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Integrated Information System for Fish Habitat Management (IISFHM) in the Quebec Region: status of system after the first phase of development

Y. Vigneault

Department of Fisheries and Oceans
Fisheries and Habitat Management Branch
Fish Habitat Division
Champlain Harbour Station, P. O. Box 15500
901 Cap Diamant, Quebec City, Que. G1K 7Y7

June 1990

Canadian Technical Report of Fisheries and Aquatic Sciences No 1744

Fisheries and Oceans Pêches et Océans

Canada

Canadian Technical Report of Fisheries and Aquatic Sciences

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Les numéros 1 à 456 de cette série ont été publiés à titre de rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

Les rapports techniques sont produits à l'échelon régional mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

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INTEGRATED INFORMATION SYSTEM FOR FISH HABITAT MANAGEMENT(IISFHM) IN THE QUEBEC REGION: status of system after the first phase of development

by

Y. Vigneault, ed.

Department of Fisheries and Oceans
Fisheries and Habitat Management Branch
Fish Habitat Division
Champlain Harbour Station
P. O. Box 15500
901 Cap Diamant,
Quebec, Que.
G1K 7Y7

Minister of Supply and Services Canada 1990
Catalogue No. Fs 97-6/1744E ISSN 0706-6457

This publication should be cited as follows:

Vigneault, Y. (ed.), 1990. Integrated Information System for Fish Habitat Management (IISFHM) in the Quebec Region: status of system after the first phase of development. Can. Tech. Rep. Fish. Aquat. Sci. No. 1744E: ix + 34 p.

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ABSTRACT

Vigneault, Y. (ed.), 1990. Integrated information system for Fish Habitat Management (IISFHM) in the Quebec Region: status of system after the first phase of development. Can. Tech. Rep. Fish. Aquat. Sci. No. 1744E: ix + 34 p.

This report describes an integrated information system for the management of fish habitat in the Quebec region, ("Système Intégré d'Information pour la Gestion de l'Habitat du Poisson/SIIGHP") after the first phase of its data processing development. The basic structure of the system, its components and various data bases are described in detail. Examples of the various textual and cartographic reports produced by the system are given with the improvements projected for the second phase of development.

RÉSUMÉ

Vigneault, Y. (ed.), 1990. Integrated information system for Fish Habitat Management (IISFHM) in the Quebec Region: status of system after the first phase of development. Can. Tech. Rep. Fish. Aquat. Sci. No. 1744E: ix + 34 p.

Ce document présente le Système intégré d'Information pour la Gestion de l'Habitat du Poisson (SIIGHP) de la région du Québec tel qu'il se présentait après la première phase de son développement informatique. La structure du système, ses composantes et les différentes bases de données contenues dans le système y sont décrites en détail. On y présente les différents rapports textuels et cartographiques pouvant être produits à partir des bases de données ainsi que les améliorations prévues dans la deuxième phase de développement.

PREFACE

This document is a summary of information contained in the following reports:

Lavalin Environment. 1989. Développement d'un système intégré d'information destiné à la gestion des habitats de poisson en milieu côtier. Vol. 1, Document synthèse; Vol. 2, Document technique; Vol. 3, Banque de références. Reports submitted to the Fish Habitat Division, Department of Fisheries and Oceans, Quebec Region, August 1989. 1: 128 p., 2: 91 p.; 3: 261 p.

Côté, E. 1989. Rapport d'évaluation du SIIGHP. Report submitted to the Fish Habitat Division, Department of Fisheries and Oceans of Canada, Quebec Region, December 1989, 48 p.

These reports may be consulted at the office of DFO in Quebec City. The summary of the reports was prepared by ACSI-BIOREX Inc. for the Fisheries and Habitat Management Branch of the department of Fisheries and Oceans of Canada.

IISFHM WORKING GROUP

Development of IISFHM

Lavalin Environment Inc.:

- Greg Weary (Manager)
- Sylvie Cloutier (Project Officer)
- Christine Tremblay (Biologist)

Sittel Microsystems Ltd. (for Lavalin):

- Philippe Hamelin (Project Officer)
- Bruno McKie (programmer)
- François Lemelin (programmer)

Fisheries and Oceans, Habitat Management Division

- Yvan Vigneault (Scientific Adviser)
- Richard Nadeau (counselor)

Evaluation of IISFHM

- Eric Côté (computer technician)

INTRODUCTION

The Integrated Information System for Fish Habitat Management (IISFHM) in the Quebec Region was developed to maintain an inventory of all relevant information on the physical and chemical characteristics of coastal habitats and on distribution of the major marine species found in the maritime areas under the jurisdiction of the Quebec Region and to record this information in a GIS for rapid, efficient generation of textual and cartographic reports to assist in the management of fish habitats.

For IISFHM, coastal habitats are by definition those between the supralittoral and the 40-m isobath. The territory covered by the physical and chemical parameters includes the coastal habitats of the St. Lawrence Estuary downstream of Ile d'Orléans, the Saguenay Fjord downstream of St. Fulgene, the north shore of the St. Lawrence Estuary and Gulf as far as Blanc-Sablon, the south shore of the estuary and gulf to Pointe-à-la-Croix (Bay of Chaleur) and the coasts of the Magdalen Islands, Anticosti Island and all the islands included in the Quebec Region (Fig. 1).

Characterization of the distribution of marine species in IISFHM is not limited to coastal habitats; it applies to the entire maritime area covered by the Quebec Region (Fig. 1).

This report describes IISFHM status as of March 31, 1990, at the end of the first phase of development of the information system.

STRUCTURE AND COMPONENTS OF THE INFORMATION SYSTEM

The Integrated Information System for Fish Habitat Management (IISFHM) includes six different databases (Fig. 2), three of which are managed by a computer system, while the other three are either archives or direct (manual) access supplementary banks.

The physical and chemical file collection includes a series of ASCII files on separate diskettes containing raw physical and chemical data that was not included in the information system during the first phase of development. Information describing each of these data collections is, however, available in the information system.

The resource map collection includes 57 maps of varying scale showing the distribution, breeding, feeding, migration and/or fishing areas of over 60 fish, crustacean and mollusc species. These maps were not digitized in the first phase of development of the information system.

The reference collection contains a series of copies of most of the sources (reports, maps, etc.) of the information in the system. Basic information on these references may be obtained from the information system.

The computerized part of the information system includes three separate databases:

- an environmental database containing raw or compiled data on a number of physical and chemical characteristics of coastal habitats and on the distribution of marine species of commercial importance;
- a map database with a series of digitized marine charts covering the entire area under study;
- two bibliographical databases giving information on the sources of data included in the system and other relevant material.

Each information base is created and managed by a separate program:

- the Oracle RDBMS, OS/2 version , allows us to enter, retrieve and process the data in the environmental database;
- AutoCAD, currently in the DOS version, is used to manage digitized cartographic data and produce maps;

- EDIBASE, DOS version, manages the bibliographical database.

A user interface has been developed to facilitate database access by non-specialists and allow information to be transferred between the environmental and map databases. Due to incompatibility between the operating systems of the Oracle (OS/2) and AutoCAD (DOS) programs, the user who wants to map data from the Oracle base must exit the OS/2 system at the system management module to access the AutoCAD draw commands. The two programs exchange information through an ASCII interfacing program. EDIBASE, on the other hand, does not exchange information with either program.

Present components of the IISFHM workstation are:

- IBM PS/2 computer Model 70-121
- Intel 80387 20 MHz math coprocessor
- 3.5 inch disk drive
- Cartridge drive (PS2TAPE)
- 115 Mb hard disk
- 14 Mb RAM
- IBM 8514/A graphics card
- IBM 8514 graphics monitor
- Canon LBP-811T two-tray plotter-printer
- CALCOMP digitizer(36 x 48)

DESCRIPTION OF COMPUTER DATABASES

ENVIRONMENTAL DATABASES (ORACLE)

Nature of data

The Oracle database is divided into 21 separate files, 18 with physical-/chemical data, one with biological data and two files detailing information sources.

Criteria for choosing physical/chemical parameters were as follows:

- Each parameter has a potential direct or indirect effect on the distribution and biology of animal species in the Gulf of St. Lawrence.
- Each parameter varies significantly over space and time within the coastal habitats of the St. Lawrence system, and the range of variation corresponds to the sensitivity levels of species using these habitats.
- In each group of possible parameters yielding the same information, only the parameter judged of highest quality was selected for the database.

The biological data file gives the physical and chemical distribution limits for the main mollusc, crustacean and commercial marine fish species in the St. Lawrence system. Current abundance figures from stations have not been included in the database due to the very wide variety of sampling methods used and the consequent impossibility of comparing data received from different sources.

Data structure

The Oracle environmental database is relational. The information contained in each of the 21 files is structured in levels. Each line in Level I may correspond to several lines in Level II, each of which in turn may correspond to several lines in Level III. The levels form separate data tables linked by the use of internal numbers. The great advantage of this organization is that it takes considerably less space and increases data processing efficiency (see Appendix I).

Description of files in Oracle data base

Bathymetry: this file contains spot depth measurements (m) compared to mean low tide in coastal areas (depths of <40 m). Depths above the benchmark level are negative.

Most of the information comes from entry of spot bathymetric data on marine charts from the Canadian Hydrographic Service (scales from 1:10000 to 1:35000 depending on the sector).

Nature of substrate: This file

contains qualitative information on the grain-size of the main component (>30% by weight) and secondary component (>5% by weight) of surface sediments at various points in the coastal area. The presence of vegetation is also noted when mentioned in the source.

Most of the information selected for the Oracle database comes from the entry of spot data from Canadian Hydrographic Service marine charts (scales varying from 1:10000 to 1:35000 depending on the coastal sector). Data were also taken from other sources generally covering more limited areas.

Coastal relief: This file contains qualitative information on the nature of the coast, the relief and the nature of the coastline by homogeneous zone.

Data were entered from charts in one unpublished and three published reports covering all of the Quebec coast.

Direction of coastal drift: This file contains information on the main movements of loose sediment along the coast. Movements are described briefly in terms of original position and direction. Current speed is not indicated.

Data come from several sources covering the Upper North Shore, Bay of Chaleur and Magdalen Islands and an unpublished report covering other Quebec coastal areas.

Coastal erosion: This file contains information obtained by comparing aerial photographs taken at various times. It excludes predictions obtained from mathematical models as they do not correspond to real erosion figures, but rather to potential erosion. The file gives the intensity of erosion (positive or negative) in m^3/yr for specific coastal sectors.

Only two studies limited to the Magdalen Islands provided coastal erosion measurements that could be included in this file.

River flow at mouth: This file contains data on the mean daily flow (m^3/sec) at the mouths of rivers flowing into the study area. An adjustment factor (equal to the ratio between the total surface of the watershed and the drained surface at the measuring station) is applied to figures from stations located upstream of the mouth.

All data currently in this file were obtained directly from the database of the Water Survey Branch of the Quebec Department of Environment, which covers 45 rivers.

Tides: This file contains historical data on monthly high and low waters at coastal stations.

Data on peak tides was obtained directly from the Marine Environmental Data Service (MEDS) of Fisheries & Oceans Canada for 12 Canadian Hydrographic Service (CHS) primary tidal stations. For 61 other CHS stations, only tidal range figures are available; these were obtained from CHS tide charts and the MEDS *Tidal Harmonic Components Book*. The Blue Book provided all reading dates used to determine tidal range figures for secondary stations.

Wave conditions: measurements: This file contains data on the frequency of observation of waves based on their height and period at coastal stations. Measurements inside wharfs have been excluded.

Figures are taken from significant height graphs based on wave periods in 12 MEDS reports (17 stations) from accelerometer buoy measurement programs.

Wave conditions: forecasting: This file includes the results of wave conditions forecasts using digital models based on wind speed and direction measurements at coastal weather stations. The models generate forecasts of wave frequency by height (m) and period (sec) category applicable to areas at least 40 m deep located offshore of municipalities for which the model was cons-

tructed.

Data currently in the database come from 27 reports covering 25 different municipalities.

Currents: mean speed of tide per hour: This file contains the mean hourly current speed and direction observed for each hour of the tide cycle for low, medium and high tidal amplitude, at 30 fixed CHS stations.

All data are taken from the CHS *Tidal Current Charts, St. Jean (I.O.) to Pointe-au-Père*. Readings were taken during the summers of 1934 and 1937.

Currents: current meter readings: This file gives information on readings from current meters anchored at fixed depths for a given period. Vertical current meter profiles and measurements made using floaters (Lagrange method) have not been included because their format is incompatible with the file structure.

The file currently contains information on 52 readings taken between 1967 and 1984, provided by the Bedford Institute of Oceanography (BIO) Data Archive Centre as well as some fifteen other readings supplied by various researchers working in the coastal area. Raw data from all these readings are available in an ASCII file (environmental file collection) or in hard copy.

Water temperature: This file includes raw temperature data (^{o}C) from spot measurements or obtained using auto-recording apparatus (CTD, BT, etc.). It does not include raw data from current meters or Ryan thermographs anchored at fixed stations due to incompatibility with the file structure.

Nearly 70% of the data currently in the bank comes from government databases. MEDS supplied over 700 vertical CTD profiles, 1500 bathythermograph profiles and 1000 sampling stations using reversing thermometers.

For over 150 Ryan thermograph readings and 40 current meter readings at fixed stations supplied by the BIO Data Archive Centre, this file includes information on stations and recording period. Raw data are available either as independent ASCII files (environmental file collection) or in hard copy.

Water salinity: This file includes raw data on salinity from spot samples or measurement using auto-recording devices. Its structure is the same as that of the Temperature: Spot Readings file, and the same stations (CTD, bottle stations and current meters) supplied the data currently in the bank.

Suspended matter: This file contains raw data on concentrations (mg/l) of total particulate matter (organic and inorganic) obtained at various stations and depths. Transparency meter data and Secchi depths are not included in this file.

Most sources of the data currently in the bank cover the mid-estuary which contains the zone of maximum turbidity.

Wind: This file contains monthly mean and peak wind speeds measured at coastal stations.

Data currently in the bank come from Volume 5 of *Canadian Climate Normals* from the Atmospheric Environment Branch of Environment Canada (15 stations) and a 7-year compilation for 11 other stations obtained from the Quebec Department of Environment meteorological database (Meteorology Branch).

Air temperature: This file contains daily temperature statistics for coastal areas.

Data currently in the bank comes from the Canadian Climate Centre in Toronto.

All available data were entered for nine coastal stations, while for 61 other stations, data were entered only for the 1st, 11th and 21st of

each month.

Ice: compilation by quadrat: This file includes data compiled on daily ice concentration for quadrats 1 degree longitude (~40 sea miles) by half a degree latitude (~30 sea miles) in coastal areas.

Data in the bank are all from the Atmospheric Environment Service's *Ice Atlas*. Maps were based on aerial observations made between 1963 and 1973.

Ice: coastal data: This file contains a historical record of freeze-up to break-up for stations on the Quebec coast and includes data on maximum ice thickness measured each winter.

Habitat descriptor matrix: This file contains data on the physical and chemical limiting factors of the significant presence of 30 commercially important fish, crustacean and mollusc species.

Data are from the study of some 300 documents relating abundance of organisms (quantitative samples) to at least one habitat descriptor (sample providing standard coverage of various types of substrate, depth, temperature, etc.). Records could cover Gulf areas not included in the coastal area (>40 metres in depth) and data in certain cases came from outside the Gulf when these filled in gaps for certain species.

Sources of map collection: This file gives a brief description of the sources used for each map in the map database.

Sources of data: This file contains summary data (compared to that in the reference database) on the sources of data included in the Oracle base.

MAP DATABASE (AUTOCAD)

The AutoCAD map database includes two series of files containing the data needed to display on maps the information in the Oracle alphanumeric database:

- basic map files
- dictionary of graphic symbols

Basic map file

Each file corresponds to one of the eight regional maps or the overall map covering the entire study area (Fig. 1). These maps were prepared by digitizing marine charts of various scales using the UTM coordinate system.

For each map, 17 separate layers of information were digitized (Table 1). These layers may be removed or recalled at will depending on the degree of complexity desired for the basic map. To facilitate routine display tasks, the basic map files have been limited to the following information layers:

- Shore
- Litto
- River
- Top. - towns
- Top. - coast
- Top. - marine
- Top. - river

Symbol dictionary

The variables that can be displayed on the map are often linked to a predetermined graphic symbol in the AutoCAD symbol dictionary.

REFERENCE DATABASE (EDIBASE)

Two electronic reference banks on EDIBASE contain detailed information on over 1000 information sources consulted to identify sources of data that could be integrated into the environmental (Oracle) database.

Physical/chemical reference bank (OCEANO)

This bank contains over 715 references consulted to establish the Oracle physical/chemical parameter files. It contains a number of sources that did not contribute data

to the Oracle base but which are nevertheless of interest.

Biological reference bank (BIOLOGIE)

This bank contains over 350 references consulted to enter data into the Habitat Descriptor Matrix file in the Oracle database and contains some references that did not provide data but are nevertheless of interest.

USE OF SYSTEM

SEARCHING AND DISPLAYING TEXTUAL INFORMATION FROM THE ORACLE BASE

To generate a textual report on data in the Oracle environmental database, the most efficient search procedure is to use search programs developed using the SQL*PLUS utility. Access to this module is through the user interface. The utility allows trained users to quickly and efficiently program a series of search instructions on one or more parameters at a time. For users who are not familiar with database structures, preprogrammed search programs are available to consult all Oracle files except Bathymetry, Substrate and Relief, for which a text report would be of no interest, as well as the two Ice files, where direct consultation of files is simpler and more useful than a search.

Table 2 shows the preprogrammed search modules currently available. For all physical and chemical parameters, search conditions are only applicable to descriptors of geographic position of the desired data. In the case of the Habitat Descriptors Matrix file, three search levels are possible: species, biological stage and NAFO area. Figs. 3 and 4 show examples of a detailed report from the Water Salinity file limiting the search to an area of 0.2 minutes latitude by 2.0 minutes longitude near the Magdalen Islands coast, and another obtained from the Habitat Descriptor Matrix that limits the search to adult Canadian Plaice in Division 4RST.

Direct consultation of data in the Oracle database is possible using the data entry functions of the user interface (see below).

SEARCH AND MAP DISPLAY OF INFORMATION IN THE ORACLE DATABASE

At present, map display of information in the Oracle database necessarily involves the following series of steps (see also Fig. 5):

1. Select geographic limits of search
2. Define search instructions for information in the Oracle data base
3. Record map file used for display
4. Map command interfacing file generated
5. Map Command file translated into a map file
6. Map file modified and map printed

Selection of geographic limits

This function may be accessed from the user interface, and is used to limit the geographic area searched by setting four longitude/latitude points.

Selecting search instructions

This function may be accessed from the user interface and allows the user to set up a series of SQL instructions using menus and lists. The search starts with selection of an Oracle file (parameter). Next, descriptors are selected along with conditions on the descriptors to limit the search. Only one file can be searched at a time. At present, files containing data that cannot be displayed in map form (wave files and the Habitat Descriptor Matrix) cannot be consulted using this function.

Map file selection

This function may be accessed from the user interface. It allows the user to record the name of the map file in the AutoCAD graphic database that will be used to display the data. The function also allows the user to enter any symbol additions, changes or deletions (AutoCAD file)

on the map to be produced.

Generating Map Command interfacing program file

This function may be accessed from the user interface, once the preceding three steps have been completed. Its purpose is to produce an ASCII file containing all information required to display the data selected in Step 2 on a map. If needed, the function also allows the resulting ASCII file to be viewed.

It is at this stage that the search commanded in Step 2 is carried out in the Oracle base. In the present state of the system, it is only possible to overlay data from more than one Oracle file by successively adding the information to the Map Command file already created.

Translating Map Command file into a Map file

To be processed by the AutoCAD program in DOS mode, the Map Command ASCII file must be translated into a binary-mode Map file. This translation function is accessed using the following procedures:

- exit OS/2 system
- go to DOS
- go to AutoCAD
- Map program command

The Map program display routines are used to overlay display variables on layers already in place on the basic maps. At present, display routines are available for the following variables:

- Bathymetry
- Relief
  - coastal nature sub-routine
  - relief sub-routine
  - shoreline type sub-routine
- Substrate
- Coastal drift
- Coastal erosion

A number of parameters can be displayed on the same map by successively translating the Map Command files created for the desired parameters and using the same Map file as a basic map. It is also possible to create a Map Batch Command file and then automatically translate the entire batch into one Map file.

Map generation

The AutoCAD program displays the map on the screen when the "Map" filename is entered.

Modification of Map file

Routines have been created using the AutoLISP utility to make simple changes to Map files and routines quickly display the results of these changes on the screen. Such changes allow for:

- choice of geographic window for map display
- changing symbols on basic maps
- moving the inset containing the map key
- presence/absence of points separating coastal sectors for Relief and Shoreline Type
- height of characters used for Bathymetry and Coastal Erosion
- presence/absence of information layers on basic map

Figures 6 to 10 show examples of maps produced for each parameter that can currently be mapped.

SEARCH AND MAP DISPLAY OF DATA OF THE MAP DATABASE

Generation of maps from the AutoCAD Map Database is a function that can be accessed directly from the main AutoCAD menu. The desired map is displayed on the screen simply by entering the "Map" filename. Before printing, the map can be modified using the routines described above.

SEARCH AND TEXTUAL DISPLAY OF THE REFERENCE DATABASE

The generation of textual reports on data contained in reference databases is a function that can be accessed directly from the main EDIBASE menu. After one of the databases has been selected, the function permits

creation of search instructions making direct use of key words, author name, words in the title and/or the source number.

PROCESSING DATA FROM ORACLE

Processing raw data from the Oracle base is not covered in the first development phase of the information system. No processing command has been included in the user interface, but certain SQL*PLUS commands allow basic mathematical operations (mean, minimum, maximum, sum, variance, standard deviation and numbering) using very simple commands.

MANUAL DATA STORAGE IN ORACLE FILES

Direct consultation, entry, modification and updating of data in the Oracle database is possible using functions accessible from the user interface. These functions generate screens displaying data contained in each of the database files using the SQL*FORMS utility.

Selecting a parameter for updating, entry or consultation generates a screen specific to that parameter. Routines have been included to convert data from the English system to the metric system and validate data entries. Procedures for manual storage are facilitated through a series of programmed functions.

AUTOMATED STORAGE OF DATA SERIES FROM THE ORACLE DATABASE

Automatic storage programs have been created for data available on tapes from three sources:

- MEDS temperature and salinity data
- St. Lawrence River Current Survey temperature and salinity data
- river flow at mouth from the Quebec Department of Environment.

Data-checking programs are used before automatic entry through the SQL*LOADER utility.

STORAGE OF DIGITIZED MAPS IN ORACLE FILES

Digitizing data contained in maps and integrating them into Oracle database files must be done using the following steps (see Fig. 11):

1. Generation of a Digitization file
2. Generation of the basic map
3. Activation of the Digitization working file and generation of an ASCII Digitization file
4. Entry of the Digitization file in the Oracle database

Generation of a Digitization working file

This function may be accessed from the user interface; it generates a file containing basic information on each record needed for the AutoCAD digitization functions.

Generation of the basic map

To access this function, the user must exit the OS/2 system and go to the DOS mode. The function is accessible in AutoCAD and generates a basic file used for digitization.

Activating the working file and generation of a Digitization file

Three programs developed using the AutoLISP utility are currently available for digitizing data on relief, bathymetry and substrate. These may be accessed from AutoCAD. The programs activate the working file and digitizing routines by direct entry on a digitizer and enter the digitized data in the working file. Digitizing is facilitated by the use of menus and questionnaires.

Storing the Digitization file in the Oracle database

This function may be accessed from the user interface, and is used to

read the information in the Digitizing files once digitizing with AutoCAD is complete and transfer it into the corresponding levels of the Oracle files.

DATA STORAGE IN THE MAP DATABASE

Data storage by digitization in the map database is a function that is accessible from the main AutoCAD menu. This function currently allows Map files to be created using the digitization functions described in the last section.

DATA STORAGE IN THE REFERENCE DATABASE

The bibliography of an information source may be entered in the reference databases directly from the main EDIBASE menu; this function provides direct data entry using a display screen.

SYSTEM LIMITATIONS AND PROPOSED IMPROVEMENTS

SYSTEM STRUCTURE

At present, the computerized part of IISFHM cannot be accessed by the uninitiated. The system is not particularly user-friendly at the moment; some menus are missing, while others are unclear, and no contextual assistance is available. As well, only one password is currently used for management of the complete system, and it is accordingly impossible to limit access for untrained users to data search and retrieval alone while protecting the remainder of the information in the system. Much more work remains to be done in automating the system, and operation at present requires familiarity with Oracle databases, OS/2 and AutoCAD.

Before making IISFHM accessible to the uninitiated, we plan to develop a system of passwords limiting access to certain functions (including data entry and updating), add and clarify menus and incorporate contextual user help. Major modification of the system structure is needed before some tasks can be automated. With the present structure, it is difficult to automate map display and digitization due to incompatibility between the user interface (in OS/2 mode) and the AutoCAD program (in DOS mode). To improve the current slow, cumbersome operation, all components must be made to run under the OS/2 operating system, by replacing the present AutoCAD program by the OS/2 version, or by an OS/2 version of SPANS. The latter presents the advantage of allowing graphic display of SQL files. These two versions should be available in the near future. This change will make it possible:

- to exploit the multitasking potential of the OS/2 system and thus generate a number of maps at the same time;
- to combine and automate in the user interface all the operations needed to generate maps containing data from the Oracle database and enter in the Oracle base data from the digitization of maps.

FILE STRUCTURE IN THE TEXTUAL DATABASE

The date descriptor format in files should be changed to allow chronological searches, which is currently impossible.

SYSTEM OPERATION

At present, the system does not allow searches, and thus display, of more than one parameter at a time. This makes any multiple display very laborious and time-consuming. Capacity for searches of several parameters at a time could be added to the system without necessitating major modifications.

Search routines could be added for the two ice-condition files.

Map display, currently limited to five physical/chemical parameters, could be possible for other mappable parameters.

There are also plans to improve the raw data processing capacity using the SQL*PLUS utility.

ADDITIONS TO ACTUAL DATABASES

The following additions are planned for the environmental database:

- creation of Oracle files to include time series for temperature and salinity
- addition of data on maritime fisheries (catch/landings per sector/ port)
- addition of data on sources of pollution and contaminant content of sediments, water and marine organisms
- addition of data on chlorophyll and nutrients

The following additions are planned for the map database:

- resource maps
- space-time distribution atlas of physical/chemical parameters prepared using the system

ACKNOWLEDGEMENTS

We wish to thank all those individuals and organizations that supplied us with information on the Quebec Region marine environment. Particular thanks go to the Marine Environmental Data Service (MEDS), the BIO Data Management Service, the Canadian Hydrographic Service and scientists at the Maurice Lamontagne Institute, as well as to the Quebec Environment Department Hydrological Survey and Meteorology branches.

REFERENCE

All requests for information on IISFHM should be addressed to:

Planning & Development Section
Fish Habitat Division
Department of Fisheries and Oceans
Champlain Harbour Station
P. O. Box 15500
901 Cap Diamant
Quebec, Que.
G1K 7Y7

Tel.: (418) 648-2510
Fax: (418) 648-4470

Table 1 List of information layers available on map collection (AutoCAD, map database)

Shoreline for coast and islands
Coastal marshes
10-metre isobath
30-metre isobath
50-metre isobath
10-fathom isobath
50-fathom isobath
River courses
Main coastal roads
Disposal site for dredged sediments
Reefs not identified as islands
Identified banks
Indications on the nature of the seabed (less detailed than information in the textual database)
Names of towns and villages on coasts or main roads. Coastal toponymy (points, coves, bays, marshes, flats, barachois, etc.)
Marine toponymy
Names of rivers

Table 2. List of data request programs in Oracle database accessible using the SQL*PLUS function

Parameter (file)	Conditions	Report
Coastal drift	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, direction
Coastal erosion	Latitude (beg. & end) Longitude (beg. & end)	Source, beg. latitude, beg. longitude, end latitude, end longitude, intensity
River flows	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, minimum flow, maximum flow, date, beginning, station name
Tides	Latitude (beg. & end) Longitude (beg. & end)	Source, station name, latitude, longitude, mean tide, high tide
Wave conditions: measurement	Station name	Source, latitude, longitude, beg. date, end date, depth, height class, period class, number of events
Wave conditions: prediction	Municipality Station name	Source, station name, name of municipality, latitude, longitude, beg. date, end date, period class, number of predictions
Currents: speed per hour of tide	Latitude (beg. & end) Longitude (beg. & end)	Source, station number, latitude, depth, amplitude, variance, speed, direction
Currents by current meter	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, depth, date
Water temperature	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, longitude, station number, depth, temperature
Water salinity	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, station number, depth, salinity
Suspended matter	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, station number, depth, concentration
Air temperature	Latitude (beg. & end) Longitude (beg. & end) Mean temperature	Source, latitude, longitude, station name

Parameter (file)	Conditions	Report
Wind	Latitude (beg. & end) Longitude (beg. & end)	Source, latitude, longitude, maximum hourly speed, maximum hourly direction, mean speed, station name
Biology - adult	Species, NAFO zone	Source, division, species, latitude, (min, max), longitude (min, max), period (beg. end), period (max, min), bathymetry (min, max), depth (min, max), temperature (min, max), salinity (min, max), substrate
Biology - adult winter	Species, NAFO zone	Source, division, species, latitude, (min, max), longitude (min, max), period (beg, end), period (max, min), bathymetry (min, max), depth (min, max), temperature (min, max), salinity (min, max), substrate
Biology - reproduction	Species, NAFO zone	"
Biology - pelagic eggs	Species, NAFO zone	"
Biology - larvae	Species, NAFO zone	"
Biology - juveniles	Species, NAFO zone	"
Biology - other	Species, NAFO zone	"

N.B. All options for any condition may be selected by choosing "*".

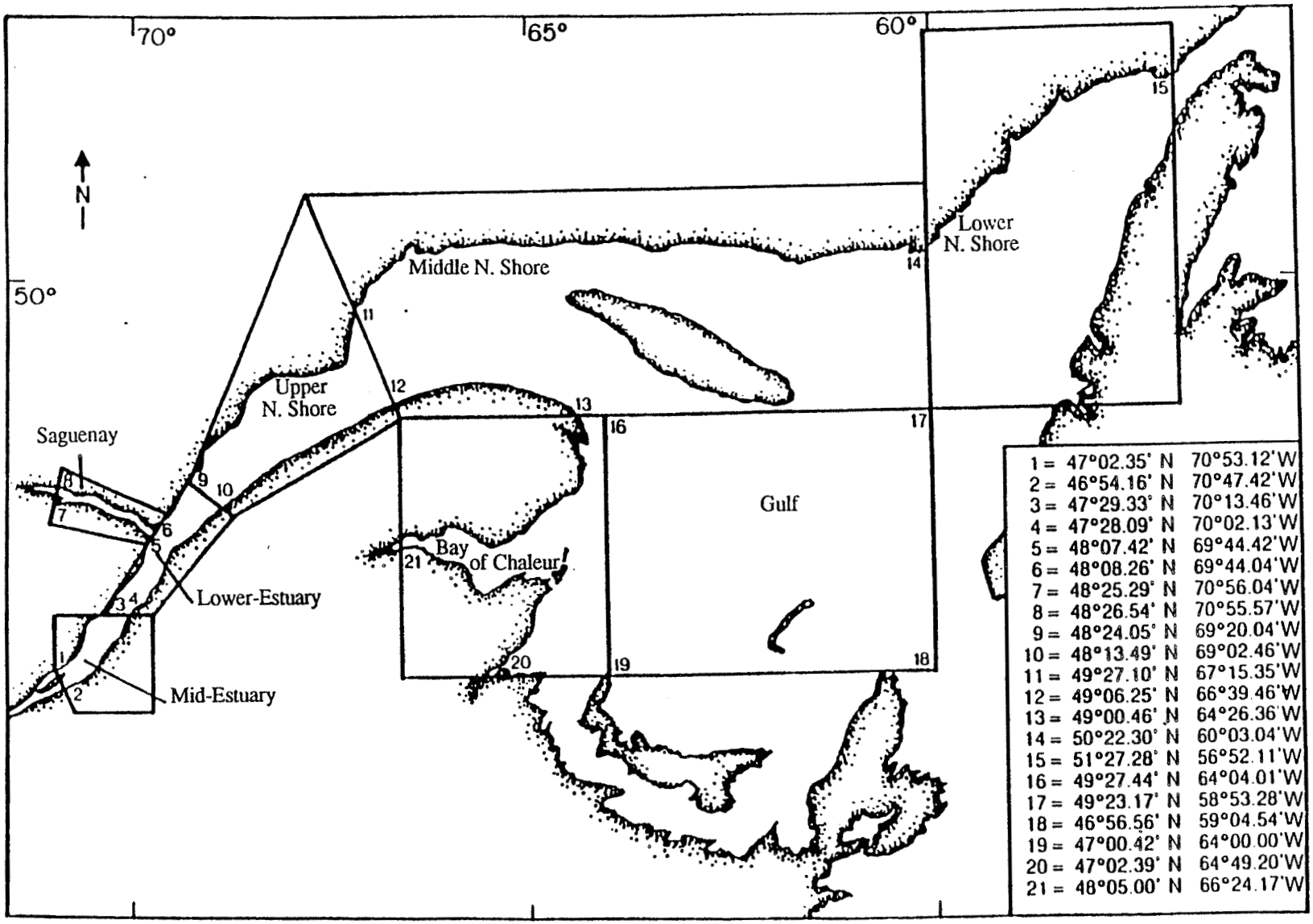

Fig. 1. Area covered by IISFHM

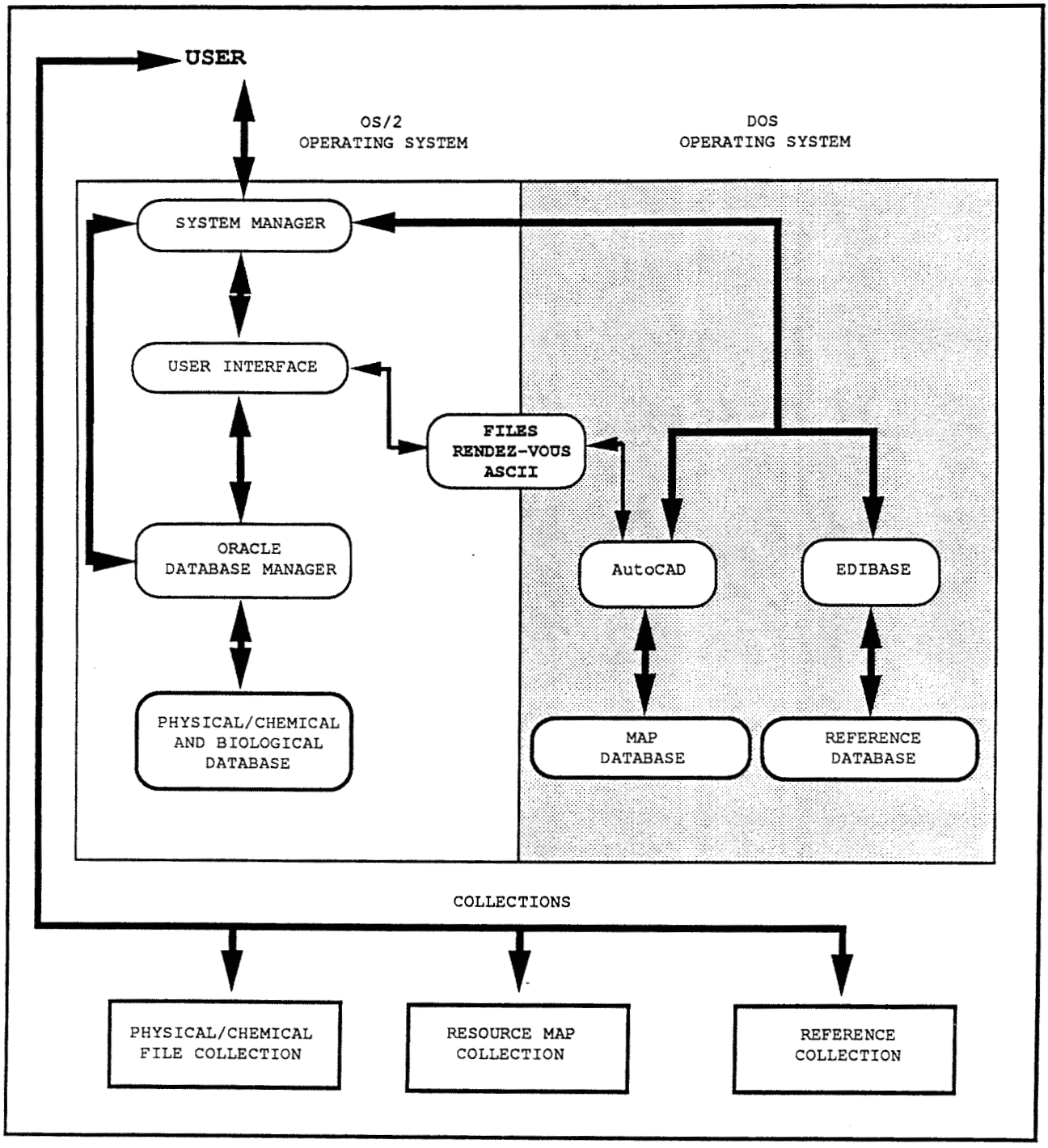

Fig. 2. IISFHM Structure

```
SQL>  start salinity
DOC>
DOC>     (c)  All rights reserved, Fisheries & Oceans Canada. (IISFHM)
DOC>
DOC>     Developed by Eric Côté, Comp. Tech. (Lavalin Environment)
DOC>
DOC>     Research on water salinity data:  spot measurements
DOC>
DOC>#
Enter value for latitude_beginning: 4724.9
Enter value for latitude_end:  4725.1
old   5:     AND POSLAT         BETWEEN &LATITUDE_BEGIN. AND LATITUDE_END
new   5:     AND POSLAT         BETWEEN 4724.9 AND 4725.1
Enter value for longitude_beginning: 6155.0
Enter value for longitude_end:  6157.0
old   5:    AND POSLONG    BETWEEN &LONGITUDE_BEGIN. AND LONGITUDE_END
new   5:    AND POSLONG    BETWEEN 6155.0 AND 6157.0
Enter value for depth_min: 0
Enter value for depth_max: 1
old   7:     ANDSAL2.DEPTH BETWEEN &DEPTH_MIN AND &DEPTH_MAX
new   7:     ANDSAL2.DEPTH BETWEEN 0 AND 1

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                        WATER SALINITY:  SPOT MEASUREMENTS

 SOURCE    LATITUDE   LONGITUDE   STATION NO.   DATE              DEPTH    SALINITY
--------- ---------- ----------- ------------ ----------------- -------- -----------
 30038        4725       6156.2          3    22-07-1985 10:15     .5        30.8
 30038        4725       6156.2          1    22-07-1985 17:45     .5        30.6
 30038        4725       6156.2          1    22-07-1985 19:45     .5        30.5
 30038        4725       6156.2          3    22-07-1985 12:45     .5        30.1
 30038        4725       6156.2          3    22-07-1985 15:45     .5        30.3
 30038        4725       6156.2          1    22-07-1985 21:45     .5        30.5
 30038        4725       6156.2          3    22-07-1985 13:45     .5        30.1
```

Fig. 3 Sample of detailed report obtained from Water Salinity file using Salinity program in SQL*PLUS mode

HABITAT DESCRIPTORS

SOURCE: 5063 SPECIES NAME: Canadian plaice

CODE: Hi pl

NAFO DIVISION: 4RST POSITION LATITUDE:

SAMPLING DATE: LONGITUDE:

SAMPLING PERIOD, BEG. 15-09-1979 END 02-10-1979

MULTIPLE CHOICE

		ADULTS	ADULTS WINTER	REPRO.	PELAGIC EGGS	LARVAE	JUVEN.	OTHER
EFFECTIVE PERIOD	MIN	02-10						
	MAX	03-09						
BATHYMETRY (m)	MIN							
	MAX							
DEPTH (m)	MIN	90						
	MAX	0						
TEMPERATURE (°c)	MIN	2						
	MAX	0						
SALINITY (%)	MIN							
	MAX							
LATITUDE	MIN							
	MAX							
LONGITUDE	MIN							
	MAX							

MULTIPLE CHOICE

SPECIES NAME:

CODE:

Fig. 4 Sample of detailed report by source obtained from Habitat Descriptors Matrix file using the SQL*PLUS program

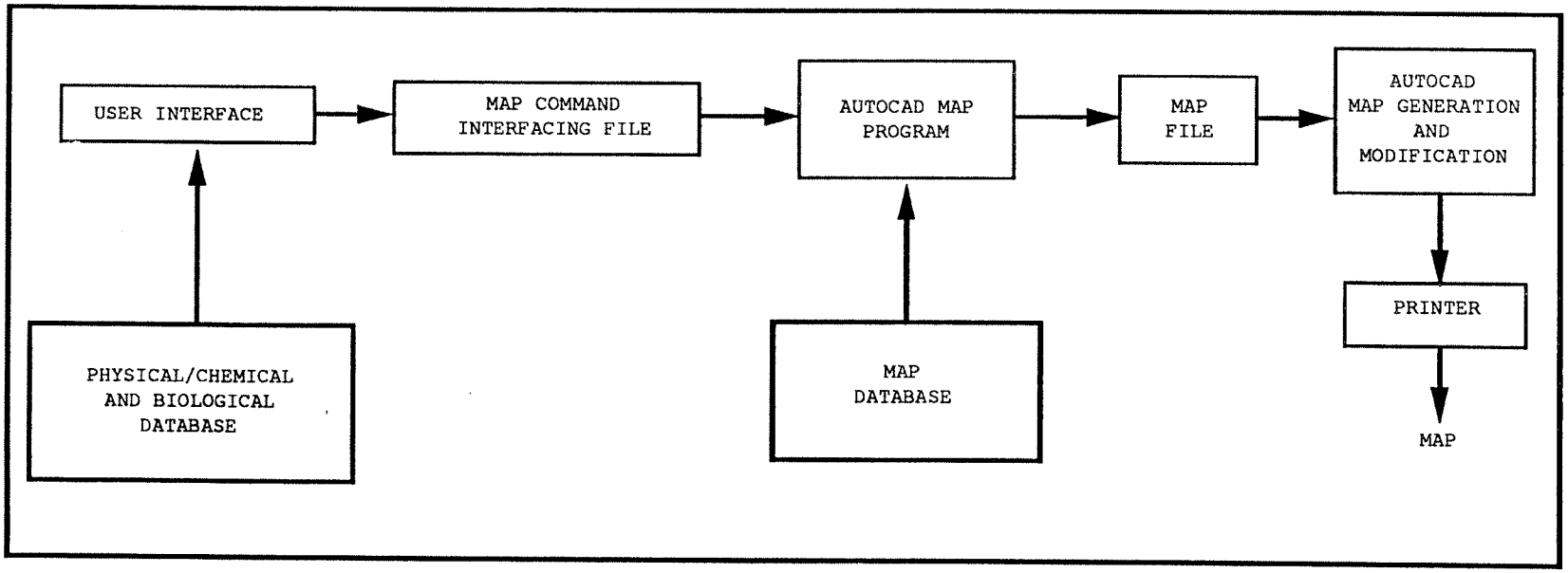

Fig. 5. Information flow chart in IISFHM to display Oracle base in map form.

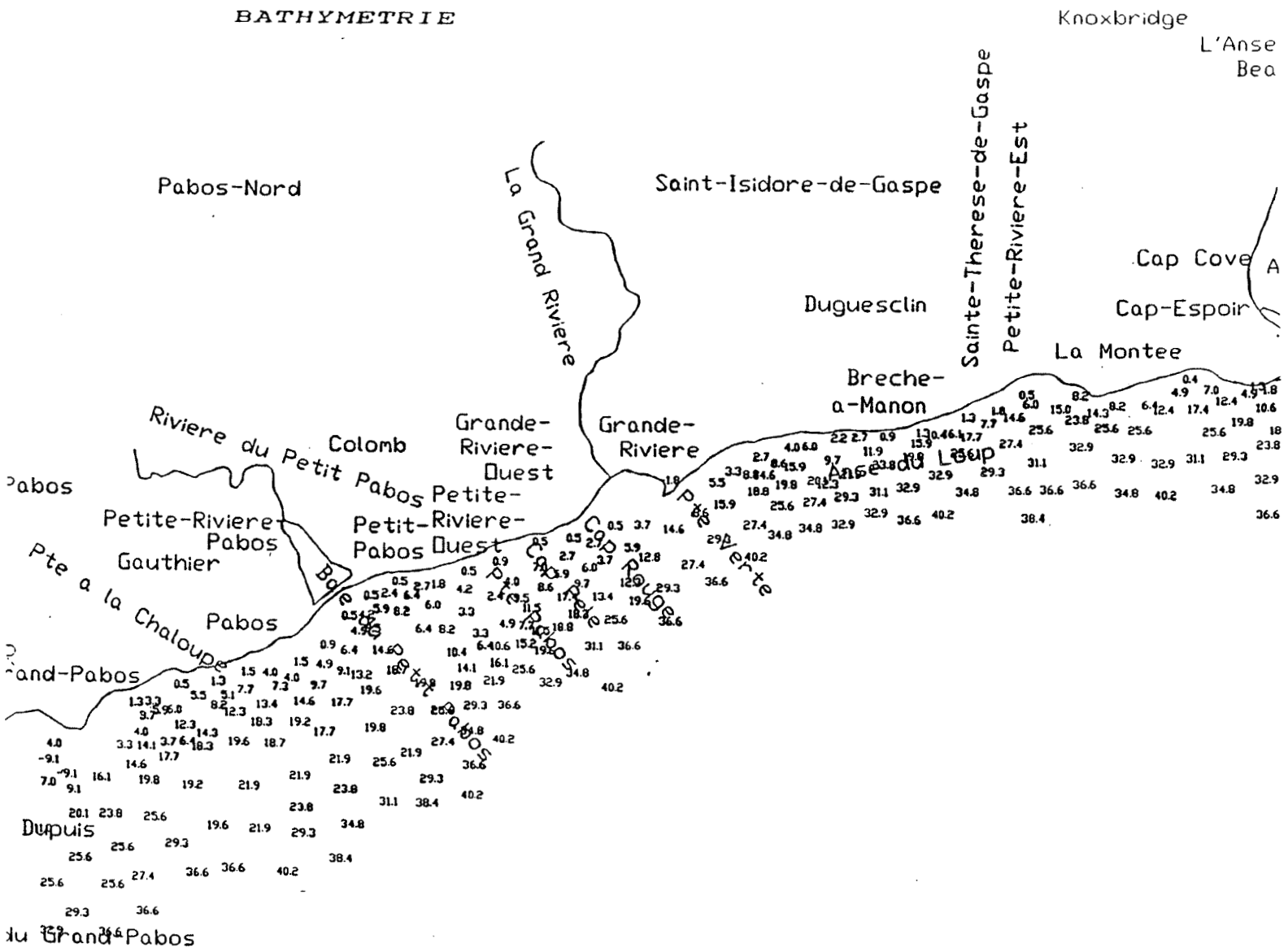

Fig. 6. Example of cartographic report produced from the Oracle database Bathymetry file and the AutoCAD map database.

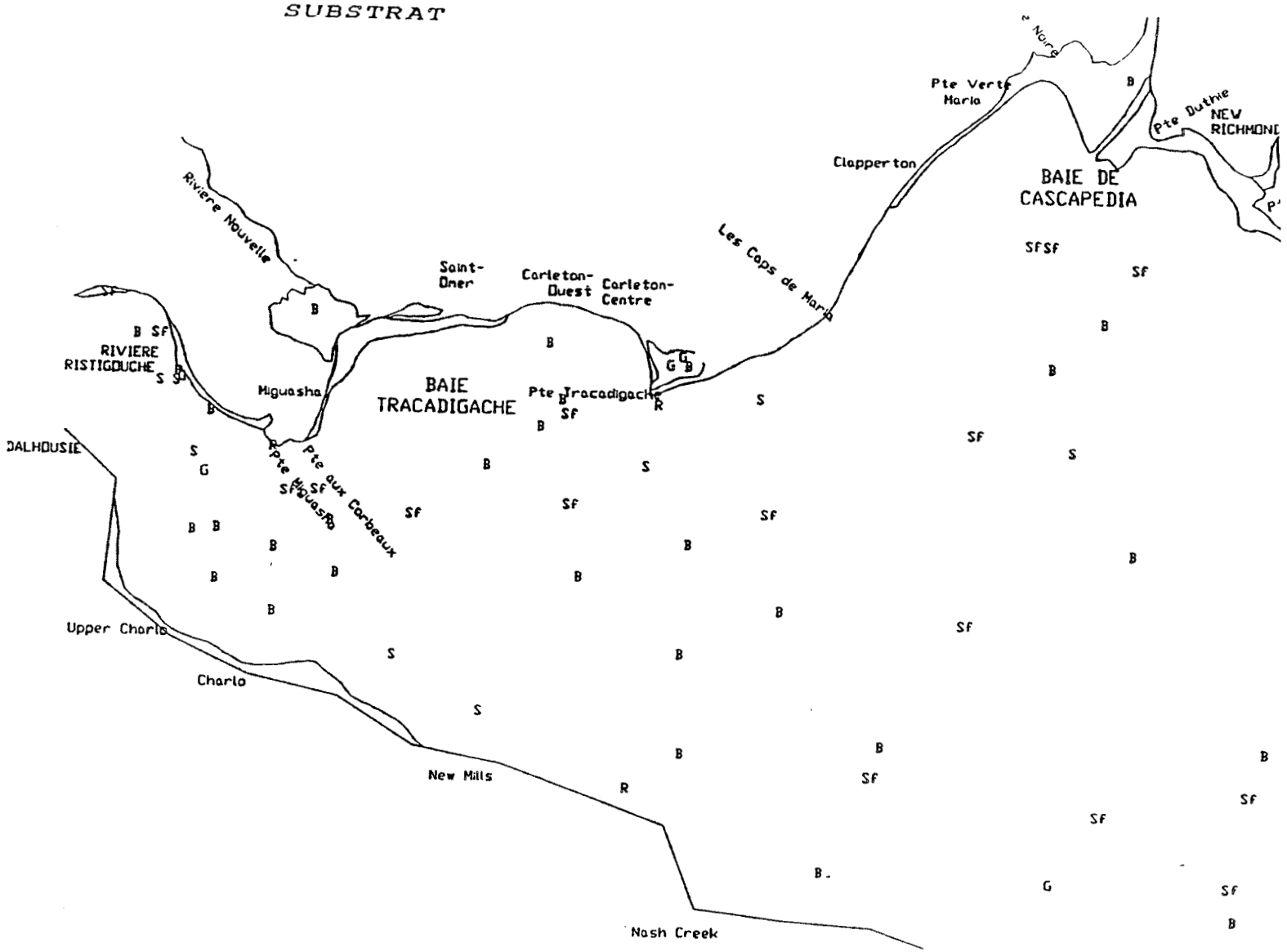

Fig. 7 Example of cartographic report produced from the Oracle database Substrate file and the AutoCAD map database.

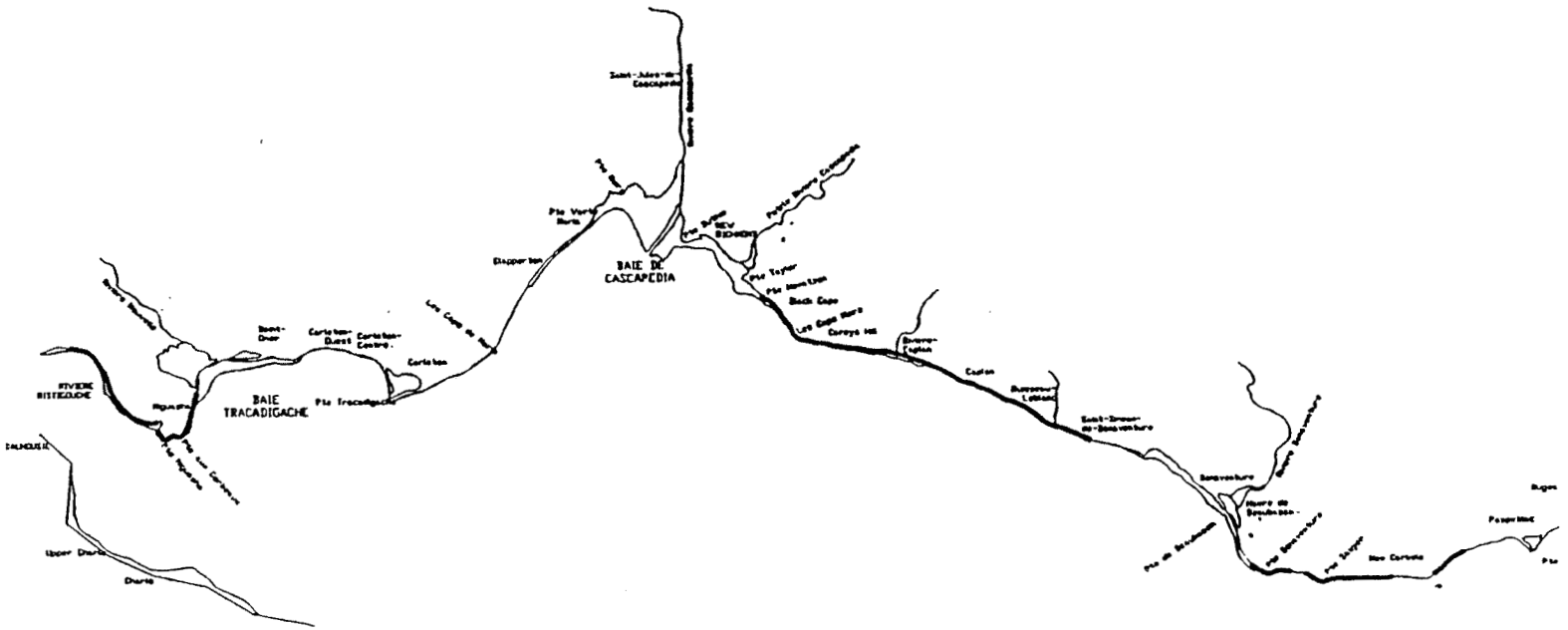

Fig. 8 Example of cartographic report produced from the Oracle database Coastal Relief: Nature of Coastline file and the AutoCAD map database.

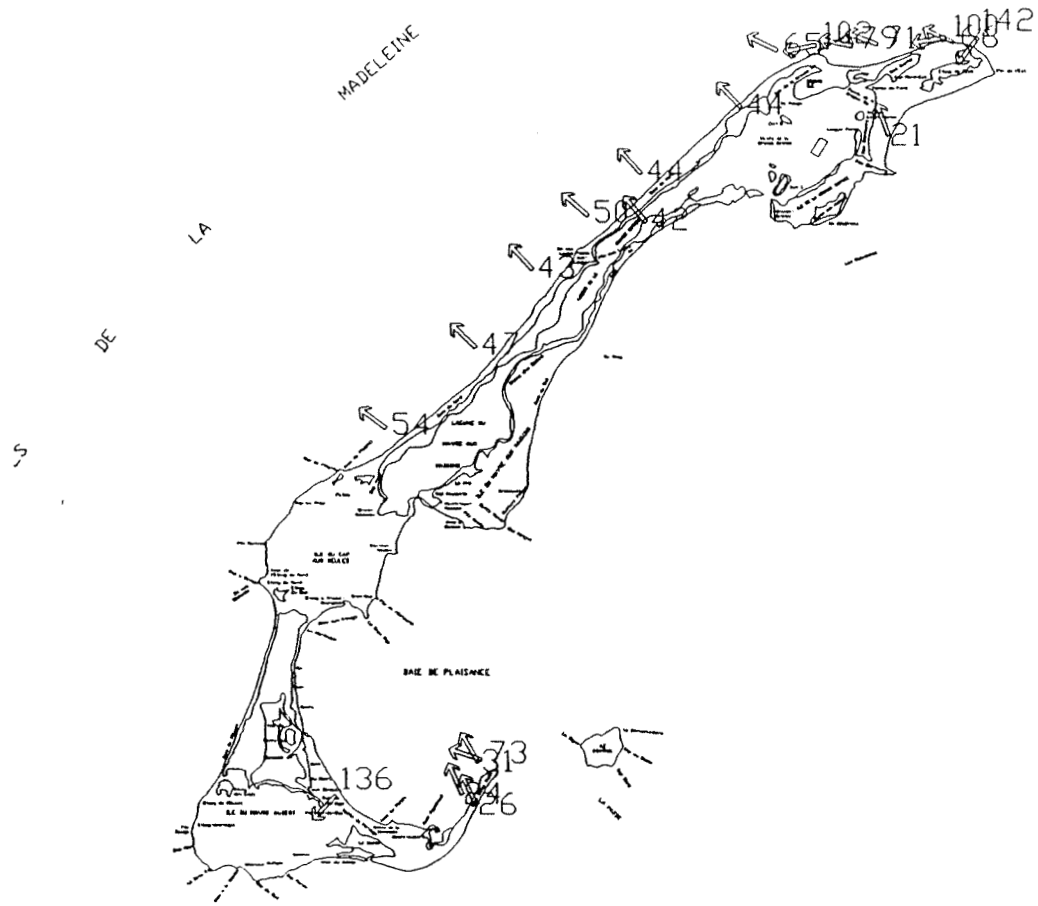

Fig. 9 Example of cartographic report produced from the Oracle database Coastal Drift file and the AutoCAD map database.

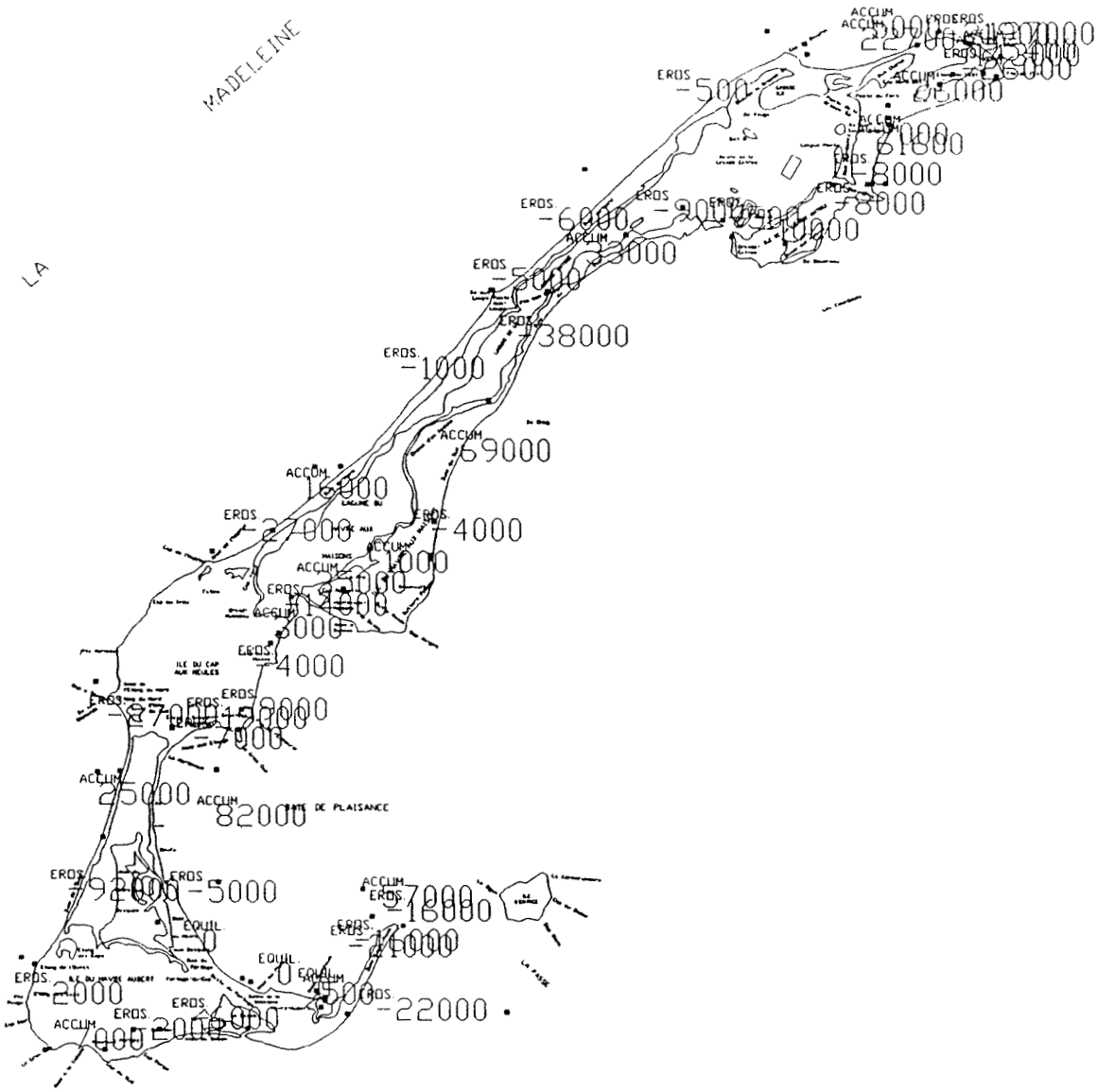

Fig. 10 Example of cartographic report produced from the Oracle database Coastal Erosion file and the AutoCAD map database.

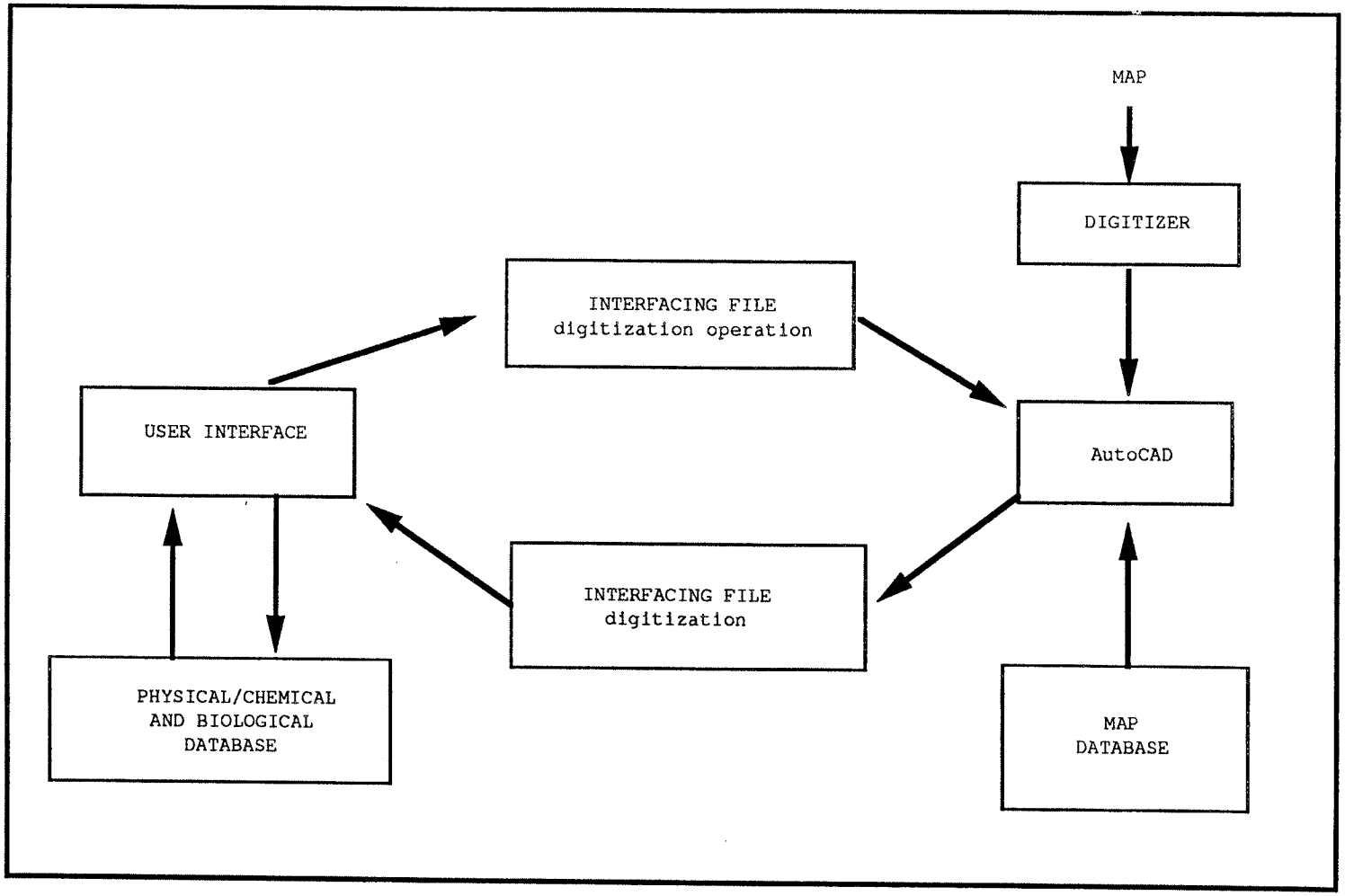

Fig. 11. Information flow in IISFHM for entry in Oracle digitized map database.

APPENDIX

STRUCTURE OF ORACLE DATABASE FILES

STRUCTURE OF ORACLE DATABASE FILES

The structure of Oracle files is shown in Fig. A.1 using two examples: the Water Temperature file and the Air Temperature file. The first file contains data structured in four levels. Each level may be described in the file using one or more descriptors which may serve as information search criteria. Ideally, the file should contain only those levels inside which a limited number of combinations is possible. In the Water Temperature file, data levels 2 and 3 have been combined to form level 2 of the file because often there is only one cruise per source (each station is visited only once). In the second example, there is only one source, and level 1 of the file thus combines data levels 1 and 2.

The structure of the Water Temperature file illustrated in Fig. A.1 does not permit entry of time series for temperatures at fixed stations because level 3 of the file refers to depths and not to hours of measurement. It does, however, give information on these time series at levels 1 and 2 of the file (source, cruise, station, sampling date/time).

The structure of each file in the Oracle database is described below:

BATHYMETRY:

N1 (Source):
- -source number
- -year of storage/data updating
- -year of bathymetric survey

N2 (Station):
- -latitude/longitude of station
- -depth (m)

NATURE OF SUBSTRATE:

N1 (Source):
- -source number
- -year of storage data updating
- -measurement method (multiple choice)
- -sampling year

N2 (Station):
- -latitude/longitude of station
- -dominant sediment type (multiple choice)
- -secondary sediment type (multiple choice)
- -presence/absence of vegetation (yes or no)

The following sediments are distinguished:

- -mud (clay and/or silt): < 0,06 mm in diameter
- -fine sand: 0,06 to 0,25 mm in diameter
- -medium and/or coarse sand: 0,25 to 2,00 mm in diameter
- -sand (unspecified) 0,06 to 2,00 mm in diameter
- -gravel: 2,00 to 4,00 mm in diameter
- -pebbles: -
- -stones: -
- -cobbles: -
- -boulders: -
- -bedrock (dominant sediments only)
- -none/unspecified (secondary sediments only)

COASTAL RELIEF:

N1 (Source):
- -source number
- -year of storage data updating)
- -coastal analysis method (interpretation of aerial photographs on various scales with or with out inspection of site)
- -year of origin of most recent aerial photographs

N2 (Coastal strips):
(for nature of coastline)
- -longitude/latitude of beginning of coastal strip
- -longitude/latitude of end of coastal strip
- -nature of coastline (rocky/not rocky)

(for relief)
- -longitude/latitude of beginning of coastal strip
- -longitude/latitude of end of coastal strip
- -relief (recent cliff/active

slope or ancient cliff/stable slope or no cliff)

(for type of coastline)
-longitude/latitude of beginning of coastal strip
-longitude/latitude of end of coastal strip
-type of coastline (multiple choice)

Type of coastline is described as follows:

-rocky beach
-stone or pebble beach
-sand or gravel beach
-muddy beach
-no beach
-beach of unidentified loose sediments

DIRECTION OF COASTAL DRIFT:

N1 (Source):
-source number
-year of storage/data updating
-method of analysis (multiple choice)

N2 (Station):
-longitude/latitude of benchmark
-direction of drift (degrees based on geographic north)

COASTAL EROSION:

N1 (Source):
-source number
-year of storage data updating
-year first observations
-year last observations

N2 (Coastal strip):
-latitude/longitude of beginning of strip
-latitude/longitude of end of strip
-rate of erosion (m^3/yr)
-type of movement (erosion, sedimentation, zone in equilibrium)

RIVER FLOW AT MOUTH:

N1 (Source X River):
-source number
-year of storage data updating
-longitude/latitude of measuring station
-name of measuring station (multiple choice)
-day/month/year first measurement
-longitude/latitude of mouth
-conversion factor used
-minimum daily flow at mouth
-day/month/year of daily minimum flow (m^3/sec)
-maximum daily flow at mouth (m^3/sec)
-day/month/year of maximum daily flow

N2 (Date):
-day/month
-mean daily flow at mouth (m^3/sec)
-standard deviation from mean
-number of years used for calculation

TIDE:

N1 (Source X Station):
-source number (one per station)
-year of storage data updating
-longitude/latitude of station
-name of station (tidal) multiple choice
-day/month/year first observations
-day/month/year last observations
-range (m) of mean tide
-range (m) of high tide
-maximum monthly amplitude (m) (per month)
-year maximum monthly amplitude recorded (per month)
-minimum monthly amplitude (m) (per month)
-year minimum monthly amplitude recorded (per month)
-maximum instantaneous level (per month)
-day/month/year/time instantaneous maximum recorded (per month)
-minimum instantaneous level (m) (per month)
-day/month/year/time instantaneous minimum recorded (per month)

WAVE CONDITIONS: MEASUREMENT:

N1 (Source X Station):
- -source number (one per station)
- -year of storage data updating
- -name and number of station (multiple choice)
- -longitude/latitude of station
- -day/month/year/hour/minute first record
- -day/month/year/hour/minute last record
- -type of apparatus (multiple choice)
- -depth of sensor (m)
- -proportion of correct data (%)
- -interval between wave-height categories (m)
- -interval between wave-period categories (sec)
- -number of calm events

N2 (Wave-height category):
- -lower limit of wave-height category (m)

N3 (Wave-period category):
- -lower limit of wave-period category (sec)
- -number of events measured

WAVE CONDITIONS: PREDICTION:

N1 (Source X Station):
- -source number
- -year of storage data updating
- -approximate position of 40 m isobath prediction (longitude/latitude)
- -name of municipality (multiple choice)
- -name of weather station providing wind data (multiple choice)
- -year of first data used
- -year of last wind data used
- -period of year covered by model (multiple choice)
- -wind conversion factors used in model (1.0 to 2.0)
- -number of wind records used

N2 (Wave-height category):
- -lower limit of wave-height category (m)

N3 (Wave-period category):
- -lower limit of wave-period category (sec)
- -number of events predicted

CURRENTS: MEAN SPEED PER HOUR OF TIDE:

N1 (Source X Station):
- -source number
- -year of storage data updating
- -number of CHS station (multiple choice)
- -longitude/latitude of station
- -depth of observation (m)
- -year of readings

N2 (Tidal amplitude):
- -tidal amplitude (medium, low, high)

N3 (Time):
- -number of hours (+ or -) before or after high water in the observation period
- -direction (degrees) of currents compared to geographic north
- -degree of variability in direction (variable or invariable)
- -mean current speed (m/sec)
- -change in current direction (yes or no)

CURRENTS: CURRENT METER READINGS:

N1 (Source X Station):
- -source number
- -year of storage data updating
- -latitude/longitude of fixed station
- -depth of fixed station (m)
- -researcher, organization (multiple choice)
- -type of apparatus used (multiple choice)

N2 (Depth):
- -current meter depth (m)
- -direction (degrees) of U axis compared to geographic north
- -direction (degrees) of V axis compared to geographic north

N3 (Time):
- -day/month/year/hour/minute of first reading
- -day/month/year/hour/minute of second reading
- -day/month/year/hour/minute of last reading

N1 (Source):
-source number
-year storage of data updating
-type of apparatus used (multiple choice)

N2 (Cruise X Station):
-cruise and station number
-longitude/latitude of station
-day/month/year/hour/minute of reading
-number of depths sampled

N3 (Depth):
-depth of reading (m)
-temperature (°C)

SALINITY OF WATER:

N1 (Source):
-source number
-year of data updating
-type of apparatus used (multiple choice)

N2 (Cruise X Station):
-cruise and station number
-longitude/latitude of station
-day/month/year/hour/minute of reading
-number of depths sampled

N3 (Depth):
-depth of reading (m)
-salinity

SUSPENDED MATTER:

N1 (Source):
-source number
-year of storage data updating
-type of apparatus used (multiple choice)

N2 (Cruise X Station):
-cruise and station number
-longitude/latitude of station
-day/month/year/hour/minute of reading
-number of depths sampled

N3 (Depth):
-depth of reading (m)
-suspended matter (mg/l)

WIND:

N1 (Source X Station):
-source number
-year of storage data updating
-longitude/latitude of weather station
-name of weather station (multiple choice)
-altitude of weather station (m)
-year first record
-year last record

N2 (Month):
-maximum hourly speed (per month) (km/h)
-direction associated with maximum hourly speed (multiple choice; Ex: NNE, ENE, NE)
-maximum speed of gusts (per month) (km/h)
-direction associated with gusts (multiple choice; Ex: NNE, ENE, NE)
-mean monthly wind speed, all directions (km/h) (per month)

N3 (Direction):
-wind direction (multiple choice; Ex: NNE, ENE, NE)
-mean wind speed (km/h) (per month)
-percentage of wind frequency (%) (per month)

AIR TEMPERATURE:

N1 (Source X Station):
-Source number
-year of storage data updating
-latitude/longitude of station
-name of station (multiple choice)
-year first record
-year last record

N2 (Date):
-day/month
-mean daily temperature (°C)
-standard deviation from mean
-number of years used for calculation

ICE: COMPILATION BY QUADRAT:

N1 (Source X Quadrat):
-source number
-storage year/data updating
-longitude/latitude of upper left

-storage year/data updating
-longitude/latitude of upper left and lower right corners of quadrat

N2 (Date):
-day/month
-number of years with ice
-total median concentration (0 to 1.0)*

* A value of 1.0 means that ice cover was complete at that date, during all years of observation.

ICE: COASTAL DATA:

N1 (Source X Station)
-source number
-entry year/data updating
-name of station (multiple choice)
-approximate longitude/ latitude of station

N2 (Year):
-year (at beginning of winter)
-day/month of permanent ice cover
-day/month of total freeze-up
-day/month of partial ice cover
-specification related to extent of partial ice cover (multiple-choice)
-day/month of another freeze-up
-maximum thickness of ice (cm)
-method of determining thickness (multiple choice)
-day/month of first ice deterioration
-day/month of first water free of ice
-day/month of complete break-up
-specification of incomplete break-up (multiple choice)
-day/month of another break-up
-specification of another break-up (multiple choice)

HABITAT DESCRIPTOR MATRIX:

-source number
-species (multiple choice)
-NAFO division, sub-division or sub-sub-division (multiple choice)
-longitude/latitude (for spot sample)
-day/month/year of sampling
-day/month/year of beginning and end of sampling period (if applicable)
-matrix

The matrix structure is given in Fig. A.2.

SOURCES OF MAP COLLECTION:

N1 (Source):
-source number
-entry year/data updating
-map number
-year of edition of map
-scale of original map (multiple choice)
-name of map
-name of Map file (AutoCAD)

SOURCES OF DATA:

N1 (Source):
-source number
-entry year/data updating
-name of author (researcher) institution
-year of edition
-description of source/title
-reference

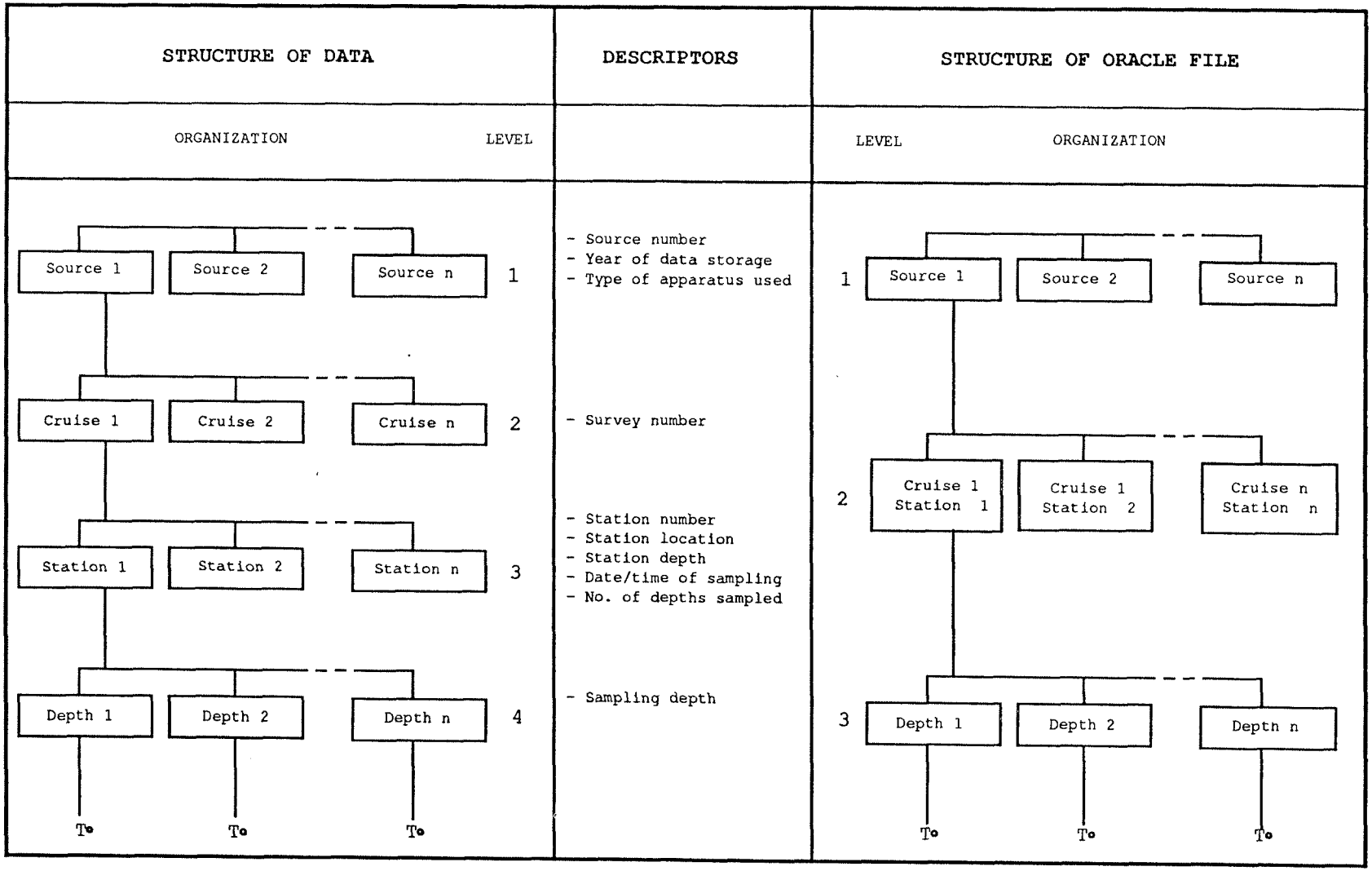

Fig. A.1a. Relation between data structure and file structure in Oracle physical/chemical and biological database. a) "Water Temperature" file, b) "Air Temperature" file.

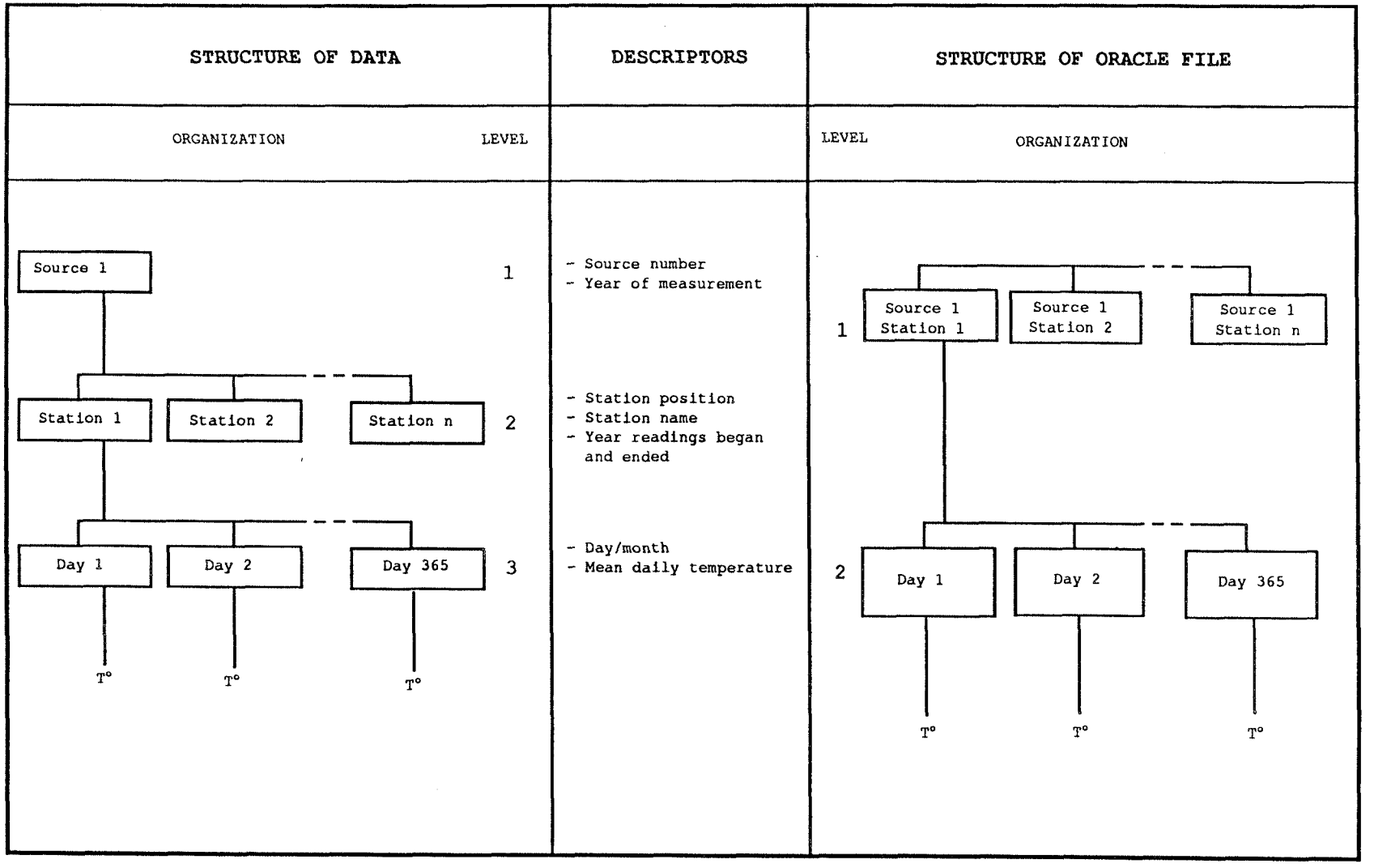
STRUCTURE OF DATA
DESCRIPTORS
STRUCTURE OF ORACLE FILE
ORGANIZATION
LEVEL
LEVEL
ORGANIZATION
Source 1
1
- Source number
- Year of measurement
Station 1
Station 2
Station n
2
- Station position
- Station name
- Year readings began and ended
Day 1
Day 2
Day 365
3
- Day/month
- Mean daily temperature
T°
T°
T°
1
Source 1 Station 1
Source 1 Station 2
Source 1 Station n
2
Day 1
Day 2
Day 365
T°
T°
T°

Fig. A.1b

STRUCTURE OF MATRIX

Stage in life cycle:	Adult	Adult winter	Repro-duction	Pelagic egg	Larvae	Juve-nile	Other
Effective period:	min max	min max	min max	min max	min max	min max	min max
Bathymetry:	min max	min max	min max	min max	min max	min max	min max
Depth:	min max	min max	min max	min max	min max	min max	min max
Water temperature:	min max	min max	min max	min max	min max	min max	min max
Salinity:	min max	min max	min max	min max	min max	min max	min max
Latitude:	min max	min max	min max	min max	min max	min max	min max
Longitude:	min max	min max	min max	min max	min max	min max	min max
Substrate:	min max	min max	min max	min max	min max	min max	min max
Suspended matter:	min max	min max	min max	min max	min max	min max	min max
Other:	min max	min max	min max	min max	min max	min max	min max

Fig. A.2