FRASER RIVER ACTION PLAN

REVIEW OF INFORMATION ON THE OCCURRENCE OF CHEMICAL CONTAMINANTS IN THE AQUATIC ENVIRONMENT OF THE FRASER RIVER BASIN

Results Summary

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REVIEW OF INFORMATION ON THE OCCURRENCE OF CHEMICAL CONTAMINANTS AND CONDITIONS OF ENVIRONMENTAL DEGRADATION IN THE AQUATIC ENVIRONMENT OF THE FRASER RIVER BASIN

Results Summary

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Disclaimer

This publication and the accompanying map atlas contain the results of a project conducted under contract to Environment Canada and Fisheries and Oceans Canada. Opinions and critique offered herein do not necessarily reflect the opinions of either agency.

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The electronic version of the summary document (in WordPerfect 5.1) and accompanying geo-referenced database (roughly 20 megabytes in DBASE V) format are available by special arrangement. For details, contact Patrick Shaw, Environment Canada.

This project was initiated in 1994, with expected completion at the end of the that year. Difficulties with both the Environment Canada (ENVIRODAT) and B.C. Ministry of Environment (SEAM) databases in conjunction with other unrelated problems slowed progress for a full year. In the interim, independent of the outcome of this work, both agencies have done or are in the process of a complete restructuring of their respective data storage systems. As such, much of the critique presented herein is outdated and does not reflect the picture at the present time with respect to data access.

The data summary and presentation is, however, the first synoptic display and evaluation of contaminants in the Fraser River Basin. Future effort in this regard should be greatly simplified by the current changes in ENVIRODAT and SEAM.

EXECUTIVE SUMMARY

A database of observations of contaminant and environmental quality data for the aquatic environment within the Fraser Basin was developed and loaded into the ARC/INFO Geographic Information System (GIS). The study compiled available data from published, unpublished and electronic sources since 1986. The two major data sources were the BC Ministry of Environment, Lands and Parks' (BC MoELP) System for Environmental Assessment and Management (SEAM) database and Environment Canada's ENVIRODAT database. Limitations in both the SEAM and ENVIRODAT databases were impediments and resulted in a much higher level of effort than would commonly be expected. The utility of these data is also limited by the design (structure) of these databases. As a consequence of this, study effort was reallocated from proposed data analysis to increase the data compilation level of effort. Data compilation was terminated by level of effort and time constraints. Nonetheless, the final database is considered to contain the vast majority of the available data.

The vast majority of the data compiled are water quality observations. The database contains very little or no data for six of the Department of Fisheries and Oceans' (DFO's) Habitat Management Areas (HMAs) representing approximately 33% of the area of the Fraser Basin. These HMAs are the Stuart/Takla, West Road, Chilcotin, Seton/Bridge, Harrison and Quesnel. There are significant gaps in both spatial and temporal coverage.

Data were screened for anomalous values and outliers and converted to standard formats. Descriptive statistics were computed for all parameters and media sampled. Data for parameters were examined relative to environmental quality guidelines and criteria. Maps showing distributions of individual parameters observed were produced for all parameters with more than 25 observations above detection limits. Indices were developed for classes of parameters (such as metals in water) where practical. The individual parameter maps and index maps illustrate "hot spots" and patterns of contamination and degradation to the extent possible from the database. Some effort was directed towards investigation of correlations between selected parameters (*e.g.*, between metals and between metals and suspended sediment) and to investigate trends over time. No significant correlations or trends were observed.

The main conclusions and recommendations of this study are: (1) a wake-up call to the agencies involved in collection of environmental monitoring data in the Fraser Basin regarding the lack of adequate data coverage over the past 10 years; and, (2) the critical need for substantial revisions to existing data management systems for such data.

RÉSUMÉ POUR LA DIRECTION

Une base de données renfermant des observations sur les contaminants et la qualité de l'environnement dans l'habitat aquatique du bassin du Fraser a été constituée et versée dans le Système d'information géographique (SIG) ARC/INFO. L'étude a permis de colliger les données d'ouvrages publiés ou inédits et de sources électroniques remontant à l'année 1986. La base de données du Système de gestion et d'évaluation environnementales (SGÉE) du ministère de l'Environnement, des Terres et des Parcs de la Colombie-Britannique et la base de données ENVIRODAT d'Environnement Canada représentent les deux principales sources de données. Les limites inhérentes aux bases de données SGÉE et ENVIRODAT ont soulevé des problèmes et exigé des auteurs de l'étude beaucoup plus de travail qu'il n'aurait fallu en temps ordinaire. De plus, la conception (structure) des deux bases de données limitait également l'utilité des données. Il s'ensuit qu'il a fallu réaffecter à la compilation des données une partie des efforts que l'on proposait de consacrer à leur analyse. Le travail de compilation a été subordonné au niveau des ressources disponibles et aux délais impartis. Néanmoins, on estime que la base de données définitive renferme la majorité des données disponibles.

La plupart des données rassemblées sont des observations sur la qualité de l'eau. La base de données renferme peu d'information, sinon aucune, sur les six zones de gestion de l'habitat de Pêches et Océans Canada, qui comptent pour environ 33 p. 100 du territoire du bassin du Fraser, à savoir les zones Stuart/Takla, West Road, Chilcotin, Seton/Bridge, Harrison et Quesnel. L'information contenue dans la base de données présente des déficiences d'ordre spatial et temporel.

Les données ont été vérifiées pour écarter les incohérences et les valeurs aberrantes, puis converties sous une forme standard. Des statistiques descriptives ont été établies à l'égard de tous les paramètres et de tous les éléments échantillonnés. Les données sur les paramètres ont ensuite été comparées aux lignes directrices et aux critères sur la qualité de l'environnement. On a dressé des cartes montrant la répartition de chacun des paramètres relevés qui ont donné lieu à plus de 25 observations au dessus du seuil de détection. Lorsque c'était possible, des index ont été établis pour des classes de paramètres (p. ex. les métaux présents dans l'eau). Dans la mesure du possible, les cartes index illustrent les * points chauds + et les tendances de contamination et de dégradation dégagées de la base de données. Les auteurs de l'étude ont également examiné les corrélations entre certains paramètres choisis (p. ex. entre différents métaux, ou entre des métaux et des sédiments en suspension) et ont tenté de dégager des tendances. Aucune tendance ni corrélation marquée n'a été relevée.

Voici les principales conclusions et recommandations de l'étude :(1) il convient d'alerter les organismes chargés de la collecte des données de surveillance environnementale dans le bassin du Fraser au fait que les données réunies au cours des dix dernières années sont lacunaires et (2) il faut réviser en profondeur les systèmes actuels de gestion des données.

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1.0 INTRODUCTION

The Fraser River Basin supports significant natural resources, a large proportion of BC's population, and a variety of natural resource based industries. The resources of the Basin, particularly salmon, are under pressure from a variety of sources. For example, the population of the lower mainland is expected to grow dramatically over then next 20 years with resulting urban pressure and impacts on the Fraser Basin. Forestry, agriculture, mining, utilities and transportation industries also contribute to environmental concerns. There is ample evidence of contaminants and contaminant effects at various locations in the Fraser Basin.

From its headwaters the Fraser River flows some 1,375 km to its delta in the southern Strait of Georgia. Its drainage basin is very large encompassing more than one-quarter of British Columbia's land mass and a small portion of Northern Washington State. The Fraser Basin includes a diversity of habitats and supports abundant fish, birds and wildlife. In particular, it supports about 66% of BC's sockeye and 60% of BC's pink salmon harvests. Millions of waterfowl use its estuary as feeding and staging grounds for their annual migrations.

The Fraser Basin is also home for about two million people, approximately 60% of BC's population. It includes about 44% of the province's farmland and its natural resources and industries account for about 80% of the province's economic production. The various human activities in the Basin introduce contaminants and pollutants of various types. The Fraser River Action Plan (FRAP) has compiled a comprehensive database of point sources in the Basin. This inventory shows that municipal wastewater discharges are a significant input to the Fraser River (the Greater Vancouver Regional District accounts for 41% of the wastewater released to the lower Fraser River). In addition to urban contributions specific activities such as farming, mining, placer mining, pulp and paper mills, saw mills and lumber yards also contribute contaminants. Various studies have demonstrated the presence and effects of contaminants in the Fraser Basin including contamination of groundwater and lakes (FRAP 1994).

The Environmental Quality Component of the FRAP is mandated to determine the present environmental quality in the Fraser River Basin and assess environmental change in response to pollution abatement efforts. To support these efforts, this study was initiated to prepare a comprehensive basin-wide review of available information on the occurrence of contaminants and conditions of environmental degradation in the receiving aquatic environment.

2.0 SCOPE OF STUDY

The Fraser Basin study area consists of a series of major drainage systems all of which flow to the mainstem Fraser River and ultimately into the Southern Strait of Georgia. Fifteen major sub-basins have been designated as DFO management units, Habitat Management Areas (HMAs), which provide a convenient tool for sustainable development planning (see Figure 1 based on Langer *et al.* 1992). It is noted that portions of the Fraser Delta HMA drain either to Burrard Inlet or Boundary Bay and do not drain to the Fraser River.

The scope of this study is limited to the aquatic receiving environment and does not include effluents, marine water, groundwater, well water, waterfowl or terrestrial wildlife and vegetation. The study does include surface waters, estuary waters, suspended and bottom sediments and resident and anadromous fish, aquatic invertebrates and aquatic plants.

The study scope includes all available data, published and unpublished. Initially, the study scope was restricted to 1985 to 1994 for contaminants and to 1990 to 1994 for nutrients. Subsequently, because of limited data coverage, it was decided to expand the study to the period from 1986 to 1994 for nutrients and from 1980 to 1994 for all other parameters.

Lastly, at the outset it was recognized that it would be impractical to compile all available data simply due to level of effort constraints. Therefore, an approach was adopted which gave initial priority to larger electronic data sources and which progressively moved to conventional paper data sources. No special emphasis was given to any group of contaminants or location.

3.0 DATA COMPILATION

The following section provides a description of the data compilation effort and summarizes the data sources examined and data compiled.

Data were compiled using Foxpro version 2.6 database management software and ARC/INFO version 3.4.1 Geographic Information System (GIS) software. Geographic coordinate information was captured at the resolution of the data source wherever possible. Where compilation onto hard copy maps was required, current versions of 1:250,000 National Topographic Series (NTS) maps were used and then digitized. Information captured from figures was entered directly into the GIS relative to digital copies of the 1:250,000 NTS maps. These digital 1:250,000 maps and a digital version of the HMA boundaries were provided by Fisheries and Oceans in Autocad DXF (data exchange) format and then imported into ARC/INFO. The resolution of the digitizing table used for data capture was 0.005" and digitizing was performed with an acceptance criterion of Root Mean Square (RMS) error less than 0.008" at scale. Conversion from North American Datum 1927 (NAD27) to North American Datum 1983 (NAD83) was performed using the National Transformation algorithm, where required.

3.1 BC Environment's SEAM Database

The first step in the data compilation effort was to obtain a copy of BC Environment's System for Environmental Assessment and Management (SEAM) database. This was based on the understanding that virtually all of BC Environment's monitoring data are stored in SEAM and that the Province is likely the largest originator of relevant data. Unfortunately, SEAM has some limitations and it was not simple to request data from SEAM for the Fraser Basin. Instead we obtained an ASCII copy of SEAM data for:

- Estuaries data (Type = '07') for all regions except Kootenay and Vancouver Island;

- Lakes and ponds data (Type = '13') for all regions except Kootenay and Vancouver Island; and,

- Rivers, creeks and streams data (Type = '21') all regions except Kootenay and Vancouver Island.

Initially this involved 786,381 observations at 93,808 stations involving 16,274 sites. For the purposes of this study, a "site" is a unique geographic location. A "station" represents the sampling of one medium (water, sediment, *etc.*) at a site on a specific data and time by a specific agency. It should be noted that in this context, samples of different fish species, including samples of different tissues from the same fish, are considered to be different stations. Also, replicate samples are coded as different stations with identical information except the station identifier. Lastly, an "observation" is the value observed for a single parameter at a station.

The process of identification of sites within the Fraser Basin proved to be a major obstacle. While SEAM *can* store geographic coordinates, hierarchical watershed codes and the NTS map sheet number, 11,824 of these 16,274 (73%) SEAM sites had no coordinate information. 11,414 SEAM sites (70%) had no NTS map sheet number and 13,670 sites (84%) had no watershed codes. Headquarters requires completion of a site form which includes either coordinates or a location map when a new SEAM site is established or an existing site changes location. In early years of the program, site coordinates were captured by digitizing. However, headquarters stopped digitizing in 1990 due to budget constraints.

It was possible to eliminate many of the sites because only samples coded as "waste water" had been collected there. Sites were also eliminated based on NTS map sheet number, by geographic coordinates and by watershed code. Additional sites were then eliminated by matching waterbody names occurring in the site descriptions against the Gazetteer of Canada for British Columbia and eliminating those which unambiguously could not be within the Basin. The next step was to obtain access to headquarters' records of site forms and maps. Unfortunately, a limited number of site forms and maps were still on file at headquarters, the remainder had been archived off site. Efforts to retrieve the archived information were unsuccessful. Coordinates were captured by digitizing for the sites where information was available. A short listing of sites lacking location information was then developed and forwarded to contacts at BC Environment regional offices and headquarters branches. Even though this process was terminated due to time constraints, it was possible to either eliminate or obtain coordinate information for most of the SEAM sites, leaving 355 sites without coordinate information that *potentially* may be within the Fraser Basin.

After extraction of data prior to 1980, data for samples coded as "wastewater", data for parameters not relevant to the study, data from outside the study area and data for which geographic coordinates could not be obtained, this left a total of 172,957 observations at 19,812 stations involving 1,589 sites. In summary, approximately 78% of the observations and stations and 90% of the SEAM sites received in the original download from SEAM were eliminated from the final database.

It is appropriate to make some general comments regarding SEAM. It was determined that the vast majority, but not all of the data collected by BC Environment are stored within SEAM. Two notable exceptions are 1992 Fraser Estuary sediment monitoring data (Swain and Walton, 1993) and Thompson River fish organochlorine body burden data (Van Oostdam, 1991). Body burden data were coded as either "biota, fish" or "biota, other" without supporting information such as species or tissue analyzed. Also, there was some concern regarding accuracy of the geographic coordinates in SEAM. Apparently, some of the coordinate information was collected recently by field staff using Global Positioning System (GPS) receivers. Whereas, other coordinates have been estimated from maps of 1:250,000 scale or smaller. There was no ability to identify the source of this coordinate information. Lastly, some sites have changed location without changing their site identifier. Information on the previous location and/or date when the change occurred is not stored in the database, and where this information had been archived it could not be retrieved.

3.2 Environment Canada's ENVIRODAT Database

Data from (1979 to present) were obtained from Environment Canada's ENVIRODAT database as a series of ASCII (American Standard for Computer Information Interchange) tables which were the results of specific queries. The only data available from ENVIRODAT for this period were water and liquid effluent monitoring data. There were no data for bottom or suspended sediment, fish or other biota.

Initially this data set involved 145,471 observations at 28,496 stations involving 351 sites. Eleven (11) of the sites were already contained in SEAM and were eliminated to avoid duplication. Thirty-two (32) sites had no coordinate information, while 2 had latitude coordinates but no longitude coordinates. Also, 16 sites had inappropriate coordinate resolution: 1 to the nearest degree and 15 to the nearest minute. Because of time constraints it was not possible to obtain locations for the ENVIRODAT sites lacking adequate coordinate information. Therefore, these sites (35 sites) were eliminated from the database. Of the sites which had coordinate information only 9 were outside the Fraser Basin. These were also eliminated. Based on the site descriptions the majority of the ENVIRODAT sites were effluent sampling locations. Only 10 of the remaining sites were water monitoring stations.

After removing data from outside the study area, data without adequate coordinate information and data for effluents, a total of 57,030 observations at 2,363 stations involving 10 sites remained. In summary, approximately 61% of the observations, 92% of the stations and 97% of the sites received in the original download from ENVIRODAT were eliminated from the final database.

It is appropriate to make some general comments regarding ENVIRODAT. The version of the ENVIRODAT database software maintained by the Pacific Region of Environment Canada is not as current as versions operated by other regions. There appears to be a general expectation within Environment Canada regional staff that the database is of high quality and more comprehensive than it is. However, it appears that the scope of the database is limited and that it contains anomalies and incomplete information that has been carried forward from previous versions of the database. 735 station records had missing dates of sampling. The database documents that the letter "Q" is used as a "flag" to mark questionable data, however, the letters "X" and "B" were also employed and not documented to identify questionable data. There are 263 instances of "X" flags which mark metal results which Environment Canada Laboratory staff suspect were contaminated and 161 instances of "B" flags which mark pH results which were measured with an instrument which was believed to be reporting values that were too low (Dunkley, pers. comm.). In addition to the above, there are a few instances of "sample numbers" which include ASCII characters which are not alphanumeric. Lastly, as with the SEAM database there is no information regarding the source and reliability of the site coordinate information in the database.

The data compilation process demonstrated some significant limitations of current management of environmental quality data. The most significant limitation of both the SEAM and ENVIRODAT databases is inadequate management of site location information. Generally, the site description information is not adequate to determine the site location. Where descriptions do provide relatively precise location information, such as "Eagle River at Cambie Bridge", there is excessive effort involved in obtaining adequate road maps or other maps and digitizing coordinates. Where geographic coordinates were provided, their accuracy was suspect because of the lack of information on source and whether coordinates are relative to North American Datum 1927 (NAD27) or 1983 (NAD83). Positional errors may be up to 200 m. Errors up to a kilometre may occur in extreme cases. For situations where no coordinate information is available and the site description does not specify a clear location, such as SEAM site: E206831 "#9 Surface Water", the data are effectively useless for mapping.

3.3 CODIS Database

The Continental and Oceanographic Data Information System (CODIS) contains summary information about organic sampling within the Fraser Basin (Fyles *et al*. 1993). This information includes bibliographic information; locations, dates and media sampled; lists of parameters measured; and information describing methodology and data quality. However, the database does not store the actual data. The intended purpose of CODIS is to aid in identification of data sets of interest for a specific purpose.

The CODIS database was examined. First, all data prior to 1986 and all SEAM stations were discarded. The remaining station data were plotted. A large proportion of the stations were located in the lower mainland. However, the SEAM and ENVIRODAT databases had already contributed a large number of stations in the lower mainland. Because there was already an abundance of data for the lower mainland and a lack of coverage in other areas, a decision was made to give low priority to compilation of further data from the lower mainland. The stations in the northern portion of the study area (everything but the lower mainland) were selected using the GIS and a list of the corresponding data sets was compiled. Data sets involving only wastewater or analyses of milk were then discarded. The resulting list of data sets is given below:

19865011A-C	19875018	19895013	19905010
19865035	19885023A-G	19905003A-G	19905011B,C
19875014A,B	19885024A-G	19905008	19915004
19875017	19895008	19905009A,C	19915005B

There were 143 stations and 12 source documents associated with these 16 data sets. The University of Victoria Organic Indicators Group (the developer of CODIS) was contacted to arrange access to the source documents for these data sets. However, they only have copies of those portions of the documentation that were included in CODIS. They do not provide a repository of the actual data. Therefore, it was necessary to pursue copies of the data through conventional sources.

3.4 Literature Review and Direct Contacts

After assembly of the electronic data sets it became apparent that there were large data gaps in spatial coverage and regarding specific data sets of interest. Some HMAs had virtually no observations of contaminants. It was considered that a significant number of important data sets had not been obtained and that it was important to pursue these. Therefore, it was decided to reallocate effort from potential analysis of the database and to redirect this towards additional data compilation effort.

The study team developed a list of references and data sources from (1) a detailed review of the 1992 and 1994 Fraser Basin bibliographies (Missler, 1992; 1994); (2) the data sets identified from CODIS (see Section 3.3, above); (3) a reference list presented in the Statement of Work for the study; (4) researcher and agency contacts suggested by the Scientific Authority; (5) computer search of relevant library holdings; and, (6) direct contacts with consulting firms who may potentially have collected relevant data. References and other data sources were then pursued through direct contact with the senior author or agency and through the libraries at Environment Canada Pacific Region, Fisheries and Oceans Pacific region Headquarters, Institute of Ocean Sciences, Pacific Biological Station, BC Environment Victoria, University of Victoria and University of British Columbia.

Through this search process, an additional 12 data sources were compiled and loaded into the database. These include data from Pitt River, Quesnel, Clearwater and Spius hatcheries, and various reports: Dwernychuk (1990), Dwernychuk *et al.* (1991), Dwernychuk *et al.* (1993), Mah *et al.* (1989), R.L.&L. Environmental Services Ltd. (1992), Swain and Walton (1993a), Tuominen and Sekela (1992) and Van Oostdam (1991).

4.0 METHODS

4.1 Data Screening and Standardization

Following completion of data compilation, units of measure and parameter coding were standardized. A parameter and unit coding system was developed which was based on the SEAM coding system. Site data was then assigned to HMAs using the GIS and the digital HMA boundary data provided by DFO. Invalid dates for data obtained from ENVIRODAT were assigned to year (but not month) based on ENVIRODAT station identifiers (which incorporate the year of collection). The database was then screened for anomalous values. These included values of parameters, such as metals, which were reported as zero - which were converted to "less than detection" values with unspecified detection limits; and unreasonably high values - which were flagged for exclusion from analyses. Generally, it was difficult to objectively identify such extreme values because there were generally insufficient data at sites to perform statistical tests for outliers. It was necessary to adopt a more subjective approach where individual values were scrutinized in relation to the values of other parameters and the range of other values observed at that site.

4.2 Descriptive Statistics

After standardization and screening for outliers had been completed, descriptive statistics were computed for each parameter. These are presented in Tables 1 and 2. Observations were excluded where data were reported as less than values with unknown detection limits or with detection limits in excess of applicable guidelines. Only observations with appropriate detection limits were included in the counts of samples and sites presented in the Tables. Minima, maxima, means and standard deviations are based only on detectable observations. "Less than" values, "greater than" values and values which were reported in the original data source as the means of replicate analyses were not included. For metals, inorganic and residue parameters in water, observations collected during freshet (for the purposes of this study considered to be from April to July inclusive) were excluded from all computations and maps. It is hypothesized that frequent high values of these parameters (which exceed guidelines for total concentrations) during freshet are due to high natural suspended solid loads and are not indicative of contamination or degraded conditions. For nutrients in water, only observations collected after 1985 were included. Computations of medians and 80th percentiles were sometimes complicated because several different detection limits had been employed. Sometimes detectable observations were reported which were below detection limits for "less than" values. This made it difficult to order the data set for computation of median and 80th percentile. In such cases, only "less than" values relative to the best detection limit were included in the computation.

4.3 Threshold Limits for Environmental Quality Parameters

Observations were examined relative to appropriate guidelines or environmental criteria. Frequently there was some difficulty in the selection of appropriate threshold limits. Guidelines were selected from the compilation by Haines *et al.* (1994) in consultation with the Scientific Authority or were specified by the Scientific Authority. For parameters observed in water and sediment, priority was given to guidelines for protection of aquatic life. Parameters observed in biota were examined relative to guidelines and criteria for protection of aquatic life, human health and piscivores. Where guidelines and criteria do not exist, parameters were examined relative to the value of the 80th percentile observed in the data. Specific details on how these limits were determined are given below.

4.3.1 Water and sediment thresholds

Canadian Council of Ministers of the Environment (CCME) guidelines were given priority. Where these were not available, priority was given to BC Ministry of Environment, Lands and Parks (BC MoELP) criteria, then working criteria from Pommen (1989), then to Environment Canada's St. Lawrence River sediment criteria for polycyclic aromatic hydrocarbons (Environment Canada, 1992), Ontario Ministry of Environment and Energy (OMEE, 1994) criteria for cobalt in sediment, and U.S. Environmental Protection Agency (EPA, 1977) criteria for barium in sediment.

In several cases, guidelines were available for specific applications and it was necessary to choose one of these guidelines. Criteria pertaining to chronic exposure were selected wherever possible. For example, where guidelines were available for "No effects level", "Low effects level" and "Significant effects level", the "Low effects level" was chosen. Where guidelines were available for "Maximum allowable concentration" and "30-day average concentration", the "30-day average concentration" was chosen. In other cases, guidelines were available for specific ranges of hardness and pH. Where required, guidelines were selected to conform with or approximate the range of conditions naturally occurring in the Fraser Basin, *i.e.*, guidelines applicable to pH greater than 6.5 were chosen and for hardness in the range 60 to 120 mg/L $CaCO_3$.

Other specific cases follow: The CCME (1987) guideline for total ammonia in water was converted based on molecular weight to a threshold for total ammonia nitrogen in water. This was necessary because the guideline is based on the concentration of ammonia whereas data were reported as the quantity of nitrogen (occurring in the form of ammonia). This was in effect, a conversion of units. The BC MoELP criterion for total phosphorus in salmon-bearing lakes (Pommen, 1989) was adopted for all water samples (the database does not distinguish between samples from salmon-bearing lakes, non-salmon-bearing lakes, and rivers and other waterbodies). The guideline for total phosphorus was also adopted for application to total phosphate in water. This assumes that all phosphorus in water is in the form of phosphate rather than, for example, elemental phosphorus or organophosphorus pesticides. The CCME (1987) guideline for cadmium in water at hardness 45 mg/L $CaCO_3$ was selected because criteria were not available for the hardness range 60 to 120 mg/L $CaCO_3$.

4.3.2 Biota thresholds

Guidelines for protection of aquatic life, human health and/or piscivores were examined. Where Canadian guidelines exist (either CCME, BC MoELP, Health and Welfare Canada, or otherwise), the most sensitive guideline, *i.e.*, the lowest threshold, was employed. Where Canadian guidelines do not exist, foreign guidelines were considered.

A problem arose where the guideline was determined on a wet weight basis and where the available data were on a dry weight basis and where the guideline was on a dry weight basis and available data were on a wet weight basis. This was the case for chlorophenols, dioxins and furans, arsenic, mercury and lead. To address this problem the guideline was converted to a wet weight or dry weight basis using the mean moisture content for biota from the database. For fish this was 77.35% based on 169 observations (range 65% to 89.4%). For aquatic invertebrates this was 83% based on 8 observations (range 65% to 88.5%).

Guidelines sometimes specify muscle of edible fish and sometimes whole body analyses. Much of the fish body burden data were obtained from the provincial SEAM database (151 of 349 stations) which does not record either the species or the specific tissue. Therefore, in most cases it can not be determined whether a specific observation is from an edible fish species or from muscle, liver or whole body. Another consideration is that in most cases where the species and tissue are known, the analyses were performed on composite samples and therefore represent an average concentration. There was no effective solution to this problem other than to exclude observations where the species and tissue are unknown. Unfortunately, this would eliminate all observations on 469 out of the 535 parameters observed on fish in the database (leaving only 66 parameters). Frequently because of costs of analysis and the higher likelihood of detectable concentrations occurring in liver tissues, many analyses of the parameters of interest are only conducted on liver samples.

Available criteria from other jurisdictions were used: The New York State Department of Environment and Conservation (NYSDEC, 1993) criterion of 3.5 µg/L (converted to wet weight basis) was adopted for chlorobenzene in fish. The Hong Kong (as cited by U.S. EPA, 1977) criterion of 1 µg/L was adopted for chromium in fish. The Chile, Ecuador, India and Venezuela (as cited by U.S. EPA) criterion of 10 µg/L was adopted for copper in fish. The New Zealand (as cited by U.S. EPA) criterion of 40 µg/L was adopted for zinc in fish.

4.4 Distribution Maps

Distribution maps were plotted for each individual parameter where there were more than 25 observations above detection limits. These maps are presented separately as a series of 236 maps in Volume 2 of this report. Selected distribution maps are contained in this volume (Volume

1). For each parameter, a ratio was computed of the observed values relative to environmental guidelines or criteria, where available. Observations where the magnitude of this ratio exceeded one (*i.e.*, greater than the guideline) were plotted as circles in size classes proportional to the this ratio. Observations less than guidelines were plotted as "plus" marks in the smallest size class. Where no guidelines existed, data were plotted relative to the 80th percentile calculated from the database.

4.5 Index Maps

The distribution maps of individual parameters are useful, but do not provide any synthesis of conditions in the Basin. Therefore a series of indices were developed and mapped to provide a level of synthesis of the available information. Separate indices were developed for dissolved nutrients and metals in water (Figures 5 and 11); metals, dioxins and furans, polycyclic aromatic hydrocarbons (PAH), chlorophenols and resin acids in sediment (Figures 13, 17, 20, 21 and 23); and dioxins and furans in fish (Figures 18 and 19). Details of the calculation of the indices are presented on the facing page accompanying each map. A consistent problem was the lack of observation of a consistent suite of parameters at stations. Therefore, the index maps typically incorporate only a subset of the available data. Index maps for other groupings of parameters were inappropriate, because of the limited number of stations for which an index could be calculated. Additional maps showing locations of stations and indicating exceedance of one or more guidelines are also presented for total nutrients in water (Figure 6) and for metals in water (Figure 12), in sediment (Figure 14) and in fish (Figure 15).

It was not possible to develop an index or presentation which synthesized all parameters of interest because of the general lack of a consistent suite of parameters. The exception to this would perhaps be the Fraser Estuary Management Program (FREMP) study area, the Fraser Estuary, where a consistent program of sediment sampling covering a broad suite of parameters has taken place for several years.

5.0 RESULTS AND DISCUSSION

5.1 Adequacy of Available Data

Figures 2, 3 and 4 illustrate the frequency distribution of sampling of water, sediment and body burdens in fish respectively. In addition, there are a maximum of 16 stations at 3 sites where body burdens for aquatic invertebrates have been sampled, 2 stations at 2 sites where contaminant (dioxins and furans) observations on suspended sediments have been performed, and 1095 stations at 120 sites where photosynthetic pigment analyses have been performed (see Tables 1 and 2).

The most abundant data are common water quality parameters such as pH, specific conductance, temperature, fecal coliforms and nutrients in water. Following these in abundance are the common regulatory metals of concern (such as cadmium, chromium, copper and zinc) and inorganic and physical parameters (such as magnesium, sulfate, chloride, hardness and alkalinity).

As can be see from the frequency distribution maps (Figures 2 to 4), the majority of the available data are water samples which outnumber either sediment or fish body burden data in frequency by two orders of magnitude. Also, there are significant gaps in the spatial distribution of all data. Several of the HMAs have very little data available. There are also some gaps in the temporal distribution of the data between the HMAs. The following six HMAs are noteworthy for the lack of available data: Stuart/Takla, West Road, Chilcotin, Seton/Bridge, Harrison and Quesnel. Collectively these represent about 33% of the area of the Fraser Basin.

As noted in Section 3, the data compilation terminated because the available level of effort had been reached, rather than by exhausting all possible information sources. Also, some data have been incorporated into the database but were not included in the study analyses because of time constraints. It is appropriate to comment on whether additional data compilation effort would significantly alter these data gaps. Most of the additional data sources which have been identified, but not incorporated into the database are for common limnology parameters (*e.g.*, Sockeye Lakes Limnology Program and BC MoELP Small Lakes Database). Much of the remainder are data sets involving a limited suite of parameters at a few sites (*e.g.*, Van Oostdam, 1991; Dwernychuk, 1990; Derksen and Mitchell, 1994; Birch and Shaw, 1994). Overall, it does not seem reasonable to suggest that an exhaustive compilation effort would resolve the apparent data gaps.

Problems associated with map scale affect the utility of the site location information. The sampling site may in fact be located in a drainage ditch or a small creek which is not shown on 1:250,000, 1:50,000, or even 1:20,000 scale maps. Unless the site description or coding specifically indicates that the site is not located in the nearest mapped waterbody, because of the general uncertainty of coordinates, it is likely to be attributed to that nearby waterbody. The problem is that many such sites are intended to provide data on potentially contaminated run-off and are not representative of the nearby waterbody. Another situation is sites located near the junction of two rivers: Is the site representative of the tributary before discharge to the mainstem, of the mainstem before addition of the tributary, or of the mixed waters of the two?

Errors, lack of consistency or documentation of coding (particularly of suspect data), missing detection limit information and omissions (particularly data sets not entered into the database) clearly limit ease of use. However, lack of information on biota species or specific tissue, lack of standardization of parameter coding (different codes may represent the same parameter but different analytical methods and detection limits), and lack of standardization of units (particularly data on a dry weight basis whereas guidelines were on a wet weight basis and vice versa) were of greater significance. These either required greatly increased effort or limited use of the data.

There is clearly a need to overhaul both the SEAM and ENVIRODAT database management systems. This has been recognized by the agencies responsible and major overhauls of the two systems are now in progress.

5.2 Results

Graphical and statistical analyses were performed on selected parameters to examine trends over time and relations between parameters. In these preliminary investigations no significant correlations were observed between any metal parameters examined (*e.g.*, between copper and zinc) even where analysis was restricted to a single HMA, and when potential outliers were excluded such as the period of freshet and observations above the 80th percentile. The maximum correlation (R value) observed was 0.38 which is not significant. Even when data from only a single site was considered (*i.e.*, Fraser River at Spences Bridge with 209 observations of metals), there were no significant correlations observed between metals in preliminary analyses. Also, no correlation was observed between suspended sediment and metal concentration. However, in this latter case there were relatively few stations with paired metal and suspended sediment data. Therefore, this conclusion is based on limited data. Graphs of selected metal and nutrient concentrations versus time were examined in preliminary investigation of trends over time. No trends were evident either on the entire data set or when data were restricted to a single HMA. Such graphs showed a fairly high component of noise which was likely sufficient to mask any trends which may exist. Level of effort did not allow further statistical investigation of trends. It is possible that statistical analyses involving selected stations from the database may provide evidence of trends. A difficulty is the identification of appropriate stations which are representative of the general area rather than monitoring the effects of specific developments or activities at a location. ***Our intention in reporting these preliminary results is to flag to the reader that care is required in selecting appropriate data from the database for any particular analysis***.

The individual parameter maps (see Volume 2) and the index and summary maps in this volume show locations of contamination, degraded conditions and "hot spots", as well as distribution of sampling effort. Generally, the indices were computed as the sum of the ratios of observed values relative to the guidelines (or 80th percentile where no guideline exists) divided by the number of parameters observed which contribute to the index. The index maps only show stations where there was a sufficient number of parameters observed. Stations are shown with symbols indicating the magnitude of the computed index value. An index value greater than one indicates that on average the values of parameters observed exceed guidelines or the 80th percentiles computed from the database. Specific details for each index are presented in the figure caption for each map. Frequently, sites are shown as a series of concentric circles with a "plus" mark in the centre indicating that parameter values are sometimes within guidelines and sometimes high (exceeding guidelines or the 80th percentile). As mentioned previously, where data were examined for trends, no trends were evident. There is a limited ability to generalize from these results, particularly as there are limited data available for most of the western portion of the Fraser Basin.

Nutrients

Elevated nutrient levels in water predominantly occur in the agricultural areas of the Thompson/Shuswap, Thompson/Nicola, Chilliwack/Lower Fraser and Fraser Delta HMAs. It should be noted, however, that the pattern shown in the Dissolved Nutrient Index (Figure 5) and Total Nutrients (Figure 6) maps is strongly influenced by phosphorus data exceeding the guideline of 15 µg/L used in this study. Pommen (1989) proposes 5 to 15 µg/L as a criterion for phosphorus only for lakes with salmonids as predominant fish species. The Ontario Ministry of Energy an the Environment (OMEE, 1994) specifies two guidelines: 30 µg/L for rivers and other fast-flowing waters and 10 to 20 µg/L for lakes. The guideline of 15 µg/L adopted from this study may be inappropriate for general application to the Fraser Basin.

pH

The map of pH in water (Figure 7) shows that 99% of pH values are within the guidelines. Extreme acid values are likely in the vicinity of acid mine drainage or effluent discharges or may simply be errors. A few, five, very alkaline pH values occur in the upper Thompson/Shuswap and could potentially reflect agricultural run-off. The lower mainland area shows a moderate variance from the guidelines both above and below the recommended range.

Fecal coliforms

The map of fecal coliforms in water (Figure 8) shows that sampling effort is associated with monitoring of community sanitary waste facilities and run-off from livestock ranges. A relatively high percentage (15%) of the observations exceed the guideline for contact recreational activity (CCME 1987) with the majority of occurrences being in the lower mainland and Thompson/Shuswap.

Dissolved Oxygen

Figure 9 illustrates the distribution of dissolved oxygen in water relative to the guideline. Spatial coverage of the data is limited. Extremely low values (<2.5 mg/L) are not uncommon. Sampling effort is likely focused on areas of concern.

Temperature

Figure 10 illustrates the distribution of temperature in water and primarily consists of observations of surface temperature. Again the spatial distribution of data is limited. It should be noted that some sites may only report temperature data during the cold season. The lack of observation of elevated temperatures at a site may reflect this. Also, it should be noted that one conspicuous elevated site is the Hot Springs near Pitt River. It is not surprising that this exceeds the guideline.

Metals in water

Figure 11 illustrates the pattern of the computed Metal Index in Water. This index focuses on twelve metals commonly of concern: aluminum, arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium and zinc. Iron and manganese were excluded because it has been hypothesized that elevated concentrations reflect natural sources in the Basin (P. Shaw, pers. comm.). At least seven of the twelve parameters were required for computation of the index. The number of sites where this index could be computed is limited relative to sites where at least one metal was observed (see Figure 12). Data collected during the period of freshet (from April to July inclusive) are excluded from these maps. However, because the index (and the guidelines) are based on observations of total metals, it is likely that some of the elevated values reflect elevated levels of suspended sediments, for example, following storm events.

Arsenic, cobalt, mercury, molybdenum, nickel and selenium concentrations in water rarely exceed the guidelines (see Volume 2). An exception is a cluster of elevated mercury values on the Pitt River. Aluminum and copper show a high frequency of values exceeding guidelines. The remaining metals: cadmium, chromium, lead and zinc show a moderate frequency of exceedance. There are subtle differences in the patterns of distribution.

Metals in sediment and fish

Figures 13 and 14 show the distribution of Metal Index in Sediment and locations of metal concentrations in sediment exceeding guidelines, respectively. It was possible to calculate the Metal Index for about 60% of the stations where metals had been sampled. The majority of stations sampled show exceedance of one or more guidelines, sometimes by several orders of magnitude. However, there are only 160 stations where metals in sediment have been observed. It is not clear whether this suggests that the majority of sediment sources within the Basin contribute to elevated levels of metals, or that the majority of sampling for metals in sediment has occurred in areas of concern as sources of metals. Almost all of the sites are clearly in the vicinity of active or abandoned mines (see Figure 16).

Figure 15 shows observations of fish body burdens of metals relative to guidelines. While there are 123 stations with observations of fish metal body burdens, these all occur at 3 sites in the Thompson/Shuswap. There are insufficient data to allow interpretation.

Dioxins and furans

Figures 17 to 19 illustrate the distribution of the computed Dioxin Index in sediment, fish liver and fish muscle, respectively. This index is based on the International Toxicity Equivalency Factors (I-TEFs) and is the sum of the Toxicity Equivalents (TEQs) of specific dioxin and furan congeners of concern. Because I-TEFs only exist for specific congeners, observations which do not specify the congener could not be included in the index. 2702 out of 6862 observations (39.38%) did not specify a congener and were not included in the analyses. For the index maps (Figures 17 to 19) values less than detection were treated as zero and the TEQs of the congeners of concern were then summed to produce an index value.

Figure 17 (sediment) shows data only from 1988 to 1990. Figures 18 and 19 (fish liver and muscle, respectively) show data only from 1988 to 1992. ***Care should be taken in the interpretation of these results because of factors such as***:

- the small number of observations for each year;
- different stations were sampled from year to year;

- ! sampling was conducted during different months from year to year;
- ! analytical detection limits improved over this period; and,
- ! variation in moisture content of fish samples (which ranged from 65% to 89.4% in these data).

Sediment

Figure 17 shows that all instances of high concentrations of dioxins and furans in sediment occurred in the vicinity of a pulp mill. Descriptive statistics for dioxin and furans in sediment (expressed as TEQs) are presented below. Note that for these descriptive statistics values below detection have been replaced with 50% of the detection limit (whereas in the maps a value of zero was employed). In the maps, index values of greater than 10 were only observed in 1988 and two very high values (> 250 TEQ at Kamloops) were reported in 1988. Even when these two high values are excluded there appears to be a significant difference between the dioxin and furan concentrations in 1988 and 1989 versus in 1990. However, it should be noted that in 1988 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-T4CDF) was the only congener detected. In 1989, both 2,3,7,8-T4CDF and octochlorodibenzodioxin (O8CDD) were detected. While in 1990 a suite of congeners were detected. There was a substantial change in analytical methods in 1990 and detection limits for specific congeners improved by an order of magnitude. The observed decrease in dioxin and furans in sediment between 1988 and 1990 may potentially be due to differences in analytical methods (particularly detection limits) and sampling rather than a real change in concentrations in the environment.

Year	No. Samples	Mean	Std. Dev.	95% Confidence Interval
88	24	38.23	78.17	5.22-39.10
88*	22	15.36	8.65	11.55-16.28
89	9	10.58	5.98	5.98-12.35
90	16	3.74	1.49	2.95-4.88

* *excludes two outlier (very high) values*

Fish

Figures 18 and 19 present the observed distribution of dioxins and furans in fish liver and fish muscle, respectively. The patterns of distribution shown for fish liver and muscle appear consistent which is reasonable given that the liver and muscle samples were generally obtained from the same fish. The figure for fish liver (Figure 18) is based on data from 1990 to 1992. In contrast, the figure for fish muscle (Figure 19) is based on data from 1988 to 1992. Fish with elevated body burdens were observed near pulp mills, downstream of pulp mills and in tributaries upstream of pulp mills.

Fish livers appear to hold higher concentrations of dioxins and furans relative to fish muscle. This difference is significant in 1990, but not significant in 1991 and 1992. This conclusion is reasonable given that the liver is an important organ in the elimination of organic contaminants from fish. The fish muscle data show a decrease in body burdens from 1988 to 1989, an increase from 1989 to 1990, a decrease from 1990 to 1991 and no change from 1991 to 1992. There is a decrease in dioxin and furan concentrations in fish liver between 1990 and 1991 and no change from 1991 to 1992. Again, it should be noted that analytical methods changed substantially in 1990. Therefore it may not be appropriate to compare the data collected before 1990 with the later data.

The data suggest a decrease in dioxin and furan body burdens in fish between 1990 and 1992 which appears reasonable given the decrease in dioxin and furan concentrations in effluents as a result of upgrading of pulp mills in 1991.

Fish Liver

Year	No. Samples	Mean	Std. Dev.	95% Confidence Interval
90	47	64.48	112.58	32.30 - 65.04
91	4	14.56	10.27	0 - 19.62
92	13	8.91	10.82	2.36 - 10.22

Fish Muscle

Year	No. Samples	Mean	Std. Dev.	95% Confidence Interval
88	21	36.92	61.42	8.96 - 37.87
89	10	2.06	1.36	1.09 - 3.68
90	74	23.54	34.67	15.64 - 23.98
91	4	2.21	1.06	0.53 - 7.28
92	16	2.36	2.75	0.89 - 3.49

All dioxin and furan sampling has been conducted in studies of pulp and/or paper mills which are potential sources. The reader is referred to Dwernychuk *et al.* (1993) and Tuominen and Sekela (1992) for a detailed analyses of these data.

Polycyclic aromatic hydrocarbons (PAH) in sediment

Figure 20 illustrates the distribution of the computed PAH Index in Sediment. Almost all stations are located in the Fraser Delta or Boundary Bay. One site was sampled north of Kamloops. Most stations analyzed the full suite of PAHs on which the index is based. The index is based on Environment Canada criteria for the St. Lawrence River. Approximately two-thirds of the stations have index values greater than one (on average exceed guidelines). PAHs are associated with a number of potential sources, particularly with petroleum hydrocarbons. A common source is run-off from roads and parking lots. It appears appropriate to monitor PAH in sediments in other parts of the Basin.

Chlorophenols in sediments

Figure 21 illustrates the distribution of the computed Chlorophenol Index in Sediment. This index is based on the observed values of up to 10 chlorophenol parameters relative to the 80th percentile computed from the database. There are no appropriate guidelines or criteria for chlorophenols in sediment. Sampling has been conducted primarily by the FREMP monitoring program and studies of pulp and/or paper mills. With two exceptions the higher values of the index are observed in the Fraser Estuary.

PCBs in sediment

Figure 22 illustrates the distribution of data on polychlorinated biphenyls (PCBs) in sediment. All data in the database (both measurements of specific and total PCBs) are presented. The assessment of PCBs is limited by the amount of data available. Almost all of the data were collected in the lower mainland. With the exception of 5 observations, the data are all below method detection limits.

Resin acids in sediment

Figure 23 presents the distribution of the computed Resin Acids Index in Sediment. All 25 stations are located in the Fraser Estuary and were conducted by the FREMP monitoring program. The Resin Acid Index is based on exceedance of the 80th percentiles for 8 resin acid parameters calculated from the database. Three (3) stations have an index value slightly greater than one. The minimum index value observed was 0.14 which occurred at 2 stations. There is sufficient range in the computed index values and in the observed concentrations of specific resin acids to suggest that the index values greater than one are not simply an artifact from basing the computation on the 80th percentile.

6.0 RECOMMENDATIONS

The main conclusions and recommendations of this study are:

1) a wake-up call to the agencies involved in collection of environmental monitoring data in the Fraser Basin regarding the lack of adequate data coverage over the past 10 years; and,

2) the need for substantial revisions to existing data management systems. [Major overhaul of both the SEAM and ENVIRODAT systems are presently underway (P. Shaw, pers. comm.).]

Some other recommendations have been mentioned earlier in the text. These and other specific recommendations are listed below.

3) Consideration should be given to a study of distribution of PAH in sediments throughout the Basin. Currently, data are only available for the Fraser Estuary. The majority of these data exceed guidelines (Environment Canada, 1992).

4) Consideration should be given to modification of routine data reporting procedures so that data are reported on a basis consistent with applicable guidelines and criteria. For example, where guidelines are expressed on a wet weight basis it is beneficial to report results on a wet weight basis. This comment is relevant to fish body burden data for chlorophenols, dioxins and furans, arsenic, lead and mercury.

5) The adoption of a criterion of 15 µg/L for total phosphorus in water has contributed substantially to the pattern of high Dissolved Nutrient Index values and stations exceeding nutrient guidelines. Pommen (1989) proposes this criterion only for lakes with salmonids as the predominant fish species. OGEE (1994) presents criteria of 10 and 20 µg/L for lakes and 30 µg/L for rivers and fast-flowing waters. The criterion of 15 µg/L as adopted by this study may not be appropriate for general application to the Fraser Basin.

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FIGURES

Figure 1. The Fraser Basin study area.

The Fraser Basin consists of 15 Habitat Management Areas (HMAs) as shown. These HMAs are summarized below.

ID	**Name**	**Area** (km²)
1	Stuart/Takla	15,100
2	Upper Fraser	35,400
3	Nechako	31,400
4	West Road	13,100
5	Chilcotin	19,600
6	Middle Fraser	24,500
7	Quesnel	14,900
8	North Thompson	20,700
9	Thompson/Shuswap	17,100
10	Thompson/Nicola	17,800
11	Seton/Bridge	6,600
12	Harrison	8,100
13	Pitt/Stave	3,200
14	Chilliwack/Lower Fraser	2,700
15	Fraser Delta	1,900

TAKLA
L.
1
STUART
L.
Salmon R.
Fort
St. James
Francois L.
Vanderhoof
Nechako R.
PRINCE
GEORGE
Hansard
3
OOTSA L.
2
FRASER R.
Wells
West Road R.
Quesnel
4
7
QUESNEL
L.
North Thompson R.
Chilcotin R.
5
6
8
FRASER R.
CHILKO
L.
Barriere
9
SHUSWAP
L.
Bridge R.
10
11
Kamloops
Salmon
Arm
Thompson R.
Lillooet R.
12
Lytton
HARRISON
L.
13
Hope
VANCOUVER
Pitt
L.
15
FRASER
DELTA
14

Figure 2. Frequency of Water Sampling

Figure 2 illustrates the number of stations where water samples were collected in each HMA over the period 1980 to 1994 by year. The term "station" refers to the combination of location, date, media sampled, sampling method and sampling agency. Generally, there is only one water sampling station record for a given location and date. Of the 22,581 station records in the database, there are 20,657 water sampling stations. As can be seen from Figure 2, for several of the HMAs the database contains virtually no water sampling stations.

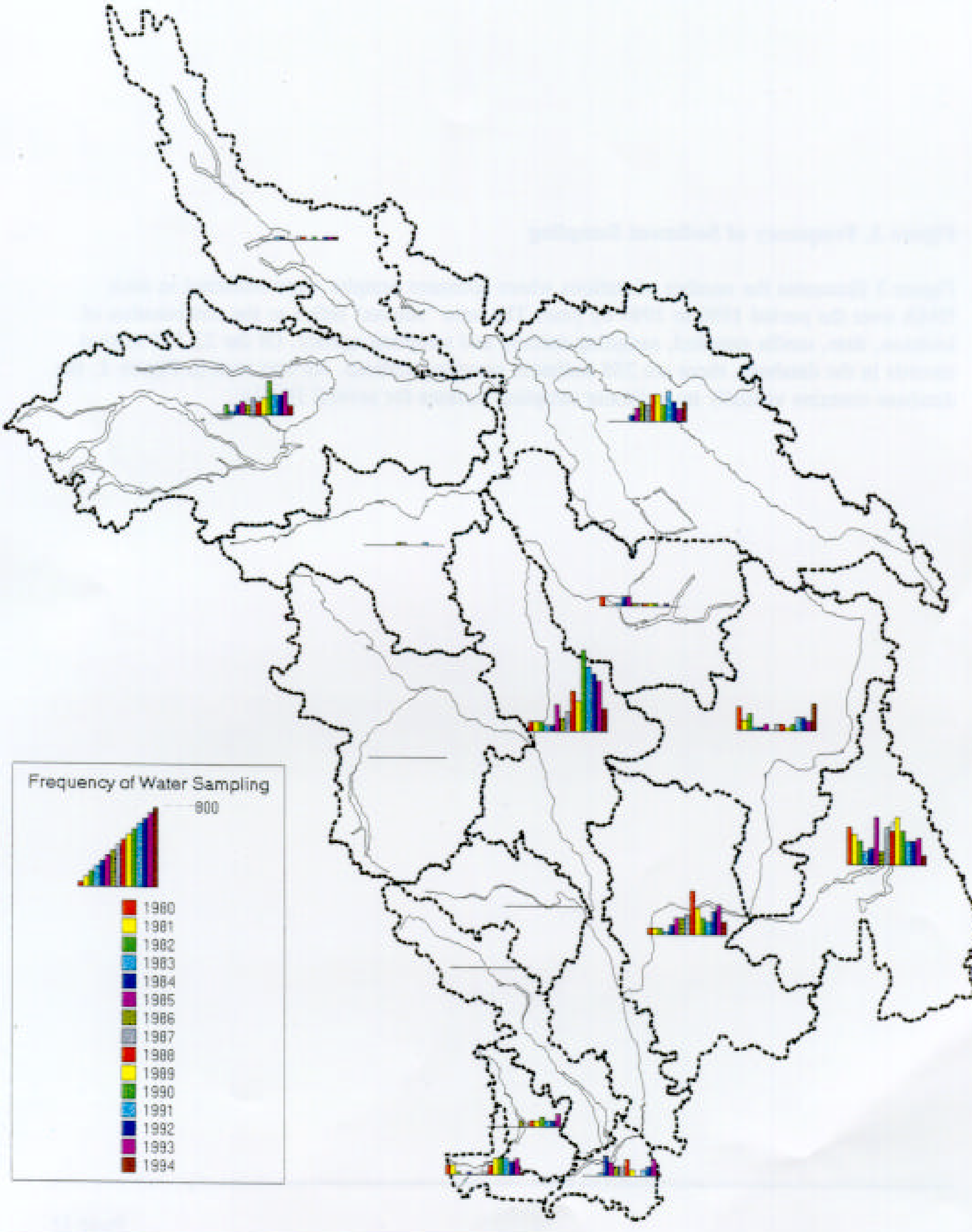

Frequency of Water Sampling
800
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994

Figure 3. Frequency of Sediment Sampling

Figure 3 illustrates the number of stations where sediment samples were collected in each HMA over the period 1980 to 1994 by year. The term "station" refers to the combination of location, date, media sampled, sampling method and sampling agency. Of the 22,581 station records in the database, there are 388 sediment sampling stations. As was seen in Figure 2, the database contains virtually no sediment sampling stations for several HMAs.

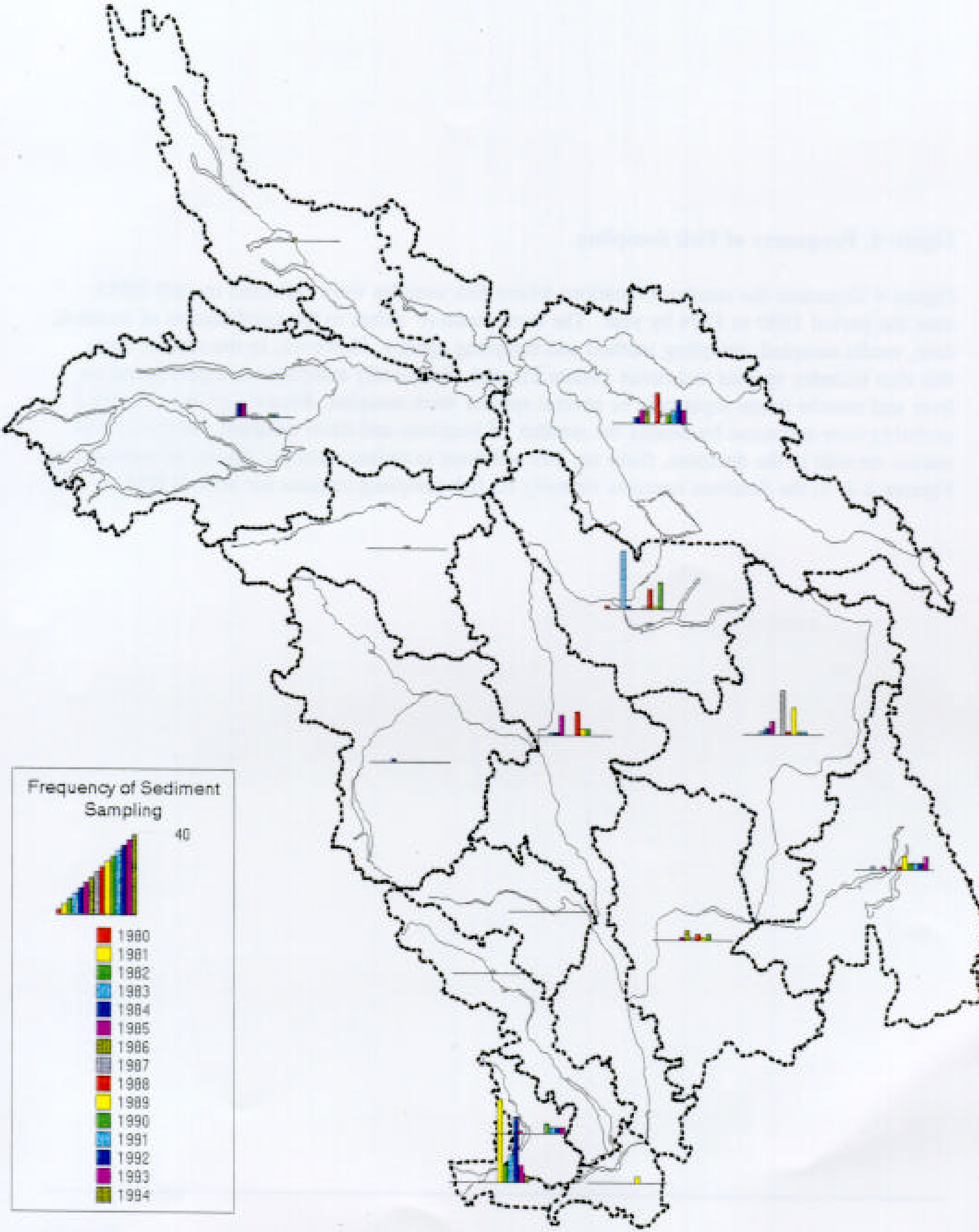
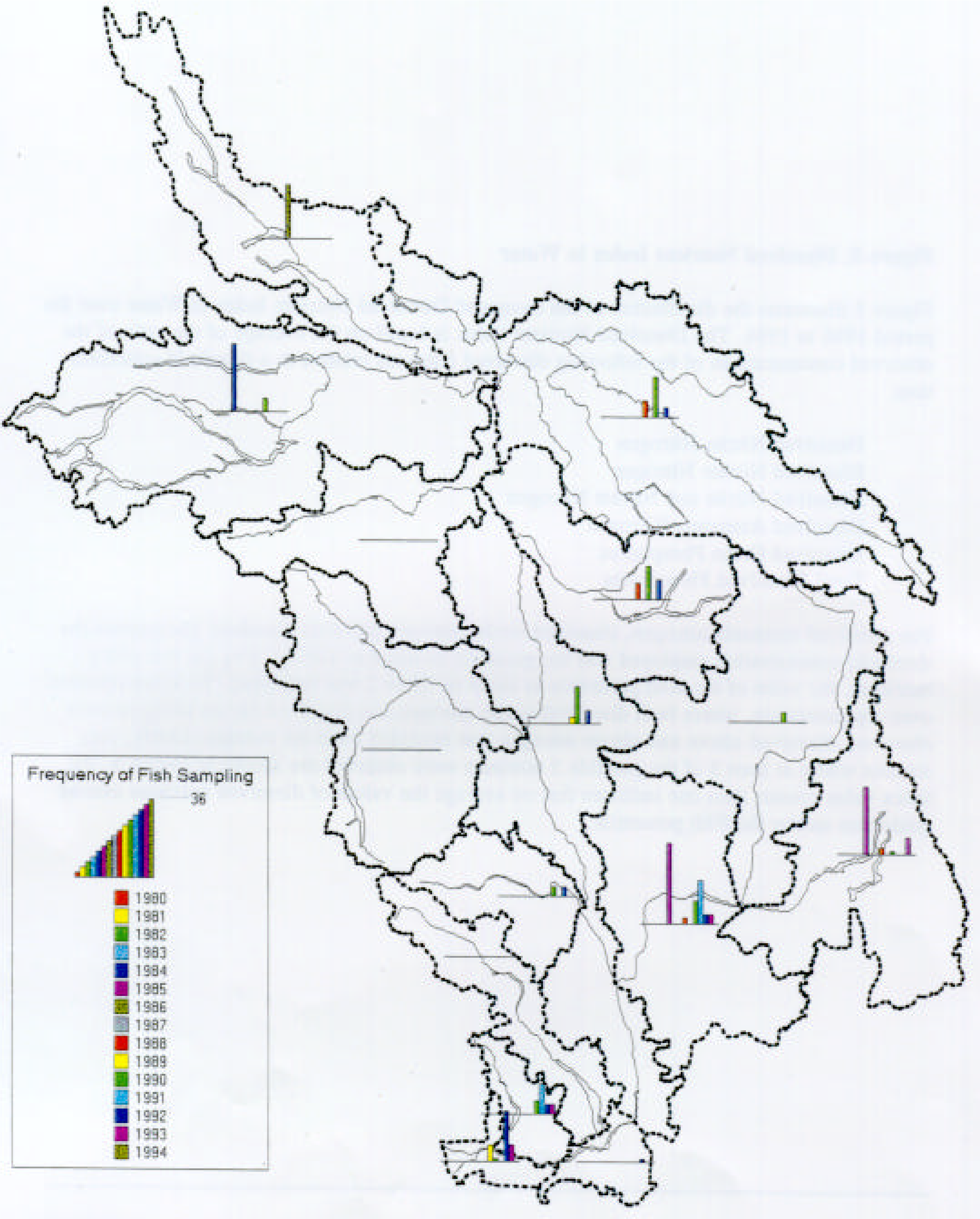

Frequency of Sediment Sampling
40
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994

Figure 4. Frequency of Fish Sampling

Figure 4 illustrates the number of stations where fish samples were collected in each HMA over the period 1980 to 1994 by year. The term "station" refers to the combination of location, date, media sampled, sampling method and sampling agency. However, in the case of biota this also includes species and tissue (where known). Frequently analyses were performed on liver and muscle tissue separately or several species were sampled. Because of this, Figure 3 probably over-estimates by double the number of locations and dates sampled. Of the 22,581 station records in the database, there are 349 sediment sampling stations. Again, as was seen in Figures 2 & 3, the database contains virtually no fish sampling stations for several HMAs.



Frequency of Fish Sampling
36
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994

Figure 5. Dissolved Nutrient Index in Water

Figure 5 illustrates the distribution of the computed Dissolved Nutrient Index in Water over the period 1986 to 1994. The Dissolved Nutrient Index is based on the average of the ratio of the observed concentrations of the following dissolved nutrients relative to a threshold concentration:

Dissolved Nitrite Nitrogen
Dissolved Nitrate Nitrogen
Dissolved Nitrite and Nitrate Nitrogen
Dissolved Ammonia Nitrogen
Dissolved Ortho Phosphorus
Total Dissolved Phosphorus

For dissolved ammonia nitrogen, dissolved nitrite nitrogen and total dissolved phosphorus the threshold concentration employed was the guideline as listed in Table 1. For the remaining nutrients, the value of the 80th percentile as listed in Table 2 was employed. To avoid potential over-representation, where both dissolved nitrite nitrogen and dissolved nitrate nitrogen were observed, dissolved nitrite and nitrate nitrogen was excluded from the average. Lastly, only stations where at least 3 of the possible 5 nutrients were observed are shown in Figure 5. An index value greater than one indicates that on average the values of dissolved nutrients exceed guidelines and/or the 80th percentile.

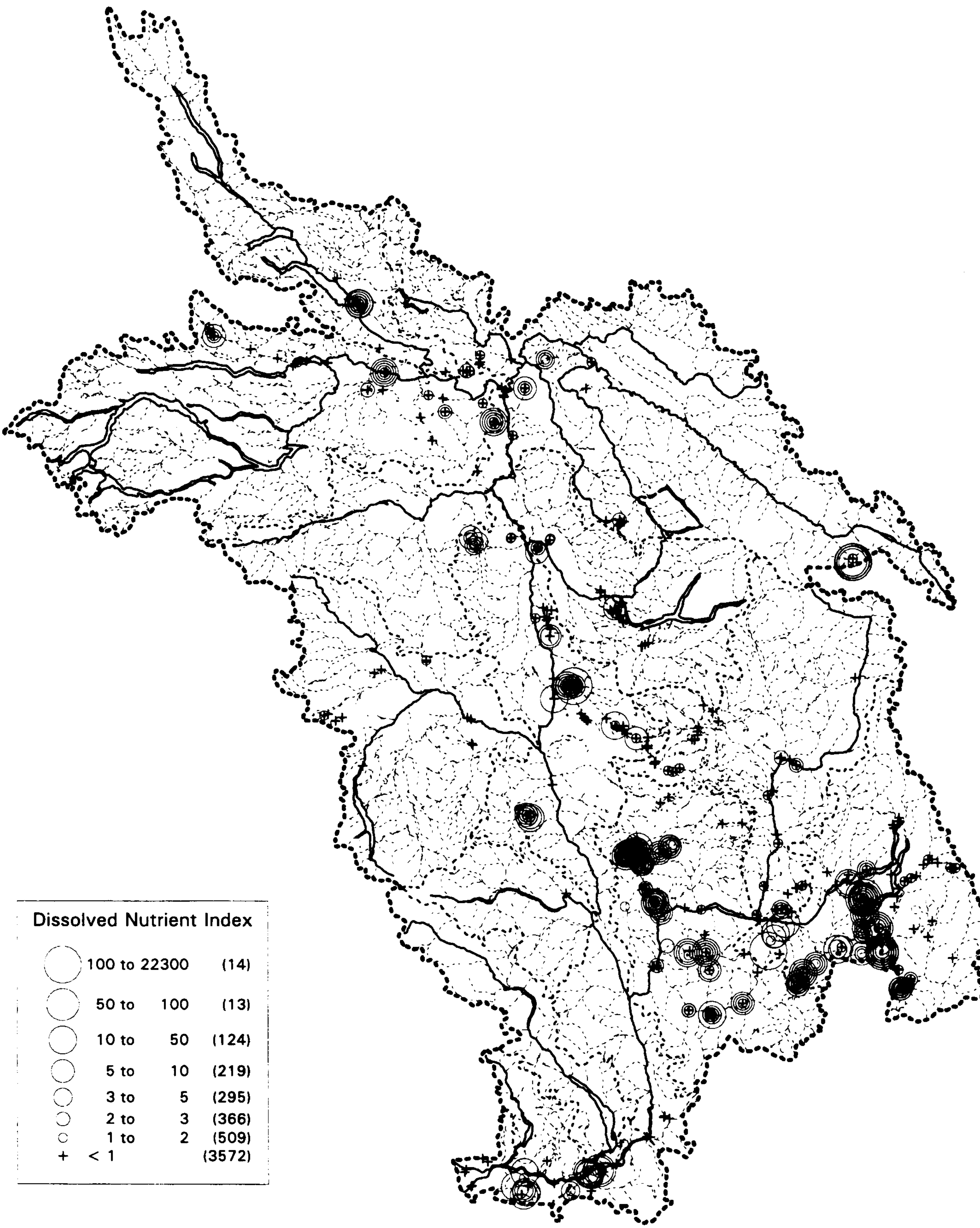
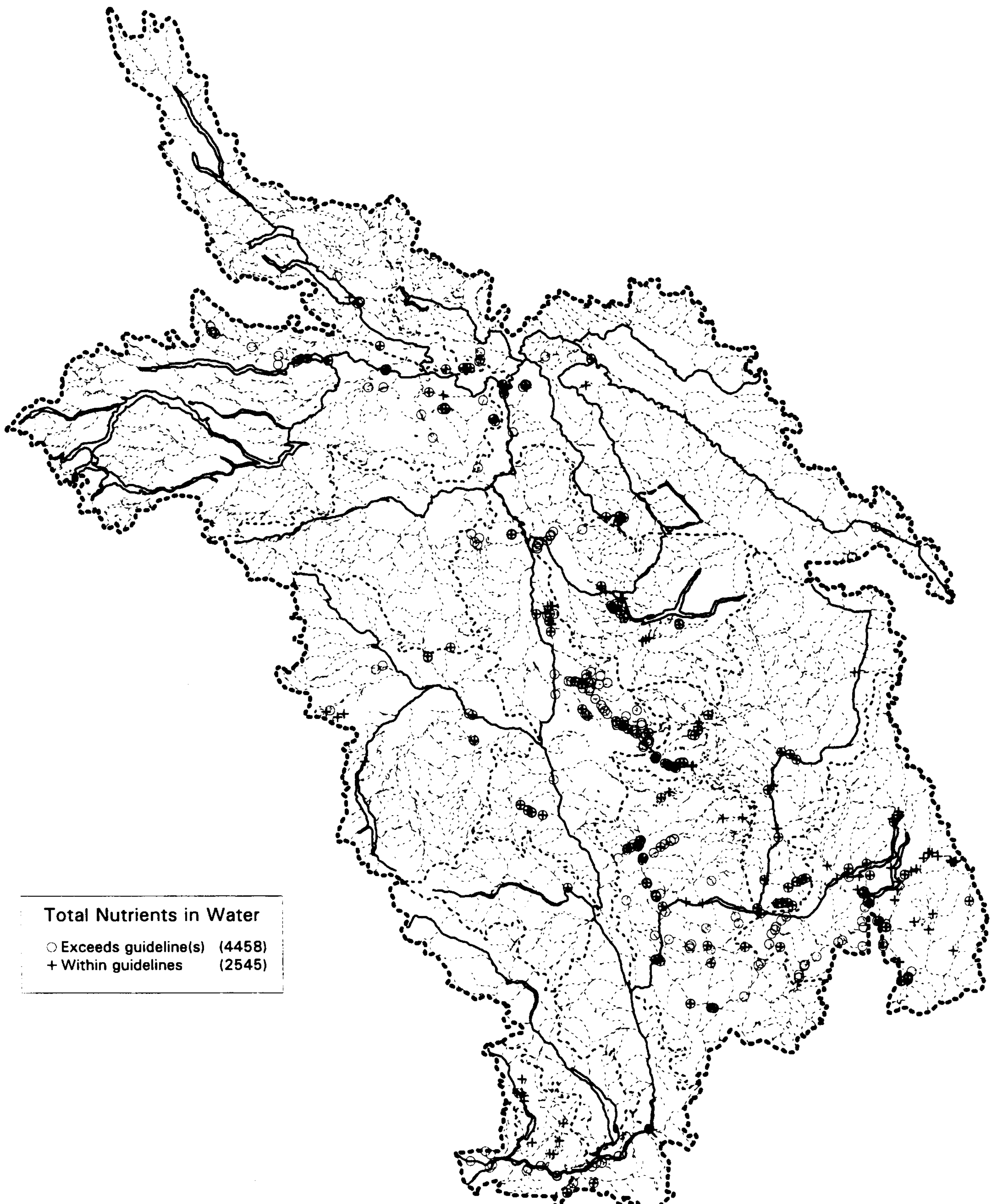

Dissolved Nutrient Index
100 to 22300 (14)
50 to 100 (13)
10 to 50 (124)
5 to 10 (219)
3 to 5 (295)
2 to 3 (366)
1 to 2 (509)
+ < 1 (3572)

Figure 6. Total Nutrients in Water

Figure 6 illustrates the distribution of observations of total nutrients in water relative to guidelines: total ammonia nitrogen, total nitrite nitrogen, total phosphorus or total phosphate (see Table 1). It was not possible to compute a Total Nutrient Index similar to the Dissolved Nutrient Index in Figure 5. Of the 7003 stations where one or more total nutrient parameters were collected, only 80 stations actually collected observations of more than one total nutrient parameter that could be assessed relative to guidelines. Computation of indices is not appropriate where most of the stations involve only a single parameter. Instead, Figure 6 illustrates all observations of total nutrients in water and shows those which exceed or do not exceed guidelines. It can be seen that at approximately 64% of the stations the concentrations observed exceed one or more of the guidelines.



Total Nutrients in Water
○ Exceeds guideline(s) (4458)
+ Within guidelines (2545)

Figure 7. pH in Water

Figure 7 illustrates the observed distribution of pH in water relative to the CCME (1987) guideline. The majority of observations are within the range of the guidelines.

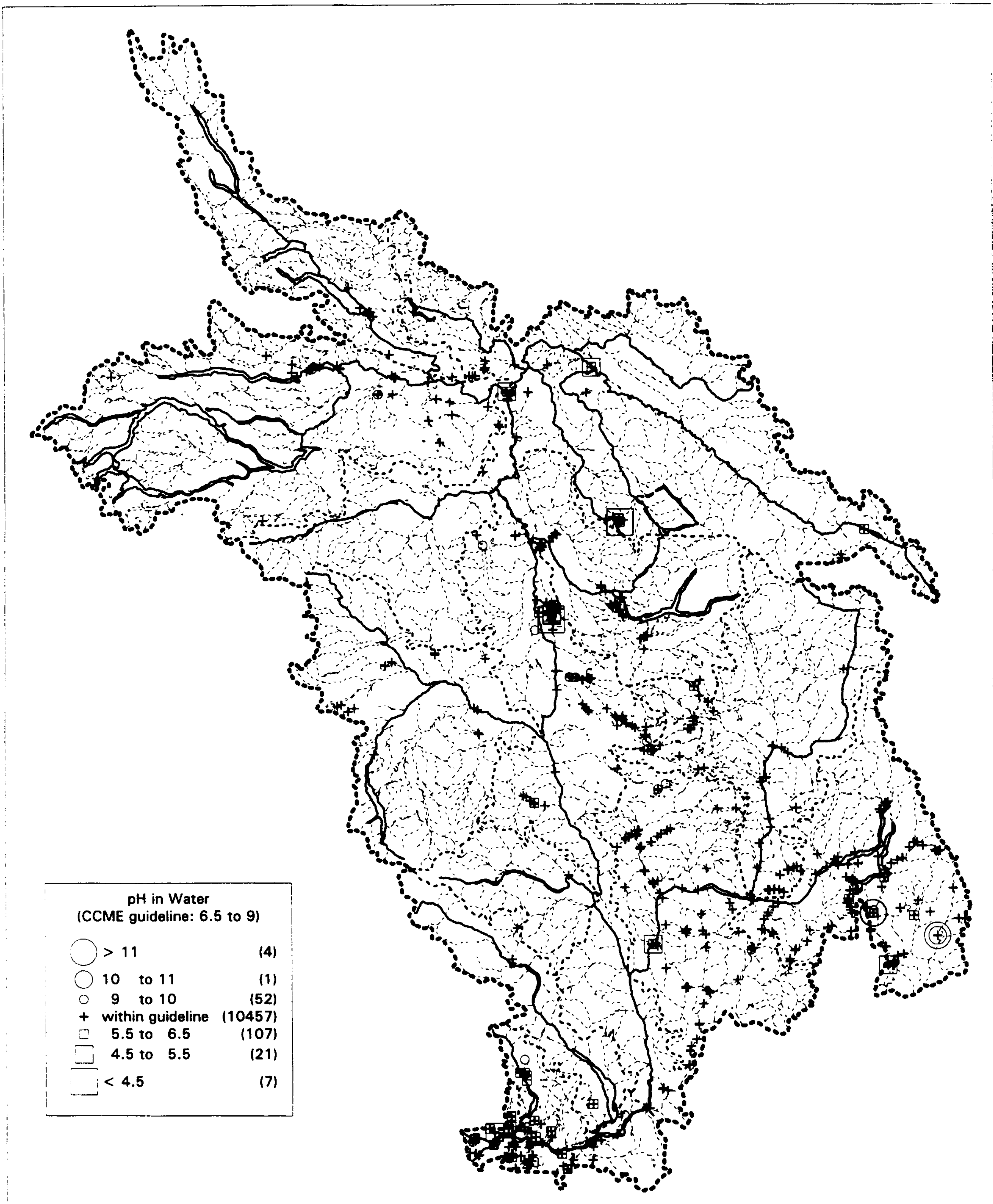

pH in Water
(CCME guideline: 6.5 to 9)
> 11 (4)
10 to 11 (1)
9 to 10 (52)
within guideline (10457)
5.5 to 6.5 (107)
4.5 to 5.5 (21)
< 4.5 (7)

Figure 8. Fecal Coliforms in Water

Figure 8 illustrates the observed distribution of fecal coliforms in water relative to the guideline for contact recreational activity (CCME 1987). The majority of stations are located in relation to community sanitary waste facilities or agricultural livestock areas.

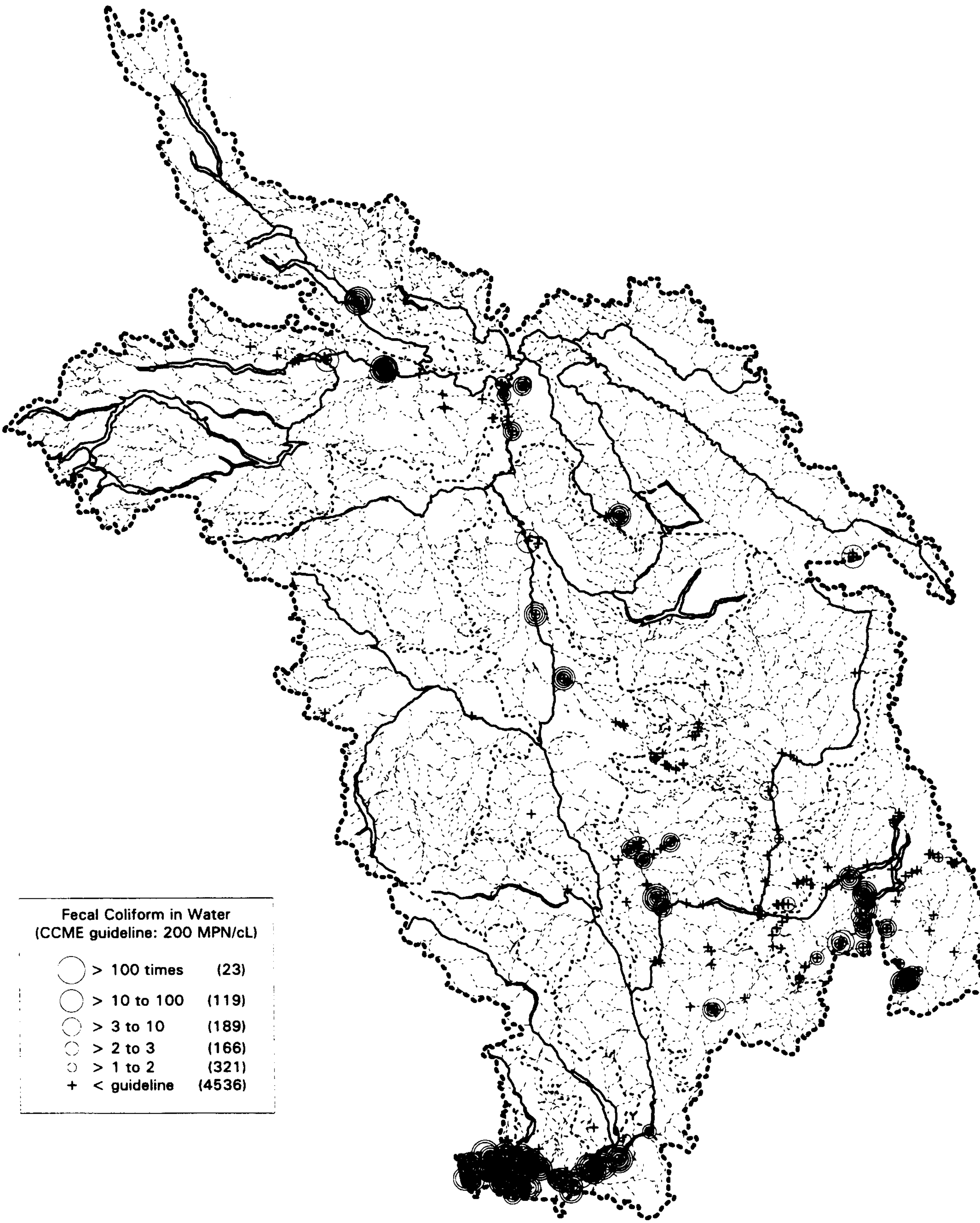
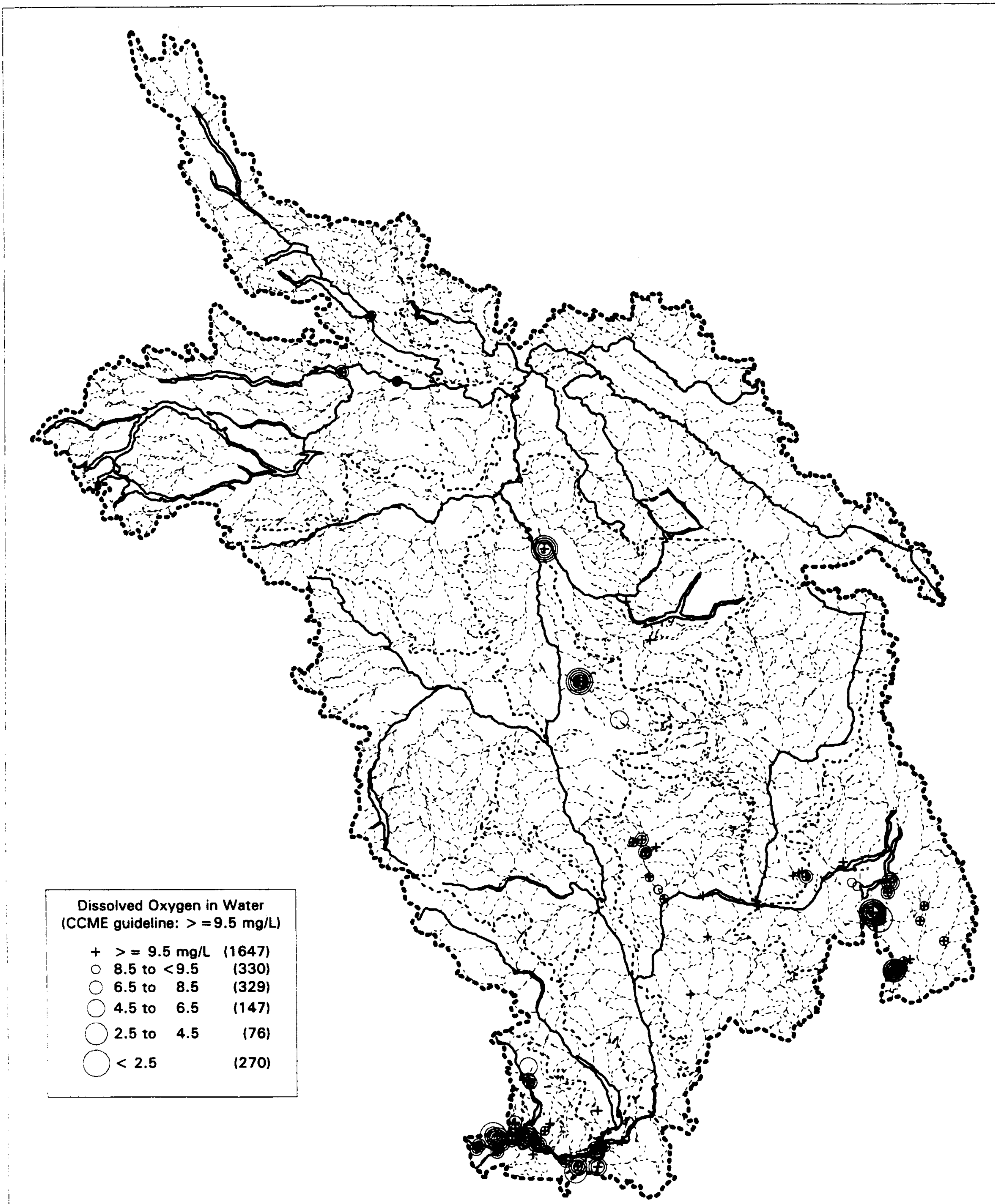

Fecal Coliform in Water
(CCME guideline: 200 MPN/cL)
> 100 times (23)
> 10 to 100 (119)
> 3 to 10 (189)
> 2 to 3 (166)
> 1 to 2 (321)
+ < guideline (4536)

Figure 9. Dissolved Oxygen in Water

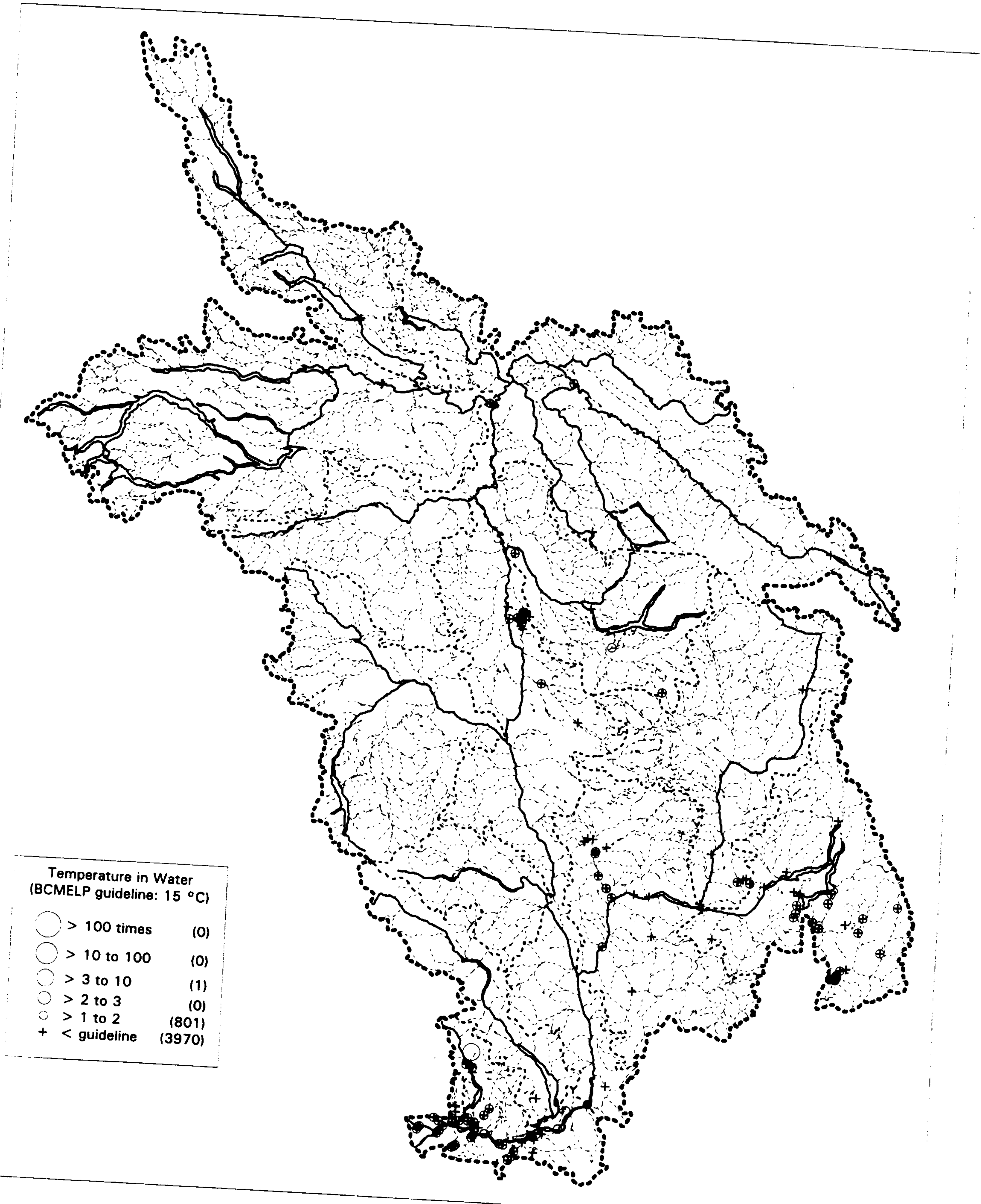
Figure 9 illustrates the observed distribution of dissolved oxygen in water relative to the CCME (1987) guideline. Circles indicate stations with oxygen concentrations which do not meet the guideline. It is noteworthy that a relatively large number (270) of the stations have very low oxygen values.



Dissolved Oxygen in Water
(CCME guideline: > =9.5 mg/L)
+ > = 9.5 mg/L (1647)
8.5 to <9.5 (330)
6.5 to 8.5 (329)
4.5 to 6.5 (147)
2.5 to 4.5 (76)
< 2.5 (270)

Figure 10. Temperature in Water

Figure 10 illustrates the observed distribution of water temperature relative to the criterion for protection of salmonid embryo survival (Nagpal *et al*., 1995). It should be noted that data for some stations does not include the warmer weather periods. Therefore, locations which are not show to exceed the temperature guideline, nonetheless, may exceed this guideline at some times of year.



Temperature in Water
(BCMELP guideline: 15 °C)
> 100 times (0)
> 10 to 100 (0)
> 3 to 10 (1)
> 2 to 3 (0)
> 1 to 2 (801)
+ < guideline (3970)

Figure 11. Metal Index in Water

Figure 11 illustrates the distribution of the computed Metal Index in Water over the period 1980 to 1994. The Metal Index is based on the average of the ratio of the observed concentrations of the following metals relative to guidelines (see Table 1):

Aluminum (Al)
Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Cobalt (Co)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Molybdenum (Mo)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

Observations collected during freshet (April to July inclusive) were excluded. Observations where the month of sampling was not known were also excluded. Lastly, only stations where at least 7 of the possible 12 metals were observed are shown in Figure 11. An index value greater than one indicates that on average the values of metals exceed guidelines. Approximately 23% of the computed Metal Index values (212 out of 920) exceed one.

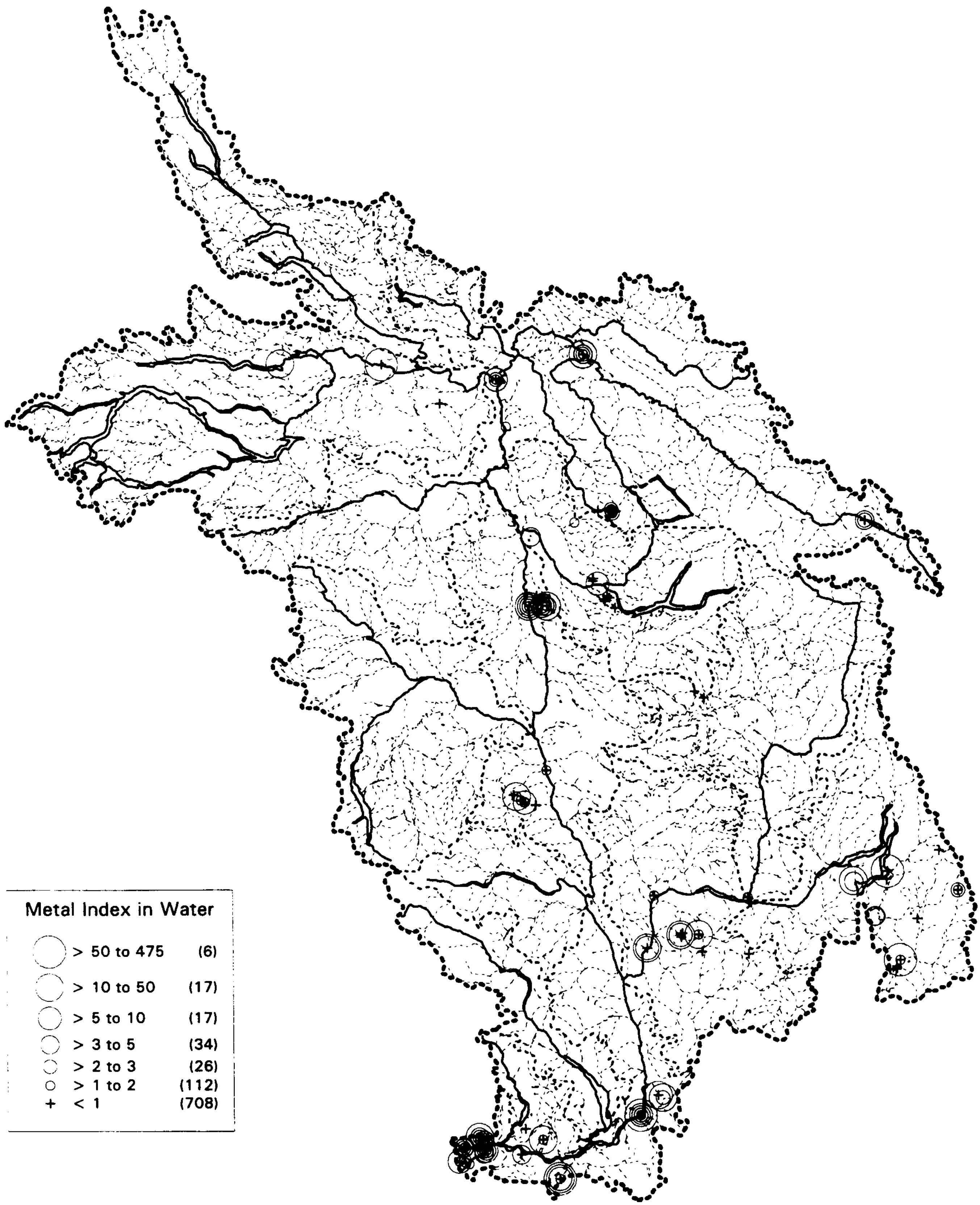

Metal Index in Water
> 50 to 475 (6)
> 10 to 50 (17)
> 5 to 10 (17)
> 3 to 5 (34)
> 2 to 3 (26)
> 1 to 2 (112)
+ < 1 (708)

Figure 12. Metals in Water

Figure 12 illustrates the distribution of the total metals in water over the period 1980 to 1994. Like Figure 11, this map is based on the following 12 metals, however, there was no requirement for a minimum number of metals to be observed at the same station.

- Aluminum (Al)
- Arsenic (As)
- Cadmium (Cd)
- Chromium (Cr)
- Cobalt (Co)
- Copper (Cu)
- Lead (Pb)
- Mercury (Hg)
- Molybdenum (Mo)
- Nickel (Ni)
- Selenium (Se)
- Zinc (Zn)

Observations collected during freshet (April to July inclusive) were excluded. Observations where the month of sampling was not known were also excluded. At approximately 38% of the stations the concentrations observed exceed one or more guidelines for metals (see Table 1).

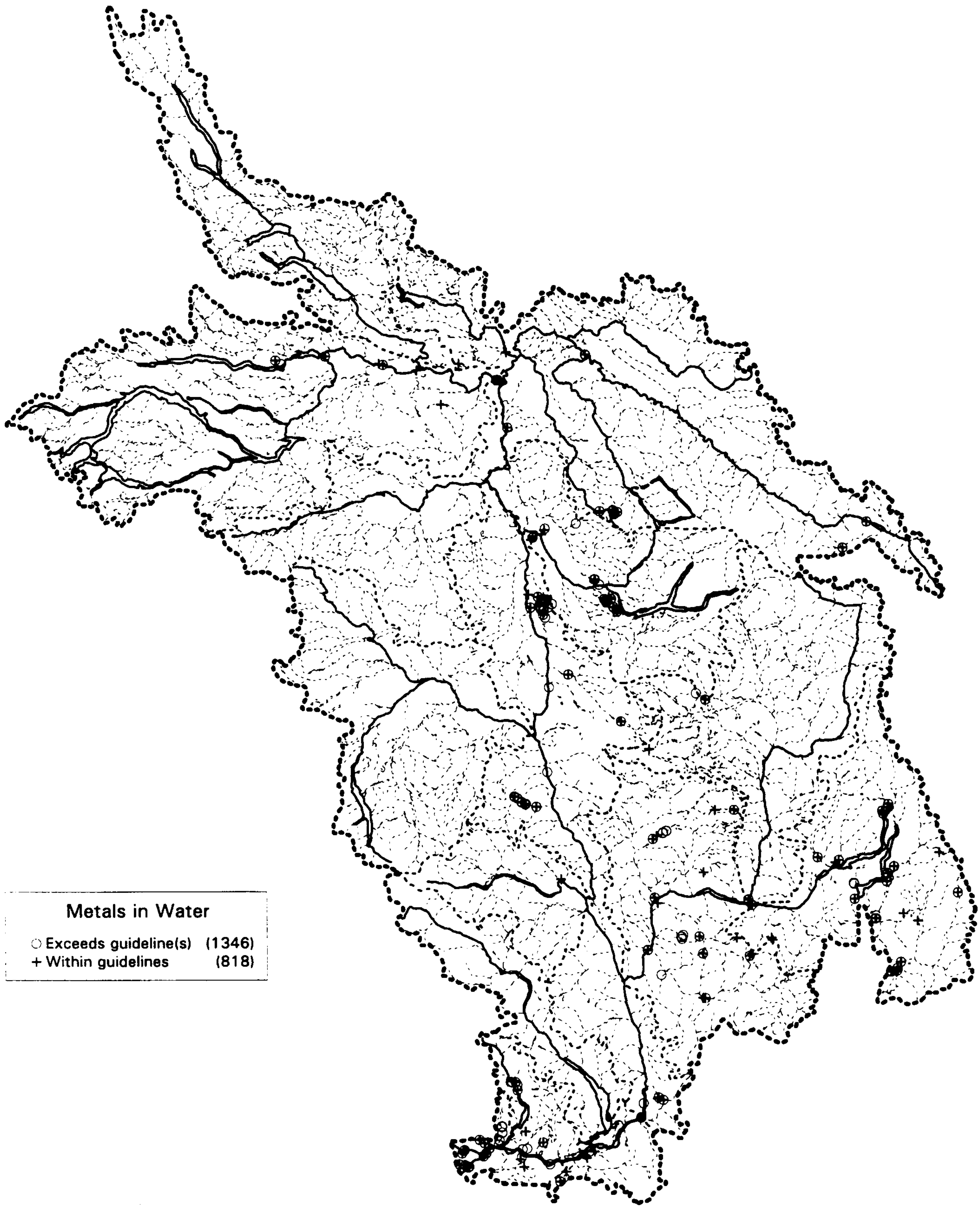

Metals in Water
○ Exceeds guideline(s) (1346)
+ Within guidelines (818)

Figure 13. Metal Index in Sediment

Figure 13 illustrates the distribution of the computed Metal Index in Sediment over the period 1980 to 1994. The Metal Index is based on the average of the ratio of the observed concentrations of the following metals relative to guidelines (see Table 1):

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Cobalt (Co)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

Only stations where at least 6 of the possible 10 metals were observed are shown in Figure 13. An index value greater than one indicates that on average the values of metals exceed guidelines. Approximately 83% of the computed Metal Index values (84 out of 101) exceed one.

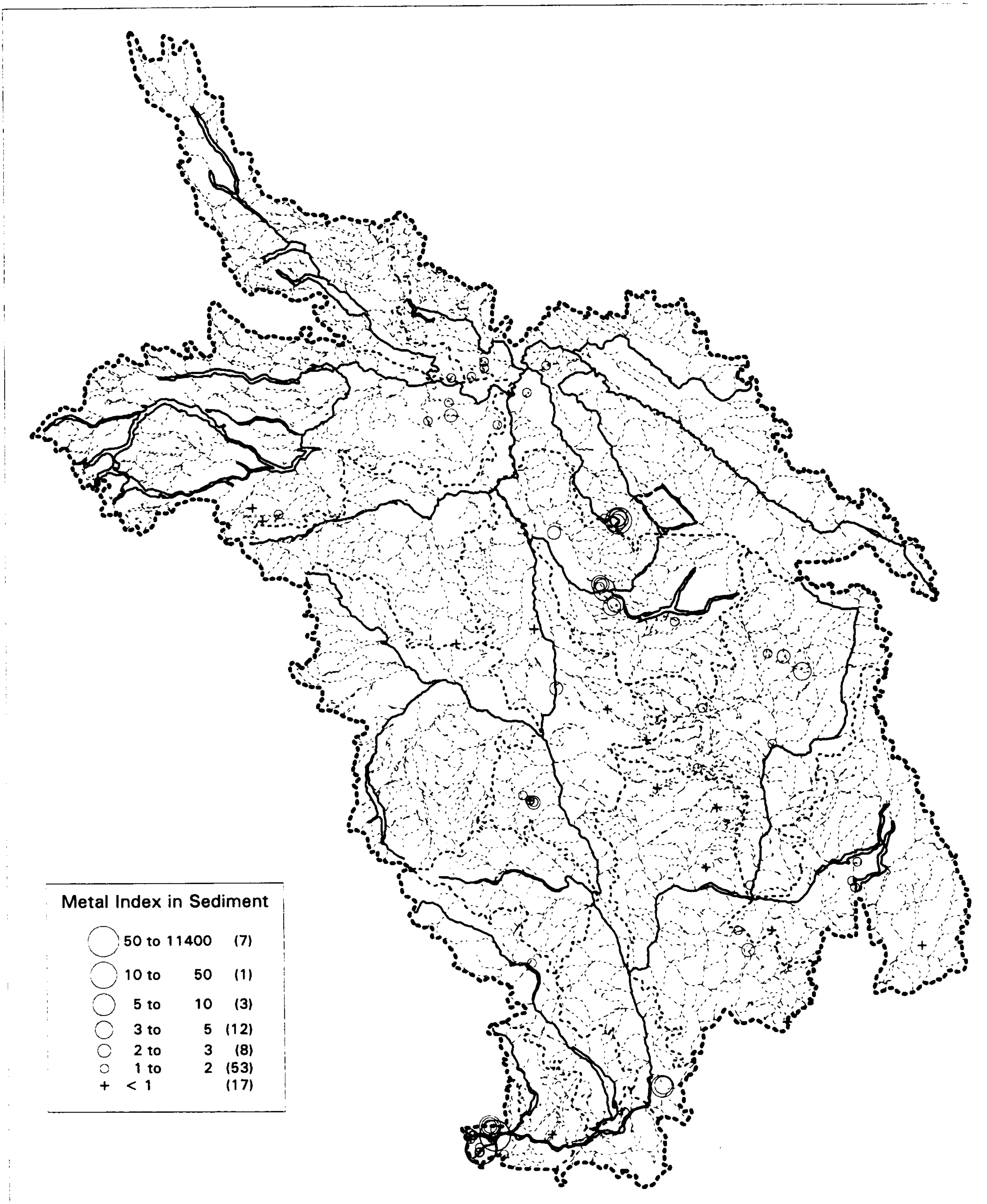

Metal Index in Sediment
50 to 11400 (7)
10 to 50 (1)
5 to 10 (3)
3 to 5 (12)
2 to 3 (8)
1 to 2 (53)
+ < 1 (17)

Figure 14. Metals in Sediment

Figure 14 illustrates the distribution of the total metals in sediment over the period 1980 to 1994. Like Figure 13, this map is based on the following 10 metals, however, there was no requirement for a minimum number of metals to be observed at the same station.

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Cobalt (Co)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Nickel (Ni)
Selenium (Se)
Zinc (Zn)

At approximately 91% of the stations the concentrations observed exceed one or more guidelines for metals (see Table 1).

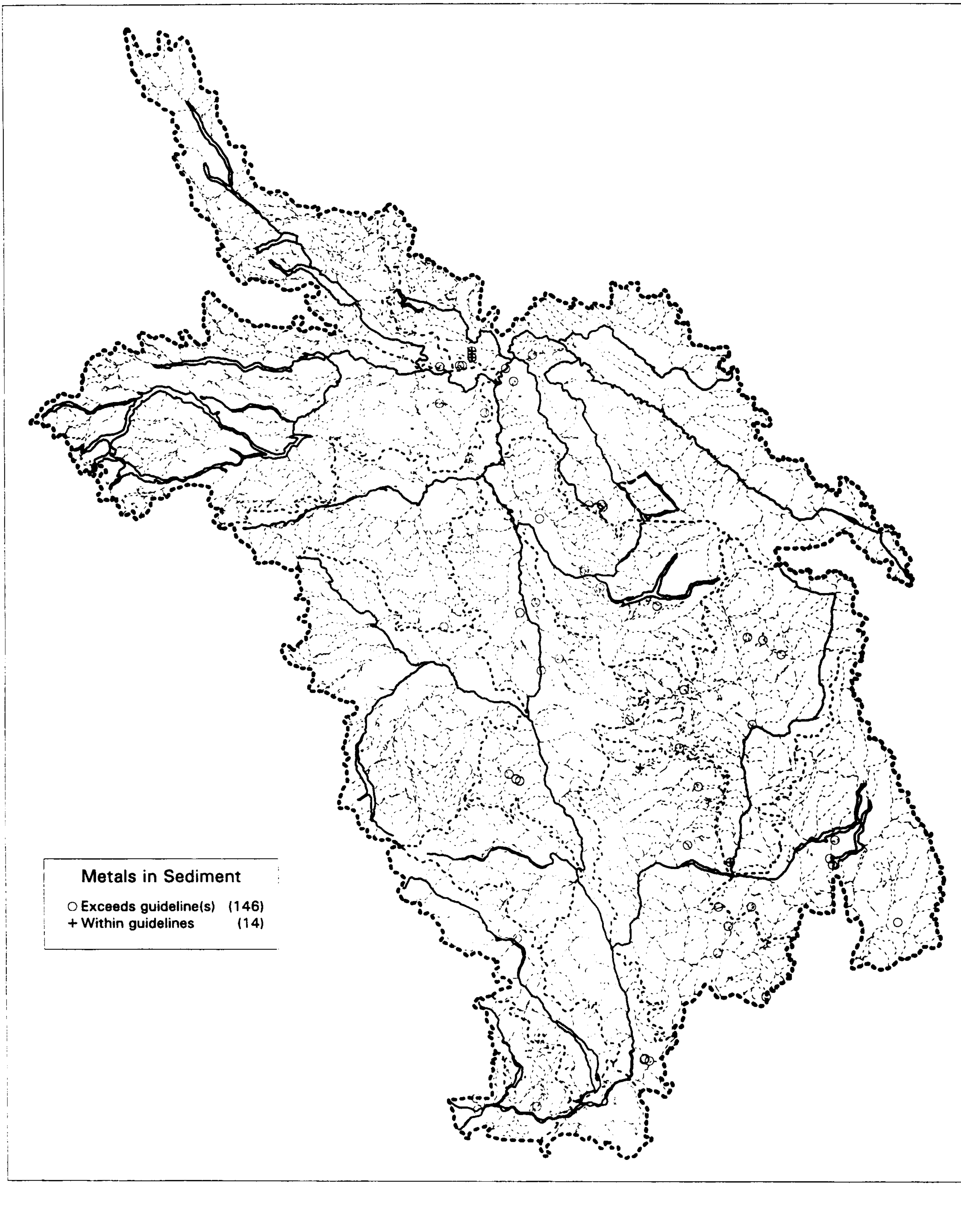

Metals in Sediment
○ Exceeds guideline(s) (146)
+ Within guidelines (14)

Figure 15. Metals in Fish

Figure 15 illustrates the distribution of the total metals in fish over the period 1980 to 1994. This map is based on the following 8 metals. It was not possible to develop a metal index for fish. Only 33 out of 123 stations had observations of more than one metal. No stations had observations of more than 4 metals. All 123 stations are south of Kamloops near the border between the Thompson/Nicola and Thompson/Shuswap HMAs.

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Selenium (Se)
Zinc (Zn)

At approximately 27% of the stations the concentrations observed exceed one or more guidelines for metals (see Table 1).

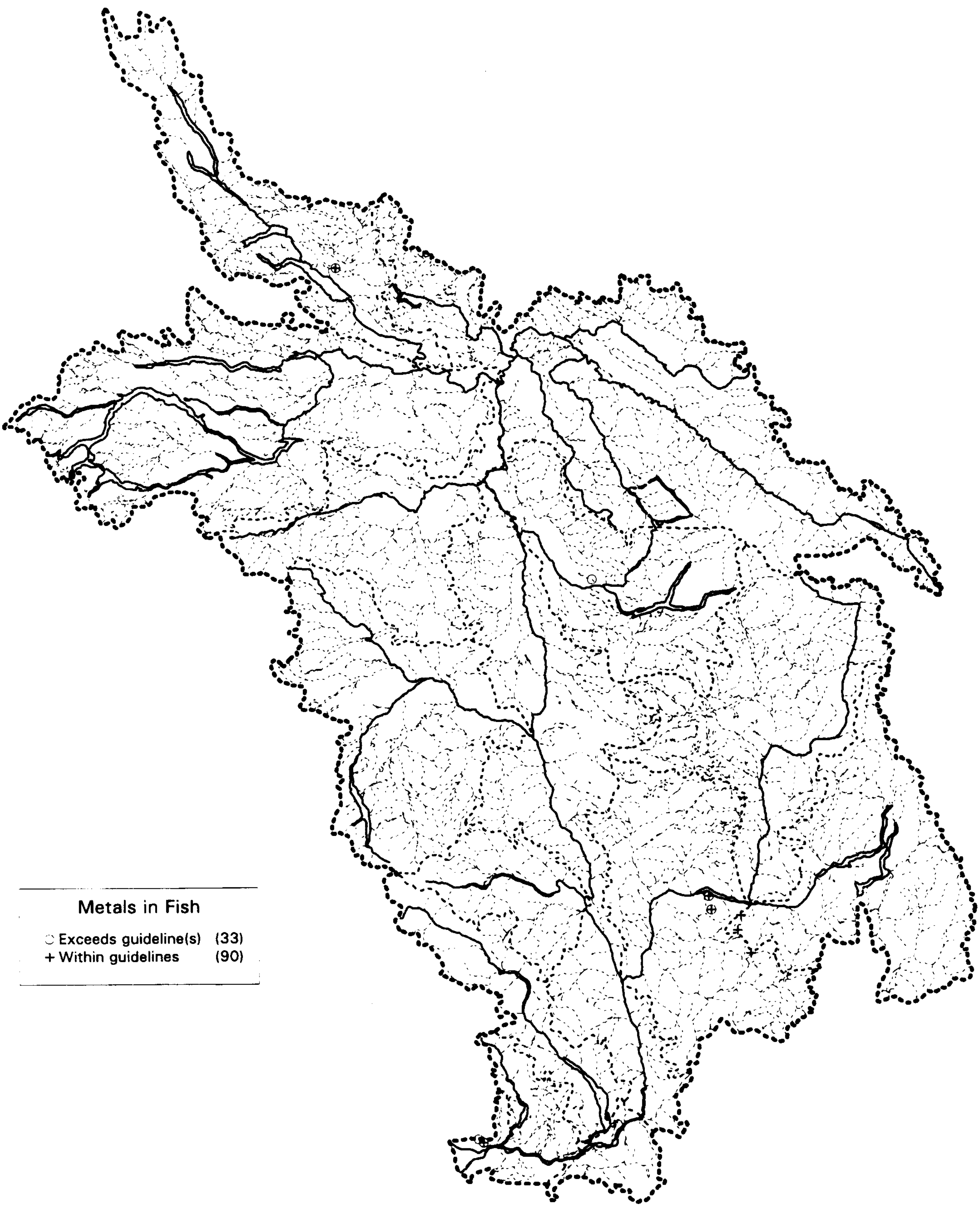

Metals in Fish
○ Exceeds guideline(s) (33)
+ Within guidelines (90)

Figure 16. Active and Abandoned Mines

Figure 16 illustrates the distribution of active and abandoned mines (potential sources of metals) within the Fraser Basin. These data are from the MINFILE database maintained by the Ministry of Energy, Mines and Petroleum Resources (L. Jones, pers. comm.).

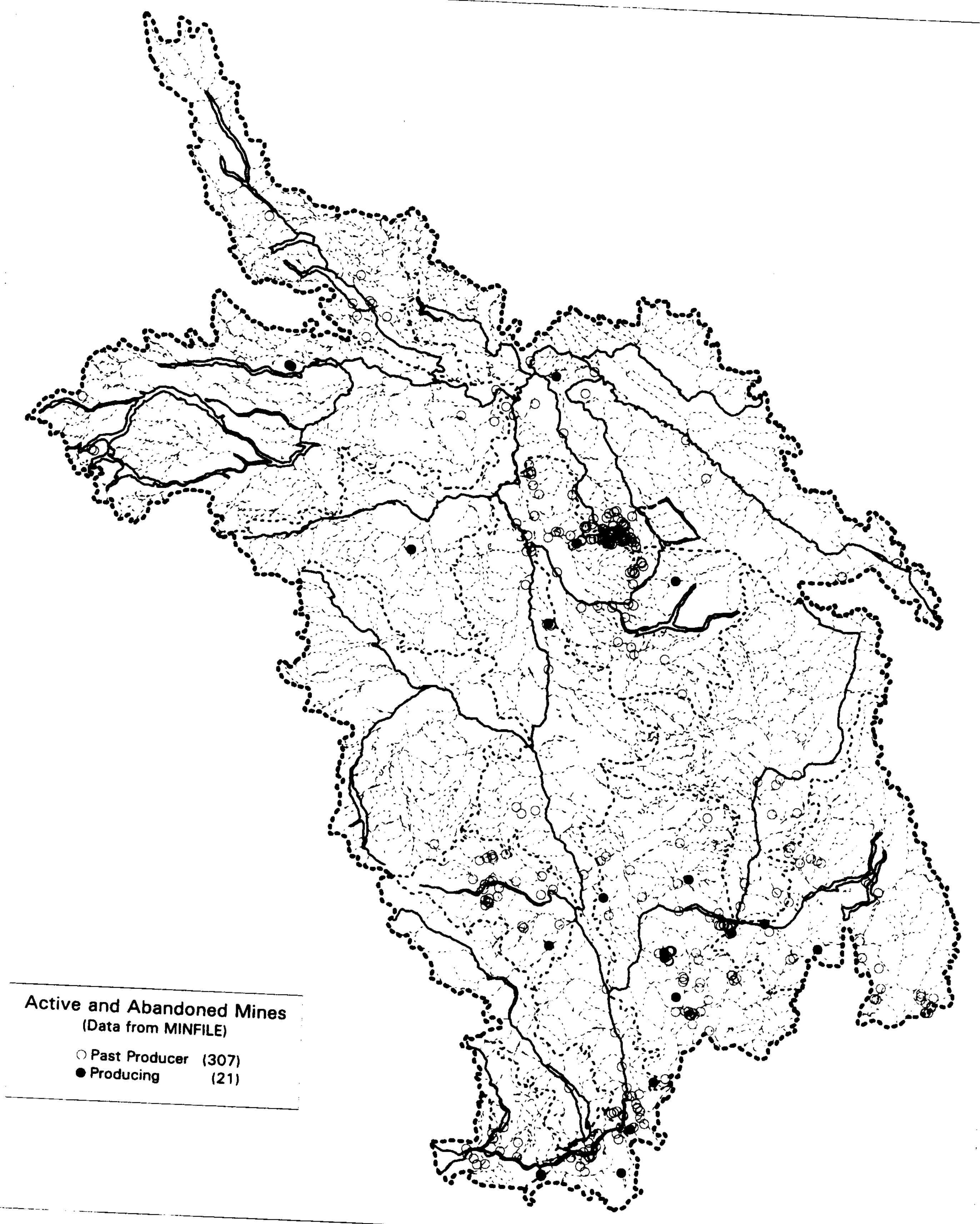

Active and Abandoned Mines
(Data from MINFILE)
○ Past Producer (307)
● Producing (21)

Figure 17. Dioxin Index in Sediment

Figure 17 illustrates the distribution of the computed Dioxin Index in Sediment over the period 1980 to 1994. Only data from 1988 to 1990 are available in the database. The Dioxin Index is the sum of the International Toxicity Equivalents (TEQs) for dioxin and furan congeners of concern. The International Toxicity Equivalents standardize the dioxin and furan congeners of concern relative to the toxicity of 2,3,7,8-tetrachlorodibenzodioxin. Therefore the Dioxin Index is a measure of the combined toxicity of the dioxins and furans in the sediment. In computing this index, values reported as below detection were treated as zero. The International Toxicity Equivalency Factors (I-TEFs) used in the computations are presented in Table 3.

Twelve (12) out of 49 stations had no detectable congeners of concern. Two very high values (more than 250 pg/g TEQ) were reported in 1988 in the vicinity of Kamloops. All stations with index values greater than ten are all in the vicinity of pulp mills.

Please see Section 5.2 (page 18-19) for discussion and concerns regarding interpretation of these results.

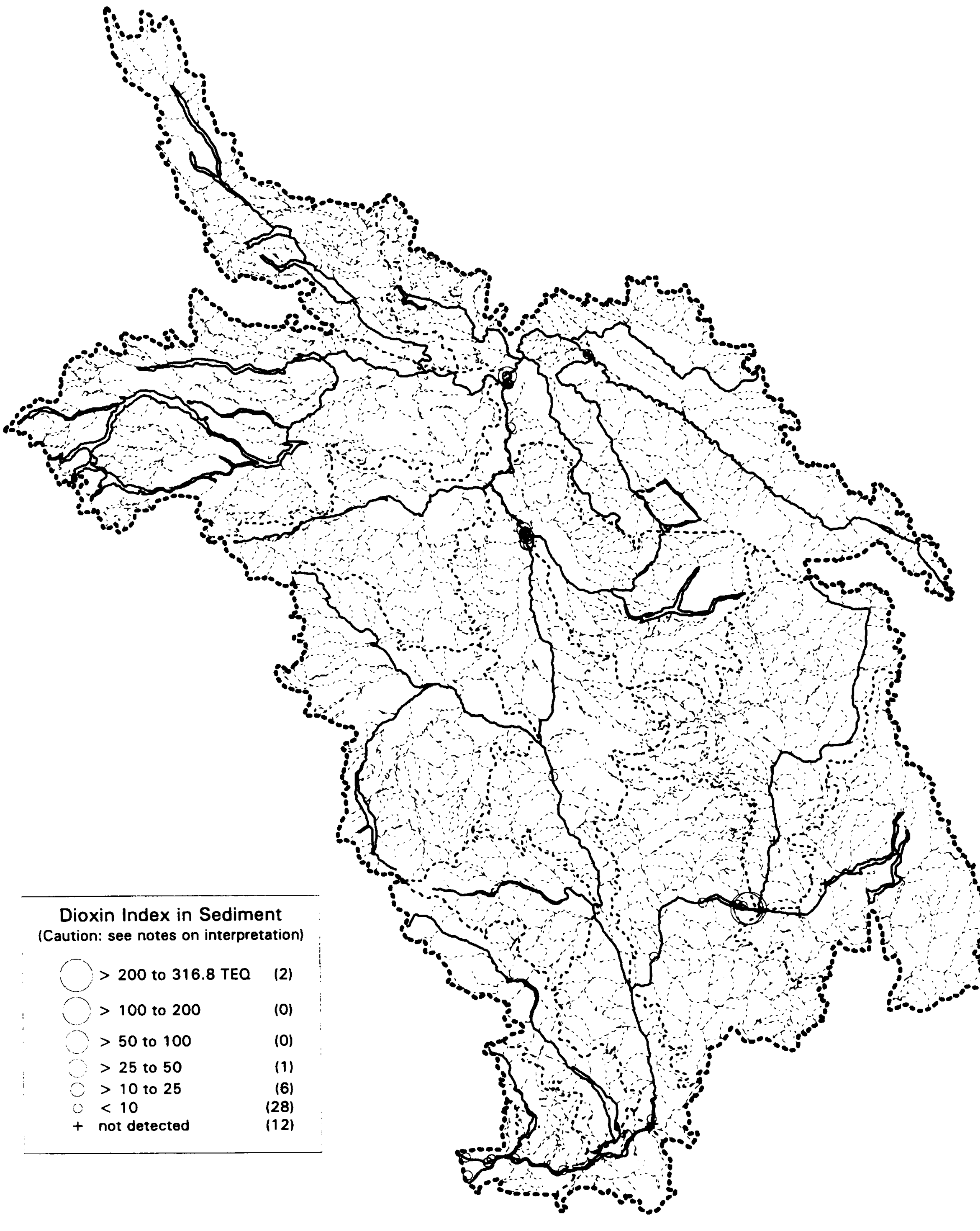
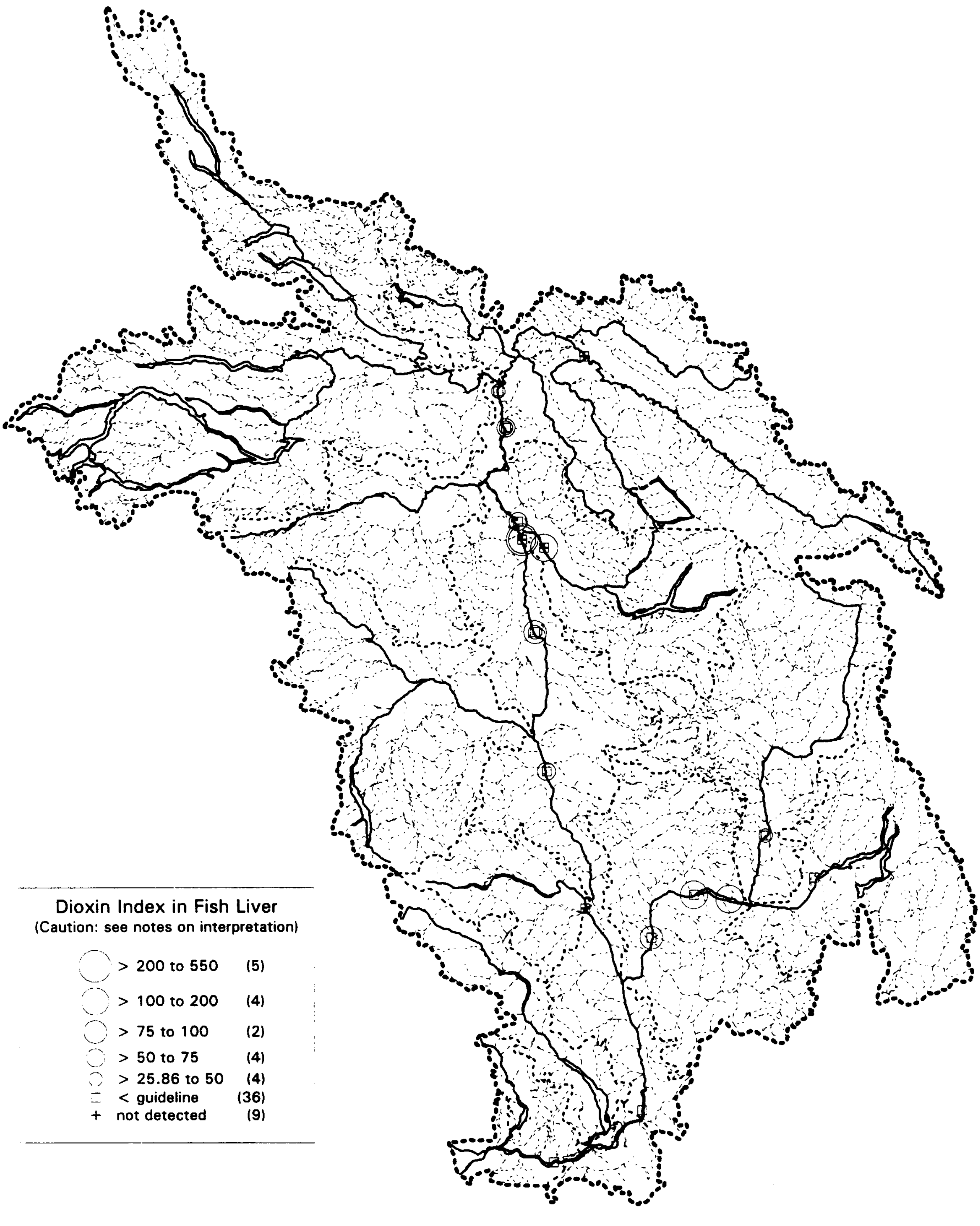

Dioxin Index in Sediment
(Caution: see notes on interpretation)
> 200 to 316.8 TEQ (2)
> 100 to 200 (0)
> 50 to 100 (0)
> 25 to 50 (1)
> 10 to 25 (6)
< 10 (28)
+ not detected (12)

Figure 18. Dioxin Index in Fish Liver

Figure 18 illustrates the distribution of the computed Dioxin Index in Fish Liver over the period 1980 to 1994. Only data from 1990 to 1992 are available from the database. The Dioxin Index is the sum of the International Toxicity Equivalents (TEQs) for dioxin and furan congeners of concern. The International Toxicity Equivalents standardize the dioxin and furan congeners of concern relative to the toxicity of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-T4CDD). Therefore the Dioxin Index is a measure of the combined toxicity of the dioxins and furans in the fish liver. In computing this index, values reported as below detection were treated as zero. The International Toxicity Equivalency Factors (I-TEFs) used in the computations are presented in Table 3.

Nine (9) out of 64 samples had no detectable congeners of concern. Nineteen (19) samples exceed the guideline for 2,3,7,8-T4CDD in fish tissue. The pattern of distribution shows some relationship to the locations of pulp mills. However, fish with high index values are seen at locations substantially downstream of pulp mills and in tributaries upstream from pulp mills.

Please see Section 5.2 (page 18-20) for discussion and concerns regarding interpretation of these results.



Dioxin Index in Fish Liver
(Caution: see notes on interpretation)
> 200 to 550 (5)
> 100 to 200 (4)
> 75 to 100 (2)
> 50 to 75 (4)
> 25.86 to 50 (4)
< guideline (36)
+ not detected (9)

Figure 19. Dioxin Index in Fish Muscle

Figure 19 illustrates the distribution of the computed Dioxin Index in Fish Muscle over the period 1980 to 1994. Only data from 1988 to 1992 are available from the database. The Dioxin Index is the sum of the International Toxicity Equivalents (TEQs) for dioxin and furan congeners of concern. The International Toxicity Equivalents standardize the dioxin and furan congeners of concern relative to the toxicity of 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-T4CDD). Therefore the Dioxin Index is a measure of the combined toxicity of the dioxins and furans in the fish muscle. In computing this index, values reported as below detection were treated as zero. The International Toxicity Equivalency Factors (I-TEFs) used in the computations are presented in Table 3.

Twenty-six (26) out of 125 samples had no detectable congeners of concern. Twenty-five (25) samples exceed the guideline for 2,3,7,8-T4CDD in fish tissue. The pattern of distribution shows some relationship to the locations of pulp mills. However, fish with high index values are seen at locations substantially downstream of pulp mills and in tributaries upstream from pulp mills.

Please see Section 5.2 (page 18-20) for discussion and concerns regarding interpretation of these results.

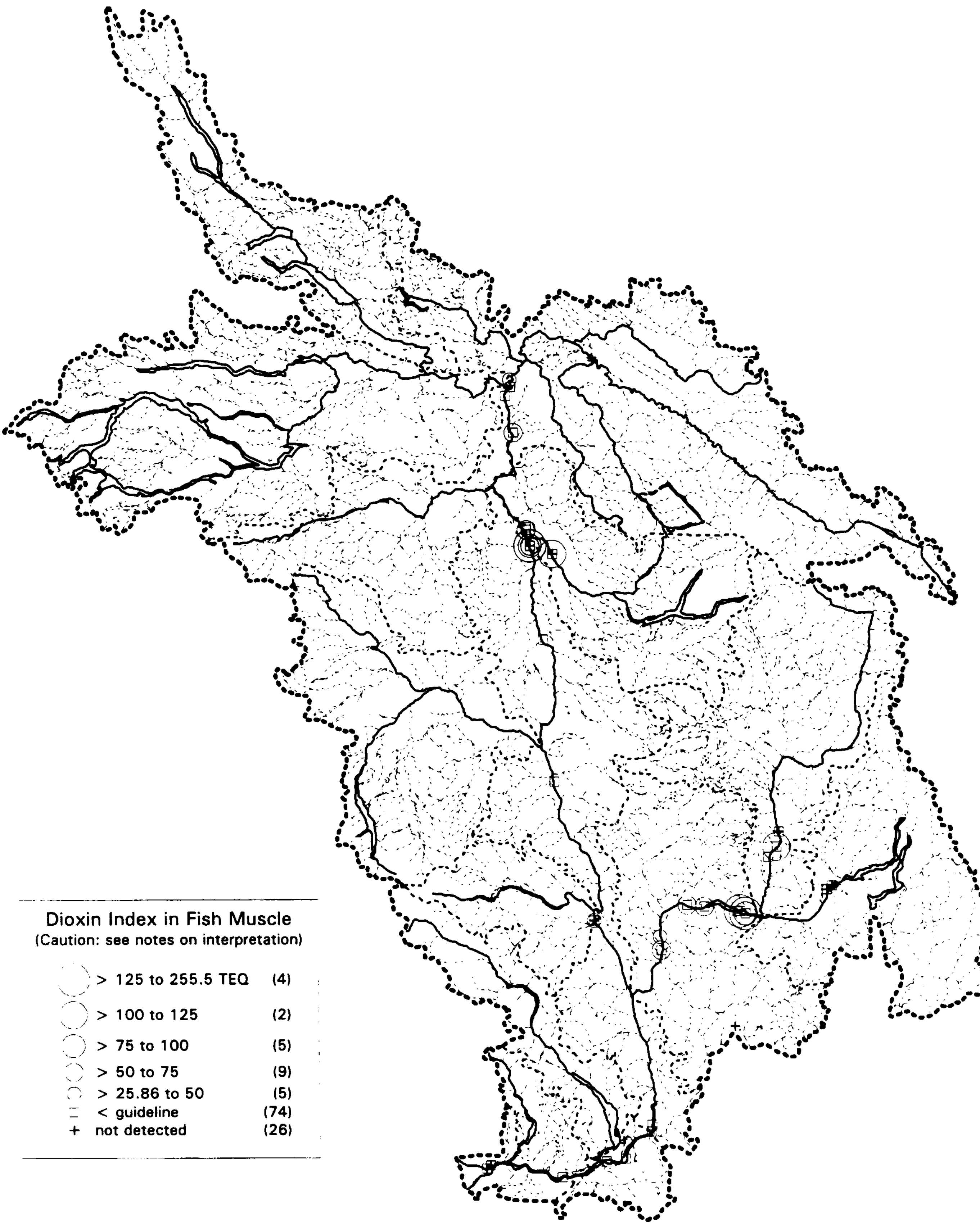

Dioxin Index in Fish Muscle
(Caution: see notes on interpretation)
> 125 to 255.5 TEQ (4)
> 100 to 125 (2)
> 75 to 100 (5)
> 50 to 75 (9)
> 25.86 to 50 (5)
< guideline (74)
+ not detected (26)

Figure 20. PAH Index in Sediment

Figure 20 illustrates the distribution of the computed PAH Index in Sediment over the period 1980 to 1994. The PAH Index is based on the average of the ratio of the observed concentrations of the following PAHs relative to guidelines (see Table 1):

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Crysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Pyrene

All stations in the database analyzed at least 13 of the possible 15 PAHs. All were located in the Fraser Estuary or Boundary Bay. An index value greater than one indicates that on average the values of PAHs exceed guidelines. Approximately 61% of the computed PAH Index values (19 out of 31) exceed one.

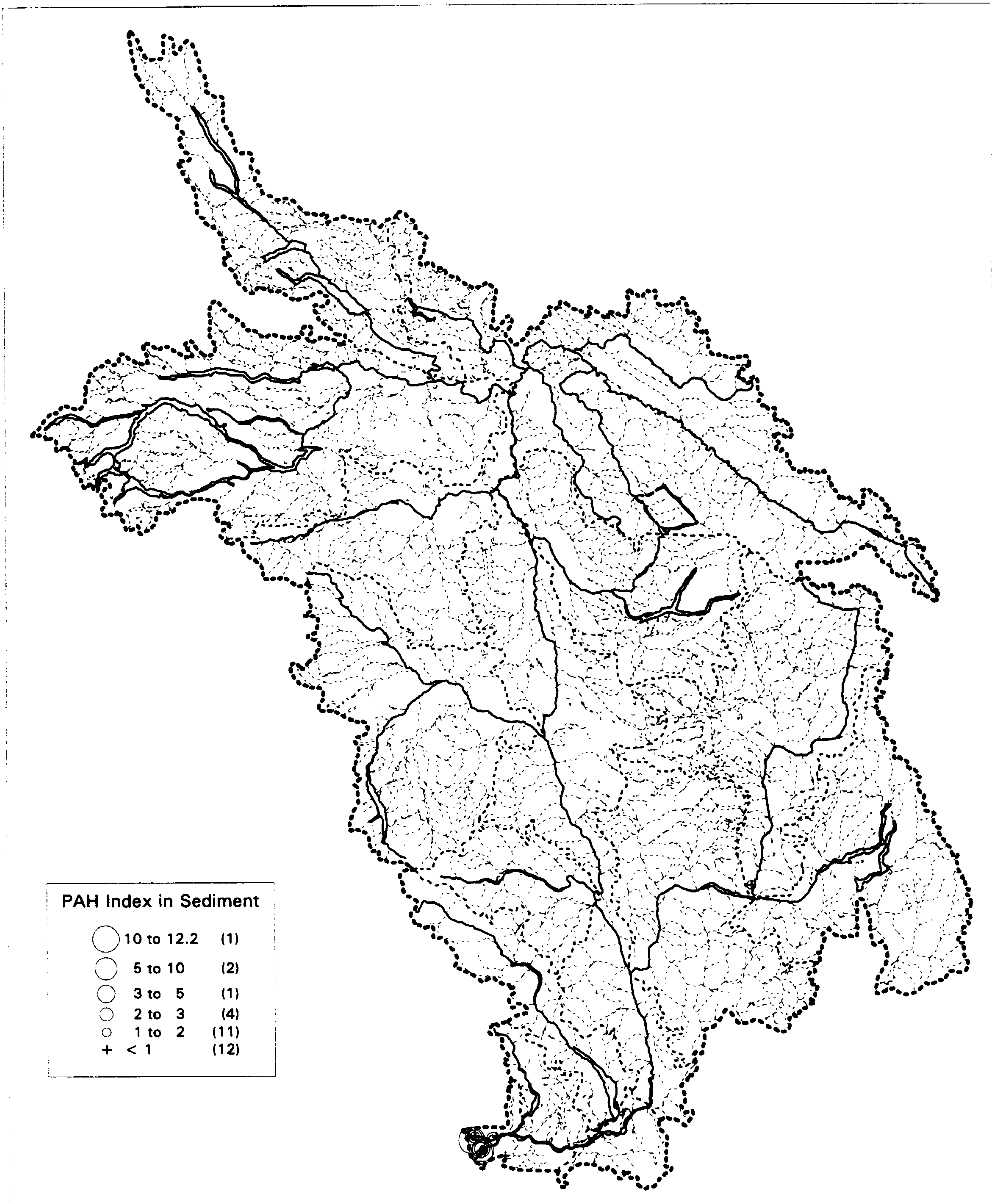

PAH Index in Sediment
10 to 12.2 (1)
5 to 10 (2)
3 to 5 (1)
2 to 3 (4)
1 to 2 (11)
+ < 1 (12)

Figure 21. Chlorophenols in Sediment

Figure 21 illustrates the distribution of the computed Chlorophenols Index in Sediment over the period 1980 to 1994. The Chlorophenols Index is based on the average of the ratio of the observed concentrations of the following chlorophenols relative to the 80th percentiles computed from the database (see Table 2):

Trichlorophenols
Tetrachlorophenols
2,3,4,6-Tetrachlorophenol
2,3,5,6-Tetrachlorophenol
Pentachlorophenol
Tetrachloroguaiacols
3,4,5-Trichloroguaiacol
Tetrachlorocatechols
3,4,5-Trichlorocatechol

All stations in the database observed at least 3 of the possible 9 chlorophenols. An index value greater than one indicates that on average the values of chlorophenols exceed the 80th percentile. Approximately 35% of the computed Chlorophenol Index values (33 out of 95) exceed one.

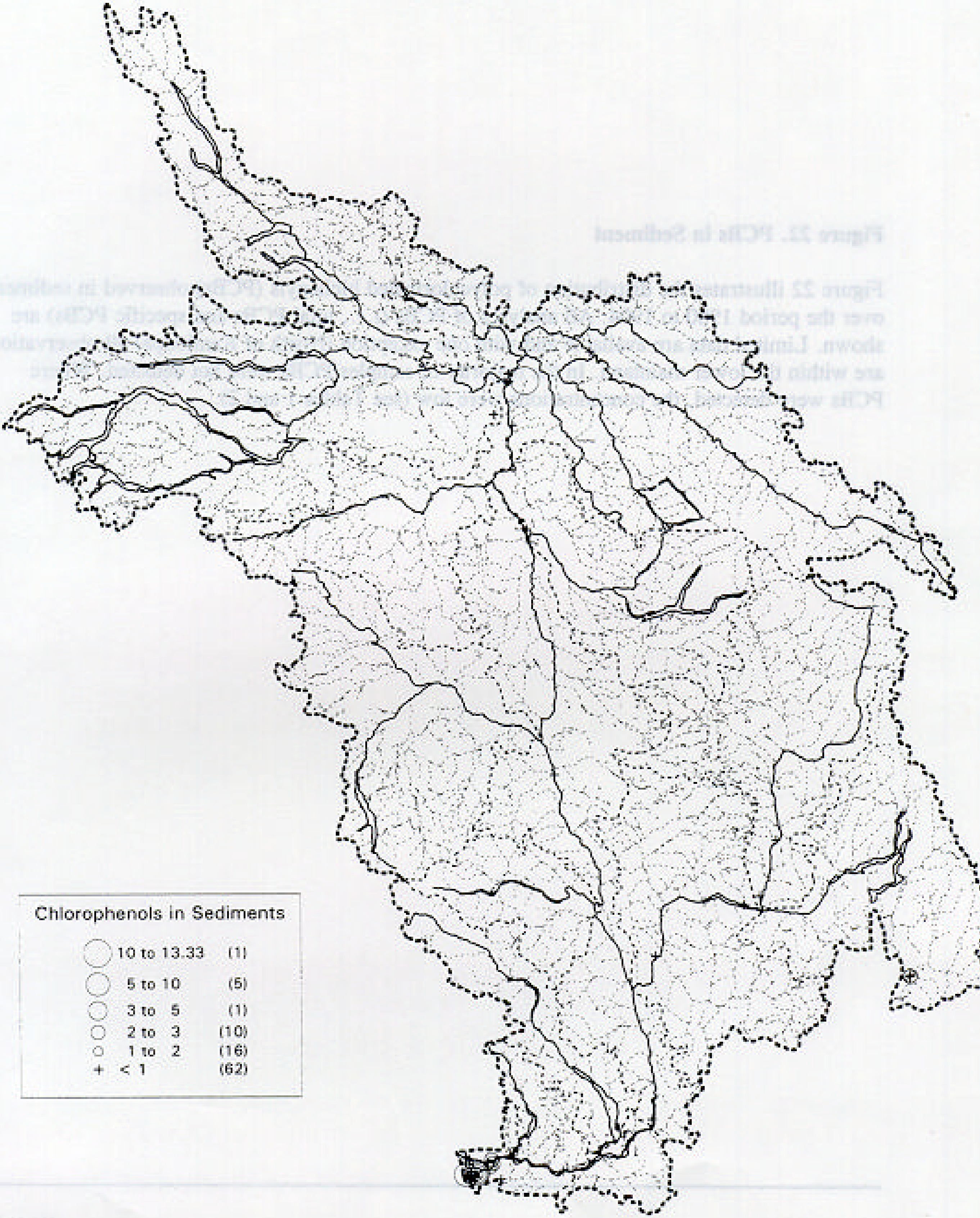

Chlorophenols in Sediments
10 to 13.33 (1)
5 to 10 (5)
3 to 5 (1)
2 to 3 (10)
1 to 2 (16)
+ < 1 (62)

Figure 22. PCBs in Sediment

Figure 22 illustrates the distribution of polychlorinated biphenyls (PCBs) observed in sediment over the period 1980 to 1994. All analyses of PCBs (*i.e.*, total PCBs and specific PCBs) are shown. Limited data are available and with one exception (North of Kamloops) all observations are within the lower mainland. In the majority of samples PCBs were not detected. Where PCBs were detected, the concentrations were low (see Tables 1 and 2).

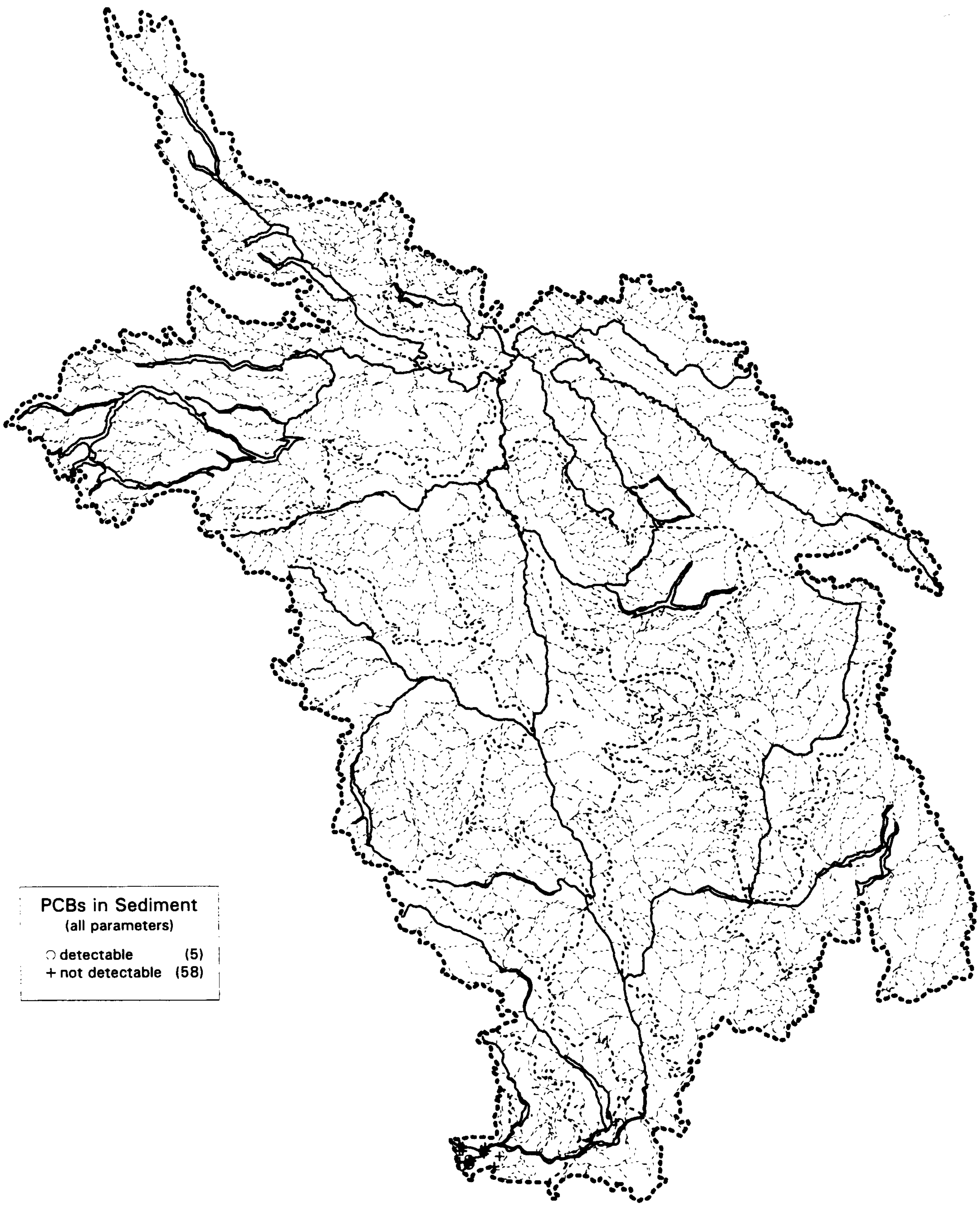
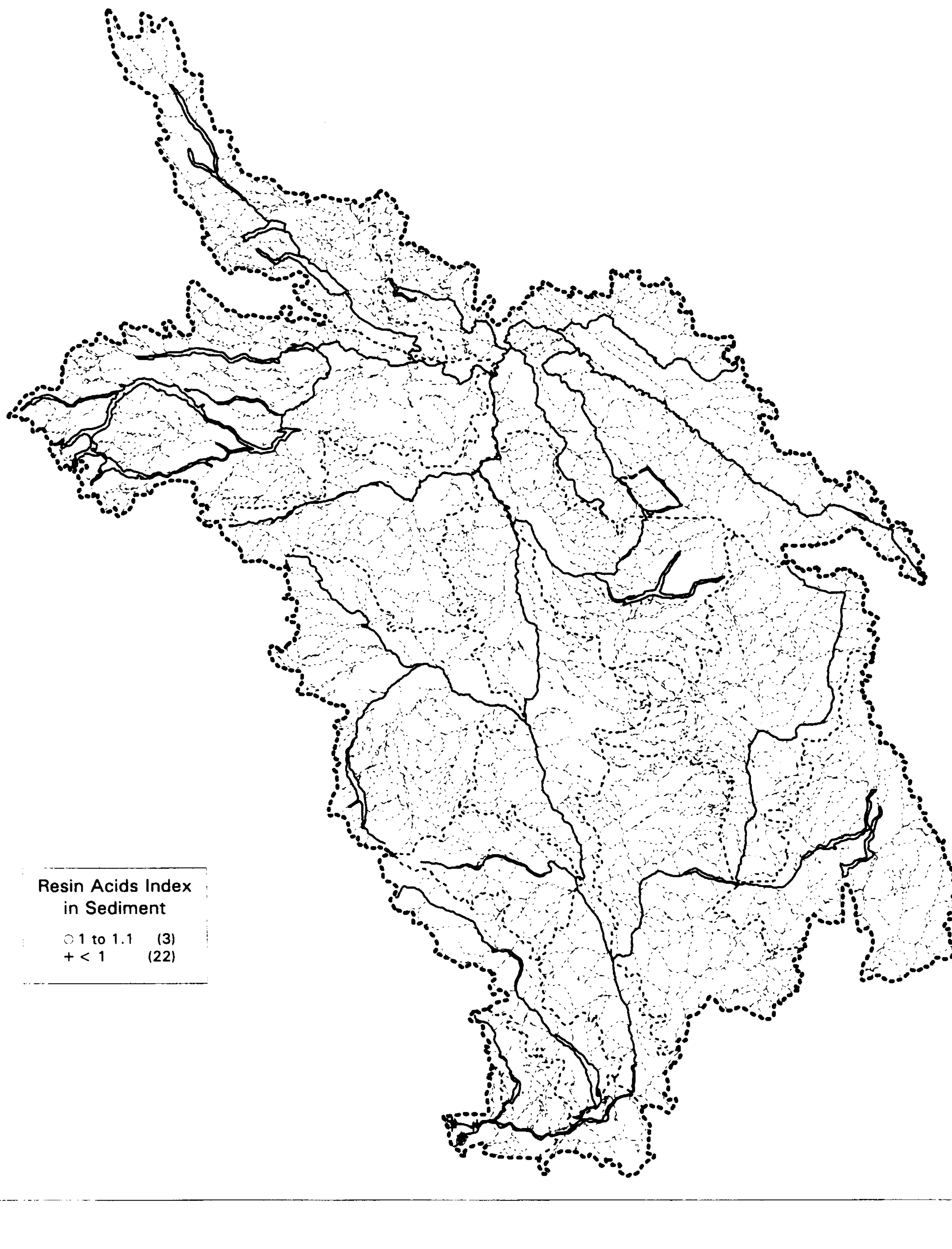

PCBs in Sediment
(all parameters)
○ detectable (5)
+ not detectable (58)

Figure 23. Resin Acid Index in Sediment

Figure 23 illustrates the distribution of the computed Resin Acid Index in Sediment over the period 1980 to 1994. The Resin Acid Index is based on the average of the ratio of the observed concentrations of the following resin acids relative to the 80th percentiles computed from the database (see Table 2):

- Abietic Acid
- Chlorodehydroabietic Acid
- Dehydroabietic Acid
- Isopimaric Acid
- Levo Pimaric Acid
- Neoabietic Acid
- Pimaric Acid
- Sandaraco Pimaric Acid

All stations in the database observed at least 7 of the possible 8 resin acids. All stations are located in the Fraser Estuary. An index value greater than one indicates that on average the values of resin acids exceed the 80th percentile. Three (3) out of 22 of the computed Resin Acid Index values exceed one.


Resin Acids Index
in Sediment
○ 1 to 1.1 (3)
+ < 1 (22)

TABLES

Table 1. Summary Statistics for Parameters with Guidelines

Parameter	Class	Guideline	Source	Total Results		Results Less Than MDL		Descriptive Statistics						
				No. Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Biota, Fish														
P022 Pentachlorophenol	Chlorophenols	2 µg/g	NY	22	3	18	3	0.01	0.02	0.0125	0.00003	<0.01	<0.01	µg/g
P022 Pentachlorophenol	Chlorophenols	2.59 ng/g WW	NY*	79	17	68	17	0.0022	0.0166	0.0069	0.00002	<0.002	<0.002	µg/g WW
T042 2,4,6-Trichlorophenol	Chlorophenols	64.6 µg/g WW	BCMELP*	79	17	68	17	4.5	86	26.03	641.20	<1	<1	ng/g WW
T061 2,3,7,8-T4CDD	Dioxins & furans	25.86 pg/g WW	H&WC*	185	29	87	23	0.6	410	39.34	3994.26	1.4	26	pg/g WW
As-T Arsenic	Metals	0.13 µg/g	BCMELP*	33	4	33	4	nc	nc	nc	nc	nc	nc	µg/g
Cd-T Cadmium	Metals	0.1 µg/g	USEPA	23	4	23	4	nc	nc	nc	nc	nc	nc	µg/g
Cr-T Chromium	Metals	1 µg/g	USEPA	33	4	20	1	1	6	1.92	2.74	<1	1	µg/g
Cu-T Copper	Metals	10 µg/g	USEPA	33	4	6	1	1	125	6.85	558.05	2	3	µg/g
Pb-T Lead	Metals	1.03 µg/g	BCMELP*	21	2	18	1	0.05	18	6.67	96.33	<1	<1	µg/g
Hg-T Mercury	Metals	0.65 µg/g	H&WC*	112	8	1	1	1	3.05	0.46	0.187	0.365	0.72	µg/g
Se-T Selenium	Metals	3 µg/g	BCMELP	33	4	33	4	nc	nc	nc	nc	nc	nc	µg/g
Zn-T Zinc	Metals	40 µg/g	USEPA	33	4	0	0	11	121	25.79	365.42	22	28	µg/g
Biota, Aquatic Invertebrates														
P022 Pentachlorophenol	Chlorophenols	2 µg/g	NY	16	3	7	2	0.02	6.1	1.59	6.71	<0.015	nc	µg/g
T061 2,3,7,8-T4CDD	Dioxins & furans	24.1 pg/g WW	H&WC*	2	1	1	1	2.6	2.6	nc	nc	<1.95	nc	pg/g WW
As-T Arsenic	Metals	0.12 µg/g	BCMELP*	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Cd-T Cadmium	Metals	0.1 µg/g	USEPA	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Cr-T Chromium	Metals	1 µg/g	USEPA	3	3	0	0	16	153	79	4783	16	nc	µg/g
Cu-T Copper	Metals	10 µg/g	USEPA	3	3	0	0	38	116	68.67	1729.33	38	nc	µg/g
Pb-T Lead	Metals	0.96 µg/g	BCMELP*	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Se-T Selenium	Metals	3 µg/g	BCMELP	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Zn-T Zinc	Metals	40 µg/g	USEPA	3	3	0	0	122	203	175	2109	122	nc	µg/g
Sediment														
C010 Chlorobenzene	Halogenated volatile organics	3.5 µg/g	NYSDEC	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
As-T Arsenic	Metals	6 µg/g	BCMELP	45	39	0	0	0.13	2540	77.20	142148	5.41	35	µg/g
Ba-T Barium	Metals	40 µg/g	USEPA	117	69	0	0	17	718	174.56	16285	125	267	µg/g
Cd-T Cadmium	Metals	0.6 µg/g	BCMELP	55	43	0	0	0.13	49700	2087.77	54462017	1	3	µg/g
Co-T Cobalt	Metals	50 µg/g	OMEE	142	92	40	28	10	78.3	19.17	131.15	13	20	µg/g
Cr-T Chromium	Metals	26 µg/g	BCMELP	148	93	1	1	4	492	41.96	2118.64	32	55.9	µg/g
Cu-T Copper	Metals	18 µg/g	BCMELP	148	93	0	0	8	108000	2282.70	129241075	41	65	µg/g
Fe-T Iron	Metals	0.2 mg/g	BCMELP	148	93	0	0	7.8	145000	30051.80	584752699	25550	38800	µg/g
Pb-T Lead	Metals	31 µg/g	BCMELP	148	93	39	31	10	50700	1201.40	31514843	16	43	µg/g
Mn-T Manganese	Metals	460 µg/g	BCMELP	148	93	0	0	0.039	35900	1272.04	12203082	484.5	964	µg/g
Hg-T Mercury	Metals	0.2 µg/g	BCMELP	93	73	12	12	0.041	0.77	0.1139	0.0113	0.07	0.13	µg/g
Ni-T Nickel	Metals	16 µg/g	BCMELP	148	93	0	0	0.22	575	42.68	2702.30	38	56	µg/g
Se-T Selenium	Metals	5 µg/g	BCMELP	42	40	0	0	0.14	378	32.15	4257.19	12	22	µg/g
Zn-T Zinc	Metals	120 µg/g	BCMELP	141	87	0	0	12	415	113.40	4874.39	103	146	µg/g
A002 Aldrin	Organochlorine pesticides	2 ng/g	SLAP	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
D022 Dieldrin	Organochlorine pesticides	0.1 ng/g	DOE92	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
D023 DDE	Organochlorine pesticides	5 ng/g	BCMELP	6	2	3	2	0.0005	0.0006	0.00053	0.00001	<0.0005	nc	µg/g
D025 DDD	Organochlorine pesticides	8 ng/g	BCMELP	6	2	5	2	0.005	0.005	nc	nc	<0.001	nc	µg/g
D026 DDT	Organochlorine pesticides	8 ng/g	BCMELP	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
E007 Endrin	Organochlorine pesticides	1 ng/g	DOE92	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
H001 Heptachlor	Organochlorine pesticides	0.3 ng/g	DOE92	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
H002 Heptachlor Epoxide	Organochlorine pesticides	1 ng/g	DOE92	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
L002 Lindane	Organochlorine pesticides	0.9 ng/g	DOE92	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
D010 Diazinon	Organophosphate pesticides	0.19 ng/g	ECOTOX	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
PA01 Acenaphthene	Polycyclic aromatic hydrocarbons	0.01 µg/g	DOE92	31	25	14	10	0.007	0.15	0.0292	0.00113	0.007	0.02	µg/g
PA02 Acenaphthylene	Polycyclic aromatic hydrocarbons	0.01 µg/g	BCMELP	31	25	18	15	0.005	0.062	0.0126	0.00025	<0.005	0.006	µg/g
PA03 Anthracene	Polycyclic aromatic hydrocarbons	0.02 µg/g	DOE92	31	25	11	7	0.005	0.16	0.0404	0.00159	0.0196	0.025	µg/g
PA04 Benzo(a)anthracene	Polycyclic aromatic hydrocarbons	0.05 µg/g	DOE92	31	25	12	7	0.011	0.54	0.0843	0.01312	0.044	0.06	µg/g
PA05 Benzo(a)pyrene	Polycyclic aromatic hydrocarbons	1 µg/g	Pommen	31	25	10	6	0.021	0.53	0.0717	0.01211	0.027	0.047	µg/g
PA07 Benzo(ghi)perylene	Polycyclic aromatic hydrocarbons	0.1 µg/g	BCMELP	31	25	15	12	0.021	0.41	0.0608	0.00896	<0.02	0.033	µg/g
PA08 Benzo(k)fluoranthene	Polycyclic aromatic hydrocarbons	0.24 µg/g	BCMELP	31	25	19	14	0.01	0.36	0.0653	0.00958	<0.02	0.024	µg/g
PA09 Crysene	Polycyclic aromatic hydrocarbons	0.1 µg/g	BCMELP	31	25	12	7	0.013	0.75	0.1026	0.02559	0.049	0.076	µg/g

nc = not computed

* *Guideline adjusted from wet weight basis to dry weight basis or vice versa based on average biota moisture content (fish: 77.35%, invertebrates: 83%)*

Table 1. Summary Statistics for Parameters with Guidelines (Continued)

Parameter	Class	Guideline	Source	Total Results		Results Less Than MDL		Descriptive Statistics						
				No. Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	90th Percentile	Units
Sediment (Continued)														
PA10 Dibenzo(a,h)anthracene	Polycyclic aromatic hydrocarbons	5 ng/g	BCMELP	8	7	0	0	0.012	0.15	0.0494	0.00243	0.022	nc	µg/g
PA11 Fluoranthene	Polycyclic aromatic hydrocarbons	0.02 µg/g	DOE92	31	25	8	5	0.006	1.61	0.2203	0.11017	0.089	0.17	µg/g
PA12 Fluorene	Polycyclic aromatic hydrocarbons	0.01 µg/g	DOE92	25	20	3	1	0.005	0.2	0.0381	0.00178	0.022	0.043	µg/g
PA13 Indeno(1,2,3-cd)pyrene	Polycyclic aromatic hydrocarbons	0.07 µg/g	BCMELP	31	25	11	9	0.005	0.55	0.0613	0.01363	0.014	0.04	µg/g
PA14 Naphthalene	Polycyclic aromatic hydrocarbons	0.02 µg/g	DOE92	31	25	5	1	0.012	0.74	0.0533	0.01976	0.02	0.028	µg/g
PA15 Phenanthrene	Polycyclic aromatic hydrocarbons	0.03 µg/g	DOE92	31	25	5	3	0.016	0.69	0.1650	0.03257	0.075	0.18	µg/g
PA16 Pyrene	Polycyclic aromatic hydrocarbons	0.49 µg/g	BCMELP	24	19	5	2	0.034	1.55	0.2209	0.11202	0.105	0.16	µg/g
P019 Total PCBs	Polychlorinated biphenyls	0.02 µg/g	BCMELP	32	6	32	6	nc	nc	nc	nc	nc	nc	µg/g
Water														
0450 Fecal Coliform	Human pathogens	200 MPN/cL	CCME	5354	332	965	207	0	920000	832.21	321069969	17	136	MPN/cL
CN-T Total Cyanide	Cyanides	5 µg/L	CCME	114	9	12	5	0.0005	0.356	0.02780	0.00236	0.0055	0.048	mg/L
D060 Dichlorophenols	Chlorophenols	0.2 µg/L	CCME	222	5	222	5	nc	nc	nc	nc	nc	nc	mg/L
M050 Monochlorophenols	Chlorophenols	7 µg/L	CCME	222	5	222	5	nc	nc	nc	nc	nc	nc	mg/L
P022 Pentachlorophenol	Chlorophenols	0.5 µg/L	CCME	254	15	248	14	0.0001	0.0044	0.00162	0.000003	<0.00005	<0.00005	mg/L
T020 Tetrachlorophenols	Chlorophenols	1 µg/L	CCME	253	15	246	15	0.0001	0.0012	0.00061	0	<0.00005	<0.00005	mg/L
T021 Trichlorophenols	Chlorophenols	18 µg/L	CCME	253	13	251	13	0.001	0.001	0.001	0	<0.00005	<0.00005	mg/L
0014 Dissolved Oxygen	Oxygen	<9.5 mg/L	CCME	2799	113	0	0	0	18.4	9.03	12.38	10	11.7	mg/L
Al-D Dissolved Aluminum	Metals	0.05 mg/L	BCMELP	519	91	112	55	0.005	3.25	0.0881	0.05449	0.012	0.03	mg/L
Al-T Aluminum	Metals	0.1 mg/L	CCME	1633	178	153	72	0.004	52.7	0.5973	4.05	0.07	0.14	mg/L
Sb-T Antimony	Metals	0.05 mg/L	BCMELP	100	29	100	29	nc	nc	nc	nc	nc	nc	mg/L
As-T Arsenic	Metals	0.05 mg/L	CCME	867	105	265	92	0.0001	0.13	0.00170	0.00005	<0.04	0.0001	mg/L
Ba-T Barium	Metals	1 mg/L	BCMELP	795	93	26	11	0.0003	0.15	0.02246	0.00022	0.013	0.0192	mg/L
Be-T Beryllium	Metals	5.3 µg/L	BCMELP	520	31	475	31	0.05	0.32	0.09844	0.00338	0.05	0.06	µg/L
Cd-T Cadmium	Metals	0.06 mg/L	CCME	1552	171	1319	170	0.0001	0.04	0.00078	0.000013	<0.0001	<0.0001	mg/L
Co-T Cobalt	Metals	0.05 mg/L	BCMELP	579	49	153	40	0.0001	0.0181	0.00081	0.000003	<0.004	0.0002	mg/L
Cr-T Chromium	Metals	2 µg/L	CCME	762	88	178	33	0.0002	2.29	0.01107	0.00931	0.0003	0.0012	mg/L
Cu-T Copper	Metals	2 µg/L	CCME	1367	140	193	49	0.0003	40.4	0.1163	2.82	0.0012	0.002	mg/L
Fe-T Iron	Metals	0.3 mg/L	CCME	1852	196	86	33	0.0013	87	0.9420	11.68	0.104	0.198	mg/L
Pb-T Lead	Metals	2 µg/L	CCME	955	100	471	68	0.0002	1	0.00776	0.00301	<0.001	<0.001	mg/L
Mn-T Manganese	Metals	1 to 0.1 mg/L	BCMELP	1654	187	270	73	0.0002	24.4	1.568	25.10	0.0074	0.017	mg/L
Hg-T Mercury	Metals	0.1 µg/L	CCME	627	49	414	40	0.00001	1.35	0.0528	0.02779	<0.01	<0.02	µg/L
Mo-T Molybdenum	Metals	1 mg/L	BCMELP	1587	181	816	145	0.0001	1.39	0.0470	0.02443	<0.01	<0.01	mg/L
Ni-T Nickel	Metals	65 µg/L	CCME	1435	183	887	163	0.0002	0.309	0.00576	0.00043	<0.05	<0.05	mg/L
Se-T Selenium	Metals	1 µg/L	CCME	493	12	121	8	0.0001	0.006	0.00027	0	<0.0001	<0.0001	mg/L
Ag-T Silver	Metals	0.1 µg/L	CCME	135	7	130	7	0.0001	0.0006	0.00022	0	<0.0001	<0.0001	mg/L
Ti-T Titanium	Metals	0.1 mg/L	BCMELP	97	24	31	14	0.003	0.103	0.0291	0.00087	<0.003	0.003	mg/L
Zn-T Zinc	Metals	0.03 mg/L	CCME	1584	176	652	137	0.0002	1.65	0.0233	0.0061	0.0009	0.0022	mg/L
0108 Total Ammonia Nitrogen	Nutrients	1.13 mg/L	CCME**	128	9	47	5	0.005	0.43	0.0478	0.0050	0.01	0.04	mg/L
0111 Total Nitrite Nitrogen	Nutrients	0.06 mg/L	CCME	151	9	101	9	0.001	7.46	0.2414	1.14	0.001	0.005	mg/L
P--T Total Phosphorus	Nutrients	15 µg/L	BCMELP	9958	455	364	61	0.002	999	0.1851	104.35	0.018	0.046	mg/L
TPO4 Total Phosphate	Nutrients	45.993 µg/L	CCME***	11	6	0	0	0.003	0.036	0.0096	0.000096	0.005	0.009	mg/L
0117 Phenols	Organics, miscellaneous	1 µg/L	BCMELP	173	27	0	0	0.002	0.29	0.0081	0.000792	0.003	0.006	mg/L
P019 Total PCBs	Polychlorinated biphenyls	1 ng/L	CCME	3	1	3	1	nc	nc	nc	nc	nc	nc	mg/L
0004 pH	Physical parameters	9 to 6.5	CCME	10649	585	0	0	2.6	11.6	7.81	0.272	7.83	8.2	pH units
0013 Temperature	Physical parameters	15 °C	BCMELP	4774	168	2	2	-2.5	29	8.55	32.81	7.5	14.5	°C
Cs37 Cesium-137	Radioactives	50 Bq/L	BCMELP	37	2	31	2	0.0014	0.006	0.0035	0.000004	<0.006	<0.006	Bq/L
U--T Uranium	Radioactives	0.3 mg/L	Pommen	80	2	27	2	0.0002	0.0008	0.00048	0	0.0003	0.0006	mg/L

nc = not computed

** Guideline for total ammonia converted to total ammonia nitrogen by molecular weight

*** Guideline for total phosphorus converted to total phosphate by molecular weight (assumes all phosphorus in form of phosphate)

Table 2. Summary Statistics for Parameters Without Specific Guidelines

Parameter	Class	Total Results		Results Less Than MDL		Descriptive Statistics						
		No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Biota, Fish												
LIPI Lipids	Biological parameters	137	29	0	0	0.2	9.1	2.74	3.13	2.22	3.85	% WW
T020 Tetrachlorophenols	Chlorophenols	22	3	22	3	nc	nc	nc	nc	nc	nc	µg/g
T021 Trichlorophenols	Chlorophenols	22	3	21	3	0.04	0.04	nc	nc	nc	nc	µg/g
T024 Tetrachloroguaiacols	Chlorophenols	79	17	54	16	1.1	285	48.02	6141.19	<1	1.7	ng/g WW
T026 Tetrachlorcatechols	Chlorophenols	79	17	69	17	4.1	13.8	6.69	10.10	<1	<1	ng/g WW
T033 2,3,4-Trichlorophenol	Chlorophenols	79	17	79	17	nc	nc	nc	nc	nc	nc	ng/g WW
T034 2,3,5-Trichlorophenol	Chlorophenols	79	17	79	17	nc	nc	nc	nc	nc	nc	ng/g WW
T043 2,4,5-Trichlorophenol	Chlorophenols	79	17	79	17	nc	nc	nc	nc	nc	nc	ng/g WW
T036 2,3,4,5-T4CP	Chlorophenols	79	17	79	17	nc	nc	nc	nc	nc	nc	ng/g WW
T037 2,3,4,6-T4CP	Chlorophenols	79	17	62	17	1.8	20	7.89	26.26	<1	<1	ng/g WW
T038 2,3,5,6-T4CP	Chlorophenols	79	17	79	17	nc	nc	nc	nc	nc	nc	ng/g WW
T039 3,4,5-Trichloroguaiacol	Chlorophenols	79	17	51	16	1.1	429	74.61	14307.84	<1	2.1	ng/g WW
T041 3,4,5-Trichlorocatechol	Chlorophenols	79	17	69	17	2.7	8.4	5.36	4.28	<1	<1	ng/g WW
0025 Moisture	Descriptive parameters	169	35	0	0	65	89.4	77.35	9.13	77.9	79.3	% WW
T060 T4CDD	Dioxins & furans	184	29	85	23	0.6	410	39.16	3982.58	1.4	29	pg/g WW
P041 P5CDD	Dioxins & furans	145	29	125	29	0.4	88	13.47	450.37	<3	<3	pg/g WW
P040 1,2,3,7,8-P5CDD	Dioxins & furans	153	19	134	19	0.4	88	14.11	467.87	2.1	8.7	pg/g WW
H010 H6CDD	Dioxins & furans	185	29	146	29	0.4	500	50.73	9995.20	<4	6.7	pg/g WW
H011 1,2,3,4,7,8-H6CDD	Dioxins & furans	21	12	20	12	0.2	0.2	nc	nc	<0.3	<0.5	pg/g WW
H012 1,2,3,6,7,8-H6CDD	Dioxins & furans	153	19	119	19	0.4	370	38.58	5358.72	5.5	16	pg/g WW
H013 1,2,3,7,8,9-H6CDD	Dioxins & furans	153	19	143	19	0.8	130	29.14	1621.52	<0.51	1.4	pg/g WW
H014 H7CDD	Dioxins & furans	141	22	128	22	1.3	26	8.6	55.24	<2.4	<4	pg/g WW
H015 1,2,3,4,6,7,8-H7CDD	Dioxins & furans	153	19	142	19	1.3	26	8.57	63.20	<0.7	5	pg/g WW
O101 O8CDD	Dioxins & furans	146	22	133	22	1.2	25	11.85	78.00	<4.05	<7.1	pg/g WW
T062 T4CDF	Dioxins & furans	185	29	38	12	0.3	1185	68.99	22584.39	7	68.1	pg/g WW
T063 2,3,7,8-T4CDF	Dioxins & furans	185	29	38	12	0.25	1185	68.77	22544.83	7	68.1	pg/g WW
P042 P5CDF	Dioxins & furans	179	29	157	29	0.5	45	6.72	102.81	<1.2	<3	pg/g WW
P043 1,2,3,7,8-P5CDF	Dioxins & furans	17	11	12	10	0.2	13	4.98	27.71	<0.1	<0.2	pg/g WW
P044 2,3,4,7,8-P5CDF	Dioxins & furans	153	19	137	19	0.3	31	4.36	54.88	0.45	3.4	pg/g WW
H016 H6CDF	Dioxins & furans	151	22	147	22	1.2	18	6.1	63.8	<1.4	<2.6	pg/g WW
H017 1,2,3,4,7,8-H6CDF	Dioxins & furans	11	7	9	6	0.5	19	9.75	171.13	<0.2	<0.2	pg/g WW
H018 1,2,3,6,7,8-H6CDF	Dioxins & furans	10	7	9	6	0.2	0.2	nc	nc	<0.2	<0.2	pg/g WW
H019 2,3,4,6,7,8-H6CDF	Dioxins & furans	152	19	152	19	nc	nc	nc	nc	nc	nc	pg/g WW
H020 1,2,3,7,8,9-H6CDF	Dioxins & furans	153	19	153	19	nc	nc	nc	nc	nc	nc	pg/g WW
H021 H7CDF	Dioxins & furans	140	22	133	22	1.4	42	13.67	218.80	<1.9	<3.8	pg/g WW
H022 1,2,3,4,6,7,8-H7CDF	Dioxins & furans	153	19	146	19	1.1	22	8.34	78.02	<0.3	1.2	pg/g WW
H023 1,2,3,4,7,8,9-H7CDF	Dioxins & furans	11	8	10	7	0.2	0.2	nc	nc	<0.2	<0.3	pg/g WW
O102 O8CDF	Dioxins & furans	150	22	148	22	0.7	4.3	2.5	6.48	<3.3	<5.6	pg/g WW
Ca-T Calcium	Inorganic parameters	33	4	0	0	173	15300	1723.82	7834129	724	1640	µg/g
Mg-T Magnesium	Inorganic parameters	33	4	0	0	597	1330	916.76	32633.31	856	1040	µg/g
Al-T Aluminum	Metals	33	4	1	1	3	1380	46.03	59254.03	3	3	µg/g
Ba-T Barium	Metals	33	4	32	3	30	30	nc	nc	<1	<1	µg/g
Co-T Cobalt	Metals	33	4	33	4	nc	nc	nc	nc	nc	nc	µg/g
Fe-T Iron	Metals	33	4	0	0	11	2400	99.39	170757	23	35	µg/g
Mn-T Manganese	Metals	33	4	28	3	1	78	17	1163	<1	<1	µg/g
Mo-T Molybdenum	Metals	33	4	33	4	nc	nc	nc	nc	nc	nc	µg/g
Ni-T Nickel	Metals	33	4	32	4	5	5	nc	nc	<5	<5	µg/g
Sr-T Strontium	Metals	33	4	18	3	1	17	4.6	21.69	<1	2	µg/g
V--T Vanadium	Metals	33	4	32	3	6	6	nc	nc	<1	<1	µg/g
P--T Total Phosphorus	Nutrients	33	4	0	0	5470	13900	8827.58	3755638	8190	10200	µg/g

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

		Total Results		Results Less Than MDL		Descriptive Statistics						
Parameter	Class	No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Biota, Aquatic Invertebrates												
LIPI Lipids	Biological parameters	2	1	0	0	1.7	26	13.85	295.25	nc	nc	% WW
T020 Tetrachlorophenols	Chlorophenols	16	3	10	2	0.02	1.4	0.538	0.387	<0.01	<0.01	µg/g
T021 Trichlorophenols	Chlorophenols	16	3	11	3	0.01	0.05	0.024	0.00032	<0.01	0.01	µg/g
0025 Moisture	Descriptive parameters	8	3	0	0	65	88.5	83	56.67	84	nc	% WW
T060 T4CDD	Dioxins & furans	2	1	1	1	2.6	2.6	nc	nc	nc	nc	pg/g WW
P041 P5CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
P040 1,2,3,7,8-P5CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H010 H6CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H011 1,2,3,4,7,8-H6CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H012 1,2,3,6,7,8-H6CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H013 1,2,3,7,8,9-H6CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H014 H7CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H015 1,2,3,4,6,7,8-H7CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
O101 O8CDD	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
T062 T4CDF	Dioxins & furans	2	1	1	1	12	12	nc	nc	nc	nc	pg/g WW
T063 2,3,7,8-T4CDF	Dioxins & furans	2	1	1	1	12	12	nc	nc	nc	nc	pg/g WW
P042 P5CDF	Dioxins & furans	2	1	1	1	2.3	2.3	nc	nc	nc	nc	pg/g WW
P043 1,2,3,7,8-P5CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
P044 2,3,4,7,8-P5CDF	Dioxins & furans	2	1	1	1	0.57	0.57	nc	nc	nc	nc	pg/g WW
H016 H6CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H017 1,2,3,4,7,8-H6CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H018 1,2,3,6,7,8-H6CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H019 2,3,4,6,7,8-H6CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H020 1,2,3,7,8,9-H6CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H021 H7CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H022 1,2,3,4,6,7,8-H7CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
H023 1,2,3,4,7,8,9-H7CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
O102 O8CDF	Dioxins & furans	2	1	2	1	nc	nc	nc	nc	nc	nc	pg/g WW
Ca-T Calcium	Inorganic parameters	3	3	0	0	2300	15900	8156.67	48909633	2300	nc	µg/g
Mg-T Magnesium	Inorganic parameters	3	3	0	0	4130	31200	17010	184483300	4130	nc	µg/g
Al-T Aluminum	Metals	3	3	0	0	2450	2650	2523.33	12133.33	2450	nc	µg/g
Ba-T Barium	Metals	3	3	1	1	9	32	20.5	264.5	<1	nc	µg/g
Be-T Beryllium	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
B--T Boron	Metals	3	3	2	2	34	34	nc	nc	<1	nc	µg/g
Co-T Cobalt	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Fe-T Iron	Metals	3	3	0	0	5390	10800	7403.33	8752233	5390	nc	µg/g
Mn-T Manganese	Metals	3	3	0	0	117	634	330.33	72942.33	117	nc	µg/g
Mo-T Molybdenum	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Ni-T Nickel	Metals	3	3	0	0	42	307	173	17563	42	nc	µg/g
Sr-T Strontium	Metals	3	3	2	2	6	6	nc	nc	<1	nc	µg/g
Te-T Tellurium	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Tl-T Thallium	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Sn-T Tin	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Ti-T Titanium	Metals	3	3	0	0	43	151	88	3159	43	nc	µg/g
V--T Vanadium	Metals	3	3	2	2	7	7	nc	nc	<1	nc	µg/g

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

Parameter	Class	Total Results		Results Less Than MDL		Descriptive Statistics						
		No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Aquatic Plants												
0143 Chlorophyll A	Biological parameters	568	80	10	6		63.8	4.57	38.15	3.1	7.1	µg/L
0143 Chlorophyll A	Biological parameters	527	40	66	9		51.5	8.48	97.89	3.13	12.7	µg/cm2
0146 Phaeophytin A	Biological parameters	27	12	15	10		0.8	0.8	0	<0.5	1.5	µg/L
0146 Phaeophytin A	Biological parameters	22	6	0	0		35.3	5.02	60.68	1.85	4.61	µg/cm2
Sediment												
P022 Pentachlorophenol	Chlorophenols	95	53	57	40	0.001	0.07	0.0208	0.00044	<0.005	0.01	µg/g
T020 Tetrachlorophenols	Chlorophenols	54	14	47	13	0.006	0.16	0.0469	0.00301	<0.005	<0.005	µg/g
T021 Trichlorophenols	Chlorophenols	54	14	48	14	0.007	0.03	0.0132	0.00008	<0.005	<0.005	µg/g
T024 Tetrachloroguaiacols	Chlorophenols	41	39	15	15	0.001	0.087	0.0127	0.00051	0.001	0.002	µg/g
T026 Tetrachlorocatechols	Chlorophenols	34	33	11	11	0.0022	0.043	0.0193	0.00012	0.0105	0.021	µg/g
T033 2,3,4-Trichlorophenol	Chlorophenols	41	39	41	39	nc	nc	nc	nc	nc	nc	µg/g
T034 2,3,5-Trichlorophenol	Chlorophenols	41	39	41	39	nc	nc	nc	nc	nc	nc	µg/g
T043 2,4,5-Trichlorophenol	Chlorophenols	41	39	41	39	nc	nc	nc	nc	nc	nc	µg/g
T042 2,4,6-Trichlorophenol	Chlorophenols	41	39	41	39	nc	nc	nc	nc	nc	nc	µg/g
T036 2,3,4,5-T4CP	Chlorophenols	41	39	41	39	nc	nc	nc	nc	nc	nc	µg/g
T037 2,3,4,6-T4CP	Chlorophenols	41	39	32	30	0.0015	0.012	0.0046	0.00001	<0.005	<0.005	µg/g
T038 2,3,5,6-T4CP	Chlorophenols	41	39	40	39	0.006	0.006	nc	nc	<0.005	<0.005	µg/g
T039 3,4,5-Trichloroguaiacol	Chlorophenols	41	39	13	13	0.001	0.005	0.0025	0.000001	0.00175	0.003	µg/g
T041 3,4,5-Trichlorocatechol	Chlorophenols	41	39	10	10	0.0043	0.1	0.0286	0.00038	0.016	0.031	µg/g
0025 Moisture	Descriptive parameters	110	62	0	0	18.6	77.6	39.09	92.89	38.9	45.6	% WW
C–T Total Carbon	Descriptive parameters	117	58	0	0	4000	382000	134905	12876274260	122000	245000	µg/g
LOI- Loss On Ignition	Descriptive parameters	41	39	0	0	1.1	47.6	9.79	185.11	4.4	5.9	%(W/W)
0033 Particle Size 16 Mesh	Descriptive parameters	53	21	10	5	0.1	42.8	10.01	163.07	0.3	18.2	%
003A Particle Size 30 Mesh	Descriptive parameters	53	21	1	1	0.1	61.9	12.69	228.08	3.4	25.2	%
003B Particle Size 50 Mesh	Descriptive parameters	77	26	1	1	0.2	52.2	15.15	168.15	12.2	25.1	%
003C Particle Size 100 Mesh	Descriptive parameters	53	21	0	0	1	58.7	18.23	243.11	14	28.1	%
003D Particle Size 140 Mesh	Descriptive parameters	53	21	2	2	0.3	18.4	6.08	22.45	5.3	8.5	%
003E Particle Size 200 Mesh	Descriptive parameters	77	26	3	2	0.3	99.5	23.98	622.50	11.1	42	%
003F Particle Size 270 Mesh	Descriptive parameters	53	21	8	3	0.1	25.3	5.82	27.03	4.1	7.2	%
003G Particle Size 400 Mesh	Descriptive parameters	53	21	11	6	0.3	22.8	8.10	33.71	3.7	10.4	%
003H Particle Size >400 Mesh	Descriptive parameters	72	25	1	1	0.2	72.6	24.89	501.68	16.7	46.8	%
Silt Silt (.063mm - 4um)	Descriptive parameters	66	65	0	0	2.5	77.7	43.34	482.31	41	65.1	%
Clay Clay (< 4µm)	Descriptive parameters	64	63	0	0	2.4	37.2	12.6	89.82	8.85	20	%
Sand Sand (2mm - .063mm)	Descriptive parameters	66	65	0	0	0.3	97.1	43.29	833.44	46.85	67.3	%
Grav Gravel (>2mm)	Descriptive parameters	47	46	0	0	0	27.2	1.87	22.06	0	1.4	%
T060 T4CDD	Dioxins & furans	49	49	49	49	nc	nc	nc	nc	nc	nc	pg/g
T061 2,3,7,8-T4CDD	Dioxins & furans	49	49	49	49	nc	nc	nc	nc	nc	nc	pg/g
P041 P5CDD	Dioxins & furans	49	49	49	49	nc	nc	nc	nc	nc	nc	pg/g
P040 1,2,3,7,8-P5CDD	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H010 H6CDD	Dioxins & furans	47	47	41	41	4.9	200	57.62	6522.43	<30	<30	pg/g
H011 1,2,3,4,7,8-H6CDD	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H012 1,2,3,6,7,8-H6CDD	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H013 1,2,3,7,8,9-H6CDD	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H014 H7CDD	Dioxins & furans	45	45	37	37	5.2	118	39.24	1604.64	<50	<50	pg/g
H015 1,2,3,4,6,7,8-H7CDD	Dioxins & furans	16	16	10	10	7.2	28	14.95	73.62	<4.5	7.5	pg/g
O101 O8CDD	Dioxins & furans	47	47	27	27	16	546	151.05	23975.84	56	160	pg/g
T062 T4CDF	Dioxins & furans	49	49	23	23	2	4521	408.65	1146080	2	77.5	pg/g
T063 2,3,7,8-T4CDF	Dioxins & furans	49	49	23	23	2	3168	286.71	566981.29	2	63.7	pg/g
P042 P5CDF	Dioxins & furans	49	49	49	49	nc	nc	nc	nc	nc	nc	pg/g

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

Parameter	Class	Total Results		Results Less Than MDL		Descriptive Statistics						
		No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Sediment (Continued)												
P043 1,2,3,7,8-P5CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
P044 2,3,4,7,8-P5CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H016 H6CDF	Dioxins & furans	47	47	46	46	10	10	nc	nc	<25	<25	pg/g
H017 1,2,3,4,7,8-H6CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H018 1,2,3,6,7,8-H6CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H019 2,3,4,6,7,8-H6CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H020 1,2,3,7,8,9-H6CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
H021 H7CDF	Dioxins & furans	44	44	42	42	8.3	29	18.65	214.245	<40	<40	pg/g
H022 1,2,3,4,6,7,8-H7CDF	Dioxins & furans	12	12	10	10	8.3	14	11.15	16.245	<3.3	<3.8	pg/g
H023 1,2,3,4,7,8,9-H7CDF	Dioxins & furans	16	16	16	16	nc	nc	nc	nc	nc	nc	pg/g
O102 O8CDF	Dioxins & furans	22	22	20	20	7.3	11	9.15	6.845	<7.9	<38	pg/g
B022 1,2-Dichlorobenzene	Halogenated volatile organics	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
B026 1,3-Dichlorobenzene	Halogenated volatile organics	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
B025 1,4-Dichlorobenzene	Halogenated volatile organics	18	17	18	17	nc	nc	nc	nc	nc	nc	µg/g
AVSu Acid Volatile Sulphide	Inorganic parameters	18	17	0	0	7.1	7750	771.44	3150757	260	494	µg/g
Ca-E Extractable Calcium	Inorganic parameters	25	23	0	0	1.7	7790	3454.75	5552307	3900	4890	µg/g
Ca-T Calcium	Inorganic parameters	142	92	0	0	49.7	185000	17053.94	882276298	8900	12700	µg/g
Mg-E Extractable Magnesium	Inorganic parameters	25	23	0	0	145	5330	2076.84	1935610	2470	2930	µg/g
Mg-T Magnesium	Inorganic parameters	148	93	0	0	555	116000	10225.05	199276898	6160	12500	µg/g
Si-T Silicon	Inorganic parameters	2	1	0	0	50	105	77.5	1512.5	nc	nc	µg/g
S--T Sulfur	Inorganic parameters	36	36	0	0	168	26200	5118.31	33683457	2465	6300	µg/g
0124 Total Inorganic Carbon	Inorganic parameters	92	56	3	1	500	189000	8100.97	599744732	2210	4700	µg/g
Al-E Extractable Aluminum	Metals	25	23	7	6	1460	6310	2901.11	1748493	2200	2730	µg/g
Al-T Aluminum	Metals	142	92	7	6	1300	123000	21159.78	302127014	17850	28200	µg/g
Sb-E Extractable Antimony	Metals	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
Sb-T Antimony	Metals	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
As-E Extractable Arsenic	Metals	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
Be-T Beryllium	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
B--T Boron	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Cd-E Extractable Cadmium	Metals	25	23	17	16	1.3	6310	4561.41	3937176	<0.5	4040	µg/g
Cr-E Extractable Chromium	Metals	25	23	0	0	1.4	12.2	4.75	8.63	3.7	5.3	µg/g
Co-E Extractable Cobalt	Metals	25	23	0	0	2	35.8	10.43	110.94	4.4	13.8	µg/g
Cu-E Extractable Copper	Metals	25	23	0	0	12.6	8140	1635.74	7586600	24.5	4160	µg/g
Fe-E Extractable Iron	Metals	25	23	0	0	5.1	17800	5803.61	25207458	5770	7110	µg/g
Pb-E Extractable Lead	Metals	25	23	0	0	5.1	2670	631.13	1067099	9.7	1640	µg/g
Mn-E Extractable Manganese	Metals	25	23	7	6	128	356	198.06	3866.41	150	203	µg/g
Hg-E Extractable Mercury	Metals	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
Mo-E Extractable Molybdenum	Metals	25	23	18	17	7.2	12	9.17	2.88	<5	7.2	µg/g
Mo-T Molybdenum	Metals	148	93	68	39	1	68.5	15.35	264.68	2	17	µg/g
Ni-E Extractable Nickel	Metals	25	23	7	6	6.4	25.7	11.39	27.46	8.2	10.9	µg/g
Se-E Extractable Selenium	Metals	25	23	18	17	15.3	56	26.36	180.90	<0.2	15.3	µg/g
Sr-T Strontium	Metals	117	69	0	0	8	1490	111.86	43057.50	64	101	µg/g
Te-T Tellurium	Metals	3	3	1	1	31	66	48.5	612.5	<20	nc	µg/g
Tl-T Thallium	Metals	3	3	3	3	nc	nc	nc	nc	nc	nc	µg/g
Sn-T Tin	Metals	29	28	7	7	6	19	10.64	13.48	8	12	µg/g
Ti-T Titanium	Metals	3	3	0	0	241	313	277	1296	241	nc	µg/g
V--T Vanadium	Metals	91	56	0	0	9	170	55.58	988.00	49	70	µg/g
Zn-E Extractable Zinc	Metals	18	17	0	0	25.7	147	49.07	937.01	31.65	65.1	µg/g
B020 Benzene	Non-halogenated volatile organic	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
B021 Ethyl Benzene	Non-halogenated volatile organic	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

		Total Results		Results Less Than MDL		Descriptive Statistics						
Parameter	Class	No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Sediment (Continued)												
S010 Styrene	Non-halogenated volatile organic	20	19	18	17	0.986	2.15	1.568	0.6774	<0.001	<0.001	µg/g
T001 Toluene	Non-halogenated volatile organic	25	23	23	21	0.13	0.283	0.2065	0.0117	<0.01	<0.01	µg/g
X002 o-Xylene	Non-halogenated volatile organic	18	17	18	17	nc	nc	nc	nc	nc	nc	µg/g
X003 m,p-Xylene	Non-halogenated volatile organic	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
0113 Total Kjeldahl Nitrogen	Nutrients	18	18	1	1	112	28300	11985.12	95878981	2240	7070	µg/g
P--T Total Phosphorus	Nutrients	79	47	0	0	87	5820	1199.38	938364	680	817	µg/g
C011 alpha-Chlordane	Organochlorine pesticides	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
C012 gamma-Chlordane	Organochlorine pesticides	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
E040 Endosulfan I	Organochlorine pesticides	30	25	30	25	nc	nc	nc	nc	nc	nc	µg/g
E041 Endosulfan II	Organochlorine pesticides	24	19	23	18	0.0015	0.0015	nc	nc	<0.001	<0.001	µg/g
E042 Endosulfan Sulphate	Organochlorine pesticides	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
M016 Methoxychlor	Organochlorine pesticides	31	25	31	25	nc	nc	nc	nc	nc	nc	µg/g
T014 Toxaphene	Organochlorine pesticides	24	19	24	19	nc	nc	nc	nc	nc	nc	µg/g
A008 Azinphos Methyl	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
C007 Carbophenthion	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
D001 Dimethoate	Organophosphate pesticides	25	23	20	18	0.025	0.096	0.0604	0.000911	<0.02	<0.02	µg/g
F030 Fensulothion	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
F031 Fenthion	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
F032 Fonofos	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
M001 Malathion	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
M002 Methamidophos	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
Mvph Mevinphos	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
P001 Parathion	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
P002 Parathion Methyl	Organophosphate pesticides	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
P003 Phosmet	Organophosphate pesticides	18	17	18	17	nc	nc	nc	nc	nc	nc	µg/g
0103 Total Organic Carbon	Organics, miscellaneous	51	46	0	0	1.5	247	25.45	2978.18	8.7	14.1	mg/g
PA06 Benzo(b)fluoranthene	Polycyclic aromatic hydrocarbons	31	25	10	8	0.02	0.8	0.103	0.0264	0.048	0.08	µg/g
P023 Polychlorinated Biphenyls	Polychlorinated biphenyls	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
PC42 PCB 1242	Polychlorinated biphenyls	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
PC48 PCB 1248	Polychlorinated biphenyls	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
PC54 PCB 1254	Polychlorinated biphenyls	25	23	21	19	0.013	0.152	0.057	0.0042	<0.01	<0.01	µg/g
PC60 PCB 1260	Polychlorinated biphenyls	18	17	17	16	0.05	0.05	nc	nc	<0.01	<0.01	µg/g
P009 Bis(diethylhexyl)Phthalate	Phthalate esters	6	2	0	0	0.14	0.64	0.477	0.0328	0.48	nc	µg/g
P010 Dimethyl Phthalate	Phthalate esters	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
P011 Diethyl Phthalate	Phthalate esters	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
P012 Di-n-Butyl Phthalate	Phthalate esters	6	2	5	2	0.12	0.12	nc	nc	<0.1	nc	µg/g
P013 Butylbenzyl Phthalate	Phthalate esters	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
P014 Di-n-Octyl Phthalate	Phthalate esters	6	2	6	2	nc	nc	nc	nc	nc	nc	µg/g
0101 Phenolphthalein 8.3 Alkalinity	Physical parameters	2	2	1	1	76	76	nc	nc	nc	nc	pg/g
0102 Total 4.5 Alkalinity	Physical parameters	2	2	2	2	nc	nc	nc	nc	nc	nc	pg/g
A030 Abietic Acid	Resin and fatty acids	25	23	0	0	0.065	1.86	0.646	0.2921	0.359	0.938	µg/g
C050 Chlorodehydroabietic Acid	Resin and fatty acids	25	23	3	3	0.05	1.09	0.406	0.0840	0.273	0.435	µg/g
D052 Dehydroabietic Acid	Resin and fatty acids	25	23	0	0	0.067	1.75	0.6831	0.3320	0.476	1.2	µg/g
D053 Dichlorodehydroabietic Acid	Resin and fatty acids	25	23	5	5	0.051	0.757	0.2552	0.0547	0.096	0.309	µg/g
I004 Isopimaric Acid	Resin and fatty acids	25	23	9	8	0.073	1.13	0.603	0.1140	0.231	0.726	µg/g
L003 Levo Pimaric Acid	Resin and fatty acids	25	23	25	23	nc	nc	nc	nc	nc	nc	µg/g
N005 Neoabietic Acid	Resin and fatty acids	25	23	18	17	0.187	0.571	0.3259	0.0174	<0.05	0.187	µg/g
P025 Pimaric Acid	Resin and fatty acids	25	23	3	3	0.107	0.718	0.2955	0.0329	0.168	0.424	µg/g
S006 Sandaraco Pimaric Acid	Resin and fatty acids	18	17	3	3	0.057	0.702	0.2754	0.0319	0.163	0.319	µg/g
0032 Total Volatile Residue	Residues	136	53	0	0	1.7	79.7	24.22	542.69	7.95	48.8	%

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

		Total Results		Results Less Than MDL		Descriptive Statistics						
Parameter	Class	No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Suspended Particulates												
T060 T4CDD	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
T061 2,3,7,8-T4CDD	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
P041 P5CDD	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
H010 H6CDD	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
H014 H7CDD	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
O101 O8CDD	Dioxins & furans	2	2	0	0		370	349.5	840.5	nc	nc	pg/g
T062 T4CDF	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
T063 2,3,7,8-T4CDF	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
P042 P5CDF	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
H016 H6CDF	Dioxins & furans	2	2	1	1		14	nc	nc	nc	nc	pg/g
H021 H7CDF	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
O102 O8CDF	Dioxins & furans	2	2	2	2		nc	nc	nc	nc	nc	pg/g
0103 Total Organic Carbon	Organics, miscellaneous	2	2	0	0		2.91	2.71	0.08	2.71	nc	%
Water												
0147 Esherichia coli	Human pathogens	471	57	47	14	1	75000	581.54	17500225	44	179	CFU/cL
0148 Enterococcus	Human pathogens	552	64	45	16	1	12600	260.02	894135	23	146	CFU/cL
0451 Total Coliform	Human pathogens	1202	147	151	61	0	71600	387.51	6329086	23	240	MPN/cL
0454 Fecal Streptococcus	Human pathogens	228	51	34	9	0	892	42.45	17270.58	1	12	CFU/cL
PSE Pseudomonas aeruginosa	Human pathogens	114	27	78	25	2	415	24.31	5147.08	<2	3	CFU/cL
0143 Chlorophyll A	Biological parameters	285	42	10	5	0.0005	0.036	0.0042	0.000044	0.0016	0.0038	mg/L
0146 Phaeophytin A	Biological parameters	43	13	37	8	0.00169	0.0037	0.0025	0.000001	<0.0005	<0.0005	mg/L
0105 Cyanide, S.A.D.	Cyanides	435	45	237	33	0.005	3.16	0.0982	0.0998	0.005	0.014	mg/L
0157 Cyanide, W.A.D.	Cyanides	250	36	156	35	0.001	0.152	0.0232	0.0008	<0.005	0.009	mg/L
1105 Dissolved Cyanide	Cyanides	32	7	23	6	0.01	0.7	0.1489	0.0473	<0.005	0.03	mg/L
THIO Thiocyanate	Cyanides	8	6	8	6	nc	nc	nc	nc	nc	nc	mg/L
D061 Dichloroguaiacols	Chlorophenols	217	5	217	5	nc	nc	nc	nc	nc	nc	mg/L
D062 Dichlorocatechols	Chlorophenols	229	5	229	5	nc	nc	nc	nc	nc	nc	mg/L
D063 Dichloroveretrols	Chlorophenols	228	5	228	5	nc	nc	nc	nc	nc	nc	mg/L
D064 Dichlorovanillins	Chlorophenols	228	5	228	5	nc	nc	nc	nc	nc	nc	mg/L
M051 Monochloroguaicols	Chlorophenols	221	5	221	5	nc	nc	nc	nc	nc	nc	mg/L
M052 Monochlorocatechols	Chlorophenols	229	5	229	5	nc	nc	nc	nc	nc	nc	mg/L
M053 Monochlorovanillins	Chlorophenols	223	5	223	5	nc	nc	nc	nc	nc	nc	mg/L
T019 Trichlorosyringols	Chlorophenols	228	5	228	5	nc	nc	nc	nc	nc	nc	mg/L
T022 Trichloroguaiacols	Chlorophenols	172	5	172	5	nc	nc	nc	nc	nc	nc	mg/L
T024 Tetrachloroguaiacols	Chlorophenols	194	5	194	5	nc	nc	nc	nc	nc	nc	mg/L
T025 Trichlorocatechols	Chlorophenols	229	5	229	5	nc	nc	nc	nc	nc	nc	mg/L
T026 Tetrachlorocatechols	Chlorophenols	227	5	227	5	nc	nc	nc	nc	nc	nc	mg/L
T027 Trichloroveretrols	Chlorophenols	228	5	228	5	nc	nc	nc	nc	nc	nc	mg/L
T028 Tetrachloroveretrols	Chlorophenols	228	5	228	5	nc	nc	nc	nc	nc	nc	mg/L
0011 Specific Conductance	Descriptive parameters	9267	564	11	6	0.133	9500	230.463	67488.53	134	370	µmho/cm
0039 Oxidation-Reduction Potential	Descriptive parameters	160	5	0	0	-0.188	0.226	0.170	0.005	0.1895	0.206	mV
0123 Total Tannin & Lignin	Descriptive parameters	197	39	3	1	0.1	13.6	1.02	1.98	0.6	1.5	mg/L
1123 Dissolved Tannin & Lignin	Descriptive parameters	1	1	0	0	2.4	2.4	nc	nc	nc	nc	mg/L
C--T Total Carbon	Descriptive parameters	372	91	0	0	3	240	29.22	818.42	21	38	mg/L
0115 Biochemical Oxygen Demand	Oxygen	101	38	93	37	2	142	54.63	1988.84	<10	<10	mg/L
0116 Chemical Oxygen Demand	Oxygen	277	50	75	20	10	324	31.60	1481.32	15	28	mg/L
B001 Bromine	Inorganic parameters	2	1	2	1	nc	nc	nc	nc	nc	nc	mg/L
Ca-T Calcium	Inorganic parameters	1039	180	0	0	0.7	362	29.34	1433.59	12.8	17	mg/L
Ca-D Dissolved Calcium	Inorganic parameters	376	95	0	0	0.66	362	35.91	2807.53	11.9	13.8	mg/L

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

Parameter	Class	Total Results		Results Less Than MDL		Descriptive Statistics						
		No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Water (Continued)												
Ca-P Particulate Calcium	Inorganic parameters	477	10	6	6	8.7	61.6	24.11	171.47	15.8	18.6	mg/L
Ca-S Soluble Calcium	Inorganic parameters	46	2	0	0	0.56	4.15	1.94	0.792	1.465	1.78	mg/L
0124 Total Inorganic Carbon	Inorganic parameters	326	80	2	1	1	155	26.40	664.30	9	13	mg/L
0104 Chloride	Inorganic parameters	553	12	8	6	0.2	19.8	3.89	24.87	0.4	0.6	mg/L
1104 Dissolved Chloride	Inorganic parameters	1542	228	249	59	0.3	128	4.03	58.07	0.6	1	mg/L
Cl-S Soluble Chloride	Inorganic parameters	50	2	0	0	0.47	1.4	0.7414	0.039	0.535	0.62	mg/L
1016 Total Residual Chlorine	Inorganic parameters	2	2	1	1	nc	nc	nc	nc	nc	nc	mg/L
0106 Fluoride	Inorganic parameters	4	2	2	2	0.09	0.09	0.09	0	<0.03	nc	mg/L
1106 Dissolved Fluoride	Inorganic parameters	625	41	151	25	0.02	0.79	0.0895	0.0057	<0.05	<0.05	mg/L
Mg-T Magnesium	Inorganic parameters	1036	180	0	0	0.1	405	15.65	1479.12	2.58	4.04	mg/L
Mg-D Dissolved Magnesium	Inorganic parameters	376	95	0	0	0.11	533	12.77	876.29	2.3	2.76	mg/L
Mg-P Particulate Magnesium	Inorganic parameters	474	10	6	6	1.5	24.7	6.83	26.50	3.75	4.7	mg/L
Mg-S Soluble Magnesium	Inorganic parameters	47	2	0	0	0.08	0.37	0.221	0.0054	0.18	0.21	mg/L
K--T Potassium	Inorganic parameters	89	42	5	4	0.12	47.3	3.44	52.07	0.5	0.8	mg/L
K--D Dissolved Potassium	Inorganic parameters	166	58	3	2	0.4	49	4.51	50.19	0.3	0.4	mg/L
K--P Particulate Potassium	Inorganic parameters	481	10	6	6	0.14	4.9	1.23	1.49	0.56	0.75	mg/L
K--S Soluble Potassium	Inorganic parameters	50	2	12	1	0.05	0.22	0.105	0.001	<0.1	0.07	mg/L
1120 Dissolved Reactive Silica	Inorganic parameters	774	62	6	6	0.06	31.1	5.64	18.58	2.6	4.17	mg/L
Si-T Silicon	Inorganic parameters	173	53	0	0	0.2	14.4	4.47	5.58	2.5	3.3	mg/L
Si-D Dissolved Silicon	Inorganic parameters	35	20	0	0	2	13.8	5.45	5.39	3.2	3.51	mg/L
Na-T Sodium	Inorganic parameters	89	42	0	0	0.2	362	19.35	2280.94	2.43	3.3	mg/L
Na-D Dissolved Sodium	Inorganic parameters	503	115	1	1	0.5	188	13.68	793.14	1.3	1.7	mg/L
Na-P Particulate Sodium	Inorganic parameters	479	10	6	6	0.5	16.9	4.72	21.27	1.7	2.6	mg/L
Na-S Soluble Sodium	Inorganic parameters	50	2	0	0	0.3	1.51	0.871	0.064	0.705	0.8	mg/L
0121 Sulfate	Inorganic parameters	81	17	0	0	1.2	182	22.76	1131.05	5	10.9	mg/L
1121 Dissolved Sulfate	Inorganic parameters	2049	244	53	15	0.11	1640	62.29	36640.42	6.2	8.6	mg/L
SO4- Soluble Sulfate	Inorganic parameters	50	2	0	0	0.92	2.3	1.69	0.097	1.53	1.63	mg/L
0125 Total Sulfide	Inorganic parameters	9	8	8	8	3.4	3.4	nc	nc	<0.5	nc	mg/L
S--T Sulfur	Inorganic parameters	67	29	0	0	0.4	374	34.86	8961.16	1.3	2.3	mg/L
S--D Dissolved Sulfur	Inorganic parameters	33	20	0	0	0.34	386	62.39	18257.39	1.14	1.78	mg/L
Sb-D Dissolved Antimony	Metals	12	9	12	9	nc	nc	nc	nc	nc	nc	mg/L
As-D Dissolved Arsenic	Metals	198	46	87	44	0.0002	0.0084	0.0012	0.000001	<0.001	<0.001	mg/L
As-E Extractable Arsenic	Metals	2	1	0	0	0.0004	0.0006	0.0005	0	0.00035	nc	mg/L
Ba-D Dissolved Barium	Metals	303	91	99	28	0.01	0.17	0.0302	0.00058	<0.01	0.01	mg/L
Be-D Dissolved Beryllium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
Bi-T Bismuth	Metals	158	47	156	47	0.02	0.13	0.075	0.0061	<0.02	<0.02	mg/L
Bi-D Dissolved Bismuth	Metals	35	20	35	20	nc	nc	nc	nc	nc	nc	mg/L
B--T Boron	Metals	157	47	60	17	0.01	0.45	0.0762	0.00621	<0.004	<0.04	mg/L
B--D Dissolved Boron	Metals	305	91	252	73	0.01	0.2	0.0324	0.00092	<0.001	<0.01	mg/L
Cd-D Dissolved Cadmium	Metals	262	57	251	55	0.0002	0.13	0.0126	0.00152	<0.0005	<0.0005	mg/L
Cd-E Extractable Cadmium	Metals	2	1	2	1	nc	nc	nc	nc	nc	nc	mg/L
Cr-D Dissolved Chromium	Metals	206	41	200	40	0.005	0.01	0.0068	0.000005	<0.001	<0.005	mg/L
Co-D Dissolved Cobalt	Metals	30	13	23	12	0.001	0.006	0.0019	0.000003	<0.001	<0.001	mg/L
Cu-D Dissolved Copper	Metals	669	93	308	55	0.001	38.7	0.2390	7.05	<0.001	0.002	mg/L
Cu-E Extractable Copper	Metals	2	1	0	0	0.003	0.003	0.003	0	0.0015	nc	mg/L
Fe-D Dissolved Iron	Metals	681	103	166	36	0.005	73.9	0.4761	15.26	0.03	0.06	mg/L
Fe-E Extractable Iron	Metals	2	1	0	0	1.2	2	1.6	0.32	0.2	nc	mg/L
Pb-D Dissolved Lead	Metals	256	59	226	54	0.001	0.5	0.0185	0.0083	<0.001	<0.001	mg/L
Pb-E Extractable Lead	Metals	2	1	1	1	0.002	0.002	nc	nc	<0.001	nc	mg/L
Li-T Lithium	Metals	429	9	6	6	0.0004	0.0635	0.0031	0.00002	0.0016	0.0022	mg/L

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

Parameter	Class	Total Results		Results Less Than MDL		Descriptive Statistics						
		No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Water (Continued)												
Mn-D Dissolved Manganese	Metals	302	89	124	39	0.002	5.69	0.266	0.478	0.01	0.02	mg/L
Mn-E Extractable Manganese	Metals	2	1	0	0	0.1	0.1	0.1	0	0.01	nc	mg/L
Hg-D Dissolved Mercury	Metals	83	6	83	6	nc	nc	nc	nc	nc	nc	mg/L
Hg-E Extractable Mercury	Metals	2	1	2	1	nc	nc	nc	nc	nc	nc	µg/L
Mo-D Dissolved Molybdenum	Metals	526	92	248	68	0.0008	1.68	0.217	0.163	<0.01	<0.01	mg/L
Ni-D Dissolved Nickel	Metals	305	91	218	81	0.002	0.052	0.0041	0.00004	<0.05	<0.05	mg/L
Se-D Dissolved Selenium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
Se-E Extractable Selenium	Metals	2	1	0	0	0.0001	0.0001	0.0001	0	<0.0001	nc	mg/L
Ag-D Dissolved Silver	Metals	118	20	117	20	0.0001	0.0001	nc	nc	<0.0001	<0.0001	mg/L
Sr-T Strontium	Metals	600	61	0	0	0.0002	9.1	0.235	0.629	0.09115	0.105	mg/L
Sr-D Dissolved Strontium	Metals	35	20	0	0	0.1	9	1.39	9.23	0.1	0.1	mg/L
Te-T Tellurium	Metals	91	22	91	22	nc	nc	nc	nc	nc	nc	mg/L
Te-D Dissolved Tellerium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
Tl-T Thallium	Metals	91	22	86	22	0.003	0.01	0.0064	0.000007	<0.03	<0.03	mg/L
Tl-D Dissolved Thallium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
Sn-T Tin	Metals	94	25	86	21	0.01	0.1	0.0425	0.0015	<0.02	<0.02	mg/L
Sn-D Dissolved Tin	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
Ti-D Dissolved Titanium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
V--T Vanadium	Metals	1383	172	847	155	0.0001	1.82	0.0113	0.00708	<0.01	<0.01	mg/L
V--D Dissolved Vanadium	Metals	284	80	254	70	0.001	0.06	0.0226	0.00019	<0.01	<0.01	mg/L
Zn-D Dissolved Zinc	Metals	248	58	208	49	0.005	0.14	0.0212	0.00074	<0.005	<0.005	mg/L
Zn-E Extractable Zinc	Metals	2	1	0	0	0.005	0.005	0.005	0	<0.001	nc	mg/L
Zr-T Zirconium	Metals	91	22	91	22	nc	nc	nc	nc	nc	nc	mg/L
Zr-D Dissolved Zirconium	Metals	3	2	3	2	nc	nc	nc	nc	nc	nc	mg/L
0109 Total NO2/NO3 Nitrogen	Nutrients	3857	9	129	8	0.002	4.51	0.2053	0.3097	0.074	0.123	mg/L
1109 Dissolved NO2/NO3 Nitrogen	Nutrients	4294	403	1372	229	0.005	13.8	0.2450	0.6637	0.009	0.05	mg/L
1111 Dissolved Nitrite Nitrogen	Nutrients	3220	296	2239	276	0.001	0.789	0.0151	0.0016	<0.005	<0.005	mg/L
0110 Total Nitrate Nitrogen	Nutrients	197	9	29	8	0.005	8.62	0.8639	2.79	0.02	0.03	mg/L
1110 Dissolved Nitrate Nitrogen	Nutrients	277	27	107	9	0.002	290	2.80	508.42	0.006	0.08	mg/L
NO3- Soluble Nitrate	Nutrients	77	2	9	2	0.01	0.97	0.2113	0.0285	0.15	0.27	mg/L
NH4- Ammonium	Nutrients	77	2	22	2	0.01	0.37	0.0444	0.003	0.02	0.04	mg/L
1108 Dissolved Ammonia Nitrogen	Nutrients	6767	441	2712	315	0.005	68	0.1280	1.63	0.005	0.01	mg/L
0112 Total Organic Nitrogen	Nutrients	152	11	114	3	0.02	0.87	0.2434	0.053	0.02	0.03	mg/L
0113 Total Kjeldahl Nitrogen	Nutrients	3444	354	136	25	0.01	50.7	0.3888	1.07	0.13	0.24	mg/L
1113 Dissolved Kjeldahl Nitrogen	Nutrients	12	5	0	0	0.04	0.4	0.14	0.0097	0.105	0.13	mg/L
0114 Total Nitrogen	Nutrients	57	11	19	2	0.06	1.23	0.3126	0.0687	0.06	0.07	mg/L
1114 Total Dissolved Nitrogen	Nutrients	3860	9	22	6	0.01	8	0.3153	0.4475	0.158	0.23	mg/L
0118 Ortho Phosphorus	Nutrients	46	4	18	4	0.005	0.4	0.0595	0.0051	0.03	0.05	mg/L
1118 Dissolved Ortho Phosphorus	Nutrients	5371	353	2276	226	0.0005	4.48	0.0525	0.0471	<0.003	0.007	mg/L
P--D Total Dissolved Phosphorus	Nutrients	6432	411	1087	139	0.003	999	0.2492	186.75	0.007	0.019	mg/L
0103 Total Organic Carbon	Organics, miscellaneous	322	63	66	20	1	42	7.07	41.85	3	9	mg/L
AOX- Adsorbable Organic Halides	Organics, miscellaneous	346	8	41	5	0.01	0.34	0.057	0.0035	0.03	0.07	mg/L
0015 Turbidity	Physical parameters	3980	265	54	14	0	320	6.46	242.66	1.9	6.3	NTU
0131 Acidity pH 8.3	Physical parameters	303	68	9	7	0.6	651	10.65	3123.02	2.5	5	mg/L
AC83 Acidity pH 8.3	Physical parameters	77	2	0	0	28.3	219	62.41	659.96	57.1	73.9	µeq/L
0101 Phenolphthalein 8.3 Alkalinity	Physical parameters	379	84	300	68	0.1	24	6.07	29.36	<0.5	0.1	mg/L
0132 Acidity pH 4.5	Physical parameters	49	23	43	21	31.2	404	185.57	28156.87	<0.5	<0.5	mg/L
AK-T Total Alkalinity	Physical parameters	1579	12	15	7	11.9	218	69.09	1359.16	55.5	91.4	µeq/L
0102 Total 4.5 Alkalinity	Physical parameters	1454	198	6	3	2.4	668	82.16	4660.56	57.9	124	mg/L
D102 Alkalinity 4.5/4.2	Physical parameters	11	5	0	0	37.3	92.6	57.6	265.24	52.1	55.7	mg/L

Table 2. Summary Statistics for Parameters Without Specific Guidelines (Continued)

		Total Results		Results Less Than MDL		Descriptive Statistics						
Parameter	Class	No.Samples	No. Sites	No. Samples	No. Sites	Minimum	Maximum	Mean	Std. Dev.	Median	80th Percentile	Units
Water (Continued)												
0107 Total Hardness	Physical parameters	2009	90	15	7	0.5	1290	96.39	14774.02	64.7	117	mg/L
1107 Dissolved Hardness	Physical parameters	134	43	0	0	4.32	483	83.62	5402.86	57.75	135	mg/L
AC-F Free Acidity	Physical parameters	77	2	0	0	0.1	2.4	0.401	0.189	0.3	0.5	µeq/L
TSS- Total Suspended Solids	Physical parameters	141	4	109	4	0.5	338	32.77	4893.53	<5	1	mg/L
Sb25 Antimony-125	Radioactives	33	2	33	2	nc	nc	nc	nc	nc	nc	Bq/L
Cs34 Cesium-134	Radioactives	34	2	34	2	nc	nc	nc	nc	nc	nc	Bq/L
Co60 Cobalt-60	Radioactives	31	2	31	2	nc	nc	nc	nc	nc	nc	Bq/L
Ra26 Radium-226	Radioactives	33	2	29	2	0.012	0.04	0.026	0.0003	<0.07	<0.07	Bq/L
H-3- Tritium	Radioactives	96	2	54	2	7	31	15.22	63.04	<8.1	12	Bq/L
A030 Abietic Acid	Resin and fatty acids	123	10	118	10	0.003	0.042	0.0144	0.0002	<0.001	<0.001	mg/L
D052 Dehydroabietic Acid	Resin and fatty acids	123	10	113	10	0.001	0.026	0.0087	0.000074	<0.001	<0.001	mg/L
I004 Isopimaric Acid	Resin and fatty acids	123	10	118	10	0.002	0.012	0.006	0.000014	<0.001	<0.001	mg/L
L003 Levo Pimaric Acid	Resin and fatty acids	123	10	120	10	0.001	0.008	0.004	0.000013	<0.001	<0.001	mg/L
N005 Neoabietic Acid	Resin and fatty acids	123	10	122	10	0.064	0.064	nc	nc	<0.001	<0.001	mg/L
P025 Pimaric Acid	Resin and fatty acids	123	10	122	10	0.011	0.011	nc	nc	<0.001	<0.001	mg/L
S006 Sandaraco Pimaric Acid	Resin and fatty acids	123	10	117	10	0.001	0.099	0.0212	0.00146	<0.001	<0.001	mg/L
0005 Total Residue	Residues	1236	202	0	0	16	1673	177.10	29799.02	67	107	mg/L
0006 Total Fixed Residue	Residues	120	26	0	0	8	292	65.88	1869.66	36	54	mg/L
0007 0.45µm Filterable Residue	Residues	418	90	4	2	1	1542	126.93	24473.94	56	70	mg/L
007H 1.0µm Filterable Residue	Residues	909	83	6	1	2	6000	135.28	57304.88	74	84	mg/L
0008 Nonfilterable Residue	Residues	3246	311	594	116	0.05	16000	28.05	112756.52	2	4	mg/L
RFF- Fixed Filterable Residue	Residues	135	4	1	1	27	300	100.98	2129.99	42	50	mg/L
0009 Fixed Nonfilterable Residue	Residues	134	28	52	15	1	220	20.89	1723.56	<1	<1	mg/L
0010 Volatile Nonfilterable Residue	Residues	1	1	0	0	1	1	nc	nc	1	nc	mg/L

Table 3. International Toxicity Equivalency Factors (I-TEFs) for Dioxin and Furan Congeners of Concern

Congener of Concern	I-TEF
2,3,7,8-Tetrachlorodibenzodioxin (T4CDD)	1
1,2,3,7,8-Pentachlorodibenzodioxin (P5CDD)	0.5
1,2,3,4,7,8-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,7,8,9-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,6,7,8-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzodioxin (H7CDD)	0.01
Octachlorodibenzodioxin (O8CDD)	0.001
2,3,7,8-Tetrachlorodibenzofuran (T4CDF)	0.1
2,3,4,7,8-Pentachlorodibenzofuran (P5CDF)	0.5
1,2,3,7,8-Pentachlorodibenzofuran (P5CDF)	0.05
1,2,3,4,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran (H7CDF)	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran (H7CDF)	0.01
Octachlorodibenzofuran (O8CDF)	0.001

Table 3. International Toxicity Equivalency Factors (I-TEFs) for Dioxin and Furan Congeners of Concern

Congener of Concern	I-TEF
2,3,7,8-Tetrachlorodibenzodioxin (T4CDD)	1
1,2,3,7,8-Pentachlorodibenzodioxin (P5CDD)	0.5
1,2,3,4,7,8-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,7,8,9-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,6,7,8-Hexachlorodibenzodioxin (H6CDD)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzodioxin (H7CDD)	0.01
Octachlorodibenzodioxin (O8CDD)	0.001
2,3,7,8-Tetrachlorodibenzofuran (T4CDF)	0.1
2,3,4,7,8-Pentachlorodibenzofuran (P5CDF)	0.5
1,2,3,7,8-Pentachlorodibenzofuran (P5CDF)	0.05
1,2,3,4,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran (H6CDF)	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran (H7CDF)	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran (H7CDF)	0.01
Octachlorodibenzofuran (O8CDF)	0.001

APPENDIX 1. Database Structure

The database consists of the 13 dBase-compatible database tables (listed below), one ARC/INFO coverage of point data: SITE (delivered in ARC export format), and one ARC/INFO coverage of polygon data: HMA (delivered in ARC export format). The digital base map information (drainage network) was supplied by the Scientific Authority and is not documented here.

Notes

There are three main tables comprising the database SITE -> STATION -> RESULT which represent the progression from site location to station sampled (date and medium) to results observed. Proper use of the database is fairly straightforward, however, it is important to consider the following:

1) A field "IGNORE" is included in Result.Dbf which essentially flags observations (IGNORE = "Y") that are unsuitable for use either because they were marked as suspect in the original data source, were considered anomalous or outliers by this study, or are "less than" values which are relative to detection limits that exceed guidelines or the 80th percentile calculated from this database. In this latter case, the field "BASIS" can be used to identify records that have been flagged because of detection limits (BASIS = "G" or "P").

2) Result.Dbf contains observations which are reported as "less than" values but with unknown detection limits. These can be identified by "RLETTER" = "<" and "RESULT" = -1. It should be noted that zero and negative values are valid data for several parameters (*e.g.*, temperature).

3) Some station records in Station.Dbf has missing or incorrect dates (one states the year as 1903, the other as 1999). These were all obtained from ENVIRODAT. The correct year of sampling for these records was derived from the first two digits of the ENVIRODAT "SAMPLE_NO". This is the reason for the apparently redundant field "YEAR" which occurs in Station.Dbf. The value of "YEAR" should always be given priority over the year derived from the date field.

4) Because of the missing and invalid dates (see #3 above), to exclude data potentially within the period of freshet it is important to also exclude data where the month of sampling is zero and where the year of sampling is either 1903 or 1999.

5) Result.Dbf includes a field: "SYMBOL" which contains an index value which was used in preparation of individual parameter distribution maps for all parameters except pH, dissolved oxygen and oxidation-reduction potential (which were based on "RESULT"). "SYMBOL" is essentially the value of the result divided by the applicable guideline or 80th percentile. A "SYMBOL" value of -1 was used for values less than detection. The field "BASIS" provides information on the contents of the field: "SYMBOL".

6) Dates of sampling in Station.Dbf are sometimes presented as ranges. Where the data source was SEAM (SOURCE_CD = 1), the date range is as recorded in the source database. For other data sources, this means that a composite sample was collected over the specified date range <u>or</u> that the date of sampling was not specified precisely. In this latter case the date range reflects the sample collection period from the sampling methods description.

7) "LOWDEPTH" and "UPDEPTH" are described as indicating the lower and upper depth of sampling from SEAM. These were received as ASCII values padded with zeros. Because of this, it was impossible to distinguish surface samples from missing data. This information was carried forward into the final database and is considered to be of limited utility.

Database Tables

BASIS.DBF - is a look-up table enumerating the meanings of the field "BASIS" which occurs in Result.Dbf;

CLASS.DBF - is a look-up table enumerating the groupings of parameters to classes which occurs in Param.Dbf;

MEDIA.DBF - is a look-up table enumerating the codes describing medium sampled which occur in Station.Dbf;

PARAM.DBF - is a look-up table enumerating the parameter codes which occur in Result.Dbf and the classes to which they are assigned;

RESULT.DBF - is the main table of parameter observations; each observation (or result) is related to station information in Station.Dbf by the "STATION_CD" and to site information in Site.Dbf by the "SITE_CD"; each observation has been assigned a unique identifier: "RESULT_CD" and can be related to its data source in Sources.Dbf by the "SOURCE_CD"

RLETTER.DBF - is a look-up table enumerating the meanings of "RLETTER" which occurs in Result.Dbf;

SADESCR.DBF - is a look-up table enumerating the meanings of "SASTATE" and "SA DESCR" which occur in Station.Dbf; this is information carried forward from the SEAM database;

SAMAGENC.DBF - is a look-up table enumerating the codes used to describe sampling agency which occur in Station.Dbf; this is mostly information carried forward from SEAM; station data compiled from other sources has been assigned codes by this study;

SITE.DBF - is the main table enumerating the sites or locations sampled; each site is assigned a unique identifier: "SITE_CD"; Site.Dbf contains Universal Transverse Mercator (UTM) Zone 10 (NAD83) coordinates for the site location derived from the ARC/INFO coverage and has been coded by HMA by the GIS using the HMA coverage;

SOURCES.DBF - is the main table enumerating bibliographic information for the sources of data contained in this database; each data source is assigned a unique identifier "SOURCE_CD" which occurs in the tables: Site.Dbf, Station.Dbf, Result.Dbf and Param.Dbf;

SPECIES.DBF - is a look-up table enumerating the codes used to describe species and tissue sampled which occur in Station.Dbf;

STATION.DBF - is the main table listing dates and media sampled at the various sites, *i.e.*, the station listing; each station is assigned a unique identifier: "STATION_CD"; Station.Dbf is related to Site.Dbf by "SITE_CD" and to Result.Dbf by "STATION_CD";

UNIT.DBF - is a look-up table enumerating the codes used for the units of observations which occur in Result.Dbf;

Database Structures

```
Structure for database : BASIS.DBF
Number of data records :        9
         Last updated : 04/24/95 at 16:01
Field  Field name  Type        Width    Dec    Start      End
    1  BASIS       Character       1               1        1   code   describing  basis  of
the                                                                                field
"SYMBOL" which occurs in Result.Dbf
          (see Note #5 above)
    2  MEANING     Character      50               2       51   description of code meaning
** Total **                       52

-------------------------------------------------------------------------------

Structure for database : CLASS.DBF
Number of data records :       25
         Last updated : 03/21/95 at  9:31
Field  Field name  Type        Width    Dec    Start      End
    1  CLASS       Character       3               1        3   code describing parameter
classification
    2  CLASS_NAME  Character      40               4       43   name of parameter class
** Total **                       44

-------------------------------------------------------------------------------

Structure for database : MEDIA.DBF
Number of data records :        7
         Last updated : 04/24/95 at 16:25
Field  Field name  Type        Width    Dec    Start      End
    1  MEDIA       Character       2               1        2   code describing medium
sampled
    2  MEANING     Character      50               3       52   description of meaning of
media code
** Total **                       53

-------------------------------------------------------------------------------

Structure for database : PARAM.DBF
Number of data records :      348
         Last updated : 04/24/95 at 13:21
Field  Field name  Type        Width    Dec    Start      End
    1  PARMCODE    Character       4               1        4   code describing parameter
observed
    2  PARM_NAME   Character      40               5       44   parameter name corresponding
to code
    3  SOURCE_CD   Numeric         3              45       47   information source for
parameter
    4  CLASS       Character       3              48       50   classification of parameter
** Total **                       51
```

```
Structure for database : RESULT.DBF
Number of data records :    243267
          Last updated : 04/25/95 at  7:55
Field  Field name  Type        Width    Dec    Start      End
    1  RESULT_CD   Numeric         6               1        6   unique identifier for
observation record
    2  STN_CD      Numeric         6               7       12   identifier   for   station
information
                                                                (relates to Station.Dbf)
    3  SITE_CD     Numeric         5              13       17   identifier for site
information  (relates
                                                                to Site.Dbf)
    4  PARMCODE    Character       4              18       21   parameter code
    5  RLETTER     Character       1              22       22   flag  identifying "less
than",  "greater
                                                                than",  "mean of
replicates",  etc.  (see
                                                                Rletter.Dbf)
    6  RESULT      Numeric        13      5       23       35   numerical value of observed
result
    7  SYMBOL      Numeric         7      2       36       42   computed   index  value  for
 individual
                                                                parmater  used in maps for
Volume 2  (see
                                                                Note #5 above)
    8  UNITCODE    Character       3              43       45   unit  code for units of
numerical  value
                                                                observed
    9  BASIS       Character       1              46       46   code  describing basis of
"SYMBOL"  value
                                                                (see  Note  #5  above  and
contents   of
                                                                Basis.Dbf)
   10  IGNORE      Character       1              47       47   flag  to identify records
that are  inap-
                                                                propriate to use (see Note
#1 above); "Y"
                                                                indicates  inappropriate
values; a  space
                                                                character indicates
appropriate values
   11  SOURCE_CD   Numeric         3              48       50   identifier  for data source
(relates  to
                                                                Sources.Dbf)
** Total **                       51

-------------------------------------------------------------------------------

Structure for database : RLETTER.DBF
Number of data records :         7
          Last updated : 04/24/95 at 15:53
```

Field	Field name	Type	Width	Dec	Start	End	
1	RLETTER	Character	1		1	1	flag code used in Result.Dbf
2	MEANING	Character	50		2	51	meaning of flag code
** Total **			52				

```
Structure for database : SADESCR.DBF                  * Note: table contains codes occurring
in
                                                      SEAM  data but not defined in  SEAM
data
                                                      dictionary. This table contains codes
for
                                                      data excluded from the final database.
Number of data records :        24
          Last updated : 04/24/95 at 16:25
Field  Field name  Type        Width    Dec    Start      End
    1  SASTATE     Character       2               1        2   sample state code from SEAM
    2  SADESCR     Character       2               3        4   sample description code from
SEAM
    3  DESCRIPT    Character      30               5       34   meaning  of sample state and
description
                                                                codes
    4  EXCLUDE     Logical         1              35       35   logical flag, should data be
included  in
                                                                this study
    5  MEDIA       Character       2              36       37   media classification
** Total **                       38

-------------------------------------------------------------------------------

Structure for database : SAMAGENC.DBF                 *  Note:  This table includes  codes
for
                                                      data  which were excluded from the
final
                                                      database.
Number of data records :        26
          Last updated : 04/24/95 at 15:48
Field  Field name  Type        Width    Dec    Start      End
    1  SAMAGENCY   Character       2               1        2   sampling agency code
    2  AGENCY_NAM  Character      35               3       37   name of sampling agency
** Total **                       38

-------------------------------------------------------------------------------

Structure for database : SITE.DBF
Number of data records :       844
          Last updated : 04/24/95 at 10:36
Field  Field name  Type        Width    Dec    Start      End
    1  SITE_CD     Numeric         5               1        5   unique  identifier for site
(relates  to
                                                                ARC/INFO   coverage
Pat.Dbf   and    to
                                                                Station.Dbf and Result.Dbf)
    2  SITENO      Character      10               6       15   site identifier from data
source
    3  HMA_NO      Numeric         2              16       17   identifer  for HMA which
site is  located
```

```
                                                                   within (relates to ARC/INFO
HMA  coverage
                                                                   Pat.Dbf)
    4  MAPSHEET    Character       8              18       25   NTS map sheet identifier
from data source
                                                                   or as used by this study for
data capture
    5  SAMAGENCY   Character       2              26       27   sampling agency code
    6  DESCR       Character      45              28       72   site description
    7  SOURCE_CD   Numeric         3              73       75   data source identifier
(relates to Sourc-
                                                                   es.Dbf)
    8  X_COORD     Numeric         8      1       76       83   UTM Zone 10 (NAD83) Easting
coordinate
    9  Y_COORD     Numeric         7              84       90   UTM Zone 10 (NAD83) Northing
coordinate
** Total **                       91

Structure for database : SOURCES.DBF
Number of data records :        14
          Last updated : 04/24/95 at 16:03
Field  Field name  Type        Width    Dec    Start      End
    1  SOURCE_CD   Numeric         3               1        3   unique identifier for data
source
    2  SOURCE      Memo           10               4       13   bibliographic citation for
data source
** Total **                       14

This database is associated with the memo file: SOURCES.DBT

-------------------------------------------------------------------------------

Structure for database : SPECIES.DBF                   * Note: Biota data from SEAM have
unknown
                                                       species/tissue. In this case the
relation
                                                       between  "SPECIES_CD" in Station.Dbf
and
                                                       this table fails.
Number of data records :        31
          Last updated : 04/24/95 at  7:49
Field  Field name  Type        Width    Dec    Start      End
    1  SPECIES_CD  Character       3               1        3   code for species and tissue
sampled
    2  SPECIES_NM  Character      40               4       43   species and tissue
description
    3  TISSUE      Character       1              44       44   code for tissue type: "L" =
liver, "M"  =
                                                                   muscle,  "W" = whole body,
"H" =  hepato-
                                                                   pancreas
```

```
** Total **                        45

-------------------------------------------------------------------------------

Structure for database : STATION.DBF
Number of data records :     22673
          Last updated : 04/25/95 at  7:56
Field  Field name  Type        Width    Dec    Start      End
    1  STN_CD      Numeric         6                1        6   unique  identifier  for
station   record
                                                                 (relates to Result.Dbf)
    2  SITE_CD     Numeric         5                7       11   unique  identifier for site
(relates  to
                                                                 Site.Dbf)
    3  MEDIA       Character       2               12       13   code for medium sampled
    4  SPECIES_CD  Character       3               14       16   code for species/tissue
sampled for biota
    5  SAMAGENCY   Character       2               17       18   code for sampling agency
    6  LABAGENCY   Character       2               19       20   code  for analytical
laboratory  (carried
                                                                 forward from SEAM)
    7  SASTATE     Character       2               21       22   code  for sample state
(carried  forward
                                                                 from SEAM)
    8  SADESCR     Character       2               23       24   code  for  sample
description   (carried
                                                                 forward from SEAM)
    9  DATEFROM    Date            8               25       32   date of start of sampling
   10  TIMEFROM    Character       4               33       36   time  of start of sampling
(local  time),
                                                                 blank if unknown
   11  DATETO      Date            8               37       44   date of end of sampling,
where relevant
```

```
   12  TIMETO      Character       4             45       48   time  of  end of sampling
(local  time),
                                                               where relevant, blank if
unknown
   13  LOWDEPTH    Numeric         6      3      49       54   lower  depth of sampling in
metres  (see
                                                               Note #7 above)
   14  UPDEPTH     Numeric         6      3      55       60   upper  depth of sampling in
metres  (see
                                                               Note #7 above)
   15  TYPE        Character       2             61       62   "Type"  classification from
SEAM  (ASCII
                                                               source file provided to this
study); "07"
                                                               = estuaries, "13" = lakes
and ponds, "21"
                                                               = rivers, creeks, streams
   16  SOURCE_CD   Numeric         3             63       65   identifier for data source
   17  YEAR        Numeric         2             66       67   year of sampling (post 1900)
** Total **                       68
--------------------------------------------------------------------------------

Structure for database : UNIT.DBF                    *  Note: This table contains code
values
                                                     carried  forward from SEAM that  are
not
                                                     included in the final database.
Number of data records :       190
          Last updated : 03/18/95 at 17:27
Field  Field name  Type        Width    Dec    Start      End
    1  UNITCODE    Character       3              1        3   unit code for units of
observation
    2  UNITS       Character       8              4       11   common abbreviation for
units
    3  UNIT_DESCR  Character      50             12       61   unit description
** Total **                       62
```

ARC/INFO Data Structures

```
Structure for feature table: HMA\PAT.DBF
Number of data records:      16
Date of last update   : 05/04/95
Field  Field Name  Type       Width    Dec
    1  AREA        Numeric       13      6                   no meaning, reserved by
ARC/INFO
    2  PERIMETER   Numeric       13      6                   no meaning, reserved by
ARC/INFO
    3  HMA_        Numeric       11                          no meaning, reserved by
ARC/INFO
```

4	HMA_ID	Numeric	11		no meaning, reserved by ARC/INFO
5	HMA_NO	Numeric	2		HMA unique identifier
6	NAME	Character	50		HMA name
7	X_COORD	Numeric	13	6	UTM Zone 10 (NAD83) Easting coordinate
8	Y_COORD	Numeric	13	6	UTM Zone 10 (NAD83) Northing coordinate
** Total **			127		

Structure for feature table: SITE\PAT.DBF
Number of data records: 834
Date of last update : 04/24/95

Field	Field Name	Type	Width	Dec	
1	AREA	Numeric	13	6	area of HMA in metres, reserved by ARC/INFO
2	PERIMETER	Numeric	13	6	perimeter of HMA in metres, reserved by ARC/INFO
3	SITE_	Numeric	11		no meaning, reserved by ARC/INFO
4	SITE_ID	Numeric	11		no meaning, reserved by ARC/INFO
5	SITE_CD	Numeric	5		unique site identifier (relates to Site.Dbf)
6	SITENO	Character	10		site identifier from data source
7	HMA_NO	Numeric	2		identifer for HMA which site is located within (relates to ARC/INFO HMA coverage Pat.Dbf)
8	MAPSHEET	Character	8		NTS map sheet identifier from data source or as used by this study for data capture
9	SAMAGENCY	Character	2		sampling agency code
10	DESCR	Character	45		site description
11	SOURCE_CD	Numeric	3		data source identifier (relates to Sourc-es.Dbf)
12	X_COORD	Numeric	8	1	UTM Zone 10 (NAD83) Easting coordinate
13	Y_COORD	Numeric	7		UTM Zone 10 (NAD83) Northing coordinate
** Total **			139		

APPENDIX 2. Information Sources

Data Sources Used for Maps and Tables

Al Stobbart, Personal Communication, 31 January 1995, Pitt River Hatchery.

B.C. Environment, SEAM Database, data obtained October 1994, all data for Types 7, 13 and 21 (aquatic media) excluding Vancouver Island region.

Dwernychuk, L.W., T.G. Boivin and G.S. Bruce. 1993. Fraser and Thompson Rivers dioxin/furan trend monitoring program 1992 final report. Report by Hatfield Consultants for Northwood Pulp and Timber Ltd., Canfor Corporation, Cariboo Pulp and Paper Company, and Weyerhaeuser Canada Limited, unpublished manuscript.

Dwernychuk, L.W., G.S. Bruce, B. Gordon, and G.P. Thomas. 1991. Fraser and Thompson Rivers: a comprehensive organochlorine study 1990/91. Report by Hatfield Consultants for Northwood Pulp and Timber Ltd., Canfor Corporation, Cariboo Pulp and Paper Company, and Weyerhaeuser Canada Limited, unpublished manuscript.

Environment Canada, ENVIRODAT database, data obtained October 1994, all data.

Lofthouse, D. Unpublished data obtained February 1995 from Clearwater River Hatchery.

Lofthouse, D. Unpublished data obtained February 1995 from Quesnel River Hatchery

Lofthouse, D. Unpublished data obtained February 1995 from Spius Creek Hatchery

Mah, F.T.S., D.D. MacDonald, S.W. Sheehan, T.M. Tuominen and D. Valiela. 1989. Dioxins and furans in sediment and fish from the vicinity of ten inland pulp mills in British Columbia. Environment Canada, Pacific and Yukon Region, 77 pp.

Swain, L.G., and D.G. Walton. 1993a. Chemistry and toxicity of sediments from sloughs and routine monitoring sites in the Fraser River estuary - 1992. B.C. Ministry of Environment, Lands and Parks, 234 pp.

Tuominen, T.A., and M.A. Sekela. 1992. Dioxins and furans in sediment and fish from the vicinity of four inland pulp and/or paper mills and one petroleum refinery in British Columbia. Environment Canada, Pacific and Yukon Region.

Data Sources Included in the Database But Not Used for Maps and Tables

The following information sources were included in the final database, but not included in the maps and tables in this report because of time constraints. Note, however, that information from Dwernychuk (1990) and Van Oostdam (1991) was included in the dioxin and furan index maps and discussion presented in Volume 1.

Dwernychuk, L.W. 1990. The Receiving Environment of the Upper Fraser River: A Pilot Environmental Effects Monitoring Program Examining Physical/Chemical/Biological Elements of the System Related to Pulpmill Effluents - 1989. Report by Hatfield Consultants Ltd. for Northwood Pulp and Timber Ltd., Prince George Pulp and Paper Ltd., Intercontinental Pulp Company Ltd., Quesnel River Pulp Co., Environment Canada and B.C. Ministry of Environment, Lands and Parks.

R.L.&L. Environmental Services Ltd. 1992. A Fisheries Investigation of Moose and Yellowhead Lakes. Report for B.C. Ministry of Environment, Lands and Parks.

Van Oostdam, J. 1991. Organochlorine Compounds in Thompson River Rainbow Trout. Report by Southern Interior Regional Office, B.C. Ministry of Environment, Lands and Parks.