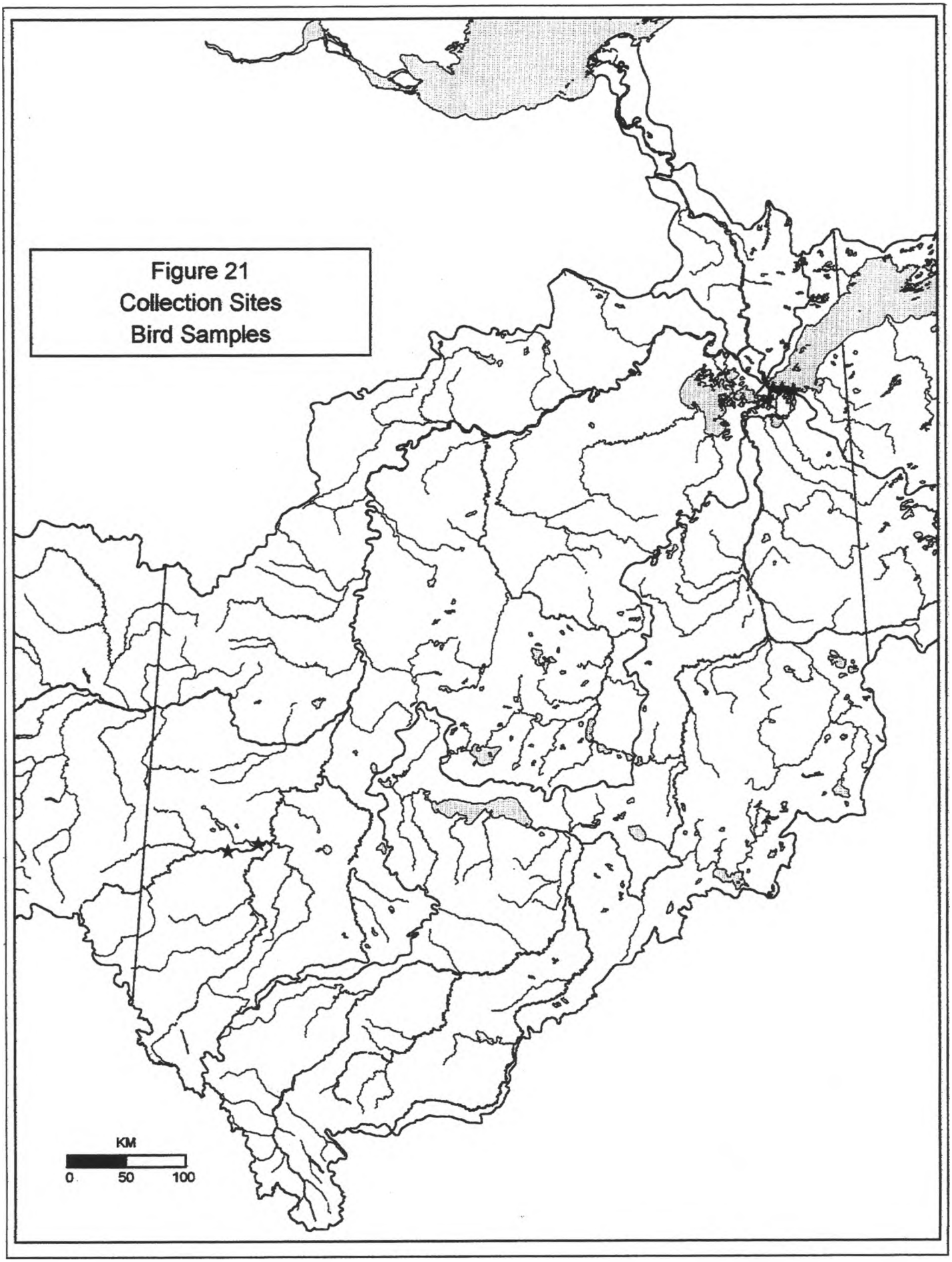


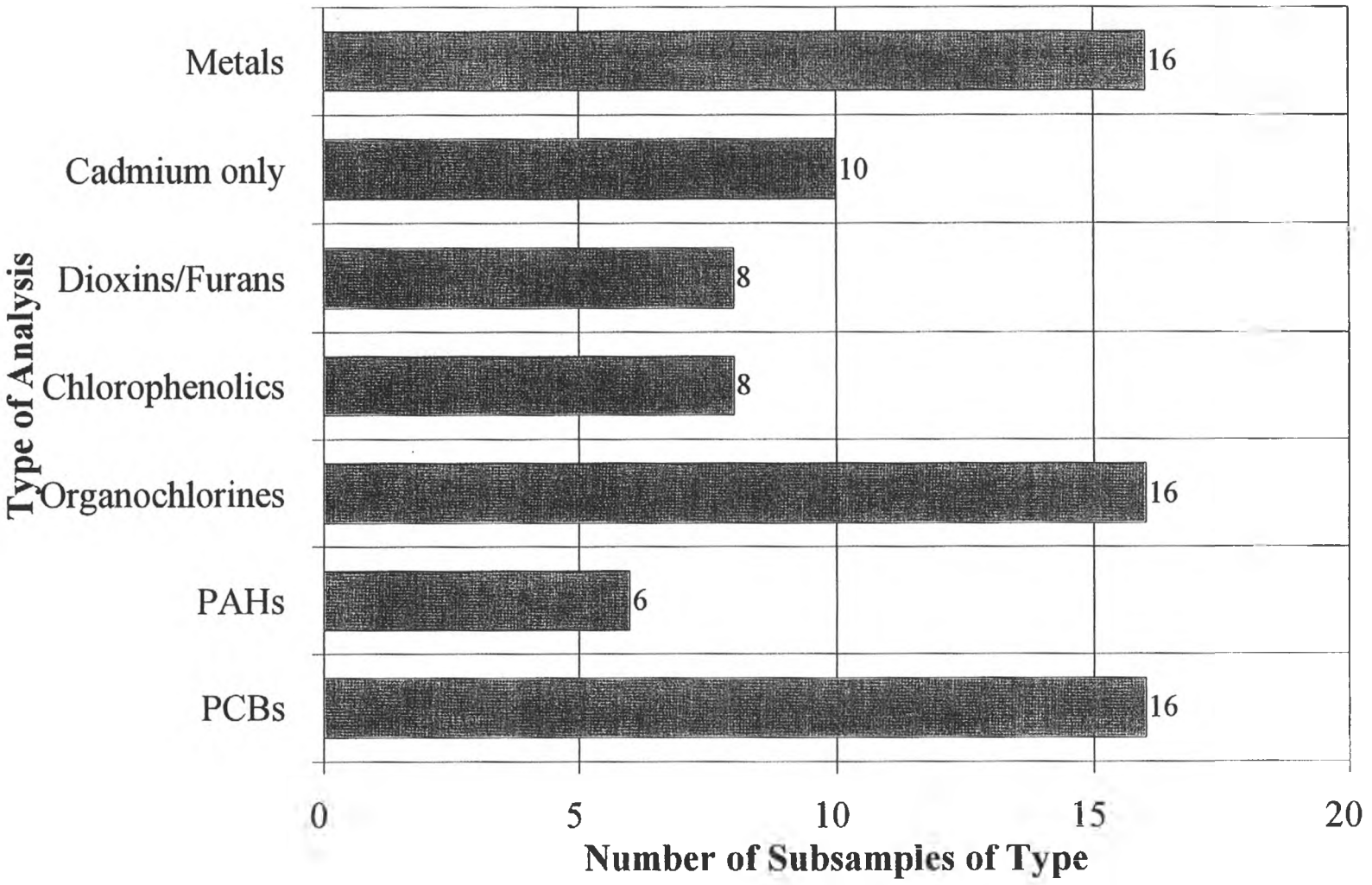
Figure 21
Collection Sites
Bird Samples
KM
0
50
100

Table 6: Projects That Collected Bird Samples

NRBS PROJECT CODE	PROJECT OBJECTIVE	PROJECT LOCALE	NO. OF ORIGINAL SAMPLES	EARLIEST SAMPLE DATE	LATEST SAMPLE DATE	REFERENCE
2362B1	To survey the occurence of birds on the Wapiti R, Peace R and Athabasca R	Peace R & Athabasca R	1421	30-JUN-92	08-JUL-92	NRBS No. 6 [60]
2363B1	To collect fledgling mergansers for contaminant analysis	Wapiti R & Athabasca R	12	04-AUG-92	12-AUG-92	NRBS No. 4 [16]
2391B1	To assess contaminants in all media in the Peace-Athabasca delta	Reserve No. 201	25	26-AUG-92	26-AUG-92	file correspondence
	TOTAL		1458			

Figure 22

Analyses Conducted on Birds



3.7 VEGETATION SAMPLES

The database contained one vegetation sample; rat root collected from the Peace Athabasca delta as part of the multi media collection made in August, 1992 (project 2391-B1). This sample was placed in cold storage and was not analysed.

4.0 DISCUSSION AND CONCLUSIONS

Defining and constructing a database to inventory samples proved to be a labour intensive task. The effort expended was notable from April, 1994, to refine the definition of fields and to compile the backlog of data into the database and to keep pace with concurrent projects as they were conducted. The success of the effort can be evaluated against the three operational goals and two legacy objectives that motivated the effort.

4.1 ACHIEVEMENT OF OPERATIONAL GOALS

Since compiling the initial backlog of projects into the database required such a notable effort, some portion of the database was always backlogged. From an operational perspective some opportunities to service timely and routine decisions of a broad nature were likely lost because the database was not entirely current. However, the demand experienced for retrievals from the database indicated that many opportunities of a more particular focus were successfully exploited.

4.1.1 To Provide Current Accurate Data for Mapping

An early link was achieved between the database and the geographical information system (GIS); a format that provided samples data ready for mapping was developed and tested as soon as data compilation was completed for mammals samples.

Workflow was adjusted at one point to ensure that data about original samples was compiled for all media in time to use it in the GIS to display the geographic extent of collections at the Science Forum held in Grande Prairie in January, 1995. In May, 1995, at an internal meeting the mapping of locations related to subsamples subjected to specific analyses was demonstrated with the GIS for sediment. The maps presented in this report were produced by the GIS using data provided from the database.

In addition to mapping with the GIS, the database was used to answer a number of geographic enquiries for NRBS researchers:

1. fish samples collected downstream of Suncor were identified to support consideration of further samples analysis.
2. latitudes and longitudes were provided to enable mapping related to particular projects.

3. river kilometres were provided to serve the presentation of displacement in relation to interpreting results.
4. sample data for fish samples with TCDD above the Health Canada guidelines was provided with latitudes and longitudes to support inclusion of a map with a screening report.

It was concluded that the database effectively supplied data for mapping; the link with the GIS was efficient. The location data was observed to not always be accurate, but once mapping revealed incorrect positioning the georeference was corrected. It is difficult to judge the correctness of a geographic coordinate unless it is viewed on a map.

The geographic coordinates reported with collected samples were reported to varying precision. From the perspective of mapping with a GIS, the precision desired and deemed practical was that obtained using geographical position by satellite (gps) technology.

Less precise measures were recorded in the database; coordinates interpolated from edge calibrations on NTS mapsheets or areal locators such as the dominion land survey system (section, township, range, meridian). From the perspective of mapping point data, a precise latitude/longitude was desirable because the base features upon which the NRBS sites were displayed were at coarser resolutions. A useful data feature for mapping would be an error term with each geographic coordinate, which would allow appropriate treatment when subsequently displaying a point on a map.

For consideration of point data taken from a river, where material is flowing down hill in the fashion of a branched gathering network, it proved convenient to incorporate the measure of kilometres upstream from a starting point. Such a system made it easy to retrieve data from the same reach of a river, although the samples were collected at different times by different projects and identified by different textual site descriptors.

> ***Recommendation:*** *use gps technology to obtain all georeferencing of sites where environmental samples are collected.*

4.1.2 To Assist in Planning Sample Collection and Analysis

It was concluded that the database did assist to some small degree in the planning of sample analysis by responding in one instance to an enquiry regarding Bull Trout material still available for analysis. Since the database contains a species code for fish samples and recorded when subsamples were subjected to particular analyses a retrieval was able to identify sample material assumed to be still in storage and thus available for further testing.

It was observed that the database had an additional administrative usefulness in providing specific lists of samples for laboratory directives and in tracking the receipt of lab results

in both printed and electronic form. Retrievals of this nature were made frequently on a routine basis.

The database function is different from the management function, although its greatest usefulness is to serve the management activities. The benefit for management is to have definitive accurate status of the state of samples and sample handling for decisions on collection strategies and analytical protocols. This can result in real cost savings as collections and analyses are expensive.

> ***Recommendation:*** *start database compilation early and resource it sufficiently to keep pace with data availability and management needs.*

4.1.3 To Assist in the Decision to Dispose of Stored Samples

Material actually removed from the environment generally went to storage before being prepared and submitted to laboratory analysis; proper handling protocols were dictated in terms of references for the collection projects. The terms of reference that involved processing (dissection) of fish consistently dictated that any remaining carcass and tissues would be retained. Therefore the database would maintain records for remaining parts and carcass.

However, fish and other sample material were almost entirely processed and stored outside of the NRBS Office; these outside agencies were not required to submit documentation confirming the precise identity and form of remaining material. Since commercial laboratories seldom reported the weight or volume of the sample material received, it was not possible to utilize their reporting to infer or confirm the amount of material remaining.

Nonetheless, the database was able to assist the decision about disposition of samples by reporting the numbers and form of remaining samples based upon the assumptions inherent in the database. Although it could not provide a definitive inventory of what was in storage, its numbers could be used as an adequate estimate to scope the decision for management.

> ***Recommendation:*** *require manifest reporting whenever the custodial agents change for a sample.*

4.1.4 Other Uses

Other retrievals made from the database in response to requests indicated some success in supporting another operational need that was not initially identified as a goal. Several requests for data compilations of particular focus confirmed that the database was useful for supporting the interpretive work of the NRBS researchers.

Specifically, these requests involved:

a. identifying subsamples of a particular media analysed for particular parameters, like sediment samples analysed for Chlorophenolics or Mercury.
b. identifying subsamples for fish tissue with a parameter value greater than the guideline defined by Health Canada, specifically for Mercury and 2378-TCDD.
c. summarizing all samples from the reach specific study (RSS) locations and all the analyses to which the subsamples were subjected.
d. identifying all samples analysed for stable isotopes that were also analysed for contaminants.
e. identifying all fish samples that were subjected to contaminant analysis.

In two instances, the database was used to assist other agencies. One university researcher who was investigating length and weight relationships for Burbot was given a retrieval of relevant data for all the Burbot contained in the database. On a regular basis the database was used to assist in identifying tag returns that had been originally tagged by the NRBS. It was concluded that these were examples of the kind of legacy utility that the database would provide to future researchers.

4.2 ACHIEVEMENT OF LEGACY OBJECTIVES

Although the database had a high degree of completeness, some data was missing. Due to the submittal of some source documents at the very end of the NRBS in combination with the demand to clear the backlog of previous projects, the time and resources did not allow the entry of inventory data from some of the latest projects. The slight degree of incompleteness applied as well to analytical data.

Since the interests of many future researchers is likely to be relatively focussed, many of them will find that they do not have to undertake any manual data entry of the NRBS results. Others, depending on the scope of their interest may have to do some data entry before proceeding with computer supported analysis.

4.2.1 To Establish and Document Complete and Correct Referencing for Samples

Since many agencies were handling samples at many different stages, it proved to be important to researchers on the NRBS that samples that met certain particular criteria could be identified with some certainty. Since the NRBS Office had access to documentation about a majority of the samples handling that occurred, it was in a good position to establish the referencing needed on several basic key dimensions.

It was important to identify the collection project with which a sample was associated; this connected it with the documentation about its collection and handling protocols. Another important reference was the one relating a subsample to its laboratory directive, called a Laboratory Analysis Approval (LAA), and hence to the printed laboratory report.

The geographical referencing of the sample site was also important; this was discussed in section 4.1.1.

Based upon the successful use of database retrievals to satisfy a variety of requests, it was concluded that the referencing fields implemented for samples was basically sufficient. Furthermore, the act of retrieving the data served to test its correctness in certain aspects.

Due to the great many researchers reporting collection information, variations were evident in the data variables reported and in the forms and conventions used to report the information. In order to compile the database this variability had to be translated into the meanings defined for fields in the database structure. The degree of definition demanded by this translation acted as a data standard which occasionally detected errors in the source data.

If a database is viewed as an agreement among its users about the meaning of variables and about the reporting standards for those variables, then study researchers ought to be involved in defining the database. In future consideration could be given to arranging for the researchers to share the demands of compiling data into the database and of ensuring data quality.

If data is used continuously by an organization then the data receives a detailed and timely examination; such activity is an effective audit of data quality. If an organization is not using data continuously, but does intend to publish data as a legacy the quality of the data needs to be ensured by a formal audit activity. If data is not processed in a timely fashion the ability to correct errors degrades.

Recommendation: *Implement a formal data quality assurance process.*

4.2.2 To Provide Easy Access to Analytical Results

The initial perspective in the NRBS Office was to limit the scope of the database to an inventory of samples collected and analysed, excluding analytical results. The anticipated volume and diversity of analytical results was extensive enough to demand caution. Experiences in Environment Canada with ENVIRODAT and in Alberta Environmental Protection with NAQUADAT indicated that maintaining a database of this kind was a demanding task. Since an inventory database would serve to define the extent of the potential task of adding analytical results, this decision could be reviewed later on a more informed basis.

Converting the many files supplied by the laboratories into one target format for each set of parameters proved to be a significant and demanding task. Conducting this effort as part of the NRBS was an efficient expenditure because of the availability of related documentation and the familiarity of the NRBS staff with the state of affairs. A similar effort by future researchers would have been additionally time consuming.

Furthermore, the conversion was timely enough to resolve instances of variations in reporting convention between the laboratories. Just as for inventory data, it was the detailed handling of the data that identified missing information or errors; if these were not resolved at least they were documented.

> ***Recommendation:*** *require laboratories supplying data to provide electronic copies that satisfy a definitive specification as to the format and content conventions of the data.*

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APPENDIX A: TERMS OF REFERENCE

No contractual Terms of Reference were prepared for the work documented in this report. The work was undertaken by the authors as a contribution in kind from their employing agencies and represents a part of their responsibilities to the Science Directors of the Northern River Basins Study.

APPENDIX B: ENVIRONMENTAL SAMPLES DATABASE USERS GUIDE

B.1 INTRODUCTION

The Environmental Samples Database comprises two sets of files:

1. Files with the prefix ESID (environmental samples inventory data); these files together contain an inventory of all the environmental samples managed.
2. Files with the prefix ESAR (environmental samples analytical results); these files contain the numerical results of various laboratory analyses that were conducted on the samples.

The ESID set of files was useful in managing the environmental samples collected by the NRBS and it provided the following benefits;

a. it served as an index to the analytical results reported by the laboratories,
b. it provided current, accurate data for mapping by the geographic information system,
c. it assisted in the administration of samples, by recording which samples were subjected to which analyses and if sample material is still in storage and thus available for further testing,
d. it served the decision at the end of the NRBS about whether to discard samples or to transfer ownership to other agencies.

The ESAR set of files was implemented to serve the goal of leaving a valuable legacy; an electronic copy of the data will assist scientists who wish to conduct further interpretation of data subsequent to the completion of the NRBS.

B.2 DATA FILES (.DBF)

"Figure 23: Summary of Files in the Environmental Samples Database" shows the relationship between the different .DBF files. These files and the data fields contained in each one are described in detail in sections B.3 and B.4. "Table 7: Summary of File Linkages", identifies the fields that link the particular files. A copy of the files are supplied on disk with this document.

The content of each file serves a particular purpose.

B.2.1 The Prime File

ESIDSAMP general and cross-referencing data common to all samples.

Figure 23: Summary of Files in the Environmental Samples Database

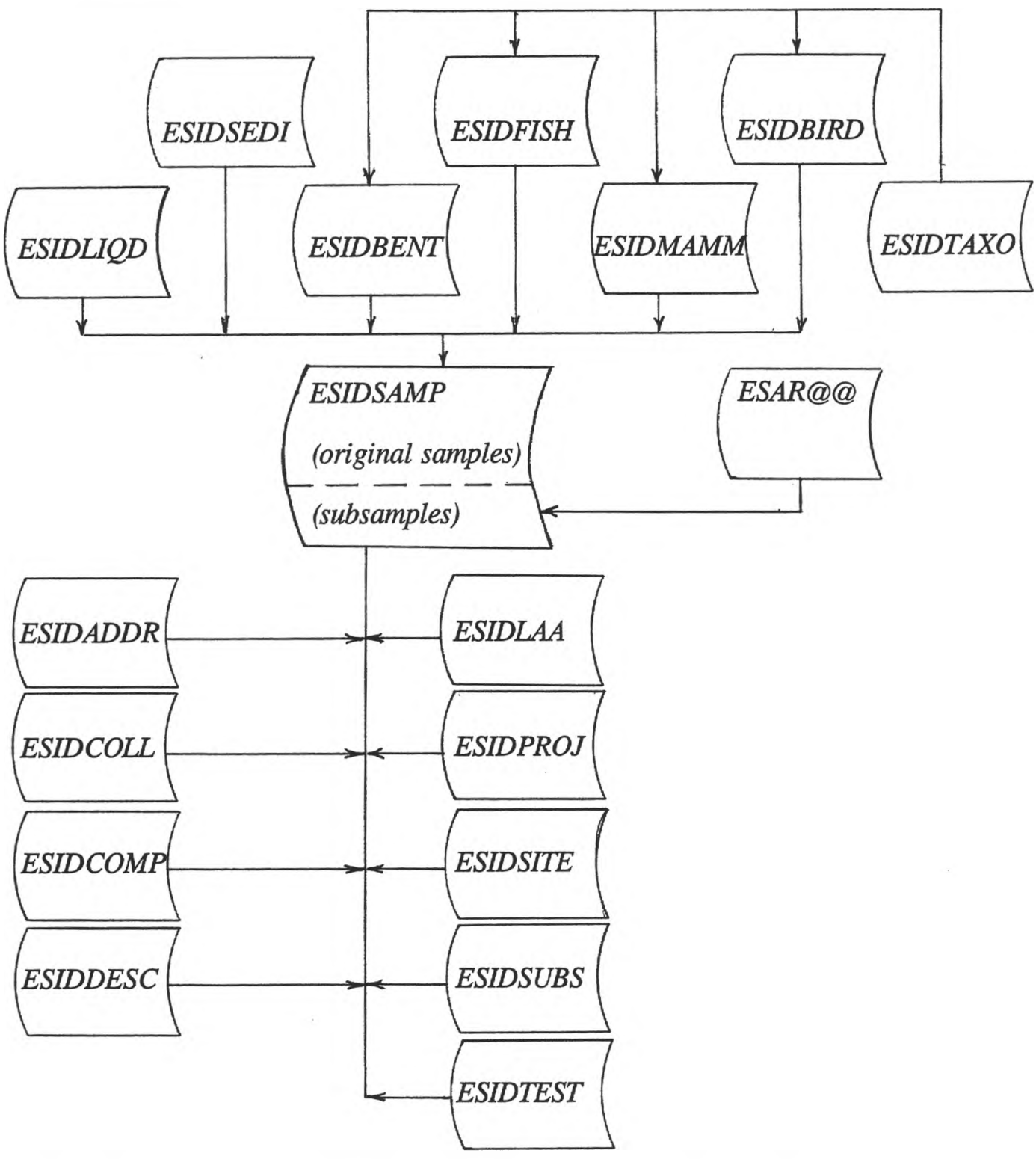

Table 7: Summary of File Linkages (page 1 of 2)				
FILENAME (.DBF)	File Description	Link from Field	Link to File (.DBF)	Link to Field
ESIDADDR	address data	ADDR_CODE	ESIDBENT	COLR_CODE
			ESIDBIRD	COLR_CODE
			ESIDFISH	COLR_CD
			ESIDLAA	LAB
			ESIDMAMM	COLR_CODE
			ESIDSEDI	COLR_CODE
			ESIDLIQD	COLR_CODE
ESIDBENT	benthic details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDBIRD	bird details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDCOLL	protocol/process	COLL_CODE	ESIDSAMP	COLN_CODE
ESIDCOMP	composite parts	COMP_CODE	ESIDSAMP	COMP_CODE
ESIDDESC	sample nature	DESC_CODE1	ESIDSAMP	DESC_CODE1
ESIDFISH	fish details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDLAA	laa tracking	LAA_NO	ESIDSAMP	LAA_NO
		LAB	ESIDADDR	ADDR_CODE
ESIDLIQD	liquid details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDMAMM	mammal details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDPROJ	data audit	PROJ_CODE	ESIDSAMP	PROJ_CODE

Table 7: Summary of File Linkages (page 2 of 2)

FILENAME (.DBF)	File Description	Link from Field	Link to File (.DBF)	Link to Field
ESIDSAMP	samples & sub-	COLN_CODE	ESIDCOLL	COLL_CODE
		COMP_CODE	ESIDCOMP	COMP_CODE
		DESC_CODE1	ESIDDESC	DESC_CODE1
		DESC_CODE2	ESIDSUBS	DESC_CODE2
		LAA_NO	ESIDLAA	LAA_NO
		LAB_ID	ESAR@@	LAB_ID
		LOCN_CODE	ESIDADDR	ADDR_CODE
		PROJ_CODE	ESIDPROJ	PROJ_CODE
		SITE_CODE	ESIDSITE	SITE_CODE
		TEST	ESIDTEST	TEST
		UNIQ_ID	ESIDBENT	UNIQ_ID
		UNIQ_ID	ESIDBIRD	UNIQ_ID
		UNIQ_ID	ESIDFISH	UNIQ_ID
		UNIQ_ID	ESIDLIQD	UNIQ_ID
		UNIQ_ID	ESIDMAMM	UNIQ_ID
		UNIQ_ID	ESIDSEDI	UNIQ_ID
		UNIQ_ID	ESAR@@	UNIQ_ID
ESIDSEDI	sediment details	COLR_CODE	ESIDADDR	ADDR_CODE
		UNIQ_ID	ESIDSAMP	UNIQ_ID
ESIDSITE	site details	SITE_CODE	ESIDSAMP	SITE_CODE
ESIDSUBS	sample form	DESC_CODE2	ESIDSAMP	DESC_CODE2
ESIDTEST	test sets	TEST	ESIDSAMP	TEST
ESAR@@	lab results	UNIQ_ID	ESIDSAMP	UNIQ_ID

B.2.2 Files that Provide Details Related to Codes Used in ESIDSAMP

ESIDADDR	addressing information for agencies that conducted collections or analyses of environmental samples.
ESIDCOLL	a reference to printed documentation about the collection or analyses protocols and procedures.
ESIDCOMP	the identification of original samples that have been combined to make a composite sample for subsequent analyses.
ESIDDESC	the descriptive terms for the codes used to record the nature of the sample.
ESIDLAA	details about the Laboratory Analysis Approval which was used by the NRBS to authorize particular analyses.
ESIDPROJ	summary counts of samples or subsamples for each sample type handled by an NRBS project.
ESIDSITE	details about particular sample sites.
ESIDSUBS	the descriptive terms for the codes used to record sample details.
ESIDTEST	the descriptive terms for the codes used to identify the set of parameters for which a subsample was analysed.

B.2.3 Files that Provide Details Particular to One Type of Sample

ESIDSEDI	details specific to the original sediment collected.
ESIDLIQD	details specific to samples collected from effluent and ambient water.
ESIDBENT	details specific to original samples of invertebrates and biofilm.
ESIDFISH	details specific to original fish samples, including fish tagged and released.
ESIDMAMM	details specific to original mammal samples.
ESIDBIRD	details specific to original bird samples

B.2.4 Files that Provide Details Related to Animal Samples

ESIDTAXO	details related to the code used to record the taxonomic identification of an animal sample.

B.2.5 Files that Provide Analytical Results for the Parameters in a Specified Test Set

ESAR@@	values of parameters measured by the laboratory for the test set indicated by the two character code, @@; these codes are described in ESIDTEST.

B.3 DATA FIELDS FOR SAMPLES INVENTORY FILES

This section describes in the meaning and acceptable entries for the fields in each *ESIDaaaa.DBF* file related to the environmental samples inventory

B.3.1 Content of File, *ESIDADDR.DBF*:

ESIDADDR.DBF contains addressing information for agencies that conducted collections or analyses of environmental samples.

1. **ADDR_CODE** [C:7];
   This field is a unique agency or location identifier of the form aaa-cc where aaa is a 3 letter code for the agency and cc is a 2 letter code for the city. This field links *ESIDADDR.DBF* with *ESIDSAMP.DBF*>LOCN_CODE or with COLR_CODE in any of the compartment files or with *ESIDLAA.DBF*>LAB
2. **CONTACT** [C:25];
   This field is a name of the individual with whom NRBS has been dealing.
3. **AGENCY** [C:25];
   This field is major name of the agency referenced.
4. **SUB_AGENCY** [C:20];
   This field is a second line of organizational address.
5. **CENTRE** [C:25];
   This field is a third line of organizational address, especially for "Centres".
6. **AD_STREET** [C:30];
   This field is a street address.
7. **AD_CITY** [C:15];
   This field is the city where the agency is located.
8. **AD_PROV** [C:2];
   This field is the proper Canada Post two-letter province abbreviation.
9. **AD_PCODE** [C:7];
   This field is the postal code associated with the mailing address.
10. **AD_MAIL** [C:12];
    This field is the mailing address if a p.o. box rather than AD_STREET.
11. **PHONE** [C:12];
    This field is the phone number of the CONTACT in the form aaa-ppp-nnnn.
12. **FAX** [C:12];
    This field is the fax number of the CONTACT in the form aaa-ppp-nnnn.

B.3.2 Content of File. *ESIDBENT.DBF*:

ESIDBENT.DBF contains details of original benthic samples collected.

1. **UNIQ_ID** [N:9.0];
   This field is a unique record identifier. This field links file *ESIDBENT.DBF* with *ESIDSAMP.DBF*.
2. **COLR_CODE** [C:7];
   This field is a code for the agency collecting the sample in the form aaa-cc (for example, PNR-CA = Prairie and Northern Region, Enivonment Canada, Calgary). This field links with *ESIDADDR.DBF*.
3. **DATE_COLL** [D:8];
   This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.
4. **TIME_COLL** [C:4];
   This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.
5. **DATE_TIME** [C:11];
   This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.
   DNR = date not reported; DATE_COLL is blank.
   TNR = time not reported; TIME_COLL is blank.
   DTNR = date and time not reported; DATE_COLL and TIME_COLL is blank.
   DMyymm = date reported to the month, yymm; DATE_COLL is blank.
   DS{A/I}nn = date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
   TH = time reported to the hour, hh; TIME_COLL is blank.
   TS{A/I}nn = time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.
   TSNR-T=S = time span, but not reported; time reported is start time.
   TSNR-T=E = time span, but not reported; time reported is end time.
6. **COLN_UNITS** [C:6];
   This field specifies units for the size of the original sample, which varies with the type of sample collected (for example, for sediment, this can be LITRES or ML or GM-WET, for a core it can be METRES or CM).
7. **COLN_VALUE** [N:6.2];
   This field records the size of the original sample in the units specified.

8. **COLN_SIG** [N:2];
   This field gives the number of decimal places accurately recorded for COLN_VALUE.
9. **DATUM_UNIT** [C:6];
   This field specifies units for the base datam from which offset is recorded.
10. **DATUM_VALU** [N:6.2];
    This field records the value of the base datum;
    for suspended sediment centrifuging this is the depth of water over river bed
    for coring this is the altitude of the drilling platform.
11. **DATUM_SIG** [N:2];
    This field gives the number of decimal places accurately recorded for DATUM_VALU.
12. **OFSET_UNIT** [C:6];
    This field specifies units for the offset from the base datum.
13. **OFSET_VALU** [N:6.2];
    This field records the value of the offset;
    for suspended sediment centrifuging, the depth of intake below water surface.
    for coring, the distance of the top surface of the core from the drilling platform.
14. **OFSET_SIG** [N:2];
    This field gives the number of decimal places accurately recorded for OFSET_VALU

B.3.3 Content of File, *ESIDBIRD.DBF*:

ESIDBIRD.DBF contains details of original bird samples collected.

1. **UNIQ_ID** [N:9.0];
   This field is a unique record identifier. This field links file *ESIDBENT.DBF* with *ESIDSAMP.DBF*.
2. **COLR_CODE** [C:7];
   This field is a code for the agency collecting the sample in the form aaa-cc (for example, PNR-CA = Prairie and Northern Region, Enivonment Canada, Calgary). This field links with *ESIDADDR.DBF*.
3. **DATE_COLL** [D:8];
   This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.
4. **TIME_COLL** [C:4];
   This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.

5. **DATE_TIME** [C:11];
This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.
DNR = date not reported; DATE_COLL is blank.
TNR = time not reported; TIME_COLL is blank.
DTNR = date and time not reported; DATE_COLL and TIME_COLL is blank.
DMyymm = date reported to the month, yymm; DATE_COLL is blank.
DS{A/I}nn = date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
TH = time reported to the hour, hh; TIME_COLL is blank.
TS{A/I}nn = time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.
TSNR-T=S = time span, but not reported; time reported is start time.
TSNR-T=E = time span, but not reported; time reported is end time.
6. **COLN_UNITS** [C:6];
This field specifies units for the size of the original sample, which varies with the type of sample collected (for example, for sediment, this can be LITRES or ML or GM-WET, for a core it can be METRES or CM).
7. **COLN_VALUE** [N:6.2];
This field records the size of the original sample in the units specified.
8. **COLN_SIG** [N:2];
This field gives the number of decimal places accurately recorded for COLN_VALUE.
9. **SEX** [C:3];
This field is the sex of the bird using the following codes;
M = male.
F = female.
n/r = not reported.
n/o = not observable.
10. **AGE** [C:4];
This field is the age of the bird using the following codes;
nn = the age in years as determined from fish aging structures.
n/o = not observable, aging structures sampled are unsuitable.
n/r = not reported.
11. **CAPT_METH** [C:3];
This field is the method of capture for the bird.
12. **BILL_D_U** [C:6];
This field specifies units for the measurement of bill depth.
13. **BILL_D_V** [N:5.2];
This field records the value for the bill depth.
14. **BILL_D_S** [N:2];
This field gives the decimal places accurately recorded for the BILL_D_V.

15. **BILL_L_U** [C:6];
    This field specifies units for the measurement of bill length.
16. **BILL_L_V** [N:5.2];
    This field records the value for the bill length.
17. **BILL_L_S** [N:2];
    This field gives the decimal places accurately recorded for BILL_L_V
18. **TAG_COL** [C:3];
    This field is the colour of the tag for birds that are tagged and released;
    O = orange.
    Y = yellow.
    n/a = not applicable, meaning a tag was not used.
19. **TAG_NO** [C:8];
    This field is the number of the tag for fish that are tagged and released;
    n/a = not applicable, meaning a tag was not used.
20. **TAXON_CODE** [C:10];
    This field contains a code referencing the taxonomic identification of the biological item; the codes used are the same as those used by the Environment Canada database, Envirodat. This field will be updated by the NRBS if time and resources permit.
21. **AOU** [C:8];
    This field is American Ornithological Union species identification number.

B.3.4 Content of File. *ESIDCOLL.DBF*:

ESIDCOLL.DBF contains a reference to printed documentation about the collection or analyses protocols and procedures.

1. **COLL_CODE** [C:4];
   This field is the code of the form nnnn for references on sampling and analytical protocols and procedures. It links ESIDCOLL.DBF to ESIDSAMP.DBF > COLN_CODE.
2. **COLL_REFER** [C:17];
   This field is an abbreviated reference to NRBS documentation that records details about the sampling or analytical protocols and procedures.
3. **COLL_TEXT** [Memo];
   This field is allows for the entry of text extracted from the reference to provide a convenient and immediate description of the methods use. This field has not been used.

B.3.5 Content of File. *ESIDCOMP.DBF*:

ESIDCOMP.DBF contains the identification of original samples that have been combined to make a composite sample for analyses. These two fields are repeated for the same COMP_CODE until all contributing original samples are accounted for.

1. **COMP_CODE** [N:4];
   This field is the numeric code assigned to a particular composite sample. This field links *ESIDCOMP.DBF* to *ESIDSAMP.DBF*>COMP_CODE
2. **SAMP_INCL** [N:9];
   This field is the UNIQ_ID of an original sample that contributed to the composite sample.

B.3.6 Content of File. *ESIDDESC.DBF*:

ESIDDESC.DBF contains the descriptive term for the code used in field DESC_CODE1 in *ESIDSAMP.DBF*.

1. **DESC_CODE1** [C:4];
   This field is the code of the form aaaa for describing the nature of the sample. This field links *ESIDDESC.DBF* to *ESIDSAMP.DBF*>DESC_CODE1. For animal samples this is usually a four character code for species; for fish the code obeys the convention documented by Mackay, Ash and Norris (1990) [38].
2. **DESC_TEXT** [C:40];
   This field is a textual description related to the DESC_CODE1.

B.3.7 Content of File. *ESIDFISH.DBF*:

ESIDFISH.DBF contains details of original fish samples collected.

1. **UNIQ_ID** [N:9.0];
   This field is a unique record identifier. This field links file *ESIDFISH.DBF* with *ESIDSAMP.DBF*.
2. **COLR_CD** [C:7];
   This field is a code for the agency collecting the sample. This field links to *ESIDADDR.DBF*>ADDR_CODE for details about the collecting agency.
3. **COLR_REF** [C:20];
   This field stores the identifying label assigned to the fish by the collecting agency. This label was often a sequential number that was therefore not unique across all collections and in one case was even repeated within the same collection. Tagged and handled fish are often assigned a number, whereas in ESIDSAMP handled and tagged fish do not receive a FIELD_ID. This field assists in referring to the documentation about the collection.

4. **DATE_COLL** [D:8];
This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.

5. **TIME_COLL** [C:4];
This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.

6. **DATE_TIME** [C:11];
This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.
DNR = date not reported; DATE_COLL is blank.
TNR = time not reported; TIME_COLL is blank.
DTNR = date and time not reported; DATE_COLL and TIME_COLL is blank.
DMyymm = date reported to the month, yymm; DATE_COLL is blank.
DS{A/I}nn = date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
TH = time reported to the hour, hh; TIME_COLL is blank.
TS{A/I}nn = time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.

7. **FL** [N:6.1];
This field is the fork length in mm; if not reported, -1 is entered.

8. **WT_UNITS** [C:6];
This field specifies units for the original sample size; usually GM-WET for fish.

9. **WT_VALUE** [N:7.2];
This field records the size of the original sample in the units specified.

10. **WT_SIG** [N:2.0];
This field gives the number of decimal places accurately recorded for COLN_VALUE.

11. **SEX** [C:3];
This field is the sexual maturity of the fish using the following codes;
F = female, mature.
FG = female green, partial gonadal development.
FGR = female gravid, eggs expressed easily with slight pressure.
FGS = female spent, post-spawning condition.
FI = female immature, no gonadal development.
M = male, mature.
MG = male green, partial gonadal development.
MGR = male gravid, sperm expressed easily with slight pressure.
MGS = male spent, post-spawning condition.
MI = male immature, no gonadal development.
n/r = not reported; n/o = not observable;unk = UN = U = unknown.

12. **AGE** [C:4];
This field is the age of the fish using the following codes;
A = Adult, age in years not known.
IM = Immature, age in years not known.
J = Juvenile, age in years not known.
nn = the age in years as determined from fish aging structures.
n/a = not applicable.
n/o = not observable, aging structures sampled are unsuitable.
n/r = not reported.
U = unknown.

13. **AGE_STRUCT** [C:3];
This field is the aging structure(s) used to determine AGE, using the following codes;
SC = scales
OT = otoliths
SO = scales and otoliths
FR = fin rays
SF = scales and fin rays
CL = cleithra
CS = cleithra and scales
VE = vertebrae
OB = other bones
LF = length frequency
n/a = not applicable, meaning not collected

14. **CAPT_METH** [C:3];
This field is the method of capture for the fish, using the following codes;
AB = angling, using bait.
AF = angling, using flies.
AL = angling, using lures.
BS = beach seine.
CF = caught by commercial fisherman.
CR = use of fisherman's creel.
DF = caught by domestic fisherman.
DN = dip net.
EF = electroshocker, backpack.
ES = electroshocker, boat.
SL = set line.
TD = trap, fish moving downstream.
TU = trap, fish moving upstream.
n/r = not reported.

15. **MESH** [C:5];
This field is the mesh size of the net if a net was used to capture the fish;
n/a = not applicable, meaning a net was not used.

16. **TAG_COL** [C:3];
This field is the colour of the tag for fish that are tagged and released;
O = orange.
PI = pink
Y = yellow.
n/a = not applicable, meaning a tag was not used.

17. **TAG_NO** [C:8];
This field is the number of the tag for fish that are tagged and released; for occasional tags used but not owned by NRBS a distinguishing letter is prefixed.
n/a = not applicable, meaning a tag was not used.

18. **EXAM_TIME** [N:4];
This field is the time of sample examination;
hhmm= using a 24 hour clock.
0 = if no examination was done.
-1 = if an examination was done, but the time was not reported.

19. **SKIN** [C:3];
This field records gross pathologic observations about the skin of the fish using the following codes;

AB = abrasions.	AC = abnormal colour.
BI = bilateral.	BL = blister.
CA = cataract.	CY = cysts.
DE = deformed.	DF = distended, fluid.
DM = distended, mucoid.	EM = excessive mucus.
ER = eroded.	EX = exophthalmia.
FR = frayed.	FV = fungus visible.
GE = gas emboli.	HA = haemorrhagic.
HY = hyperplasia.	L = lesions.
LC = lesions, closed.	LL = lens lost.
LM = lesions, multiple.	LO = lesions, open.
LP = large parasites.	LS = lesions, single.
LT = lost scales.	MO = mottled.
NC = necrotic.	NM = normal.
OC = opaque cornea.	PA = parasites.
PL = pale.	R = reduced.
TE = telangiectasia.	TU = tumour.
UL = ulcer.	n/a = not applicable = not examined.

n/r = not reported.

20. **EYES** [C:3];
This field records gross pathologic observations about the eyes of the fish using the same codes used for SKIN.

21. **FINS** [C:3];
This field records gross pathologic observations about the fins of the fish using the same codes used for SKIN.

22. **GILLS** [C:3];
    This field records gross pathologic observations about the gills of the fish using the same codes used for SKIN.
23. **TAXON_CODE** [C:10];
    This field contains a code referencing the taxonomic identification of the biological item; the codes used are the same as those used by the Environment Canada database, Envirodat. This field has not been used.

B.3.8 Content of File. *ESIDLAA.DBF:*

ESIDLAA.DBF contains details about the Laboratory Analysis Approval which was used by the NRBS to authorize particular analyses. This file is useful for operational tracking of samples under analysis and may be removed from the legacy version of the database.

1. **LAA_NO** [C:3];
   This field is the number of the LAA. This field links *ESIDLAA.DBF* to *ESIDSAMP.DBF*>LAA
2. **LAA_DATE** [D:8];
   This field is the date the LAA was issued.
3. **LAB_DATE** [D:8];
   This field is the date the last result directed by the LAA was reported by the laboratory on its printed report form.
4. **LAB** [C:6];
   This field is a code for the agency analysing the sample, of the form aaa-cc. This field links *ESIDLAA.DBF* to *ESIDADDR.DBF*>ADDR_CODE.
5. **LAB_REFER** [C:19];
   This field is a laboratory reference to the package of results submitted to the NRBS Office.

B.3.9 Content of File. *ESIDLIQD.DBF:*

ESIDLIQD.DBF contains details of original liquid samples collected, including effluent and ambient water.

1. **UNIQ_ID** [N:9.0];
   This field is a unique record identifier. This field links file *ESIDLIQD.DBF* with *ESIDSAMP.DBF*>UNIQ_ID.
2. **COLR_CODE** [C:7];
   This field is a code for the agency collecting the sample in the form aaa-cc (for example, PNR-CA = Prairie and Northern Region, Enivonment Canada, Calgary). This field links with *ESIDADDR.DBF*>ADDR_CODE.

3. **DATE_COLL** [D:8];
This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.
4. **TIME_COLL** [C:4];
This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.
5. **DATE_TIME** [C:11];
This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.

DNR = date not reported; DATE_COLL is blank.
TNR = time not reported; TIME_COLL is blank.
DTNR = date and time not reported; DATE_COLL and TIME_COLL is blank.
DMyymm = date reported to the month, yymm; DATE_COLL is blank.
DS{A/I}nn = date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
TH = time reported to the hour, hh; TIME_COLL is blank.
TS{A/I}nn = time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.
TSNR-T=S = time span, but not reported; time reported is start time.
TSNR-T=E = time span, but not reported; time reported is end time.

6. **COLN_UNITS** [C:6];
This field specifies units for the size of the original sample (usually LITRES) for liquid samples).
7. **COLN_VALUE** [N:6.2];
This field records the size of the original sample in the units specified.
8. **COLN_SIG** [N:2];
This field gives the number of decimal places accurately recorded for COLN_VALUE.
9. **DATUM_UNIT** [C:6];
This field specifies units for the base datam from which offset is recorded.
10. **DATUM_VALU** [N:6.2];
This field records the value of the base datum; usually the depth of water over river bed.
11. **DATUM_SIG** [N:2];
This field gives the number of decimal places accurately recorded for DATUM_VALU.
12. **OFSET_UNIT** [C:6];
This field specifies units for the offset from the base datum.

13. **OFSET_VALU** [N:6.2];
This field records the value of the offset; usually the depth of intake below liquid surface.
14. **OFSET_SIG** [N:2];
This field gives the number of decimal places accurately recorded for OFSET_VALU

B.3.10 Content of File. *ESIDMAMM.DBF*:

ESIDMAMM.DBF contains details of original mammal samples collected.

1. **UNIQ_ID** [N:9.0];
This field is a unique record identifier. This field links file *ESIDBENT.DBF* with *ESIDSAMP.DBF*.
2. **COLR_CODE** [C:7];
This field is a code for the agency collecting the sample in the form aaa-cc (for example, PNR-CA = Prairie and Northern Region, Enivonment Canada, Calgary). This field links with *ESIDADDR.DBF*> ADDR_CODE.
3. **DATE_COLL** [D:8];
This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.
4. **TIME_COLL** [C:4];
This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.
5. **DATE_TIME** [C:11];
This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.

DNR =	date not reported; DATE_COLL is blank.
TNR =	time not reported; TIME_COLL is blank.
DTNR =	date and time not reported; DATE_COLL and TIME_COLL is blank.
DMyymm =	date reported to the month, yymm; DATE_COLL is blank.
DS{A/I}nn =	date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
TH =	time reported to the hour, hh; TIME_COLL is blank.
TS{A/I}nn =	time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.
TSNR-T=S =	time span, but not reported; time reported is start time.
TSNR-T=E =	time span, but not reported; time reported is end time.

6. **TAXON_CODE** [C:10];
   This field contains a code referencing the taxonomic identification of the biological item; the codes used are the same as those used by the Environment Canada database, Envirodat. This field will be updated by the NRBS if time and resources permit
7. **SEX** [C:3];
   This field is the sex of the mammal using the following codes;
   M = male.
   F = female.
   n/r = not reported; n/o = not observable.
8. **AGE** [C:4];
   This field is the age of the mammal using the following codes;
   nn = the age in years.
   n/o = not observable, aging structures sampled are unsuitable.
   n/r = not reported.
9. **WT_UNITS** [C:6];
   This field specifies units for the size of the original sample, usually GM-WET for mammals.
10. **WT_VALUE** [N:7.2];
    This field records the size of the original sample in the units specified.
11. **WT_SIG** [N:2];
    This field gives the number of decimal places accurately recorded for COLN_VALUE.
12. **CAPT_METH** [C:4];
    This field is the method of capture for the mammal.
13. **WRAPPED** [C:18];
    This field is the material used to wrap the carcass.
14. **CONDITION** [C:6];
    This field is the condition of the carcass at capture.
15. **TRAP_LINE** [C:4];
    This field is registered trap line number.
16. **HABITAT** [C:10];
    This field is a description of the capture habitat.

B.3.11 Content of File. *ESIDPROJ DBF:*

ESIDPROJ.DBF contains details of original mammal samples collected.

1. **PROJ_CODE** [C:9];
   This field is the NRBS project code. This field links *ESIDPROJ.DBF* to *ESIDSAMP.DBF*>PROJ_CODE.
2. **SAMP_CODE** [C:4];
   This field is the type of sample; it allows a breakdown of information for projects that do multi-media sampling or analysis.

9. **PROJ_DESC** [C:40];
This field is a description of the project.

B.3.12 Content of File, *ESIDSAMP.DBF*:

ESIDSAMP.DBF is the prime entry point for this database. It contains data about both original samples and subsamples prepared for and sent to laboratory analysis. The data fields represent data that is mostly common to all samples.

1. **UNIQ_ID** [N:9.0];
This field is a unique record identifier. This field links file *ESIDSAMP.DBF* with the compartment files (*ESIDLIQD.DBF*, *ESIDSEDI.DBF*, *ESIDBENT.DBF*, *ESIDFISH.DBF*, *ESIDMAMM.DBF*, and *ESIDBIRD.DBF*) and the analytical results files (*ESAR@@.DBF*).
2. **OWNER** [C:5];
This field is the owner of the sample using the following codes;
NRBS = Northern River Basins Study.
3. **PROJ_CODE** [C:9];
This field is the NRBS project code. This field links *ESIDSAMP.DBF* to *ESIDPROJ.DBF*.
for example, 2322D1 = Basin-wide Fall 1994 Sediment Survey.
4. **SITE_CODE** [C:4];
This field is a unique site identifier of the form nnnn. This field links file *ESIDSAMP.DBF* with *ESIDSITE.DBF*.
5. **SAMP_CODE** [C:4];
This field identifies the type of sample using the following codes;

BENT =	benthos.	BIRD =	birds.
FISH =	fish.	LIQD =	liquid.
MAMM =	mammals.	SEDI =	sediment.

6. **DESC_CODE1** [C:4];
This field gives descriptive details about the nature of the sample in the format aaaa, where aaaa is a four character abbreviation. This field links *ESIDSAMP.DBF* with *ESIDDESC.DBF*>DESC_CODE1
for example, SUSP = Sediment; Suspended
7. **DESC_CODE2** [C:8];
This field gives descriptive details about the form of the subsample in the format aa-a-aaa. This field links to *ESIDSUBS.DBF*>DESC_CODE2.
for example, CE-C-P = centrifuged from effluent, composited, prepared.
8. **FIELD_ID** [C:25];
This field is the identifier affixed to the sample in the field at the time of collection; it is usually written onto the container that holds the sampled material. It is this field which ensures the NRBS ability to track custody of the sample; it should be entered as it appears on the sample or subsample.

9. **SAMP_UNITS** [C:6];
This field specifies the units for the size of the sample or subsample; for sediment this can be LITRES, ML, GM-WET or GM-DRY (when prepared).
10. **SAMP_VALUE** [N:7.3];
This field records the size of the sample or subsample in the units specified.
11. **SAMP_SIG** [N:2.0];
This field gives the number of accurate decimal places for SAMP_VALUE.
12. **COLN_CODE** [C:4];
This field gives referencing information for the sampling protocols and procedures in the format nnnn. This field links *ESIDSAMP.DBF* to *ESIDCOLL.DBF*>COLL_CODE.
13. **COMP_CODE** [N:4];
This field links to the file, *ESIDCOMP.DBF* that contains the source samples for composite samples.
14. **STATUS** [C:1];
This field gives the current status of the sample using the following codes;
A = being analysed.
D = destructive testing.
F = sampling failed; for example, when a fish dies before release.
H = handled; captured, examined and released.
I = insufficient sample amount.
O = observed, not handled.
P = pass on; previously tagged, recaptured and released.
R = returned; previously tagged, recaptured and kept.
S = in storage.
T = tagged and released.
U = unresolved, unknown.
X = expended.
15. **LOCN_CODE** [C:7];
This field identifies the agent with current custody of the sample in the format aaa-ccn, where aaa = a code for the agency and cc = a code for the city in which the agency is based. This field links to *ESIDADDR.DBF*>ADDR_CODE.
for example, RLL-ED = R.L. & L. Environmental Services Ltd., Edmonton
16. **LAA_NO** [C:3];
This field links to a file that contains data about the analytical results provided by laboratories.
17. **TEST** [C:2];
This field is a code of the form aa to indicate which analyses the subsample has undergone. This field links *ESIDSAMP.DBF* to *ESIDTEST.DBF*>TEST
18. **LAB_ID** [C:14];
This field is the laboratory sample identification.

19. **XREF_DBF** [C:12];
This field allows the entry of the .DBF file name for those instances when additional data is available in another file linked by UNIQ_ID. In the case of original samples the file name is for the original sample details. In the case of a subsample the file name is for an analytical resutls file.

B.3.13 Content of File, *ESIDSEDI.DBF*:

ESIDSEDI.DBF contains data particular to original sediment samples.

1. **UNIQ_ID** [N:9.0];
This field is a unique record identifier. This field links file *ESIDSEDI.DBF* with *ESIDSAMP.DBF*.
2. **COLR_CODE** [C:7];
This field is a code for the agency collecting the sample as follows;
PNR-CA = Prairie and Northern Region, Enivonment Canada, Calgary.
3. **DATE_COLL** [D:8];
This field records the date the sample was collected in the form, yy/mm/dd; it is used in conjunction with the fields, TIME_COLL and DATE_TIME. When sampling occurs over a span of days the latest date, the date the sampling was completed, is the date entered.
4. **TIME_COLL** [C:4];
This field records the time the sample was collected in the form hhmm using the 24 hour clock; it is used in conjunction with the fields DATE_COLL and DATE_TIME. When sampling occurs over a span of time the latest time, the time the sampling is completed, is the time entered.
5. **DATE_TIME** [C:11];
This field guides the interpretation of the fields DATE_COLL and TIME_COLL. The following codes are used.
DNR = date not reported; DATE_COLL is blank.
TNR = time not reported; TIME_COLL is blank.
DTNR = date and time not reported; DATE_COLL and TIME_COLL is blank.
DMyymm = date reported to the month, yymm; DATE_COLL is blank.
DS{A/I}nn = date reported as a span, either accurate (A) or inaccurate (I), of length nn in days; DATE_COLL is blank.
TH = time reported to the hour, hh; TIME_COLL is blank.
TS{A/I}nn = time reported as a span, either accurate (A) or inaccurate (I), of length nn in hours; TIME_COLL is blank.
TSNR-T=S = time span, but not reported; time reported is start time.
TSNR-T=E = time span, but not reported; time reported is end time.
6. **COLN_UNITS** [C:6];
This field specifies units for the size of the original sample; for sediment, this can be LITRES or ML or GM-WET, for a core it can be METRES or CM.

7. **COLN_VALUE** [N:6.2];
   This field records the size of the original sample in the units specified.
8. **COLN_SIG** [N:2];
   This field gives the number of decimal places accurately recorded for COLN_VALUE.
9. **DATUM_UNIT** [C:6];
   This field specifies units for the base datam from which offset is recorded.
10. **DATUM_VALU** [N:6.2];
    This field records the value of the base datum;
    for suspended sediment centrifuging, this is the depth of water over river bed.
    for coring this is the altitude of the drilling platform.
11. **DATUM_SIG** [N:2];
    This field gives the number of decimal places accurately recorded for DATUM_VALU.
12. **OFSET_UNIT** [C:6];
    This field specifies units for the offset from the base datum.
13. **OFSET_VALU** [N:6.2];
    This field records the value of the offset;
    for suspended sediment centrifuging, the depth of intake below water surface.
    for coring, the distance of the top surface of the core from the drilling platform.
14. **OFSET_SIG** [N:2];
    This field gives the number of decimal places accurately recorded for OFSET_VALU

B.3.14 Content of File. **ESIDSITE.DBF:**

ESIDSITE.DBF contains data about geographical references.

1. **SITE_CODE** [C:4];
   This field is a unique site identifier of the form nnnn; project 3144-D1 will use numbers beginning with 9001. This field links file *SPECSAMP.DBF* with *SPECSITE.DBF*.
2. **SITE_DESC** [C:40];
   This field is the primary descriptor of the location where the sample was collected; it provides the major geographical feature first and then refines this with added detail. Spacing is compressed to maximize text. Several standard abbreviations without periods are used;

Br	= bridge	d/s	= downstream of.
L	= lake	mo	= mouth of.
R	= river	u/s	= upstream of.

   Some examples are;
   Athabasca R;u/s Hinton,hwy40 Br
   Athabasca R;u/s Berland R

3. **SITE_DESC2** [C:40];
This field is the secondary descriptor of the location where the sample is collected; it provides local details of the site. Spacing is compressed. Several standard abbreviations without periods are used;
RB+10m = ten meters off the right bank, facing downstream.
LC = left centre, facing downstream.
fr = from.
Some examples are;
3119B2-site G;fr Br to 7km u/s
220m u/s Berland R,RB+50m

4. **WATERSHED** [C:10];
This field is the Water Survey of Canada drainage basin code; it is left blank because it will be assigned using the geographical information system (GIS).

5. **REACH** [C:9];
This field is used to tag or cluster sites of common interest for particular scientific enquiries using the database; contractors will leave this blank.

6. **RIV_KM** [N:6.0];
This field provides the kilometre displacement upstream from the mouth of the MacKenzie River; it is computed for the latitude and longitude by the GIS and converted back into the ESIDSITE file.

7. **GEO_CONTXT** [C:2];
This field qualifies the interpretation of the georeferencing given;
G1 = for a single point that is globally accurate for the sample; like a sediment core.
R2 = for a paired point that is globally accurate for the sample; like the downstream and upstream points of a linear sampling sweep up a river (in which case the downstream point is reported in LAT and LON and the second point is reported in LAT2 and LON2) or endpoints of a transect.
P1 = for a single point that is the centroid of a polygonal sampling focus.
P2 = for a paired point that is the lower left-hand corner (SW) of a square window encompassing an areal sampling focus and the associated upper right-hand corner (NE) of the window.

8. **LAT** [N:10.6];
This field is the latitude as decimal degrees, the format required by the GIS.

9. **LON** [N:11.6];
This field is the longitude as negative decimal degrees; as required by the GIS.

10. **LAT2** [N:10.6];
This field is a second latitude when required.

11. **LON2** [N:11.6];
This field is a second longitude when required.

12. **UTM_X** [N:7.0];
This field is the full UTM easting.

13. **UTM_Y** [N:7.0];
This field is the full UTM northing.

14. **UTM_ZONE** [N:2.0];
    This field is the UTM zone; for Alberta this is either 11 or 12.
15. **UTM_X2** [N:7.0];
    This field is a second full UTM easting.
16. **UTM_Y2** [N:7.0];
    This field is a second full UTM northing.
17. **UTM_ZONE** [N:2.0];
    This field is the UTM zone related to the second UTM easting and northing.
18. **MER** [N:1.0];
    This field is the Dominion Land Survey (DLS) meridian.
19. **RGE** [N:2.0];
    This field is the DLS range.
20. **TWP** [N:3.0];
    This field is the DLS township.
21. **SEC** [N:2.0];
    This field is the DLS section.
22. **LSD** [N:2.0];
    This field is the DLS legal subdivision (lsd).
23. **PREC** [C:3];
    This field indicates the precision within the section; lsd, 1/4 or 1/2.
24. **MER2** [N:1.0];
    This field is a second DLS meridian.
25. **RGE2** [N:2.0];
    This field is a second DLS range.
26. **TWP2** [N:3.0];
    This field is a second DLS township.
27. **SEC2** [N:2.0];
    This field is a second DLS section.
28. **LSD2** [N:2.0];
    This field is a second DLS legal subdivision (lsd).
29. **PREC2** [C:3];
    This field is a second precision within the section; lsd, 1/4 or 1/2.

B.3.15 Content of File. *ESIDSUBS.DBF:*

ESIDSUBS.DBF contains a description of the form of the sample as encoded in field DESC_CODE2 in *ESIDSAMP.DBF*.

1. **DESC_CODE2** [C:8];
   This field is the code of the form aa-a-aaa for describing the form of the sample. This field links *ESIDSUBS.DBF* to *ESIDSAMP.DBF* > DESC_CODE2.
2. **SUBS_TEXT** [C:40];
   This field is a textual description related to the DESC_CODE2.

B.3.16 Content of File, *ESIDTAXO.DBF*:

ESIDTAXO.DBF contains a description of the taxonomic identification of the animal sample as encoded in field TAXON_CODE in files *ESIDBENT.DBF*, *ESIDFISH.DBF*, *ESIDMAMM.DBF* and *ESIDBIRD.DBF*. It is intended that this taxonomy be the same one in use by the ENVIRODAT database developed by Environment Canada; however, it has not been implemented for use by the NRBS.

B.3.17 Content of File, *ESIDTEST.DBF*:

ESIDTEST.DBF contains a description of the analytical test set encoded in field TEST in file *ESIDSAMP.DBF*.

1. **TEST** [C:2];
   This field is the code of the form aa for describing the set of analytical tests to be conducted on this subsample. This field links *ESIDTEST.DBF* to *ESIDSAMP.DBF*>TEST.
2. **TEST_DESC** [C:40];
   This field is a textual description related to the field, TEST.

B.4 DATA FIELDS FOR ANALYTICAL RESULTS FILES

This section describes the meaning and acceptable entries for the fields in each file related to the analytical results reported for the environmental subsamples. Every *ESAR@@.DBF* file for contaminant results from commercial laboratories has the same basic structure, where @@ is a two character code for the test set:

1. Subsample identifying information;

a. **UNIQ_ID** [N:9];
   This field is the unique identifier for the subsample that was sent to a particular analysis. This field links file *ESAR@@.DBF* with *ESIDSAMP.DBF*.

b. **LAB_ID** [C:14];
   This field is the unique identifier used within the laboratory for the subsample.

c. **LAB_DATE** [D:10];
   This field is the date reported by the laboratory for this test set and batch; if different parameters within the test set are reported on different dates, the latest date is entered. If no date is reported, then the field is blank.

d. **SIZE_V** [N:10.6];
   This field is the value of the size of the sample if reported by the laboratory; otherwise the field is blank.

e. **SIZE_U** [C:6];
   This field gives the units in which the size of the lab sample is reported; if no size of subsample is reported, this field contains "n/r".

f. **SIZE_S** [N:2];
This field gives the number of significant digits for the SIZE_V field.

2. Analytical results, comprising fields that repeat for each parameter in the @@ test set;

a. **<par>_D** [C:3];
This field indicates the result of analyses using codes;
CD = valid concentration detected
ND = no concentration detected
NDR = peak detected, but quantification criteria not met
n/r = not reported; analysis for this parameter not conducted

b. **<par>_V** [N:9.5];
This field is the value of the parameter measured.

c. **<par>_U** [C:6];
This field is the units of measurement for the parameter.

d. **<par>_S** [N:2];
This field is the significant digits reported. This number is not the significant figures in a statistical sense. This number serves to record accurately in the database the number of digits the laboratory actually reported. For example;

for lab value = 22	_V value = 22.000000	_S value = 2
for lab value = 2	_V value = 2.000000	_S value = 1
for lab value = 2.22	_V value = 2.220000	_S value = 3
for lab value = 0.20	_V value = 0.200000	_S value = 2
for lab value = 0.002	_V value = 0.002000	_S value = 3

e. **<par>_L** [N:8.5];
This field is the value of the detection limit for the parameter.

f. **<par>_M** [C:7];
This field is the method of measurement for the parameter. This code field is only present for those parameters that have measurement methods that can vary for different parameters within a test set. For example, the test set for metals (ME) contains the field for each parameter and it is set equal to the NAQUADAT code when reported. In many cases the measurement method used applies to all the parameters in a test set in the same laboratory batch; a reference for the method description in these cases is recorded in the field *ESIDSAMP.DBF*>COLL_CODE.

3. The valid values for parameter fields for analytical results vary dependent upon the entry in the **<par>_D** field:

<par>_D	**<par>_V**	**<par>_U**	**<par>_S**	**<par>_L**
"CD"	entry	units	entry	entry
"ND"	zero	units	as for _L	entry
"NDR"	entry	units	entry	entry
"n/r"	blank	blank	blank	blank

Identifying details about subsamples are contained in and referenced through the primary file, *ESIDSAMP.DBF*. In the cases of non-contaminant data from non-commercial laboratories the fields contained in the file are generally those reported by the researcher even if some duplicate fields contained in the ESID files; they are matched to UNIQ_ID as timing and resources permitted.

In order to assist scientists in a preliminary identification of a particular subsample, a retrieval which gathers together fundamental identifying information is described in section B.5.

B.4.1 Content of File. **ESARAX.DBF**:

ESARAX.DBF was planned to contain the results of analyses for AOX, EOX and EOCl. This file has not been implemented.

B.4.2 Content of File. **ESARBO.DBF**:

ESARBO.DBF was planned to contain the results of analysis for Biological Oxygen Demand (BOD). This file has not been implemented.

B.4.3 Content of File. **ESARCPn.DBF**:

ESARCPn.DBF contains the results of analyses for Chlorophenolics (CP), where n is a sequence number (1, 2). Due to the number of parameters in the CP test set the dBASEIV specification of 255 fields is exceeded; the parameters have been partitioned into two files. The parameters included in each CP file are identified in the following subsections.

B.4.3.1 Content of File, **ESARCP1.DBF**:

ESARCP1.DBF contains the CP results for chlorophenols, chloroguaiacols, chlorocatechols, and chloroveratroles. Recoveries for related surrogates are contained in file *ESARCP2.DBF*. The order of the parameters are:

No.	**<par>**	**Parameter name**
1	CL1PH1	2-Chlorophenol
2	CL1PH2	3-Chlorophenol
3	CL1PH3	4-Chlorophenol
4	CL2PH1	2,3-Dichlorophenol
5	CL2PH2	2,4-Dichlorophenol
6	CL2PH3	2,4/2,5-Dichlorophenol
7	CL2PH4	2,5-Dichlorophenol
8	CL2PH5	2,6-Dichlorophenol
9	CL2PH6	3,4-Dichlorophenol
10	CL2PH7	3,5-Dichlorophenol
11	CL2PH8	4,6-Dichlorophenol

12	CL3PH1	2,3,4-Trichlorophenol
13	CL3PH2	2,3,5-Trichlorophenol
14	CL3PH3	2,3,6-Trichlorophenol
15	CL3PH4	2,4,5-Trichlorophenol
16	CL3PH5	2,4,6-Trichlorophenol
17	CL3PH6	3,4,5-Trichlorophenol
18	CL4PH1	2,3,4,5-Tetrachlorophenol
19	CL4PH2	2,3,4,6-Tetrachlorophenol
20	CL4PH3	2,3,4,6/2,3,5,6-Tetrachlorophenol
21	CL4PH4	2,3,5,6-Tetrachlorophenol
22	CL5PH	Pentachlorophenol
23	CL1GU1	4-Chloroguaiacol
24	CL1GU2	5-Chloroguaiacol
25	CL1GU3	6-Chloroguaiacol
26	CL2GU1	3,4-Dichloroguaiacol
27	CL2GU2	4,5-Dichloroguaiacol
28	CL2GU3	4,6-Dichloroguaiacol
29	CL3GU1	3,4,5-Trichloroguaiacol
30	CL3GU2	3,4,6-Trichloroguaiacol
31	CL3GU3	4,5,6-Trichloroguaiacol
32	CL4GU	3,4,5,6-Tetrachloroguaiacol
33	CL1CA1	3-Chlorocatechol
34	CL1CA2	4-Chlorocatechol
35	CL2CA1	3,4-Dichlorocatechol
36	CL2CA2	3,5-Dichlorocatechol
37	CL2CA3	3,6-Dichlorocatechol
38	CL2CA4	4,5-Dichlorocatechol
39	CL3CA1	3,4,5-Trichlorocatechol
40	CL3CA2	3,4,6-Trichlorocatechol
41	CL4CA	3,4,5,6-Tetrachlorocatechol
42	CL2VE1	4,5-Dichloroveratrole
43	CL3VE1	3,4,5-Trichloroveratrole
44	CL4VE	Tetrachloroveratrole

B.4.3.2 Content of File, **ESARCP2.DBF**:

ESARCP2.DBF contains the CP results for chlorosyringaldehydes, chlorosyringols, trichlorotrimethoxybenzene, chlorovanillins, chloroanisoles and all surrogates for the CP test set. The order of the parameters are:

No.	**<par>**	**Parameter name**
1	CL1SYA1	2-Chlorosyringaldehyde
2	CL2SYA1	2,6-Dichlorosyringaldehyde
3	CL1SYG1	3-Chlorosyringol
4	CL2SYG1	3,5-DiChlorosyringol
5	CL3SYG1	3,4,5-Trichlorosyringol

6	CL3MEO3B	4,5,6-Trichlorotrimethoxybenzene
7	CL1VA1	5-Chlorovanillin
8	CL1VA2	6-Chlorovanillin
9	CL2VA1	5,6-Dichlorovanillin
10	CL1AN1	2-Chloroanisole
11	CL1AN2	3-Chloroanisole
12	CL1AN3	4-Chloroanisole
13	CL2AN1	2,3-Dichloroanisole
14	CL2AN2	2,4-Dichloroanisole
15	CL2AN3	2,5-Dichloroanisole
16	CL2AN4	2,6-Dichloroanisole
17	CL2AN5	3,4-Dichloroanisole
18	CL2AN6	3,5-Dichloroanisole
19	CL3AN1	2,3,4-Trichloroanisole
20	CL3AN2	2,3,5-Trichloroanisole
21	CL3AN3	2,3,6-Trichloroanisole
22	CL3AN4	2,4,5-Trichloroanisole
23	CL3AN5	2,4,6-Trichloroanisole
24	CL3AN6	3,4,5-Trichloroanisole
25	CL4AN1	2,3,4,5-Tetrachloroanisole
26	CL4AN2	2,3,4,6-Tetrachloroanisole
27	CL4AN3	2,3,4,6/2,3,5,6-Tetrachloroanisole
28	CL4AN4	2,3,5,6-Tetrachloroanisole
29	CL5AN	Pentachloroanisole
30	S_BR1PH1	Surrogate 4-Bromophenol
31	S_BR3PH1	Surrogate 2,4,6-Tribromophenol
32	S_BR2AN1	Surrogate 2,6-Dibromoanisole
33	S_BR3AN1	Surrogate 2,4,6-Tribromoanisole
34	S_CL1PH3	Surrogate 4-Chlorophenol
35	S_CL2PH2	Surrogate 2,4-Dichlorophenol
36	S_CL3PH4	Surrogate 2,4,5-Trichlorophenol
37	S_CL3PH5	Surrogate 2,4,6-Trichlorophenol
38	S_CL4PH1	Surrogate 2,3,4,5-Tetrachlorophenol
39	S_CL5PH	Surrogate 13C6-Pentachlorophenol
40	S_CL1GU1	Surrogate 4-Chloroguaiacol
41	S_CL3GU3	Surrogate 4,5,6-Trichloroguaiacol
42	S_CL4GU	Surrogate 3,4,5,6-Tetrachloroguaiacol
43	S_CL2CA4	Surrogate 4,5-Dichlorocatechol
44	S_CL4CA	Surrogate 13C6-Tetrachlorocatechol
45	S_CL1VA1	Surrogate 5-Chlorovanillin

B.4.4 Content of File, **ESARDFn.DBF**:

ESARDFn.DBF contains the results of analyses for polychlorinated dibenzodioxins and dibenzofurans (DF), where n is a sequence number (1 to 4). Due to the number of parameters in the DF test set the dBASEIV specification of 255 fields is exceeded; the parameters have been partitioned into four files. The parameters included in each DF file are identified in the following subsections.

ESARDF.DBF contains the results of analyses for 2378- polychlorinated dibenzodioxins and dibenzofurans (DF); the parameters are the same as described in section 4.6.1 for file *ESARDF1.DBF*. *ESARDF.DBF* has been resolved to a set of subsample records that contain no duplicates.

The conversion process wrote to multiple target files for each separate source file, reserving one record in each target file for each record in the source file. Since the DF results were converted from multiple source files, multiple (duplicate) records were reserved for the same sample. These multiple records were not resolved for the non-2378 congener files; if non-2378 data is of interest the ESARDF.DBF file should be used as a guide to resolve the files described in the following subsections.

B.4.4.1 Content of File, **ESARDF1.DBF**:

ESARDF1.DBF contains the DF results for all 2378- CDD and CDF compounds. The "Totals" included in this file for each tetra- to octa- subset includes any values for non-2378 congeners, which are contained in files *ESARDF3.DBF* and *ESARDF4.DBF*. In addition, this file contains recoveries for related surrogates, lipid content and moisture content. The order of the parameters are;

N	<par>	Parameter name
1	CL4DD15	2,3,7,8-TCDD
2	CL5DD06	1,2,3,7,8-PeCDD
3	CL6DD03	1,2,3,4,7,8-HxCDD
4	CL6DD04	1,2,3,6,7,8-HxCDD
5	CL6DD06	1,2,3,7,8,9-HxCDD
6	CL7DD01	1,2,3,4,6,7,8-HpCDD
7	CL8DD01	1,2,3,4,6,7,8,9-OCDD
8	CL4DDTOT	Total TCDD
9	CL5DDTOT	Total PeCDD
10	CL6DDTOT	Total HxCDD
11	CL7DDTOT	Total HpCDD
12	CL4DF14	2,3,7,8-TCDF
13	CL5DF07	1,2,3,7,8-PeCDF
14	CL5DF15	2,3,4,7,8-PeCDF
15	CL6DF04	1,2,3,4,7,8-HxCDF
16	CL6DF07	1,2,3,6,7,8-HxCDF
17	CL6DF09	1,2,3,7,8,9-HxCDF

18	CL6DF14	2,3,4,6,7,8-HxCDF
19	CL7DF01	1,2,3,4,6,7,8-HpCDF
20	CL7DF04	1,2,3,4,7,8,9-HpCDF
21	CL8DF01	1,2,3,4,6,7,8,9-OCDF
22	CL4DFTOT	Total TCDF
23	CL5DFTOT	Total PeCDF
24	CL6DFTOT	Total HxCDF
25	CL7DFTOT	Total HpCDF
26	S_CL4DD15	Surrogate 13C12-2,3,7,8-TCDD
27	S_CL4DF14	Surrogate 13C12-2,3,7,8-TCDF
28	S_CL5DD06	Surrogate 13C12-1,2,3,7,8-PeCDD
29	S_CL5DF07	Surrogate 13C12-1,2,3,7,8-PeCDF
30	S_CL5DF15	Surrogate 13C12-2,3,4,7,8-PeCDF
31	S_CL6DD03	Surrogate 13C12-1,2,3,4,7,8-HxCDD
32	S_CL6DD04	Surrogate 13C12-1,2,3,6,7,8-HxCDD
33	S_CL6DF04	Surrogate 13C12-1,2,3,4,7,8-HxCDF
34	S_CL6DF07	Surrogate 13C12-1,2,3,6,7,8-HxCDF
35	S_CL6DF09	Surrogate 13C12-2,3,4,6,7,8-HxCDF
36	S_CL6DF14	Surrogate 13C12-1,2,3,7,8,9-HxCDF
37	S_CL7DD01	Surrogate 13C12-1,2,3,4,6,7,8-HpCDD
38	S_CL7DF01	Surrogate 13C12-1,2,3,4,6,7,8-HpCDF
39	S_CL7DF04	Surrogate 13C12-1,2,3,4,7,8,9-HpCDF
40	S_CL8DD	Surrogate 13C12-OCDD
41	LIPIDDF	Lipid Content
42	MOISTDF	Moisture Content

B.4.4.2 Content of File, **ESARDF2.DBF**:

ESARDF2.DBF contains the DF results for all mono-, di-, and tri- CDD and CDF congeners and related surrogates. The order of the parameters are;

N	**<par>**	**Parameter name**
1	CL1DD01	1-MonoCDD
2	CL1DD02	2-MonoCDD
3	CL2DD01	2,3-DiCDD
4	CL2DD02	2,7-DiCDD
5	CL2DD03	2,7/2,8-DiCDD
6	CL2DD04	2,8-DiCDD
7	CL3DD01	1,2,3-TriCDD
8	CL3DD02	1,2,4-TriCDD
9	CL3DD03	2,3,7-TriCDD
10	CL1DDTOT	Total MonoCDD
11	CL2DDTOT	Total DiCDD
12	CL3DDTOT	Total TriCDD
13	CL1DF01	2-Mono CDF
14	CL1DF02	4-Mono CDF

15	CL2DF01	2,4-DiCDF
16	CL2DF02	2,6-DiCDF
17	CL2DF03	2,8-DiCDF
18	CL3DF01	2,3,8-TriCDF
19	CL3DF02	2,4,6/2,4,8-TriCDF
20	CL1DFTOT	Total MonoCDF
21	CL2DFTOT	Total DiCDF
22	CL3DFTOT	Total TriCDF
23	S_CL2DD03	Surrogate 13C12-2,7/2,8-DiCDD
24	S_CL3DD03	Surrogate 13C12-2,3,7-TriCDD
25	CL1DDHOM	MonoCDD Homologue
26	CL2DDHOM	DiCDD Homologue
27	CL3DDHOM	TriCDD Homologue

B.4.4.3 Content of File, **ESARDF3.DBF**:

ESARDF3.DBF contains the DF results for all non-2378 tetra- to octa- CDD congeners. The "Total" value contained in *ESARDF1.DBF* includes any readings for these parameters. The surrogates related to these parameters are the same surrogates as are contained in *ESARDF1.DBF*. The order of the parameters are;

N	**<par>**	**Parameter name**
1	CL4DD01	1,2,3,4/1,2,3,6/1,2,6,9-TCDD
2	CL4DD02	1,2,3,7/1,2,3,8-TCDD
3	CL4DD03	1,2,3,9-TCDD
4	CL4DD04	1,2,4,6/1,2,4,9-TCDD
5	CL4DD05	1,2,4,7/1,2,4,8/1,3,7,8/1,4,6,9-TCDD
6	CL4DD06	1,2,6,7-TCDD
7	CL4DD07	1,2,6,8-TCDD
8	CL4DD08	1,2,7,8-TCDD
9	CL4DD09	1,2,7,9-TCDD
10	CL4DD10	1,2,8,9-TCDD
11	CL4DD11	1,3,6,8-TCDD
12	CL4DD12	1,3,6,9-TCDD
13	CL4DD13	1,3,7,9-TCDD
14	CL4DD14	1,4,7,8-TCDD
15	CL5DD01	1,2,3,4,6-PeCDD
16	CL5DD02	1,2,3,4,7-PeCDD
17	CL5DD03	1,2,3,6,7-PeCDD
18	CL5DD04	1,2,3,6,8-PeCDD
19	CL5DD05	1,2,3,6,9-PeCDD
20	CL5DD07	1,2,3,7,9-PeCDD
21	CL5DD08	1,2,3,8,9-PeCDD
22	CL5DD09	1,2,4,6,7/1,2,4,8,9-PeCDD
23	CL5DD10	1,2,4,6,8/1,2,4,7,9-PeCDD
24	CL5DD11	1,2,4,6,9-PeCDD

25	CL5DD12	1,2,4,7,8-PeCDD
26	CL6DD01	1,2,3,4,6,8-HxCDD
27	CL6DD02	1,2,3,4,6,9-HxCDD
28	CL6DD05	1,2,3,6,7,9/1,2,3,6,8,9-HxCDD
29	CL6DD07	1,2,4,6,7,9/1,2,4,6,8,9-HxCDD
30	CL7DD02	1,2,3,4,6,7,9-HpCDD
31	CL4DDHOM	TCDD Homologue
32	CL5DDHOM	PeCDD Homologue
33	CL6DDHOM	HxCDD Homologue
34	CL7DDHOM	HpCDD Homologue

B.4.4.4 Content of File, **ESARDF4.DBF**:

ESARDF4.DBF contains the DF results for all non-2378 tetra- to octa- CDF congeners. The "Total" value contained in *ESARDF1.DBF* includes any readings for these parameters. The surrogates related to these parameters are the same surrogates as are contained in *ESARDF1.DBF*. The order of the parameters are;

N	**<par>**	**Parameter name**
1	CL4DF01	1,2,3,4/1,2,3,6/1,2,3,8/1,4,6,9/1,6,7,8/2,4,6,7-TCDF
2	CL4DF02	1,2,3,7/1,3,6,9/2,3,6,8-TCDF
3	CL4DF03	1,2,3,9-TCDF
4	CL4DF04	1,2,4,6/1,2,4,7/1,3,4,6/1,3,4,7/1,3,7,8-TCDD
5	CL4DF05	1,2,4,8/1,3,4,8/1,3,6,7/1,3,7,9-TCDF
6	CL4DF06	1,2,6,7/1,3,4,9-TCDF
7	CL4DF07	1,2,6,8/1,4,6,7/1,4,7,8-TCDF
8	CL4DF08	1,2,6,9/3,4,6,7-TCDF
9	CL4DF09	1,2,7,8-TCDF
10	CL4DF10	1,2,8,9-TCDF
11	CL4DF11	1,3,6,8-TCDF
12	CL4DF12	1,4,6,8-TCDF
13	CL4DF13	2,3,6,8-TCDF
14	CL4DF15	2,4,6,8-TCDF
15	CL5DF01	1,2,3,4,6/1,2,3,4,7/1,2,4,6,9/2,3,4,6,8-PeCDF
16	CL5DF02	1,2,3,4,8-PeCDF
17	CL5DF03	1,2,3,4,9-PeCDF
18	CL5DF04	1,2,3,6,7-PeCDF
19	CL5DF05	1,2,3,6,8/1,2,4,6,7/1,2,4,7,8/1,3,4,6,7/1,3,4,7,8-PeCDF
20	CL5DF06	1,2,3,6,9/1,2,4,8,9/1,2,6,7,9-PeCDF
21	CL5DF08	1,2,3,7,9/1,2,6,7,8-PeCDF
22	CL5DF09	1,2,3,8,9-PeCDF
23	CL5DF10	1,2,4,6,8/1,3,4,6,8-PeCDF
24	CL5DF11	1,2,4,7,9/1,3,4,6,7-PeCDF
25	CL5DF12	1,3,4,7,9/1,4,6,7,8-PeCDF
26	CL5DF13	1,3,6,7,8-PeCDF
27	CL5DF14	2,3,4,6,7-PeCDF

28	CL6DF01	1,2,3,4,6,7-HxCDF
29	CL6DF02	1,2,3,4,6,8-HxCDF
30	CL6DF03	1,2,3,4,6,9/1,2,3,6,7,9-HxCDF
31	CL6DF05	1,2,3,4,7,9-HxCDF
32	CL6DF06	1,2,3,4,8,9-HxCDF
33	CL6DF08	1,2,3,6,8,9-HxCDF
34	CL6DF10	1,2,4,6,7,8/1,3,4,6,7,8-HxCDF
35	CL6DF11	1,2,4,6,7,9-HxCDF
36	CL6DF12	1,2,4,6,8,9-HxCDF
37	CL6DF13	1,3,4,6,7,9-HxCDF
38	CL7DF02	1,2,3,4,6,7,9-HpCDF
39	CL7DF03	1,2,3,4,6,8,9-HpCDF

B.4.5 Content of File. **ESARME.DBF**:

ESARME.DBF contains the results of analyses for Metals (ME). The ME results include a **<par>_M** field for each parameter in addition to the basic 4 fields. The parameters included in the ME test set are included in the following order:

No.	**<par>**	**Parameter name**
1	AS	Arsenic
2	CD	Cadmium
3	CR	Chromium
4	CU	Copper
5	HG	Mercury
6	HG_CH3	Methyl Mercury
7	HG_IN	Inorganic Mercury
8	PB	Lead
9	V	Vanadium
10	ZN	Zinc

B.4.6 Content of File. **ESARMO.DBF**:

ESARMO.DBF contains the results of analyses for mixed function oxygenase (MFO) in liver microsomes as reported by the Department of Fisheries and Oceans, Freshwater Institute. Lockhart et al (1966) [99] reported these results with basic inventory data; this file contains the data fields as reported by the researchers. The meaning of the fields are self-evident and details may be reviewed in the referenced report. For the parameters, the value, the significant digits and the detection limit are give; the parameters for the MO test set are included in the following order:

No.	**<par>**	**Parameter name**
1	EROD	ethoxyresorufin-O-deethylase
2	AHH	aryl hydrocarbon hydroxylase
3	P450	cytochrome P-450 content

B.4.7 Content of File. **ESAROC.DBF:**

ESAROC.DBF contains the results of analyses for Organochlorines (OC), including Toxaphene. The parameters included in the OC test set are included in the following order:

No.	<par>	Parameter name
1	ALDRIN	Aldrin
2	BHC_A	BHC alpha-
3	BHC_B	BHC beta-
4	BHC_D	BHC delta-
5	BHC_G	BHC gamma- (Lindane)
6	CLDN_A	Chlordane alpha-
7	CLDN_G	Chlordane gamma-
8	DDE_PP	DDE p p'-
9	DDD_PP	DDD p p'-
10	DDT_OP	DDT o p'-
11	DDT_PP	DDT p p'-
12	DIELDR	Dieldrin
13	EN_1	Endosulfan I
14	EN_2	Endosulfan II
15	EN_SO4	Endosulfan sulphate
16	ENDRIN	Endrin
17	CL6BZ	Hexachlorobenzene
18	CL7	Heptachlor
19	CL7_EP	Heptachlor epoxide
20	MEOCL	Methoxychlor
21	MIREX	Mirex
22	CL9_T	Nonachlor trans-
23	OCLDN	Oxychlordane
24	TOXAPH	Toxaphene
25	S_CL8NAA	Surrogate Octachloronaphthalene
26	S_BR1PHY	Surrogate Monobromobiphenyl

B.4.8 Content of File. **ESARPA.DBF:**

ESARPA.DBF contains the results of analyses for Polycyclic Aromatic Hydrocarbons (PAHs). The parameters included in the PA test set are included in the following order:

No.	<par>	Parameter name
1	NAA	Naphthalene
2	ACY	Acenaphthylene
3	ACE	Acenaphthene
4	FL	Fluorene
5	PHR	Phenanthrene
6	AN	Anthracene

7	FLE	Fluoranthene
8	PY	Pyrene
9	AN_A	Benzo (a) anthracene
10	CH	Chrysene
11	FLE_B	Benzo (b) fluoranthene
12	FLE_K	Benzo (k) fluoranthene
13	FLE_BK	Benzo (b/k) fluoranthene
14	PY_A	Benzo (a) pyrene
15	PY_E	Benzo (e) pyrene
16	PY_I	Indeno (1,2,3-c,d) pyrene
17	AN_AH	Dibenzo (a,h) anthracene
18	PE	Perylene
19	PE_GHI	Benzo (g,h,i) perylene
20	NAA1	C1 naphthalene
21	NAA2	C2 naphthalene
22	NAA3	C3 naphthalene
23	NAA4	C4 naphthalene
24	NAA5	C5 naphthalene
25	PHR_AN1	C1 phenanthrenes, anthracenes
26	PHR_AN2	C2 phenanthrenes, anthracenes
27	PHR_AN3	C3 phenanthrenes, anthracenes
28	PHR_AN4	C4 phenanthrenes, anthracenes
29	PHR_AN5	C5 phenanthrenes, anthracenes
30	RE	Retene
31	FLE_PY1	C1 fluoranthenes, pyrenes
32	FLE_PY2	C2 fluoranthenes, pyrenes
33	FLE_PY3	C3 fluoranthenes, pyrenes
34	FLE_PY4	C4 fluoranthenes, pyrenes
35	FLE_PY5	C5 fluoranthenes, pyrenes
36	TH_XX	Dibenzothiophene
37	TH_XX1	C1 Dibenzothiophene
38	TH_XX2	C2 Dibenzothiophene
39	PAH_ALL	Total for all PAHs
40	S_NAA	Surrogate Naphthalene d-5
41	S_ACE	Surrogate Acenaphthene d-10
42	S_PHR	Surrogate Phenanthrene d-10
43	S_PY	Surrogate Pyrene d-10
44	S_CH	Surrogate Chrysene d-12
45	S_PY_A	Surrogate Benzo(a)pyrene d-12
46	S_PE	Surrogate Perylene d-12
47	S_AN_AH	Surrogate Dibenz(ah)anthracene d-14
48	S_PE_GHI	Surrogate Benzo(ghi)perylene d-12
49	S_NAA_2M	Surrogate 2-Methylnaphthalene d-10
50	S_BR1PHY	Surrogate Monobromobiphenyl

B.4.9 Content of File. **ESARPCn.DBF:**

ESARPCn.DBF contains the results of analyses for polychlorinated biphenyls (PCBs), where n is a sequence number (1 to 3). Due to the number of parameters in the PC test set the dBASEIV specification of 255 fields is exceeded; the parameters have been partitioned into three files. The parameters included in each PC file are identified in the following subsections.

B.4.9.1 Content of File, **ESARPC1.DBF**:

ESARPC1.DBF contains the PC results for PCB congeners with IUPAC numbers up to and including PCB 101. The order of the parameters are;

N	<par>	Parameter name
1	PB5_8	PCB 5/8
2	PB15	PCB 15
3	PB16_32	PCB 16/32
4	PB17	PCB 17
5	PB18	PCB 18
6	PB19	PCB 19
7	PB22	PCB 22
8	PB24_27	PCB 24/27
9	PB25	PCB 25
10	PB26	PCB 26
11	PB28	PCB 28
12	PB28_31	PCB 28/31
13	PB31	PCB 31
14	PB33	PCB 33
15	PB40	PCB 40
16	PB41ET	PCB 41/64/71
17	PB42	PCB 42
18	PB44	PCB 44
19	PB45	PCB 45
20	PB46	PCB 46
21	PB47_48	PCB 47/48
22	PB49	PCB 49
23	PB52	PCB 52
24	PB54	PCB 54
25	PB56_60	PCB 56/60
26	PB60	PCB 60
27	PB66	PCB 66
28	PB66_95	PCB 66/95
29	PB70_76	PCB 70/76
30	PB74	PCB 74
31	PB77	PCB 77

32	PB83	PCB 83
33	PB84	PCB 84
34	PB84_89	PCB 84/89
35	PB85	PCB 85
36	PB86	PCB 86
37	PB87	PCB 87
38	PB89	PCB 89
39	PB90_101	PCB 90/101
40	PB91	PCB 91
41	PB95	PCB 95
42	PB97	PCB 97
43	PB99	PCB 99
44	PB101	PCB 101

B.4.9.2 Content of File, **ESARPC2.DBF**:

ESARPC2.DBF contains the PC results for PCB congeners with IUPAC numbers from PCB 103 to PCB 189 inclusive. The order of the parameters are;

N	**<par>**	**Parameter name**
1	PB103	PCB 103
2	PB105	PCB 105
3	PB107	PCB 107
4	PB110	PCB 110
5	PB114	PCB 114
6	PB118	PCB 118
7	PB121	PCB 121
8	PB128	PCB 128
9	PB129	PCB 129
10	PB130	PCB 130
11	PB131	PCB 131
12	PB134	PCB 134
13	PB135_144	PCB 135/144
14	PB136	PCB 136
15	PB137	PCB 137
16	PB138	PCB 138
17	PB138ET	PCB 138/163/164
18	PB141	PCB 141
19	PB143	PCB 143
20	PB146	PCB 146
21	PB149	PCB 149
22	PB151	PCB 151
23	PB153	PCB 153
24	PB154	PCB 154
25	PB156	PCB 156
26	PB157	PCB 157

27	PB158	PCB 158
28	PB159	PCB 159
29	PB170	PCB 170
30	PB170_190	PCB 170/190
31	PB171_202	PCB 171/202
32	PB171	PCB 171
33	PB172	PCB 172
34	PB173	PCB 173
35	PB174	PCB 174
36	PB175	PCB 175
37	PB176	PCB 176
38	PB177	PCB 177
39	PB178	PCB 178
40	PB179	PCB 179
41	PB180	PCB 180
42	PB182	PCB 182
43	PB182_187	PCB 182/187
44	PB183	PCB 183
45	PB185	PCB 185
46	PB187	PCB 187
47	PB189	PCB 189

B.4.9.3 Content of File, **ESARPC3.DBF**:

ESARPC3.DBF contains the PC results for PCB congeners with IUPAC numbers from PCB 191 to PCB 209 inclusive, as well as the three PCB coplanars and all related surrogates. The order of the parameters are;

N	**<par>**	**Parameter name**
1	PB191	PCB 191
2	PB193	PCB 193
3	PB194	PCB 194
4	PB195	PCB 195
5	PB195_208	PCB 195/208
6	PB196	PCB 196
7	PB196_203	PCB 196/203
8	PB197	PCB 197
9	PB198	PCB 198
10	PB199	PCB 199
11	PB201	PCB 201
12	PB202	PCB 202
13	PB203	PCB 203
14	PB205	PCB 205
15	PB206	PCB 206
16	PB207	PCB 207
17	PB208	PCB 208

18	PB209	PCB 209
19	PBTOT	PCB Total
20	PB77	PCB 77
21	PB126	PCB 126
22	PB169	PCB 169
23	S_PB77	Surrogate 13C12-PCB 77
24	S_PB126	Surrogate 13C12-PCB 126
25	S_PB169	Surrogate 13C12-PCB 169
26	S_BR1PHY	Surrogate Monobromobiphenyl
27	S_CL8NAA	Surrogate Octachloronaphthalene

B.4.10 Content of File, **ESARPS.DBF**:

ESARPS.DBF contains the results of particle size (PS) analysis on sediment as reported by the National Water Research Institute (NWRI). Some identifying fields for the subsamples are included in the file as reported; the meanings are self-evident. For the parameters, the value and the significant digits are contained in the file; the parameters for the PS test set are included in the following order:

No.	**<par>**	**Parameter name**
1	SAMPLE_WEI	sample weight (gm)
2	MEAN_SAMPL	mean sample volume (cm**3)
3	MEAN_DENSI	mean density (gm/cm**3)
4	SPECIFIC_V	mean specific volume (cm**3/gm)
5	_GRAVEL	percent gravel
6	_SAND	percent sand
7	_SILT	percent silt
8	_CLAY	percent clay
9	FOLK_LABEL	Folk label
10	SHEPPARD_L	Shepard label

B.4.11 Content of File, **ESARRA.DBF**:

ESARRA.DBF contains the results of analyses for Resin acids (RA). The parameters included in the RA test set are included in the following order:

No.	**<par>**	**Parameter name**
1	PIM	Pimaric Acid
2	PIM_SCO	Sandaracopimaric Acid
3	PIM_IS	Isopimaric Acid
4	PIM_DIS	Dehydroisopimaric Acid
5	PAL	Palustric Acid
6	ABI	Abietic Acid
7	ABI_NEO	Neoabietic Acid
8	ABI_D	Dehydroabietic Acid
9	ABI_CD01	12-Chlorodehydroabietic Acid

10	ABI_CD02	14-Chlorodehydroabietic Acid
11	ABI_CD03	12/14 Chlorodehydroabietic Acid
12	ABI_DD01	12,14 Dichlorodehydroabietic Acid
13	S_CAR_OMP	Surrogate o-Methyl Podocarpic Acid
14	LIPIDRA	Lipid content
15	MOISTRA	Moisture content

B.4.12 Content of File. **ESARRN.DBF:**

ESARRN.DBF contains the results of analyses for radionuclide (RN). Smithson (1993) [nn] reported radioisotopes for fish collected from traditional winter harvest sites at the west end of Lake Athabasca. Bourbonniere, Telford and Kemper (1996) [nn] reported radioisotopes for sediment cores taken from Lake Athabasca, including measures taken to determine geochronology. The parameters contained in this file do not have a <par>_D field, but do have a <par>_M field; the parameters for the RN test set are included in the following order:

No.	**<par>**	**Parameter name**
1	PO210	Polonium-210
2	PB210	Lead-210
3	RA226	Radium-226
4	TH228	Thorium-228
5	TH230	Thorium-230
6	TH232	Thorium-232
7	U	Uranium
8	CS137	Cesium-137
9	RA224	Radium-224

B.4.13 Content of File. **ESARSH.DBF:**

ESARSH.DBF contains the results of analyses for steroid hormones (SH) and gonad morphology on fish by the Department of Fisheries and Oceans, Freshwater Institute. Brown, Evans, Vandenbyllaardt and Bordeleau (1993) [mm] reported these measures on fish taken from the reach specific study sites on the Upper Athabasca River in spring and fall, 1992. Some identifying fields for the subsamples are included in the file as reported; the meanings are self-evident. For the parameters, the value and the significant digits are contained in the file; the parameters for the SH test set are included in the following order:

No.	**<par>**	**Parameter name**
1	GONAD__G_	gonad weight (gm)
2	GSI	gonadosomatic index (%)
3	E2	plasma 17B-estradiol (ng/ml)
4	TEST	plasma testosterone (ng/ml)
5	KTEST	plasma ketotestosterone (ng/ml)
6	EGGWT	clutch egg weight (mg)

7	EGGD	clutch egg diameter (um)
8	CLUTCH	amount clutch (%)
9	ABFEC	absolute fecundity (# eggs)
10	RLFEC	relative fecundity (# eggs/gm)
11	MI	maturity index

B.4.14 Content of File. **ESARSI.DBF**:

ESARSI.DBF contains the results of analyses for stable isotopes (SI) on fish, benthos and sediment by the Department of Fisheries and Oceans, Freshwater Institute. Hesslein and Ramlal (1993) [mm] and Hesslein (1996) [mm] reported stable isotopes of sulfur, carbon and nitrogen. Some identifying fields for the subsamples are included in the file as reported; the meanings are self-evident. For the parameters, the value and the significant digits are contained in the file; the parameters for the SI test set are included in the following order:

No.	**<par>**	**Parameter name**
1	D34S	stable isotope of sulfur (%.)
2	D13C	stable isotope of carbon (%.)
3	D15N	stable isotope of nitrogen (%.)

B.4.15 Content of File. **ESARSO.DBF**:

ESARSO.DBF was planned to contain the results of analysis for streambed oxygen demand (SOD). This file has not been implemented.

B.4.16 Content of File. **ESARTC.DBF**:

ESARTC.DBF contains the results of analyses for organic, inorganic and total carbon (TC) on sediment by the National Water Research Institute. Some identifying fields for the subsamples are included in the file as reported; the meanings are self-evident. For the parameters, the value and the significant digits are contained in the file; the parameters for the SI test set are included in the following order:

No.	**<par>**	**Parameter name**
1	ORG	organic carbon (%)
2	INORG	inorganic carbon (%)
3	TOTAL	total carbon (%)

B.4.17 Content of File. **ESARTE.DBF**:

ESARTE.DBF was planned to contains the results of analyses for taxonomic enumerations (TE). This file has not been implemented.

B.4.18 Content of File. **ESARWC.DBF:**

ESARWC.DBF contains the results of analyses for basic Water Chemistry (WC) parameters. The parameters included in the WC test set are included in the following order:

No.	<par>	Parameter name (units)
1	ALK_PP	pp Alkalinity (mg/l)
2	ALK_T	Total Alkalinity (mg/l)
3	C_ORG_D	Dissolved Organic Carbon, DOC (mg/l)
4	C_ORG_T	Total Organic Carbon, TOC (mg/l)
5	CA	Calcium (mg/l)
6	CL_IDE	Chloride (mg/l)
7	CO3	Carbonate (mg/l)
8	CO3_BI	Bicarbonate (mg/l)
9	COLOUR	True Colour (units)
10	COND_SP	Specific Conductance (umhos/cm)
11	COND_TY	Conductivity (umho)
12	F_IDE	Fluoride (mg/l)
13	FE	Iron (mg/l)
14	HARD_T	Total Hardness (mg/l)
15	K	Potassium (mg/l)
16	MG	Magnesium (mg/l)
17	MN	Manganese (mg/l)
18	N_KJ_T	Total Kjeldahl Nitrogen (mg/l)
19	N_KJ_D	Dissolved Kjeldahl Nitrogen (mg/l)
20	N_NH3	Ammonia Nitrogen (mg/l)
21	N_NO2	Nitrite Nitrogen (mg/l)
22	N_NO3	Nitrate Nitrogen (mg/l)
23	N_NO23	Nitrite + Nitrate Nitrogen (mg/l)
24	NA	Sodium (mg/l)
25	OH	Hydroxide (mg/l)
26	P_D_T	Total Dissolved Phosphorus (mg/l)
26	PH	pH (units)
27	PHENOL	Phenols (mg/l)
28	PO4_O_D	Dissolved Orthophosphate (mg/l)
29	PO4_D	Dissolved Phosphate (mg/l)
30	PO4_T	Total Phosphate (mg/l)
31	SIL_R	Silica, Reactive (mg/l)
32	SO4	Sulphate (mg/l)
33	SOL_D_T	Total Dissolved Solids, TDS (mg/l)
34	SOL_S_T	Total Suspended Solids, TSS (mg/l)
35	TURB	Turbidity (NTU)
36	ZN	Zinc (mg/l)

B.5 SOME EXAMPLE RETRIEVALS

This section describes the process followed in one example case to retrieve data from the database to provide displays useful to NRBS operations. The database was purposively constrained to a documented set of .DBF files; the expectation was that individuals familiar with dBASEIV or other compatible database management packages would be able to easily extract the data in the form wanted.

B.5.1 GIS Theme File:

This retrieval was developed to provide a basic identification of samples or subsamples for mapping using the GIS. It represents the set of fields that essentially describe the original sample or subsample. Most of the fields are selected from the ESIDSAMP file. Linking with the ESIDSITE file is required to obtain geographical descriptors as well as the latitude and longitude values that the GIS uses to display the point. In addition, linking is required to the sample detail file (ESIDaaaa, where aaaa is the sample media) to obtain the date collected and other details.

Several GIS theme files were prepared for use in the NRBS paper atlas and in the electronic atlas. These files are provided on the disk in the back of this report.

B.5.1.1 Inventory of Original Samples;

A file is provided for the original samples collected from each media. Basic identifying information is included plus index fields to show if a subsample had been analysed for any of the contaminant test sets (CP, DF, ME, OC, PA, PC, RA). These files comprise;

a. ESXYLIQD.DBF; for mapping liquid samples.
b. ESXYSEDI.DBF; for mapping sediment samples.
c. ESXYBENT.DBF; for mapping benthic samples.
d. ESXYFISH.DBF; for mapping fish captured for analysis.
e. ESXYMAMM.DBF; for mapping mammals.
f. ESXYBIRD.DBF; for mapping birds captured for analysis.

The maps in the RESULTS section of this project report were made using these files.

B.5.1.2 Mapping Analytical Results;

Four files were prepared to accommodate mapping of actual detected levels of contaminants. The identifying information in the file is for the subsample analysed; linking was used to include geographical data and date collected as well as measured values for selected parameters from the ESAR@@ file. These files comprise;

a. ESXYME.DBF; for mapping all metals concentrations.
b. ESXYTX.DBF; for mapping toxaphene concentrations.
c. ESXY2378.DBF; for mapping TCDD and TCDF concentrations.

B.6 INSTALLING THE DATABASE

The database of environmental samples is provided on a disk bound in a plastic sleeve as the last page in this report.

The disk contains three files, using 1,078,583 bytes.

1. INSTALL.BAT; being 72 bytes in size.
2. DISCLAIM.TXT; being 493 bytes in size.
3. ESDB.EXE; being 1,078,018 bytes in size.

To install the database, copy the three files on this disk to a directory on your hard drive and type install. The result will be 43 files totalling 17,199,991 bytes. To use these files requires familiarity with dBASE IV and MS-DOS.

APPENDIX C: LEGACY LOCATIONS FOR PRINTED ANALYTICAL RESULTS

The analytical results reported in printed form by the laboratories were bound separately and placed in two locations where they may be viewed by the public.

1. Alberta Environmental Protection
   Environmental Assessment Division
   6th Floor, Oxbridge Place, 9820 106 St.
   EDMONTON AB T5K 2J6

   Contact: Earle Baddaloo
   phone: 403-427-6102
   fax: 403-422-9714

2. Environment Canada
   Prairie and Northern Region
   Environmental Conservation Branch
   Room 300, Park Plaza, 2365 Albert St.
   REGINA SK S4P 4K1

   Contact: Bill Gummer
   phone: 306-780-5322
   fax: 306-780-7614