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West Coast Newfoundland Oil Spill Sensitivity Atlas

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WEST COAST NEWFOUNDLAND OIL SPILL SENSITIVITY ATLAS

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EXECUTIVE SUMMARY

The West Coast Newfoundland Oil Spill Sensitivity Atlas has been produced as a planning tool to assist in the preparation, priorization, and implementation of countermeasures that may be required in response to an oil spill related to future oil and gas drilling activities offshore western Newfoundland. The atlas is a computer-based Geographic Information System (GIS) product developed to run on an IBM-compatible PC using Intera Tydac SpansMap software. The system has been intentionally structured for use by relatively inexperienced operators.

The coastline is described in terms of beach characteristics, physical environment, human use, and biological resources. The atlas consists of existing data available from a large variety of sources. No original field data collection was undertaken for this project. A multi-disciplinary team was assembled for this project to gather basic resource data, implement a GIS-based database, assign environmental sensitivity rankings within study area, and suggest approaches to oil spill countermeasures.

The coastline contained within the study area is more than 2,900 km in overall length stretching from Cape Anguille in the south to Cape Norman in the north. To facilitate data management, within the atlas, the study area has been divided into seven logical geographic regions. Digital base maps were constructed in Transverse Mercator Projection from recent LANDSAT satellite imagery. To ensure consistency of geographic accuracy for both base maps and environmental data, National Topographic Series 1:50,000 UTM topographic sheets were used as the basis for establishing the locations of data attributes and ground-truthing features. In consideration of the accuracy of the input LANDSAT data, the advertized accuracy of the final atlas is about 1:70,000.

The entire coast has been divided into a series of individual shoreline segments each having a homogeneous geological make up. The data files which describe segment-by-segment geomorphology have been reclassified so that several other environmental and human use parameters are attached to the shoreline segments and can be presented as distinct and directly comparable layers in the GIS. Each parameter has been classified in a GIS-compatible format to reflect sensitivity to oiling.

Apart from Oil Residence Index, the length of time spilled oil is expected to remain on a shoreline of given geological structure and wave energy, no attempt is made to derive a overall sensitivity index. The SpansMap software and the atlas data structure do, however, permit the simultaneous presentation of all data associated with a given shoreline segment as a mechanism to display all classified parameters collectively. This allows the system operator to determine countermeasures priorities based on conditions at the time of the spill as well as historical environmental descriptions.

RÉSUMÉ

L'Atlas de sensibilité aux déversements de pétrole de la côte ouest de Terre-Neuve est un outil conçu pour aider à préparer, à classer par ordre de priorité et à mettre en oeuvre les contre-mesures nécessaires en réponse à un déversement de pétrole lié aux activités de forage pétrolier et gazier au large de la côte ouest de Terre-Neuve. L'atlas est un système d'information géographique (SIG) qui est exploitable sur un ordinateur compatible avec l'OP d'IBM à l'aide du logiciel SpansMap d'Intera Tydac. Le système a été délibérément structuré pour utilisation par des personnes relativement peu versées en informatique.

Le côte est décrite en termes de caractéristiques du littoral, de milieu physique, d'utilisation humaine et de ressources biologiques. L'atlas est constitué de données existantes provenant d'une vaste gamme de sources. Aucune donnée originale n'a été recueillie sur le terrain pour ce projet. Une équipe multidisciplinaire a rassemblé les données fondamentales, mis sur pied une base de données en SIG, attribué des cotes de sensibilité environnementale et suggéré des approches en matière de contre-mesures.

Le côte étudiée s'étend sur plus de 2 900 km, de Cap Anguille au sud à Cap Norman au nord. Pour faciliter la gestion des données de l'atlas, elle a été divisée en sept régions géographiques logiques. Des cartes de base numériques ont été dessinées dans la projection de Mercator transversale à partir d'images LANDSAT récentes. Pour assurer l'uniformité des cartes de base et des données environnementales, les cartes topographiques UTM au 1/50 000 de la Série nationale de référence topographique ont servi à localiser les attributs de données et les caractéristiques de réalité du terrain étudié. Compte tenu de la précision des données LANDSAT utilisées, l'atlas est exact au 1/70 000 approximativement.

Toute la côte a été divisée en segments de composition géologique homogène. Les fichiers de données qui décrivent la géomorphologie, segment par segment, ont été reclassifiés afin que plusieurs autres paramètres environnementaux et humains puissent s'appliquer aux segments et être présentés comme des couches distinctes et directement comparables dans le SIG. Chaque paramètre a été classifié dans un format compatible avec le SIG pour refléter la sensibilité à la marée noire.

À part l'index de rétention du pétrole, qui indique combien de temps une nappe de pétrole pourrait demeurer sur la rive d'une structure géologique donnée, en tenant compte de l'énergie des vagues, on n'a pas tenté de calculer un index de sensibilité globale. Toutefois, le logiciel SpansMap et la structure de l'atlas permettent la présentation simultanée de toutes les données liées à un segment comme moyen d'afficher tous les paramètres classifiés dans leur ensemble. L'utilisateur peut donc établir l'ordre de priorité des contre-mesures d'après les conditions prévalant lors du déversement et des descriptions environnementales antérieures.

1. INTRODUCTION

In 1991, eight licences were granted for the exploration for offshore hydrocarbon reserves in the Gulf of St. Lawrence off the West Coast of Newfoundland. During that summer, a considerable amount of geophysical survey work was undertaken as part of the evaluation of these lands. In anticipation of eventual offshore drilling activities off the west coast, the Canada-Newfoundland Offshore Petroleum Board (CNOPB), with support from Environment Canada, made an application to the Environmental Studies Research Fund (ESRF) for funding for the development of a computerized oil spill sensitivity atlas for the west coast of Newfoundland. In the spring of 1992, Seaconsult Limited of St. John's, Newfoundland, was awarded the contract to develop this atlas. Since the time of contract award, Seaconsult has been restructured under the name Seaborne Information Technologies Ltd.

As requested by ESRF, the atlas developed by Seaborne has been assembled as a digital product in the form of a geographical information system (GIS). This report describes the development and content of the atlas and presents samples of map products available in the digital atlas.

1.1 Project Objectives

The atlas has been constructed to be used by a relatively inexperienced operator on a modest desk top computer. Data files have been structured to be easily updated or transferred to alternate GIS or mapping systems.

The atlas specifically documents known biophysical and human use features that will be important in determining the overall sensitivity of any stretch of this shoreline to floating oil. It is anticipated that the atlas will be used as a tool by an On-Scene Commander (OSC) in the priorization, preparation, and implementation of oil spill countermeasures in response to any oil spill related to west coast Newfoundland drilling activities. As well, the atlas will be useful in the preparation by offshore operators of site-specific drilling permit applications.

The timing of the ESRF program is timely considering the current movement within Environment Canada to develop a national sensitivity mapping system under the Green Plan. Seaborne has developed a West Coast Newfoundland atlas that is compatible in content with similar products being developed by Environment Canada.

1.2 Study Team

Seaborne assembled a multi-disciplinary team of specialists to address the wide variety of issues relating to the development of a comprehensive environmental atlas. As well as in-house expertise, Seaborne has included experts from the university and consulting sectors in the project team.

Seaborne was responsible for overall coordination of the atlas development; development of the physical environmental, logistics, and countermeasures portions; formatting of data files; and development of map standards and composition. John Harper of Coastal and Ocean Resources Inc. in Sidney, BC, developed the shoreline classification scheme; determined wave exposure; and determined a process for determining an oil residence index for west coast beaches. The Centre for Cold Ocean Resources Engineering (C-CORE) at Memorial University of Newfoundland (MUN) coded the shoreline according to the Harper scheme. Alvin Simms and Elizabeth Lambert of the MUN department of Geography were responsible for processing of remote sensing data and GIS development. MUN biologists Bob Hooper and Bill Montevecchi provided data in the areas of coastal marine biology and seabird distribution. Washburn and Gillis Ltd. in Fredericton, NB, provided offshore fisheries data. Canning & Pitt Management of St. John's provided socioeconomic data input including a database of historical fish landings.

1.3 Associated Studies

At the time the atlas was being developed, the Seaborne team was involved in two complementary programs which yielded data that enhanced the ESRF product. The first was a biological survey of the shoreline in Gros Morne National Park conducted by Bob Hooper and the second was a contract between Seaconsult Limited and the Humber Arm Environmental Association to compile all known marine environmental data for the Humber Arm/Bay of Islands area. Each of these studies provided the means for specific focus on areas of significant environmental importance and high human activity.

2. STRUCTURE OF THE WEST COAST ATLAS

2.1 Mapping Software

The Newfoundland west coast atlas is housed on a PC-based GIS system. After consideration of cost, portability of the hardware/software components, ease of use, and the ability to update of resource data, SPANS Map running on OS/2 was chosen as the host GIS software. Since the development of the digital atlas, a windows version of the software has been produced. SPANS Map is the mapping and display derivative of SPANS, a comprehensive GIS software system, developed in Canada by Intera Tydac.

2.2 Atlas Regions

So that the long and detailed coastline of the study area can be accommodated in sufficient detail in the SPANS Map environment, the west coast Newfoundland study area has been divided into a series of regions. Each region is an individual SPANS universe with all base map, control, and environmental data files related to each universe housed in an individual directory.

2.2.1 Large Scale Local Presentation - Seven Local Regions

The West Coast Study Area between Open Bay (about 10 km west of Cape Norman) south to the mouth of the Codroy River has been divided into seven regions. Each region covers about 30-35 minutes of latitude and overlaps adjacent regions by several kilometres. The base maps for these regions were derived from the six LANDSAT imagery scenes captured on August 9, 1991. These six scenes were cut and pasted so that the area covered by each of the seven regions would be logical (e.g. all of Gros Morne National Park is one region) and also so that critical local areas near the edges of regions were fully covered in at least one, and often in both of the adjacent regions (e.g. Shallow Bay, River of Ponds, and Ferolle Point). The seven regions into which the study area is divided are described in Table 2.1 below and shown in Fig. 2.1 - Fig. 2.7.

SPANS Map allows for viewing of either temporary or preset-scale map windows in any universe. For general use of the atlas, a number of preset windows have been established within each universe. In each universe, the smallest on-screen scale representation for a preset map window is between 1:500,000 and 1:650,000. At this scale, the entire region can be viewed on screen. BELLISLE, PORTSAUN, PORTLAND, GROSMORN, BAYISLND, and PAUXPORT have north and south sub-region windows at a scale of about 1:300,000. PAUXPORT also has a central sub-region window at this scale. ANGUILLE has no sub-region windows. BAYISLND has smaller windows at a scale of about 1:100,000 for selected areas. All regions have several local windows at a scale of about 1:50,000. The naming scheme for these standard windows is both logical and descriptive. The place names indicated in Fig. 2.1 - Fig. 2.7 show the approximate coverage of individual windows at scales greater than 1:300,000.

Table 2.1

Description of Individual Atlas Regions

Common Name	Total Length of Coastline	Atlas Directory	North Latitude	South Latitude
Belle Isle	357.4 km	BELLISLE	51°35'50"N	50°57'21"N
Port Saunders	513.3 km	PORTSAUN	51°06'27"N	50°27'08"N
Portland Creek	209.2 km	PORTLAND	50°32'11"N	49°54'57"N
Gros Morne	412.9 km	GROSMORN	50°00'06"N	49°16'14"N
Bay of Islands	690.0 km	BAYISLND	49°24'31"N	48°46'38"N
Port au Port	543.2 km	PAUXPORT	48°49'51"N	48°06'47"N
Anguille	176.9 km	ANGUILLE	48°13'07"N	45°50'07"N

2.2.2 Small Scale Overview - West Coast Study Area

A separate SPANS universe covering the entire West Coast Study Area is included in the atlas for the presentation of all low-resolution offshore data. The base map for the West Coast Study Area was derived from an existing 1:1,000,000 digital map and is shown in Fig. 2.8. Approximate locations of the seven large scale atlas regions described in 2.2.1 are also indicated on this base map.

2.3 Data Resources

The atlas reflects the state of current knowledge of the study area. No new survey work was funded under the ESRF contract. The information included in the atlas has come from public records, scientific literature, personal experience, and previous surveys.

As described in Chapter 3 of this report, the digital base map for this project was developed from LANDSAT satellite imagery obtained by the Canadian Centre for Remote Sensing (CCRS) in 1991.

A principal source of coastline data was a continuous aerial video of the entire study area obtained by Dr. Don Forbes of the Atlantic Geosciences Centre (AGC) in 1985. This video was used to calibrate remote sensing imagery, to classify shoreline beach morphology, to identify significant biological features, and to provide a variety of human use information.

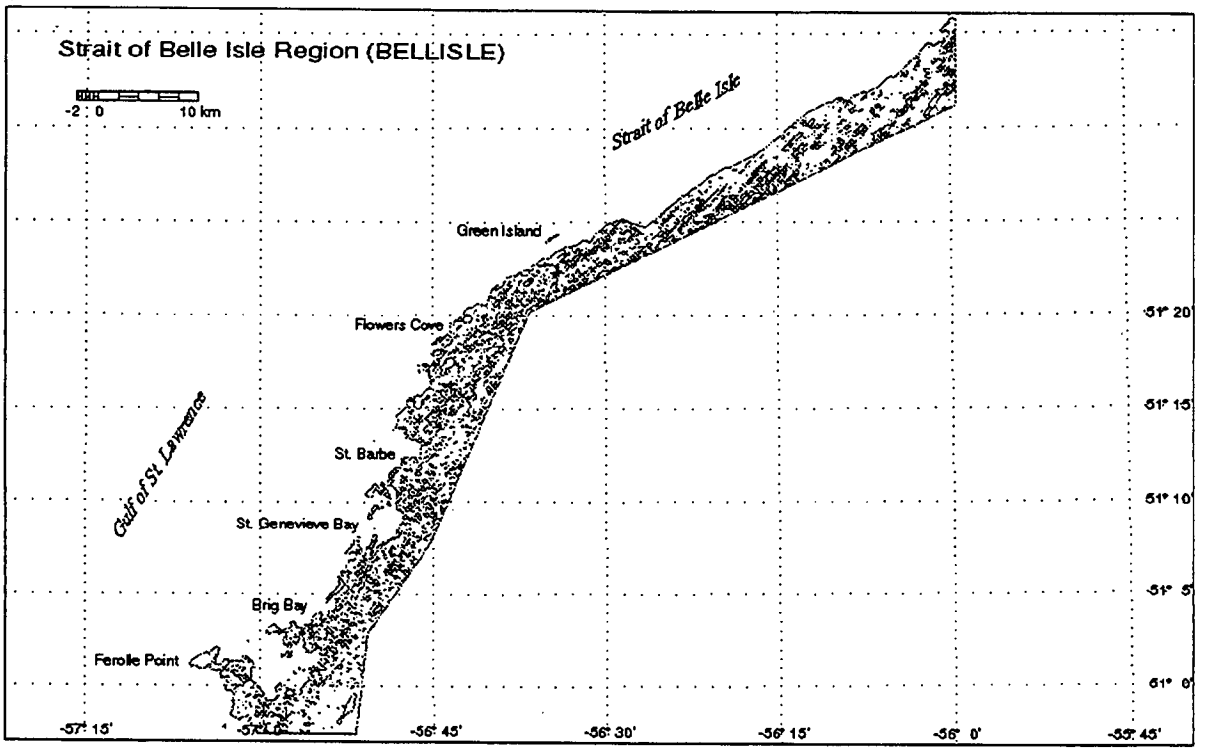

Fig.2.1. Strait of Belle Isle Region Showing Locations of Map Windows.

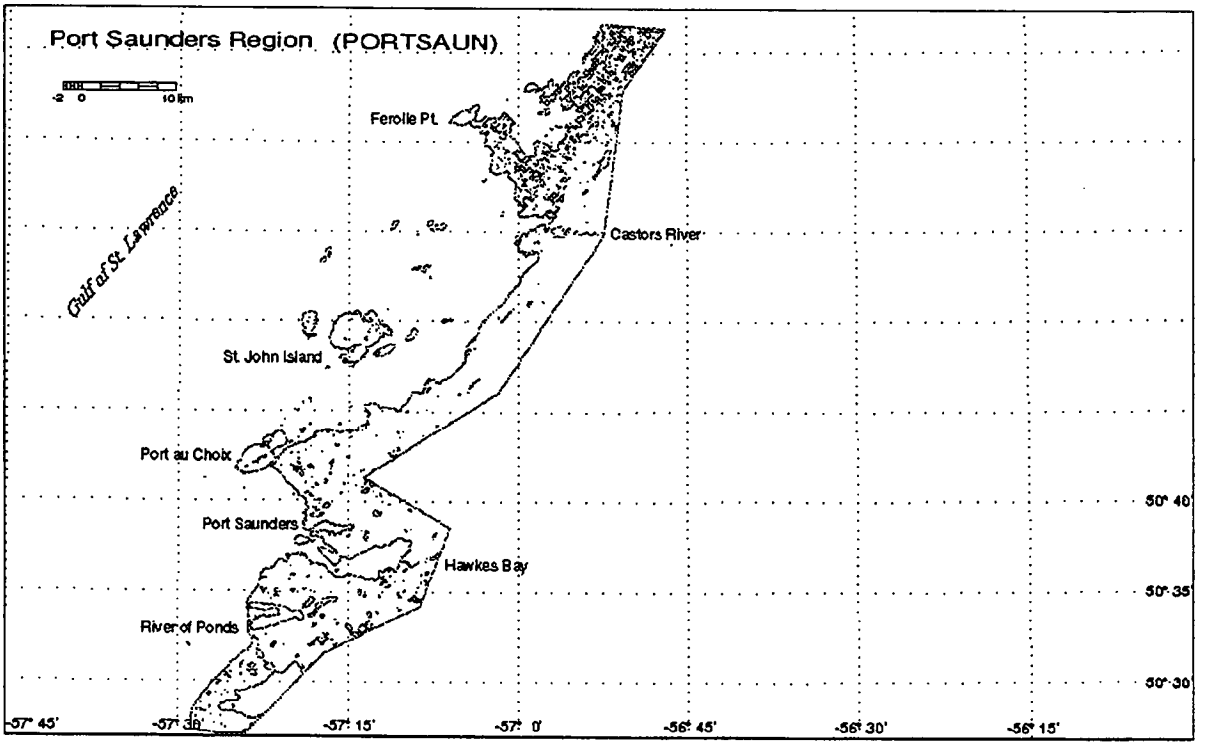

Fig. 2.2. Port Saunders Region Showing Locations of Map Windows .

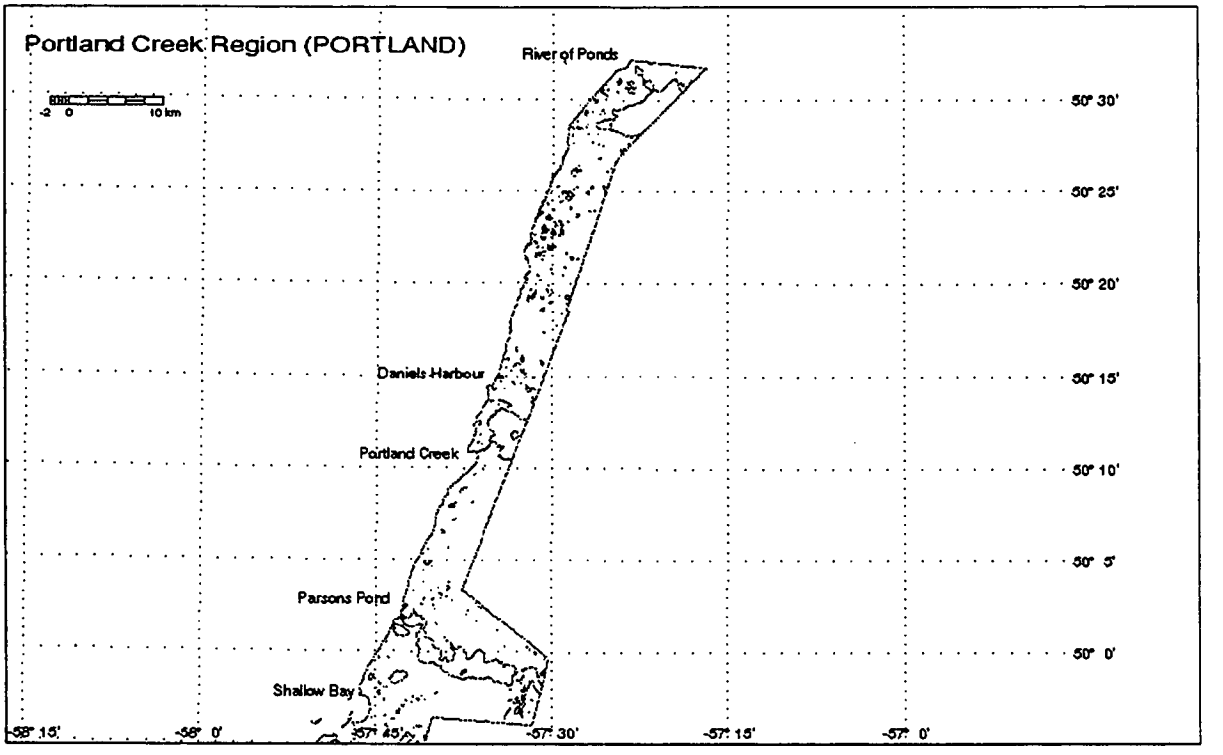

Fig.2.3. Portland Creek Region Showing Locations of Map Windows.

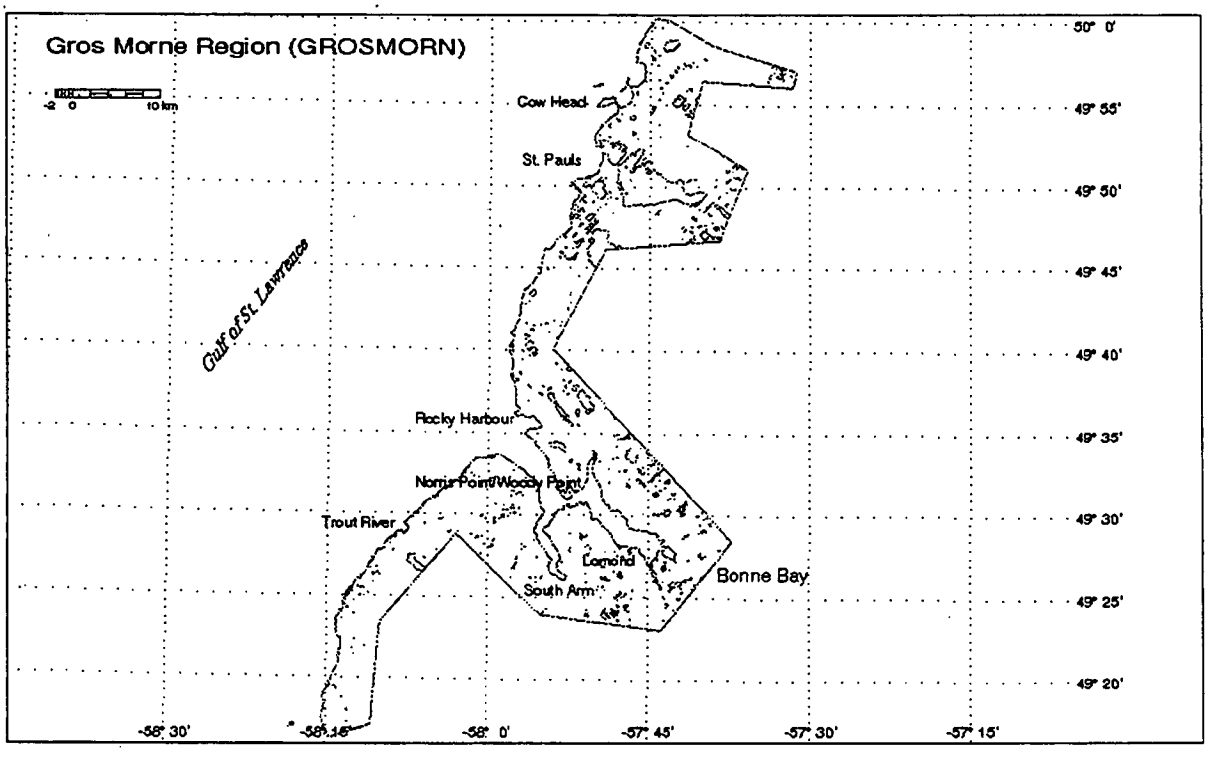

Fig. 2.4. Gros Morne Region Showing Locations of Map Windows .

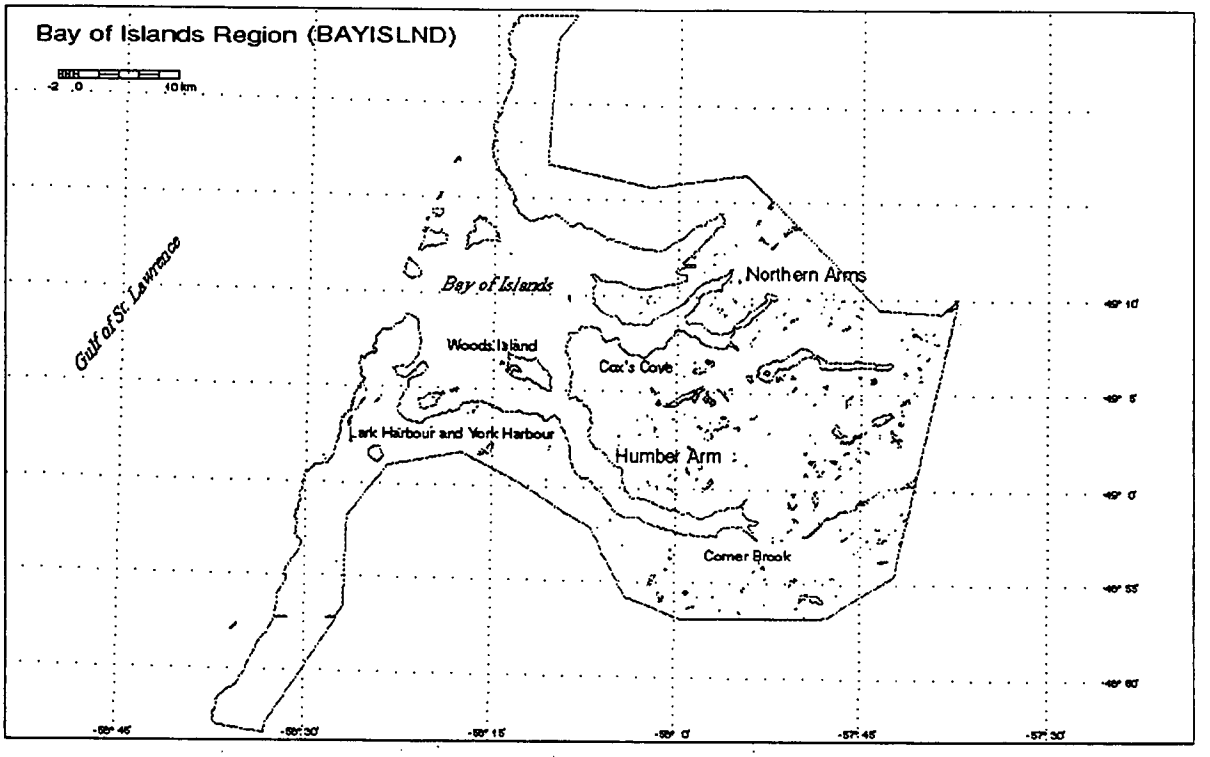

Fig.2.5. Bay of Islands Region Showing Locations of Map Windows.

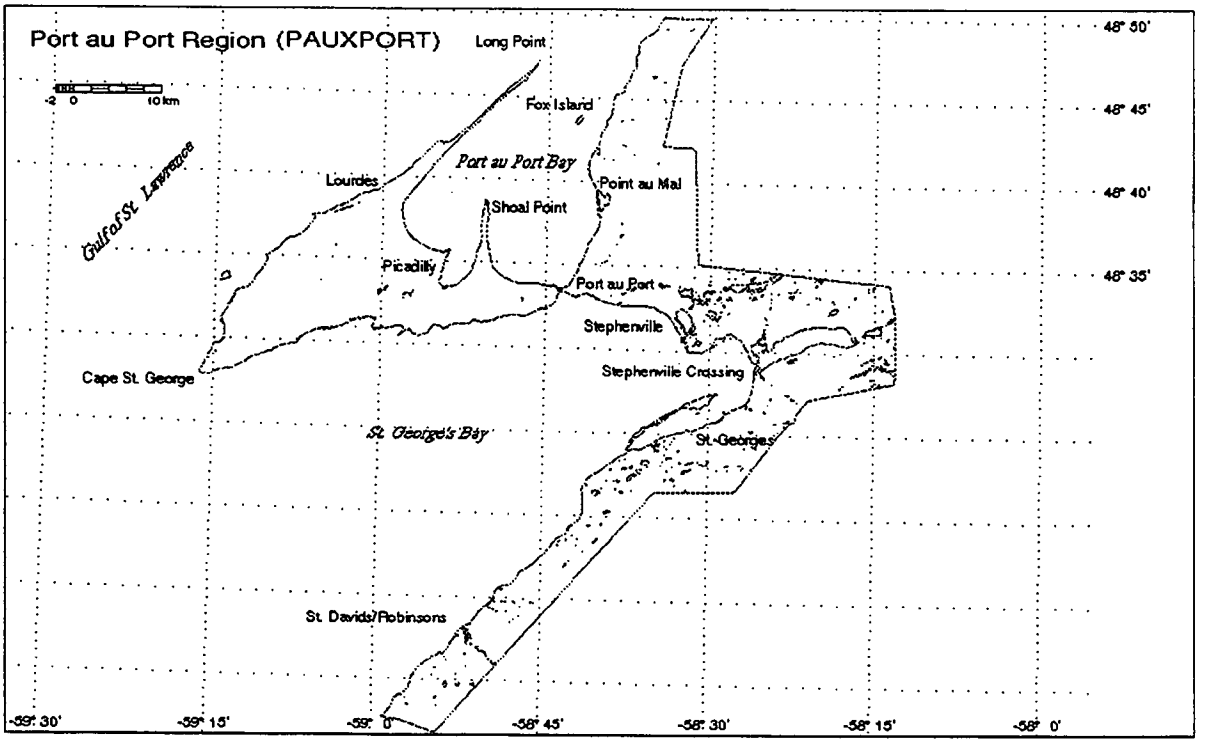

Fig. 2.6. Port au Port Region Showing Locations of Map Windows .

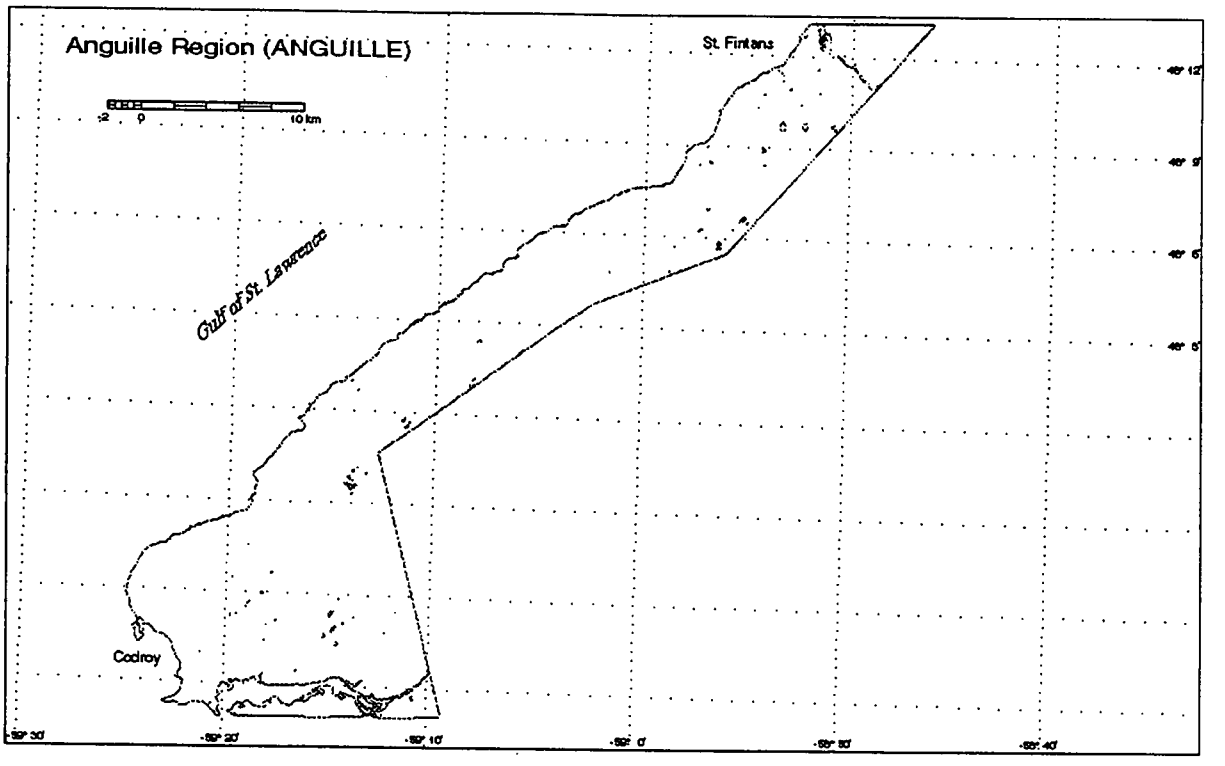

Fig.2.7. Anguille Region Showing Locations of Map Windows.

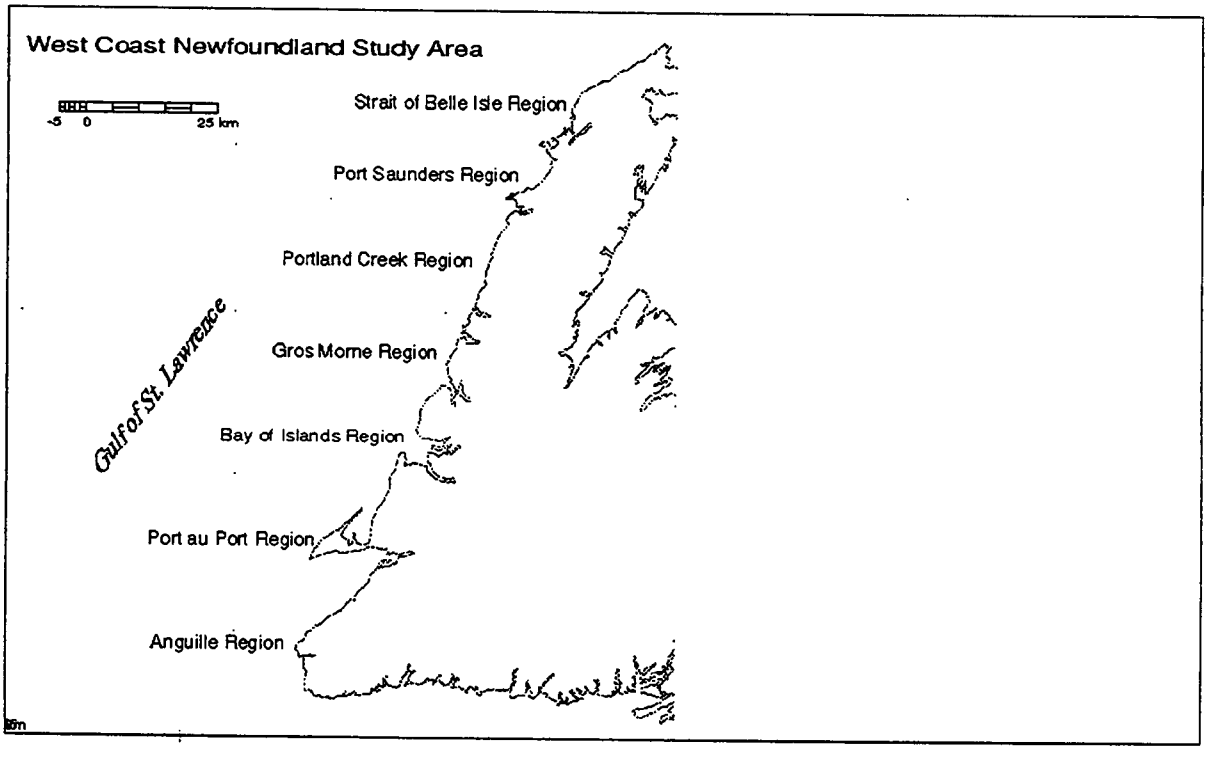

Fig. 2.8. West Coast Newfoundland Study Area Showing Locations of Seven Regions .

Specific sources of data are documented along with descriptions of the data files in later chapters of this report. Resource data were transcribed to hard copy 1:50,000 National Topographic System (NTS) maps for digitization. Original copies of the NTS sheets were used by all resource specialists to reduce inconsistent positioning errors that can be caused by digitizing from photocopies. Seaborne dedicated multiple copies of the complete set of topographic sheets covering the study area to this analogue recording of raw resource data.

2.4 Data Lineage

The origin of data is detailed here in the descriptions of the particular resource data included in the atlas. This information is also included in digital form in the point databases found in the computerized atlas. The formats of these databases have been standardized to include the following fields:

DATE Year in which the data point attributes were current

SOURCE Brief reference to the source of the data point attributes

CONTACT Office, agency or individual that is responsible for archiving source data and that may be contacted for further information

TELEPHONE Telephone number that can be used in contacting the source data agency

2.5 Sensitivity Presentation

The virtue of calculating a single overall shoreline sensitivity index for the study area was considered at the beginning of the atlas development. Such an index would incorporate all geological, physical, biological, and socioeconomic data to provide the OSC with a single evaluation of the environmental sensitivity of the section of coastline in question. As the development progressed, a decision to not implement such an index was made for two reasons. First, the data available for use in the atlas are, in many cases, patchy making consistency difficult to achieve. Second, the evaluation of the sensitivity of coastal resources to oil pollution is largely subjective. The combination of geological, biophysical, and socioeconomic data attributes relating to a given section of coastline is often unique as are the conditions of the spill event itself. It is the current general opinion of oil spill specialists in Canada (Wedeles et. al., 1993) that the computerized sensitivity atlas should be a means of efficiently presenting coastal environmental data for evaluation by the OSC and his advisors. Final decisions on response actions will be made by the OSC after a review of the spill situation and all environmental data presented by the atlas and resource specialist advisors.

This atlas does, however, provide sensitivity evaluations for individual data parameters. The resulting ranking of environmental parameters is consistent throughout the atlas. With the

exception of coastal geomorphology, every parameter has been ranked according to a simple scale with the highest rank indicating the most sensitive resource. As will be discussed in detail in 4.6, the west coast Newfoundland atlas includes a means of reviewing all available environmental data for a particular section of shoreline simultaneously, thereby allowing the user to make his own assessment.

A useful guide to overall sensitivity is the Oil Residence Index (ORI) of a section of shoreline. The ORI is an estimation of the length of time that oil will remain on the beach given the local geology and wave energy conditions and has been calculated with a high level of confidence for the entire study area. Details concerning the determination of ORI are presented in section 5.4 of this report.

2.6 Temporal Data Presentation

For parameters where sufficient data exist, monthly or seasonal files have been created. The coastal fisheries data (see 6.1) and coastal seabird data (see 6.9) are both presented for all atlas regions as a series of monthly files as well as an annual summary file.

For the entire west coast study area, offshore seabird data (see 6.10) are presented as a series of monthly files with an annual summary. Some offshore fisheries data (see 6.7) are presented in the context of summer and winter ranges. Offshore surface current data (see 8.2) are presented in representative summer and winter files. Offshore pack ice data (see 8.3) are presented as a series of weekly median ice edges throughout the period of the ice season. Monthly normal values are presented for historical weather data (see 8.1).

2.7 National Sensitivity Mapping Standards

The Conservation and Protection Branch of Environment Canada is presently developing a national sensitivity mapping program. At the time of development of the west coast Newfoundland atlas, the details of the national program were still under consideration. In the absence of firm national guidelines, Seaborne has attempted to develop a mapping system that will be similar to others in the country.

The principle feature of the west coast Newfoundland atlas is the definition of shoreline segments based on geomorphology and the subsequent linking of other environmental data directly to these segments. This philosophy is consistent with the coastal sensitivity mapping program under development by the British Columbia Ministry of Environment as well as the Environment Canada initiative.

Environment Canada has recently evaluated the hardware and software currently available for desk-top sensitivity mapping applications. The results of this review have been published in the

report *Evaluation of Desk top Mapping Software* (Horne, 1993). In this review, SPANS Map was rated favourably because of its user friendliness and its ability to easily accept other database formats.

In December, 1992, the principle author of this report was an attendee at a workshop sponsored by Environment Canada to find a consensus in sensitivity mapping among Canadian marine oil spill specialists and to develop of draft standards. Recommendations for future standards resulting from this workshop been described in the Environment Canada report *Results of a Protocols and Standards Consensus Workshop, December 14-17, 1992* (Wedeles et. al., 1993). Table 2.2 lists the features recommended in this report along with comments on how each is addressed in the west coast Newfoundland atlas.

Table 2.2

Comparison of Seacborne Atlas Attributes With National Sensitivity Map Standards

	RECOMMENDED NATIONAL STANDARDS	WEST COAST NEWFOUNDLAND ATLAS Features Included	
Platform	- must run on a modest field computer	Y	- runs on a laptop computer using SPANS Map in OS/2 or windows
Geographic Boundaries	- 20-metre isobath to upper level of marine processes	Y	- nearshore/shoreline high resolution data
	- associated backshore and upland resources	Y	- 5-10 km backshore terrestrial swath - locations of outfitters - coastal land use data
Human Use (Development)	- wharves/breakwaters/jetties - marinas/slipways	Y	- all wharves and breakwaters on NTS sheets and in AGC video - specifications for wharves administered by DFO or Transport Canada are included
	- industrial sites	Y	- all coastal industrial sites, fish plants, loading terminals, and oil handling facilities
	- weirs/dams	n/a	- no dams or weirs in the study area - natural barachois are shown as detailed geographic features
Human Use (Recreation)	- recreational beaches	Y	- all picnic sites and campsites - all municipal, provincial, and national parks - all golf courses
	- recreational fishing	Y	- all DFO-registered salmon rivers
	- natural areas - eco-tourism	Y	- all provincial ecological and wildlife reserves
Human Use (Resource Extraction)	- fishing/shellfish harvesting	Y	- summary catch statistics and catch landing locations

	RECOMMENDED NATIONAL STANDARDS	WEST COAST NEWFOUNDLAND ATLAS Features Included	
	- aquaculture	Y	- all registered aquaculture sites
	- logging	n/a	- no coastal logging operations in the study area
	- agriculture	Y	- provincial agricultural reserves
Human Use (Cultural/Historic)	- cultural	Y	- all archaeologically significant sites
	- subsistence harvesting	n/a	
Human Use (Urban)	- residential	Y	- areas of human development from LANDSAT imagery - incorporated municipal boundaries and census statistics - shoreline cabins
	- shipping/transport	Y	- all wharves, loading terminals, ferry wharves
Nature (Marine Mammals)	- whales	Y	- offshore ranges for many whale species
	- seals	Y	- offshore whelping grounds (on winter pack ice)
	- otters	n/a	
	- walrus	n/a	
	- polar bears	N	- winter polar bear sightings in the study area are rare
Nature (Birds)	- pelagic birds	Y	- all documented coastal and offshore pelagic bird data
	- coastal zone birds	Y	- all documented coastal zone bird data
	- bird colonies	Y	- all documented coastal nesting areas
	- shore birds	Y	- all documented shorebird data
	- raptors	Y	- all documented eagle and osprey data
	- special birds	Y	- documented sites for endangered species (Harlequin Duck and Piping Plover)
Nature (fish and shellfish)	-	Y	- in addition to catch data, salmon rivers, and aquaculture, the distribution of herring and caplin shoreline spawning and the offshore ranges for groundfish and shellfish
Nature (Habitat and Shoreline)	- geomorphology	Y	- entire coastline has been classified in detail using Harper scheme
	- habitat	Y	- intertidal and subtidal biological habitats are included for the Gros Morne and Bay of Islands regions

	RECOMMENDED NATIONAL STANDARDS	WEST COAST NEWFOUNDLAND ATLAS Features Included	
Nature (Meteorological/Oceanographic))	- air temp - precipitation	Y	- AES climate normals for all reporting weather and climate measurement stations
	- wind	Y	- AES climate normals for all reporting weather and climate measurement stations - Transport Canada normals for offshore areas
	- exposure/fetch	Y	- exposure based on fetch with and without the effects of nearshore boulder barriers has been determined for the entire study area
	- current	Y	- offshore surface currents for summer and winter conditions
	- sea state	Y	- Transport Canada normals for offshore areas
	- ice accretion	Y	- shoreline ice formation for the Gros Morne and Bay of Islands regions
	- ice conditions	Y	- weekly median offshore pack ice edge
	- tides	Y	- tidal ranges for all CHS primary and secondary ports
	- storm surge	Y	- all documented storm surge/coastal flooding areas
Base map (scale)	- offshore coverage at 1:250,000		
	- nearshore coverage at 1:50,000	Y	- all data based on 1:50,000 NTS sheets
	- variable scale	Y	- SPANS Map allows for zoom to variable scale from about 1:650,000 up to about 1:20,000
Base map (content)	- coastline	Y	- high-resolution coastline developed from LANDSAT imagery
	- bathymetry	N	- no bathymetry contours or soundings - some shallow water bathymetry implied in raw imagery
	- hydrology	Y	- fresh water ponds and rivers indicated in LANDSAT imagery are mapped
	- roads/railway	N	- some road information can be inferred from the LANDSAT human development data - most roads are visible in satellite imagery
	- place names	Y	- detailed place names from CGNDB

	RECOMMENDED NATIONAL STANDARDS	WEST COAST NEWFOUNDLAND ATLAS Features Included	
Symbols (colours)	- B/W and colour hard-copy	Y	- hard copy available in B/W and colour in .PCX bitmap or metafile formats - best printing is done using an external graphics utility
	- significance of colour	Y	- all sensitivity rankings are coded by consistent and progressively "hot" colour scheme
	- range of colours	Y	- system capable of 256-colour palette. Data indicated by basic universal 16-colour palette. Colours are selectable within software.
Symbols (standards)	- titles	Y	- pre-assembled maps all have standard titles, scale bars and lat/long grids
	- units	Y	- SPANS Map allows either English or metric units
	- key map	N	- no key maps in SPANS Map - In SPANS Map, the selected window is displayed on the larger base map before final selection
	- parameter symbols	Y	- a variety of general symbols are available - few specific symbols are included
Sensitivity Ranking	- pre-spill ranking	Y	- all data parameters are individually ranked for oil spill sensitivity - Oil Residence Index provides an overall indication of sensitivity to oiling - SPANS Map allows for simultaneous evaluation of all segment-based environmental data in map, histogram, and map form

3. BASE MAPS

At the time work on the digital atlas began, no digital map products of a suitable scale and which cover the study area were available through Energy, Mines, and Resources Canada (EMR). In the absence of suitable digital base maps, the West Coast Newfoundland Oil Spill Sensitivity Atlas base map was constructed from LANDSAT TM satellite imagery.

Six satellite overlapping images which together cover the entire study area were taken consecutively along a north-south orbit over a period of less than fifteen minutes on August 9, 1991. Unlike hard copy maps for the area, the vintage of the features presented in this imagery is identical. A sample of the imagery obtained is shown here in Fig. 3.1. After processing, the satellite data provided a high-resolution digitized coastline; a consistent and up-to-date picture of the road network; locations of areas of human development; and a picture of coastal zone land use.

3.1 Processing of LANDSAT TM Imagery

The satellite imagery used for this project was purchased from the Canadian Centre for Remote Sensing (CCRS) through Radarsat International Inc. The imagery included a single quadrant from each of six scenes captured on August 9, 1991 by the Thematic Mapper (TM) sensor of the LANDSAT-5 satellite. Each quadrant covers a square area of 185 km x 185 km inside the scene. Centre points of each quadrant ordered were selected to provide the optimum coverage of the coastline. The actual limits of the mapped coastline extend from Open Bay on the northern peninsula to the mouth of the Codroy river in the south.

The data from three spectral bands (green, red, and near infrared) were purchased so that some land use information could be extracted. In addition to providing a coastline (water/land interface including lakes and significant rivers), the processed imagery has been processed to provide GIS layers for features including forests; developed areas; grasslands; open vegetated lands; and bare gravel, sand, or rock surfaces.

The processing of the imagery was completed in the GEOIDAL laboratory in the Department of Geography at Memorial University. This work was done using an Aires DIPIX image processing system served by a VAX mini-computer. The analysis of the LANDSAT data included image transfer, pre-processing, processing, and processing stages.

3.1.1 Image Transfer

The raw imagery was transferred from the Radarsat magnetic tape to the DIPIX system.

3.1.2 Pre-processing

The raw image was calibrated during pre-processing so that:

a) The digital value of the image was correlated to the radiation reflected from the earth's surface. This involved matching land use categories at specific points (as determined by groundtruthing) with a distinct signature at the corresponding position on the imagery. For the west coast atlas, hundreds of land use features at distinct recognizable locations were selected from AGC the airborne video and transferred to 1:50,000 NTS topographic sheets. These features at known locations were used to ground-truth the imagery.

b) The raster geometry of the image was matched with an established coordinate system and geographical projection. In this study, hundreds of geographic features which were clearly discernable on both the imagery and on the NTS 1:50,000 sheets of Universal Transverse Mercator (UTM) Projection were matched and a geometric correction network established. The points were selected so that the principal area of interest (study area coastline) was covered completely. To eliminate any chance of bias, no two grid lines were used twice for geo-reference points on a given sheet. Using these reference points, the satellite imagery was "rubber-sheeted" to fit the UTM system. The resulting accuracy of the corrected images is less than 2 pixels (60 metres). This correction also ensures the best possible fitting of data overlays to the base map as most of the raw resource data have been positioned on new NTS 1:50,000 sheets prior to digitizing.

3.1.3 Processing

The image was processed to extract land use information throughout the imagery. This was a time-consuming task requiring the full power of the AIRES/VAX system. To make the job manageable, processing was completed in six sections corresponding to the original six Radarsat quadrant files.

The land/water interface was extracted by creating a binary image and applying an edge detection filter to the coastline. The basic binary raster files extracted from each section were vectorized for use in SPANS. Small patches of cloud were present in some parts of the study area at the time of the satellite image. These have been corrected by direct removal when the clouds were found over open water, by signal enhancing the land features underneath to eliminate clouds, or by replacing missing shore sections with a coastline digitized from the appropriate NTS sheet (see 4.2).

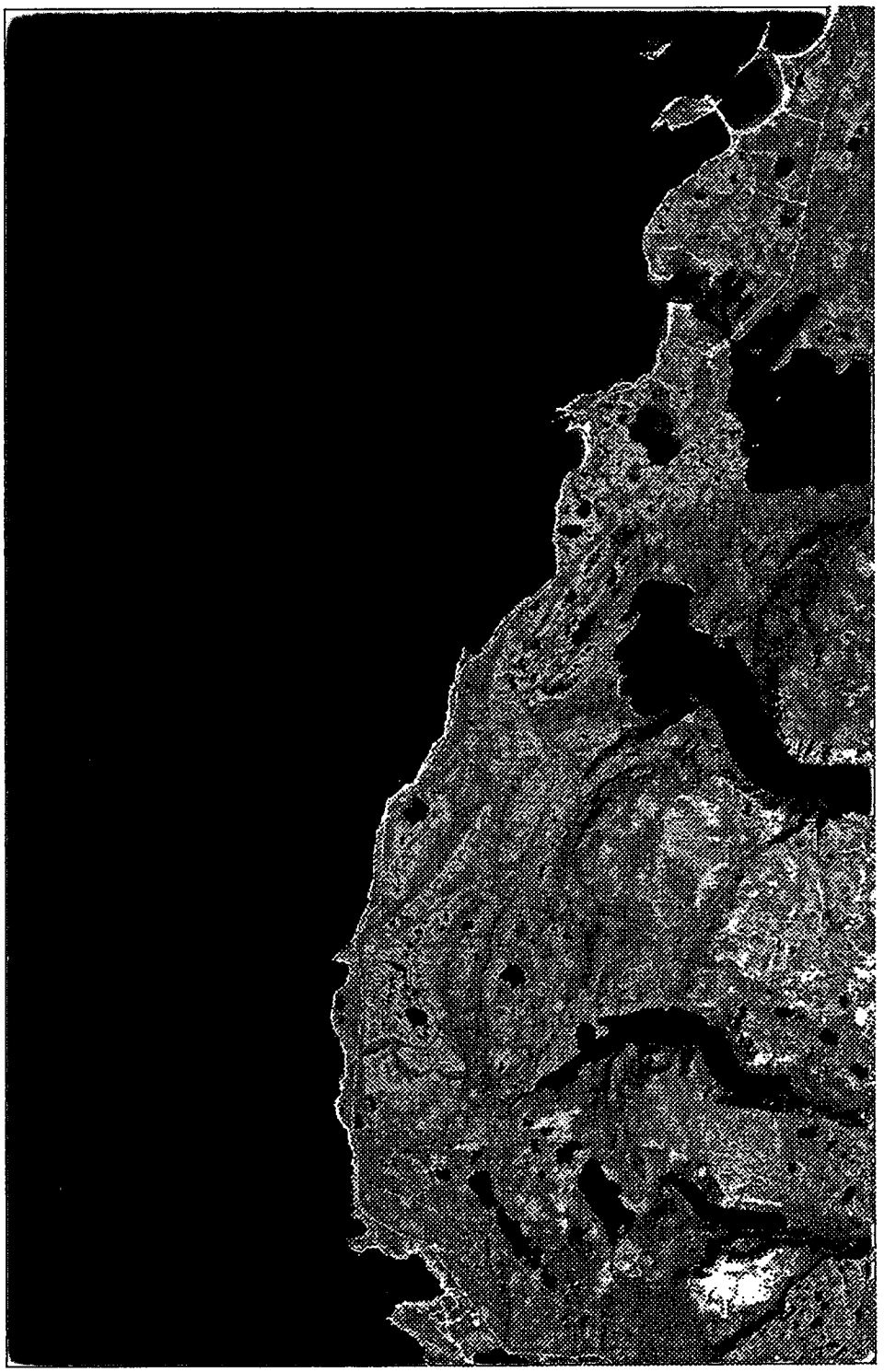

Fig. 3.1 South West Quadrant of the Third August 9, 1991, LANDSAT Image Showing the Coastline of Gros Morne National Park Between Rocky Harbour and Shallow Bay.

3.1.4 Post-processing

Post-processing of data was completed as a GIS function. This involved the transfer of the final raster data files from the image analysis medium to the GIS.

3.2 Addition of Place Names

Place names have been added to the base map from the digital Canadian Geographic Names Database (CGNDB) created by the Technical Services Branch of the National Atlas Information Service of EMR. This database was created to label digital 1:50,000 topographic maps in the National Topographic Database (NTDB). The Newfoundland CGNDB file has been edited so that unnecessary fields and features outside the study area have been removed. The coding has been simplified so that generic feature types now include only community names, marine features (bays, coves, straits, etc.), land features (headlands, islands, etc.), and lakes and rivers.

3.3 Limitations to Land Use Classifications

Although the LANDSAT TM imagery provides data a wide range of data signatures associated with specific geo-referenced points, it is difficult in a project of this nature to undertake a complete analysis of land use. One problem is the difficulty of providing comprehensive ground-truthing for such a large area, especially considering the inconsistent timing of available data. Another is the coarse resolution of the LANDSAT imagery making the discrimination of small features that might be defined by a single signature. In consideration of the available data, it has been necessary to build composite land use categories to describe the human use, bare surface, forest, grasslands, and low vegetation distribution in the study area. These are included as the vector files DEVELOP (human development), BARE (bare rock, sand, or gravel), FOREST (coniferous or deciduous), GRASS (open areas with consistent grassy vegetation), and SCRUB (mixed low vegetation - may be bog or wetland), respectively. Descriptions of the file format for these layers are presented here in Appendix 4. The road system has been incorporated into the general human development layer. The paved portion of roadways are generally too narrow to be resolved in the imagery. Often, a road can be identified by the combined effect of the pavement, shoulder, and the cleared area on either side. This composite is, however, similar to many other developed areas and impossible to define as a roadway. In cases where the road runs through an area of consistent vegetation, the narrow paved part of the road is obscured. An attempt was made to identify areas of shallow water by water colour as shoals are often visible in the raw imagery. When imported into SPANS, areas of shallow water often have the same digital signature as sea surface features caused by reflected light and small waves and so are difficult to distinguish specifically in GIS format.

Both the roads and the shallow water are easily seen in the satellite images which are attached as graphics slides in the atlas. The imagery is quite clear on screen and, even in the hard copy representations, a lot of road and some shallow water detail are visible.

4. GIS APPLICATIONS

4.1 SPANS Map Software

The atlas has been developed for use with SPANS Map, a mapping software application developed in Canada by Intera Tydac. SPANS Map is a desktop mapping package used to query and display information related to specific geographic locations. SPANS Map runs on a PC microcomputer under Windows or the OS/2 operating system. Data associated with a particular location can be presented on user-scaled maps, spreadsheets, a variety of charts, or as a linked text or images.

All files used in the SPANS Map GIS presentation are in standard SPANS format. Each geographic region is contained in a specific universe defined by north-south and east-west extent and map projection. Universe files required for the definition of the SPANS Map universe include:

CURPARAM.DAT	VISTA.LOG
SP.DAT	SPANS.DAT
SP.DBD	SPANS.DBD
SP.KEY	SPANS.KEY

Data files must be imported into the specific spans universe and formatted so that the position of each constituent point can be given a localized grid reference code (morton number) which relates to the universe in question. Input files for vector data include those with *.VEC (vector) and *.VEH (header) information. When these two file types are imported into a SPANS Map universe, three files with *.VTX (vector), *.MAP, and *.TBB (Database) extensions are created. Standard Dbase or FoxPro *.DBF files or Lotus *.WK1 file have been used to input point-based resources data. When imported into SPANS Map, these files are converted to the *.TBB database format.

For map printing applications, bitmap graphics files in *.PCX format have been captured from maps composed in SPANS Map then transferred to DOS for layout and printing in COREL Draw for windows.

4.2 Base Map Corrections

The LANDSAT imagery was obtained as six individual sequential scenes captured on August 9, 1991. As part of the image processing procedure described above, these scenes were geographically corrected and sectioned for direct use in the SPANS GIS environment.

The first stage of this process was the identification and positioning of reference points in each scene. These reference points were small features (50-100 metres in dimension) that could be clearly located on both the imagery and the complementary 1:50,000 scale NTS sheet for the

area. As the NTS series is based on aerial photography, less horizontal distortion is likely in these maps than in the hydrographic charts which describe the coastline of the area. Typically, cross-roads of major highways, small islands, or small bays that were unlikely to have changed between the time of mapping and the time of the satellite imagery were chosen for this purpose. With a well-distributed network of reference points available each scene could then be "rubber-sheeted" to correct all points in the scene and transformed into the mercator projection required for the atlas.

After the land use classification exercise (completed in the image processing stage of the project) and the geographic correction described above, the land/water interface data were imported into SPANS and used to develop the base map for the atlas. Vector polygons describing the coastline, islands, inland lakes and ponds, and rivers large enough to be discerned in the satellite imagery were extracted to define the base map for the atlas.

In some cases, repairs to the base map vectors were necessary. In particular, limited cloud cover over the Port au Port Peninsula, in the Bay of Islands, and in the Strait of Belle Isle obscured the coastline for the visible light LANDSAT sensors. The morning sun at the time of the image capture combined with the dramatic topography of the coastline caused shadowing over west-facing shores and obscuring of land features. The transformation of vector data from the Aires format to SPANS format occasionally resulted in incomplete vectorization of polygons and gaps in the coastline. Finally, large intertidal features such as mud flats not covered by water at the time of the image capture appear as dry land in the processed image. In all of the above cases, these vectors were identified by a comprehensive manual review of the coastline by the atlas program manager and the program GIS specialist and ultimately repaired in SPANS. In cases where small gaps existed or where clouds over water appeared as islands, repairs were implemented manually using SPANS utilities. In cases where sections of coastline on the order of hundreds to thousands of metres in length were affected, digitized sections of the 1:50,000 NTS maps covering those areas were spliced into the base map.

The resolution of the raw LANDSAT image data is 30 metres. To produce an attractive base map at the 1:50,000 scale of most environmental data used in the atlas, the vector files were smoothed. This procedure has been undertaken only to improve the appearance of the atlas in larger scale presentations, not to increase the accuracy of the coastline.

Land use data obtained from the satellite imagery are presented as areas rather than as line boundaries. Because of the large number of polygons defined by the individual pockets of specific light reflection signatures in the original satellite imagery, some simplification of land use data was required to meet the data presentation capacity of SPANS Map. Areas of approximately less than 50-100 metres in diameter have been eliminated or merged with nearby areas to provide a more general presentation of these data. As each land use data layer has been filtered individually, there is some overlap noticeable between layers. With all satellite-based data geographically corrected and smoothed, these data were streamlined to reduce data volumes. As the focus of the atlas is on the shoreline, the satellite data was trimmed to a coastal corridor with a width of about 5 km.

The atlas was made more manageable by dividing the study area into manageable regions as described in Table 2.1. The result is seven individual base maps. Each region is included as an individual SPANS universe contained in a single data directory. For the presentation of general physical and biological data, a SPANS universe covering the entire west coast is included in the atlas. For this representation is a 1:1,000,000 digital base map on already archived at GEOIDAL was used.

4.3 Data Digitization

Environmental data to be presented as layers over the were all initially located on the 1:50,000 base maps by study team resource specialists and digitized in SPANS format. All data were digitized using Tydac software on a 36" x 48" digitizing table. For consistency of correction of the X-Y digitizer data to mercator projection, ten to twelve UTM grid line intersections standard reference points were selected for each of the NTS sheets covering the study area. These points were used to correct data digitized from every copy of each NTS sheet.

Digitized data can be classified into three basic geographic types: shoreline segments; shoreline human boundaries; and point data. As described in 5.1, shoreline segments are defined as sections of shoreline each having a distinct homogeneous geomorphology. The entire coastline in the study area has been classified in this manner. These segments were digitized as small contiguous vectors defined by the end points of the geomorphological segments. As each section was digitized, the vector was coded with a map-based identification number and a parameter code which represents the shoreline geological classification. Raw data were recorded as digital segment vectors in files which cover each individual NTS map sheet. The raw data files were then merged into a single file that could be manipulated in SPANS for complete inclusion in the atlas GIS.

One of the resultant products of the digitization of individual shoreline segments is a vector representation of the coastline. Human boundaries along the shoreline were developed as subsets of this digital coastline as defined by endpoints marked on the original NTS sheet.

Specific locations of point data were digitized directly from 1:50,000 sheets using the reference points defined for the digitization of the shoreline segments. The Latitude/Longitude positions determined for these points were then incorporated into standard database files.

4.4 Shoreline Segment Presentation

The segments defined by the coastal geomorphology provide a natural geographic matrix for the presentation of a large variety of descriptive shoreline data. If a variety of environmental parameters can be attributed to single segments, a comparative evaluation of all segments as part of a decision-making process is possible.

In order that the segment data be clearly visible at all scales when presented in SPANS Map, the vectors describing each segment were redefined as polygons having a longitudinal dimension as per the original vector segment and a lateral dimension of 100 metres resulting from a 50 metre buffer added to each side of the original segment.

During the initial digitization, each of the original segments was given an ID based on the NTS sheet on which it was found. All NTS sheet-based files were then merged into a single file covering the entire study area, each segment was given a unique identification number. A summary of segment characteristics was incorporated into a master database containing Unique ID, NTS ID, Latitude and Longitude for the centroid of the buffered segment polygon, and segment length (calculated from segment polygon area).

Using the NTS ID number for relocating a segment on an original map sheet and the Unique ID for identifying the segment record in the master database, additional fields were added to the master database to describe parameters other than geomorphology that could be attributed to that section of beach. The master database was then expanded to include a wide variety of physical, biological, and human attributes. In some cases, this was done by re-coding the original geomorphology map sheet and manually transferring shoreline data classes to the correct Unique ID. In other cases, composite attributes were determined through the combination of two or more existing attribute fields. Once the expanded master database had been revised, the data were used to create new vector files in SPANS from the geographical description of the geomorphology vector files and the attribute classification for a particular parameter in the master database.

4.5 SPANS Map Set-up

SPANS Map comes in two versions to run on either the IBM OS/2 operating system or Microsoft Windows in MS-DOS. The ESRF atlas was developed in the OS/2 environment but can also run, albeit less efficiently, on the windows version. To ensure that the ESRF atlas runs efficiently, both windows and OS/2 users should maximize the processing capacity and RAM memory on the machine to be used for atlas applications.

The ESRF atlas in its present configuration relies on a structured colour palette for the presentation of standard map assemblies. All maps have been prepared with a common colour scheme to imply level of concern for any parameter. In general, the less important or sensitive classes of a given attribute are coded in darker colours while the more sensitive classes are bright with red being the peak. The basic 16-colour palette defined for the ESRF atlas is described below in Table 4.1.

While the system can run effectively on a 16-colour video display, a 256-colour display is recommended for a complete presentation of all data. Pale colours which do not conflict with the basic palette are desirable for background colouring of land masses and fresh water features. The expanded palette also allows for presentation of the satellite images in 16 shades of grey.

Table 4.1

Basic 16-Colour Palette

Sequence	Row	Position	Colour	Red	Green	Blue
1	1	1	white	255	255	255
2	1	2	dark grey	131	131	131
3	1	3	light grey	205	205	205
4	1	4	purple	170	0	170
5	2	1	pink	255	0	255
6	2	2	dark blue	0	0	170
7	2	3	light blue	0	0	255
8	2	4	dark green	0	117	0
9	3	1	light green	0	255	0
10	3	2	teal	0	255	138
11	3	3	turquoise	85	255	255
12	3	4	olive	138	179	0
13	4	1	yellow	255	255	0
14	4	2	rust	170	0	0
15	4	3	red	255	0	0
16	4	4	black	0	0	0

4.6 SPANS Map Overall Sensitivity Presentation

SPANS Map has a number of utilities for the presentation of database information. It is possible to simultaneously view a database in spreadsheet format in one window, a map window showing the location of a highlighted record in the database, and a third window with a histogram representation of the highlighted record in the database.

As described in 4.4, a master database has been created. Each record in this database summarizes the environmental data associated with an individual shoreline segment and is georeferenced to the centroid point of that segment. When the master database is opened, the data for each segment can be highlighted in succession by simply clicking on each centroid in the map window with the mouse. As all environmental data parameters are classified within the

database in ascending order of sensitivity to oil, the relative sensitivity of each segment can be quickly evaluated by the operator.

4.7 Attached Text and Graphics Data

In addition to database files which are incorporated as individual layers of the GIS, text and graphic data files can be added to the digital atlas as support documentation. Auxiliary graphics data files can be added either as bit-map slides which are opened directly from the universe directory or are attached to a specific geographic locations in an existing database. In the west coast Newfoundland atlas, the former application is a used to store standard maps and LANDSAT satellite images. In each case, the graphic product covers a large area and is not particulary site-specific. The latter application is used to store tabular weather data in the REGIONAL universe.

5. SHORELINE DESCRIPTION

5.1 Coastal Geomorphology

Shoreline mapping methodology closely followed that outlined by Harper *et al.* (1991) which is widely accepted as a base for oil spill sensitivity assessments and countermeasure planning. The technique is descriptive in nature, uses an associated database to record a high degree of detail, and can be easily summarized for different scales of presentation. Coastal types have been selected on the basis of most-commonly occurring geomorphologies for the area (e.g., mapping is directly tailored to the region).

A coastal classification scheme based on composite sedimentological and morphological factors, and similar to that currently in use by the British Columbia Ministry of Environment, was developed for mapping the west coast shore zone. A hierarchical approach is used so that shore sections were delineated first on the basis of substrate/texture and then characterized by shoreline morphology. As a result, discrete coastal classes are defined by unique combinations of substrate, sediment and morphology.

Classification nomenclature are given below in Table 5.1. The complete classification scheme is presented in Table 5.2. Table 5.2 also includes an abbreviated classification scheme which considers only substrate and sediment texture for ease in presentation on screen.

Table 5.1

Coastal Classification Nomenclature

Substrate		Rock
		Rock and Sediment or Sediment Alone
		Man-Made
Texture		Gravel
		Gravel and Sand
		Sand
		Mud
Morphology	Width	Wide
		Narrow
	Slope	Platform
		Cliff

Table 5.2

Coastal Geology Classification Scheme

SUBSTRATE	SEDIMENT	WIDTH	SLOPE	COMBINED CLASSIFICATION	DETAILED CLASS	GENERAL CLASS
Rock	N/A	Wide	Flat	Wide Rock Platform	1	1
Rock	N/A	Narrow	Flat	Narrow Rock Platform	2	1
Rock	N/A	Narrow	Steep	Rock Cliff	3	1
Rock	Cobble or Gravel	Wide	Flat	Wide Gravel Beach on Rock Platform	4	2
Rock	Cobble or Gravel	Narrow	Flat	Narrow Gravel Beach on Rock Platform	5	2
Rock	Cobble or Gravel	Narrow	Steep	Narrow Gravel Beach with Rock Cliff	6	2
Rock	Sand and Gravel	Wide	Flat	Wide Sand and Gravel Beach on Rock Platform	7	3
Rock	Sand and Gravel	Narrow	Flat	Narrow Sand and Gravel Beach on Rock Platform	8	3
Rock	Sand and Gravel	Narrow	Steep	Narrow Sand and Gravel Beach with Rock Cliff	9	3
Rock	Sand	Wide	Flat	Wide Sand Beach on Rock Platform	10	4
Rock	Sand	Narrow	Flat	Narrow Sand Beach on Rock Platform	11	4
Rock	Sand	Narrow	Steep	Narrow Sand Beach with Rock Cliff	12	4
Sediment	Cobble or Gravel	Wide	Flat	Wide Gravel Flat	13	5
Sediment	Cobble or Gravel	Narrow	Flat	Narrow Gravel Flat	14	5
Sediment	Cobble or Gravel	Narrow	Steep	Steep Gravel Beach	15	5
Sediment	Sand and Gravel	Wide	Flat	Wide Sand & Gravel Flat	16	6
Sediment	Sand and Gravel	Narrow	Flat	Narrow Sand & Gravel Flat	17	6
Sediment	Sand and Gravel	Narrow	Steep	Narrow Steep Sand & Gravel Beach	18	6
Sediment	Sand	Wide	Flat	Wide Sand Flat	19	7
Sediment	Sand	Narrow	Flat	Narrow Sand Flat	20	7
Sediment	Sand	Narrow	Steep	Narrow Sand Beach	21	7
Sediment	Mud			Mud Flat	22	8
Sediment	Organics			Estuary/Marsh/Lagoon	23	9
N/A	Unknown				24	10
N/A	Man Made			Landfill	25	11
N/A	Man Made			Structure	26	11

Notes: "Wide" indicates beach width > 30 m; "Narrow" indicates beach width < 30 m; Beaches cannot be both wide and steep

The morphological factors of width and slope are related interactively to the energy of the coastal environment. Each reflects the potential for sediment mobility, as well as indicating the likely shoreward extent of oil contamination. Man-made structures (eg. causeways, break waters, docking facilities etc.) are described as either permeable (structures such as bridges, wharves, etc.) or impermeable (land fill such as causeways, break waters, etc.). Distinct, sensitive coastal environments such as estuaries, lagoons, and salt marshes have been identified.

Mapping of the coastal geology of the study area was accomplished with the aid of low altitude aerial videos collected and archived by the Atlantic Geoscience Centre (AGC) during a helicopter survey of the west coast in September and October of 1985. The aerial video was supplemented by some preliminary hard-copy mapping of selected areas by AGC scientists, vertical aerial photographs obtained from the Newfoundland Department of Environment and Lands, and personal observations made by members of the project team during past field programs.

During the coastal mapping process, project geomorphologists divided the coastline into over 2000 shoreline segments, each having a homogenous geological composition. Shoreline segment extents and classifications were recorded on new NTS topographic sheets at a scale 1:50,000 and then digitized for use in a SPANS GIS environment. Mapping at a scale of 1:50,000 proved to be practical given the resolution of the original video data.

Detailed and general coastal geomorphology are found in the GEOCODE and GEOCLASS vector files, respectively. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plates 6.1 and 10 in Appendix 3.

5.2 Backshore Description

The description of the backshore is based on the shoreline field survey conducted during the summer of 1992 by Bob Hooper of the Memorial University of Newfoundland Biology Department. Under a contract from Parks Canada, Mr. Hooper evaluated the coastline of Gros Morne National Park in considerable detail. As well as a backshore geomorphology, the Hooper survey yielded information on intertidal and subtidal biology (see 6.8), shoreline litter deposition (see 5.5), and winter ice development (see 8.3) for the area. Because of Mr. Hooper's direct experience, the description of each of these parameters has been extended to cover the Bay of Islands region as well. Due to the lack of primary detailed data, this classification has not been attempted for the other regions.

The nature of the backshore can strongly influence the nature and stability of shore systems. The categories used to describe the backshore were chosen with this type of interactive potential in mind. The Gros Morne and Bay of Islands regions have been classified in terms of: flats; sand dunes; high storm berm; eroding raised marine sediment terrace; slumping soils; steep, stable slopes; cliffs; manmade shorelines (road fill, seawall, etc.); deltas of rivers or streams; and canyons of rivers or streams.

Backshore data are found in the BACKSHOR vector files. Classification of data is described in Appendix 4. A sample of this data in map form is presented in Plate 11 in Appendix 3.

5.3 Wave Energy Determination

Mechanical wave energy is the most important process in shaping the coastline and is of importance in determining potential oil residence in the shore zone. As such, estimates of coastal wave exposure were considered a key attribute to be added the atlas.

There are no direct measurements of wave exposure along this coast. Woodward-Clyde (1983) describe results from a numerical modelling study using wind data to hindcast waves. The wave climate determined for this study covered only three locations: Trout River, Fox Island River, and Crabbes River. The results provide a general background on wave exposure but are not applicable to most of the project area as a result of complex coastal configuration, differing fetch characteristics and differing pack ice characteristics along the coast.

A simple Wave Exposure Classification (see WAVEXP vector files) was used to categorize the coast. The approach follows that of Harper et. al. (1991) that was used in oil spill sensitivity mapping of the British Columbia coast. Five wave exposure levels were defined based on consideration of effective fetch characteristics and maximum fetch for shore points. Harper et. al. (1992) used intertidal biota for a field characterization of the exposure categories and show good agreement between predicted exposures and observed intertidal communities.

Although the classification procedure does not consider wind characteristics (frequency, duration, and strength of various wind directions) it provides an objective, systematic basis for characterizing wave exposure for a large number of shore units.

Maximum wave fetches were measured to characterize the coastal wave exposure along the West Coast of Newfoundland. For the west coast of Newfoundland, the longest fetch across the Gulf of St. Lawrence is usually to the south west. As this is the direction of the prevailing wind for the area, the Exposure Classes based on fetch are expected to be quite representative of coastal wave energy. Exposure categories are listed below in Table 5.3.

Table 5.3

West Coast of Newfoundland Wave Exposure Categories

EXPOSURE RATING	EXPOSURE CLASS	MAXIMUM FETCH
Exposed	1	> 500 km
Semi-exposed	2	50 - 500 km
Semi-protected	3	10 -50 km
Protected	4	1 - 10 km
Very Protected	5	< 1 km

Most of the outer coast is classified as Semi-Exposed corresponding to a fetch of between 50 and 500 km. The outer coast from Pointe Riche south to Bay of Islands was generally classified as Exposed due to >500 km fetches open to the southwest towards the Bay of Chaleur. Permanent harbours fall into the Protected or Very Protected categories whereas some seasonal anchorages may fall into the Semi-Protected category.

Many sections of the west coast of Newfoundland are protected by nearshore boulder barriers. In some cases these barriers act as breakwaters which can greatly reduce the wave energy actually reaching the intertidal zone. The effect of the boulder barriers is demonstrated along the outer coast of Gros Morne National Park by the existence of delicate biological communities that would not be expected on high wave energy beaches.

Stretches of boulders have been identified (from the aerial video, maps, and personal observations), classified (as either present or significant), and then plotted on the study area 1:50,000 NTS sheets. The exposure rating for the coast was then modified according to the breakwater effect of the boulder barriers on individual shore segments.

Wave exposure data with and without the effect of boulder barriers are found in the REVEXP and EXPOSURE vector files, respectively. The classification of data is described in Appendix 4. The distribution of nearshore boulders is included in the BOULDER vector file. A sample of the wave exposure considering the effects of boulder barriers data layer in map form is presented in Plate 1.1 in Appendix 3. A sample of the boulder barriers data layer in map form is presented in Plate 3.1 in Appendix 3.

5.4 Oil Residence Index

The residence time of oil stranded in the shore zone and the effectiveness of mitigative action depend to a great extent on the permeability and mobility of affected shore sediments. While

absolute measures of sediment permeability and mobility at any location can only be obtained through careful long-term field observations, qualitative first approximations of these attributes can be derived from a few readily acquired sedimentological and morphological measures.

Coastal sediment permeability is mainly a function of sediment texture and the nature of the underlying substrate. In general, gravels are highly permeable while muds are comparatively impermeable. Sand is less permeable than gravel and decreases the permeability of a gravel matrix.

The effects of sediment mobility on oil dispersal are complex; cyclic erosion and deposition in moderate energy environments can result in oil burial and increased energy environment may disperse stranded oil. Sediment mobility depends to some extent on texture but is also affected by the cross-sectional and plan morphology of the shore. Where sediment is present, erosion and reworking are most likely along steep, exposed shorelines, while sediment accretion typically occurs in coastal embayments or gently sloping shores.

The period that oil is likely to remain on a beach following a spill is presented in the atlas as an Oil Residence Index (ORI) (see Table 5.4). The relationships between coastal geomorphology and wave exposure leading to the oil residence time is shown in Table 5.5.

Table 5.4

Oil Residence Index Classification

ORI CLASS	ESTIMATED OIL RESIDENCE PERIOD
0	Cannot be Classified
1	Days to Weeks
2	Weeks
3	Weeks to Months
4	Months
5	Months to Years

ORI data are found in the ORI vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 3.2 in Appendix 3.

Table 5.5

Oil Residence Index Determination

Detailed shoreline types (vector file = GEOCODE) are as listed in Table 5.2. Wave exposure (vector file = WAVEXP) are as per Table 5.3.

SHORELINE TYPE	ORI if WAVEXP=1	ORI if WAVEXP=2	ORI if WAVEXP=3	ORI if WAVEXP=4	ORI if WAVEXP=5
Wide rock platform	1	2	3	4	4
Narrow rock platform	1	2	3	4	4
Rock cliff	1	2	3	4	4
Wide gravel beach on rock platform	3	4	4	5	5
Narrow gravel beach on rock platform	3	4	4	5	5
Narrow gravel beach with rock cliff	3	4	4	5	5
Wide sand and gravel beach on rock platform	2	3	4	5	5
Narrow sand and gravel beach on rock platform	2	3	4	5	5
Narrow sand and gravel beach with rock cliff	2	3	4	5	5
Wide sand beach on rock platform	1	2	3	4	4
Narrow sand beach on rock platform	1	2	3	4	4
Narrow sand beach with rock cliff	1	2	3	4	4
Wide gravel flat	3	4	4	5	5
Narrow gravel beach	3	4	4	5	5
Steep gravel beach	4	5	5	5	5
Wide sand and gravel flat	2	3	4	5	5
Narrow sand and gravel beach	2	3	4	5	5
Steep sand and gravel beach	3	4	4	5	5
Wide sand flat	1	2	3	4	4
Narrow sand beach	1	2	3	4	4
Steep sand beach	4	4	3	4	4
Mud flat	n/a	n/a	3	5	5
Estuary/marsh/lagoon	n/a	n/a	5	5	5
Undefined	0	0	0	0	0
Land fill	1	2	3	4	4
Structure	2	3	4	5	5
Water	0	0	0	0	0

5.5 Deposition of Floating Garbage

Floating materials including seaweeds, driftwood, garbage, and oil tend to be deposited along particular portions of the shore determined by local circulation and wind conditions. While these mechanisms are not well known in the study area, the quantities of flotsam observed by Hooper on the shores of Gros Morne National Park and in the Bay of Islands can be considered as indicators of the most likely resting places for large quantities of floating oil in the event of a spill. In this atlas, shoreline deposition of garbage is rated as low, intermediate, or high.

The shores of Gros Morne are already receiving much more anthropogenic materials than had been previously anticipated. The most common garbage on the shore originates with the fishing industry including ropes, floats, lobster traps, outboard oil bottles, etc. Most of the other materials observed is domestic rubbish and wood waste. Much that can be identified as to origin, appears to come from the Maritimes and Quebec.

Litter deposition data are found in the DEPOSIT vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 5.1 in Appendix 3.

6. BIOLOGICAL AND FISHERIES DESCRIPTION

6.1 DFO Catch Data

Very little site-specific information exists in a format that is readily usable for an atlas of this type on the geographical distribution of coastal fisheries resources in western Newfoundland. To adequately identify sections of shoreline which are associated with significant stocks, quantify the size of stock relating to each section of shoreline, and determine the seasonal distribution of stocks would require in-depth interviews with local fishermen. The effort required for such an evaluation is beyond the budget of this atlas. As an alternative, Seaborne has used DFO catch statistics to describe local fishing activity.

DFO Statistics Branch routinely records landings at the point on shore at which they are landed. In fact, 151 communities are registered as landing locations within the study area and are included in the atlas. In this atlas, landings are categorized by community, species, month, catch weight and catch value. The location on shore where a catch is landed does not necessarily imply the presence of local stocks. Larger vessels in particular may fish anywhere on the coast and choose to land their catches at home ports or at facilities specifically suited to the species caught.

Seaborne has developed an overall database which provides for each community (community name and DFO code) and each species (common name) a mean monthly catch as a dollar value for the period 1984-90. The catch values were then classified into seven indexed categories for logical comparison between communities. A representative position (wharf, slipway, fish plant, etc.) was then determined for each community and added as a georeference.

The catch record database is important as a human use parameter as it clearly shows the economic importance of the fishery for each community throughout the year. The database also has some use as a biological indicator for species such as lobster or salmon which are generally taken close to home port in small boats.

Monthly and annual fish catch data for each of the communities registered by DFO are found in the ...CATCH database files and annual catch data associated with shoreline segments are found in the ANNCATCH vector files. The classification of vector data is described in Appendix 4 and databases are described in Appendix 5. A sample of this data layer in map form is presented in Plate 2.2 in Appendix 3.

6.2 Fish Plant Data

All fish plants registered with the Newfoundland Department of Fisheries for the 1992 season have been identified and are included in the atlas in a point-referenced database format. As well as including owner and contact information and Department of Fisheries identification codes, the database also indicates whether the fish plant uses a salt water or fresh water system. The

geographical location of each facility is the same as that used for the DFO catch landing site in the community in question so the species and volume of catch processed by the plant can be inferred from the DFO catch data for that community.

Fish plant locations are found in the FISHPLAN point database. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 2.2 in Appendix 3.

6.3 Aquaculture Data

At the time of the atlas development, there were few active aquaculture licenses on the west coast. These operations are involved in mussel, scallop, or lobster culture and are licensed by the Newfoundland Department of Fisheries. These locations are presented in point-referenced databases which include species, owner and contact information only.

Aquaculture locations are found in the AQUACULT point database. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 2.2 in Appendix 3.

6.4 Salmon Rivers

In Newfoundland, rivers supporting important salmon runs are registered by DFO. Salmon can be expected to enter these rivers from the sea for spawning in the summer months. The atlas indicates the location of the mouth of each of these rivers as a distinct point on the coastline. The shore segment in which the mouth of the river is found is also classified as a salmon river.

Locations of the mouths of registered salmon rivers are found in the SALMON point database. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 2.2 in Appendix 3.

6.5 Capelin Spawning Beaches

Capelin in western Newfoundland spawn on sand or gravel beaches in the intertidal zone or, if surface water temperatures become too high (above about 8.5°C), in deeper water. Spawning takes place in spring early summer, becoming progressively later to the north. Capelin eggs stay on the bottom where they stick to the sand and gravel until hatching (Carscadden, 1981).

As comprehensive survey data were not available for this project, capelin spawning is presented in terms of preferred beach habitat. Beach types determined in the coastal geomorphology classification have been evaluated as capelin spawning habitats and reclassified according to a five-point preference scheme as detailed in Table 6.1.

Table 6.1

Classification of Shoreline According to Capelin Spawning Preference

Spawning Preference	Rank	Geomorphology
Very Low	1	Mud flats, estuaries, man made structures
Low	2	Bedrock platforms or cliffs
Moderate	3	All sand beaches and flats
High	4	All sand & gravel beaches and flats
Very High	5	All gravel beaches and flats

Capelin spawning areas are found in the CAPLIN vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 7.2 in Appendix 3.

6.6 Herring Spawning Beaches

Herring spawn nearshore along several areas along the west coast of Newfoundland. In the past, when stocks were more abundant, a large Gulf of St. Lawrence herring population would migrate into Bonne Bay and the Bay of Islands for the winter where they were heavily fished. It now seems that the herring population is smaller and more localized. Spawning can occur in any month between April and October but tends to be concentrated in May and September (Ahrens, 1984).

DFO has surveyed a large part of the study area to determine the distribution of herring spawn (Hooper, 1987). Using this survey data, and extending the findings to other parts of the coast, Hooper has re-classified shoreline segments throughout the study area in terms of nearshore herring spawning according to the scheme presented in Table 6.2.

Herring spawning areas are found in the HERRING vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 1.2 in Appendix 3.

Table 6.2

Classification of Shoreline According to Herring Spawning Preference

Spawning Preference	Class
Unclassified	0
Spawning Possible - likely to be light	1
Not surveyed -suspected significant spawning	2
Surveyed - significant spawning	3
Surveyed - heavy spawning	5

6.7 Offshore Biology

General distributions of biological populations are included in the West Coast Study Area Universe (REGIONAL). Biological data from several sources (see Appendix 6) were transferred to transparent sheets overlaying the two complementary CHS charts which cover the study area at a scale of 1:350,000. As all original data were obtained in the form of hard copy maps at a variety of scales, the transfer was accomplished with the aid of proportional grid systems laid on the original maps and on the CHS charts. Each was transparency geo-corrected through a series of common reference points which allowed for consistent digitization of data. Each data type is presented as a pair of files, reflecting the north (CHS 4021) and south (CHS 4022) base maps used in the digitization of data.

Because of the inaccuracies inherent in the original small scale data and the cumulative error involved in re-scaling and transfer, the overall accuracy of the offshore biological data is in the order of hundreds to thousands of metres. Offshore biological data contained in the atlas includes:

Pelagic Fishes
- Herring (*Clupea harengus*)
- Atlantic Mackerel (*Scomber scombrus*)

Groundfish (flatfish)
- Witch Flounder (*Glyptocephalus cynoglossus*)
- Greenland Halibut (*Reinhardtius hippoglossoides*)
- American Plaice (*Hippoglossoides platessoides*)

Groundfish
- Redfish (*Sebastes* sp.)
- Atlantic Cod (*Gadus morhua*)

Marine Mammals
- Blue Whale (*Balanoptera musculus*)
- Harp Seal (*Phoca groenlandica*)
- Harbour Seal (*Phoca vitulina concolor*)
- Killer Whale (*Orcinus orca*)
- Fin Whales (*Balenoptera physalus*)
- Pilot or Pothead Whales (*Globicephala melaena*)
- Minke Whales (*Balenoptera acutorostrata*)
- Humpback Whales (*Megaptera novaeanliae*)

Marine Invertebrates (crab and lobster)
- American Lobster (*Homarus americanus*)
- Rock Crab (*Cancer* sp.)
- Hermit Crab (*Pagurus acadianus*)

Marine Invertebrates (shrimp)
- Shrimp (*Pandalus borealis*)
- Shrimp (*Crangon septemspinosus*)
- Shrimp (*Pandalus montagui*)

Marine Invertebrates (bivalve molluscs)
- Iceland Scallop (*Chlamys islandicus*)
- Giant Scallop (*Placopecten magellenicus*)

Marine Invertebrates (decapod molluscs)
- Short Fin Squid (*Ilex* sp.)

Detailed descriptions of the vector files which describe the ranges of the above biological populations are presented here in Appendix 6. References for each of the species listed above are found in Chapter 12.

6.8 Intertidal and Subtidal Biological Habitats

As a result of the 1992 coastal survey of Gros Morne National Park (Hooper, 1993) sufficient data became available for the re-classification of atlas shoreline segments in terms of biological habitats. Both the physical structure of the beach (geomorphology and wave exposure) and representative biological species or communities were considered in the development of classification schemes for the intertidal (see Table 6.3) and subtidal (see Table 6.4) habitats in the Gros Morne Region of the atlas. Habitat classification was also undertaken for the Bay of Islands Region based on Bob Hooper's personal experience in past surveys of the region, the availability of relatively high quality AGC aerial video for this area, and also on the similarity of the region to the Gros Morne Region.

Intertidal biological habitat data are presented in the INTERTID vector files while subtidal biological habitat data are presented in the SUBTIDAL vector files. The classification of both intertidal and subtidal data is described here in Appendix 4. Samples of the intertidal and subtidal habitat data layers are presented in map form in Plates 4.1 and 4.2, respectively, in Appendix 3.

Table 6.3

Classification of Intertidal Biological Habitats

Class	Substrate	Biological Community
0	Unclassified	
1	Road fill	
2	Exposed sediments	Temporary seaweeds
3	Exposed cliff and boulder	High *Porhyra* and spray zone
4	Exposed estuary	Green seaweeds
5	Sheltered cliff	Barnacles, mussels, seaweed zonation
6	Exposed cobble/boulder	Green and brown algae
7	Sheltered sediments	Soft shell clams and eel grass
8	Sheltered bedrock	Black lichen and periwinkle
9	Sheltered cobble/boulder	*Ascophyllum* and red periwinkle
10	Exposed bedrock platform	Rockweed and Irish Moss pools
11	Sheltered estuary	Eel grass
12	Salt marsh	Hybrid subarctic salt marsh
13	Unclassified	

6.9 Coastal Seabirds

A comprehensive review of coastal seabirds is included in the atlas. Dr. W. Montevecchi of Memorial University was responsible for transcribing all known bird observation data directly to the study area NTS map sheets. Sources of data include Montevecchi (1993), Cairns et al. (1989) and Howes and Montevecchi (1993). Data used in the atlas include the location and timing of each observation along with the species and number of birds sighted. Special reference is made to nesting birds. A master point database file (SEABIRD) incorporates all of Montevecchi's collated data. Details of the structure of this file can be found in Appendix 5.

Table 6.4

Classification of Subtidal Biological Habitats

Class	Substrate	Biological Community
0	Unclassified	
1	Mobile sediments	Sand dollars
2	Stable sediments	Clam beds (*Mya*)
3	Sheltered bedrock and boulders	General - cordweed and cunner
4	Exposed bedrock and boulders	Whelks and horse mussels
5	Sheltered bedrock and boulders	Kelp beds (*Laminaria*)
6	Sheltered bedrock and boulders	Sea urchin beds
7	Sheltered bedrock and boulders	Rhodolith and coralline communities
8	Accumulated industrial or municipal waste	
9	Sheltered sediments	Eel grass meadows

A series of monthly point database files (JANBIRD1...DECBIRD1) detailing bird nesting sites has been developed from this master file is presented for the entire study area. Similarly, sites where nesting does not occur are documented in a second series of monthly database files (JANBIRD2...DECBIRD2). A description of both sets of files is presented in Appendix 5.

Once the coastal seabird observation database was assembled, it was then possible to re-classify the shoreline segments in terms of seabird distribution. The length of classified shoreline was extended through the subjective evaluation of areas where the probability of seabird activity was thought to be high even though hard observation data did not exist. Indicators of undocumented bird activity included an assessment of habitat, the presence of droppings on rocks witnessed in the AGC video, and the traditional naming of geographic features (Bird Rocks etc.). As for other atlas data where ranges have been extended without direct observation, the classification has been noted as "suspected" only. The classification scheme presented in Table 6.5 was used to describe the seabird attributes of each segment.

A detailed description of the SEABIRDS vector file is presented in Appendix 4. A sample of map representation of all seabird data is presented in Plate 2.1 of Appendix 3.

Table 6.5

Coastal Seabird Sensitivity Classification Scheme

Class	Type of Coastal Seabird Area
1	Suspected fall staging area for waterfowl
2	Suspected waterfowl breeding site
3	Suspected fall staging area for shorebirds
4	Suspected concentration of diving birds
5	Suspected seabird breeding site
6	Known fall staging area for waterfowl
7	Known waterfowl breeding site
8	Known fall staging area for shorebirds
9	Known concentration of diving birds
10	Known seabird breeding site
11	Known endangered species site

6.10 Offshore Seabirds

At the time of the atlas development, Dr. A. Lock of the Canadian Wildlife Service (CWS) was upgrading the digital database of offshore seabird observations in Atlantic Canada. This digital database incorporates much of the shipboard survey data published in the *Revised Atlas of Eastern Canadian Seabirds* (Brown, 1986).

CWS pelagic bird data were provided for an area extending from 47°N, 55°W in the south east to 52°N, 60°W in the north west. The data are reported by month and by species and are referenced to standard grid points throughout the offshore portion of the study area. Bird density is averaged and referenced to geographic blocks one degree of longitude wide by half-degree of latitude high. Each block has been labelled by the coordinates of the southeast corner.

The offshore bird data presented in the monthly SEABIRD3 point database files have been reduced to the average density of each of eight bird groups per linear kilometre as sighted from reporting ships. As well, a density sum is given for the "Vulnerable Birds" (fulmars, shearwaters, gannets, and alcids). "Vulnerable" refers to susceptibility to oil mortality. A second density sum is given for all eight bird-groups.

7. HUMAN USE DESCRIPTION

Human use is considered to be one of the key components in assessing overall sensitivity of the coastline. The communities along this coast all depend upon marine resources for their livelihood and would be impacted heavily in the event of an offshore spill. Human use is described in the atlas through a composite view of development at several levels.

7.1 Areas of Human Development from LANDSAT Imagery

Populated areas are indicated in the LANDSAT imagery human development layer. Along with road surfaces, large developed areas around towns, communities, industries, wharf facilities can be identified. Although this layer is not discriminating, it does show clearly areas of concentrated human activity.

Human development areas are found in the DEVELOP vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plates 6.2, 8, and 12 in Appendix 3.

7.2 Populated Areas

The 1991 Canada census enumerated the population of the area in considerable detail. For the atlas project the cost of purchasing these detailed data from Statistics Canada was prohibitive. Census data was obtained, however, for incorporated municipalities from the Newfoundland Department of Municipal and Provincial Affairs *1992 Measures in Effect* (Newfoundland Government, 1992) . In the atlas, this information is presented in the form of a database that can be used directly in SPANS Map. Included in this data base are the 1991 census value along with the Gazetteer of Canada - Newfoundland location of the municipality.

Census data are found in the CENSUS point data base. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 6.2 in Appendix 3.

7.3 Human Boundaries

Large areas of the study area have been designated for specific human use. These areas include: incorporated municipalities; national, provincial, and municipal parks; and wildlife, agricultural, and ecological reserves. In each case, boundaries have been surveyed and mapped for these areas.

Because of the coastline focus of the atlas, and because of the effort required to trace inland boundaries of these areas over multiple NTS sheets, only the shoreline boundaries of these areas

are included in the atlas.

The boundaries for these areas were identified in the provincial Land Use Management (LUM) atlas and transferred to standard NTS sheets for digitizing.

Human use boundaries are found in the HUMUSE vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 6.2 in Appendix 3.

7.4 Industrial Areas

The economy of the west coast is based almost entirely on the fishery and forestry sectors. As a result, coastal industrial facilities are limited to the pulp mills at Stephenville and Corner Brook, a few manufacturers with shore loading facilities, oil distribution terminals, and local fish processing plants. Although several small saw mills are found on the west coast, few are actually located on the shoreline.

These facilities are documented in individual industrial (INDUST), oil terminal (OILSTORE), and fish plant (FISHPLAN) data base files that can be used directly in SPANS Map. Sources of the data used in these files are the LUM atlas, the major oil distributors (Ultramar, Irving, and Imperial), and the Newfoundland Department of Fisheries, respectively. Descriptions of the field structures of these files is presented in Appendix 5. A sample of this data layer in map form are presented in Plate 6.2 in Appendix 3.

7.5 Recreational Areas

In addition to the coastline boundaries of parks, a point data file has been developed to indicate all important recreational sites. Included in this file are the locations of guide/outfitters, camp sites, picnic sites, hiking trails, golf courses, and view points.

The sources of this information are the Newfoundland Department of Environment and Lands LUM Atlas, parks maps, road maps, town maps, and the observations of the study team. Recreational areas are found in the RECREAT point data base. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 6.2 in Appendix 3.

7.6 Coastal Cabins

In addition to permanent west coast municipalities and communities, fishing or recreational camps have been established in several remote areas along the coastline. These camps are occupied temporarily during summer months and are usually found on low-lying ground just

above the high water line at locations where a small boat can be landed. Often the immediate area has been cleared for and there is a source of fresh water nearby.

In this atlas, temporary settlements are mapped as points and are defined by the presence of cabins observed close to the beach. The sources of this information are the AGC aerial video and personal observations made by the study team. Cabin locations are found in the CABIN point data base. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plates 6.2 and 12 in Appendix 3.

7.7 Archaeological Sites

The west coast of Newfoundland has a rich maritime history. Many locations in the study area have been identified as important archaeological sites. All known archaeological sites in the study area have been catalogued by the Historic Resources Division of the Newfoundland Ministry of Tourism and Culture. In the Historic Resources Division catalogue, each site is specifically located and documented. For this atlas presentation, archaeological sites are presented as shoreline segments and not as specific points for two reasons: a) It is very likely that a larger area of significance is associated with the known site, and b) the need to maintain the security of such areas and Historic Resources does not wish to reveal specific sites through the atlas.

In the event that a spill is threatening a section of coastline having archaeological significance, spill response personnel should contact Historic Resources Division directly for advice on specific archaeological sites.

Archaeological areas are found in the ARCHCODE vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plates 6.2 and 9 in Appendix 3.

8. PHYSICAL ENVIRONMENT

Background physical environmental data are presented in the atlas in the form of historical summaries. Because much of this data is general, all physical environment information is included in the small-scale REGIONAL universe covering the entire study area.

8.1 Historical Weather Data

Historical weather data have been archived by the Atmospheric Environment Service (AES) of Environment Canada. The network of data collection stations in the study area includes 30 stations operated by AES and climatic stations operated by the Newfoundland Department of Environment and Lands.

For stations which have recorded data for twenty of the last thirty years, summary data were available in the 1961-90 Canadian Climate Normals published by AES. For stations having less archived data, summaries were assembled specifically for the atlas by AES in Downsview, Ontario.

Data summaries consist of mean, minimum, and maximum values by parameter and month for each observing station. A data base which includes the location of each station, the parameters measured, and some history of the station can be used directly in SPANS Map. Summary tables exist as ASCII text files attached to each station using the SPANS Map appended text feature.

Locations of historical weather data observing stations are presented here in Fig. 8.1.

8.2 Oceanographic Information

Very little oceanographic survey data exist for the study region. No direct wave measurements have been made along the west coast of the island. Local wave climates were described by Woodward Clyde (1983) using numerical modelling methods to hindcast wave conditions from historical winds. The summary wave data presented in the atlas is included in the Transport Development Centre Gulf of St. Lawrence Wind and Wave Climate Atlas (MacLaren Plansearch, 1992). In the TDC atlas, the ESRF study area is contained in a single region. Summary data from the TDC atlas, including directional wave data and significant wave height by month, are presented in a table which has been appended to offshore data points associated with the coastline of each region. Offshore normal winds from the TDC atlas are presented in a parallel table appended to adjacent points in the REGIONAL universe of the west coast Newfoundland atlas.

Tidal information is presented in the Canadian Hydrographic Service 1992 (CHS) Gulf of St. Lawrence tide tables (CHS, 1992). For the west coast of Newfoundland, all tidal predictions are made for a primary port at Harrington Harbour on the north shore of the Gulf of St. Lawrence. Seven secondary ports with similar tidal characteristics as Harrington Harbour are situated on the west coast of Newfoundland. Tidal ranges for each of these stations are included in the atlas in the form of a database that can be used directly in SPANS Map. Locations of these secondary ports are shown here in Fig. 8.1.

Direct current meter measurements have been conducted by the Bedford Institute of Oceanography (BIO) in the head of St. George's Bay and in the Strait of Belle Isle. Summaries for these data sets are presented in a current meter data catalogue published by DFO. Surface current and current meter measurements were made in the head of Humber Arm as part of the 1980 harbour development study. Because of the local nature and the difficulty of interpretation of these data sets, they have not been included in the atlas. The current data that are included in the ESRF atlas are the offshore surface current grid that is used by the Canadian Coast Guard (CCG) in the CANSARP computerized Search and Rescue system. Residual current values, expressed in speed (cm/s) and direction (°T) representing summer and winter conditions are presented in the REGIONAL universe in a data base that can be used directly in SPANS Map.

8.3 Ice Formation

Ice information is presented in the Gros Morne and Bay of Islands regions as segments classified in terms of development of landfast ice or the incursion of sea ice on the intertidal shoreline. This shoreline ice data is the direct result of directed intertidal survey work conducted by Memorial University researchers up to the summer of 1991 and classified by Bob Hooper for this project. The classification scheme for shoreline ice formation is presented in Table 8.1. This classification indicates the level of protection provided to the shoreline against an oil spill by winter ice formations. Ice formation data are found in the ICE vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 5.2 in Appendix 3.

Table 8.1

Shoreline Ice Formation Classification

CLASS	DESCRIPTION
1	Land fast protective ice cover
2	Ice foot attached to the upper shore
3	Pack ice scour in the lower shore
4	Major destructive ice scour

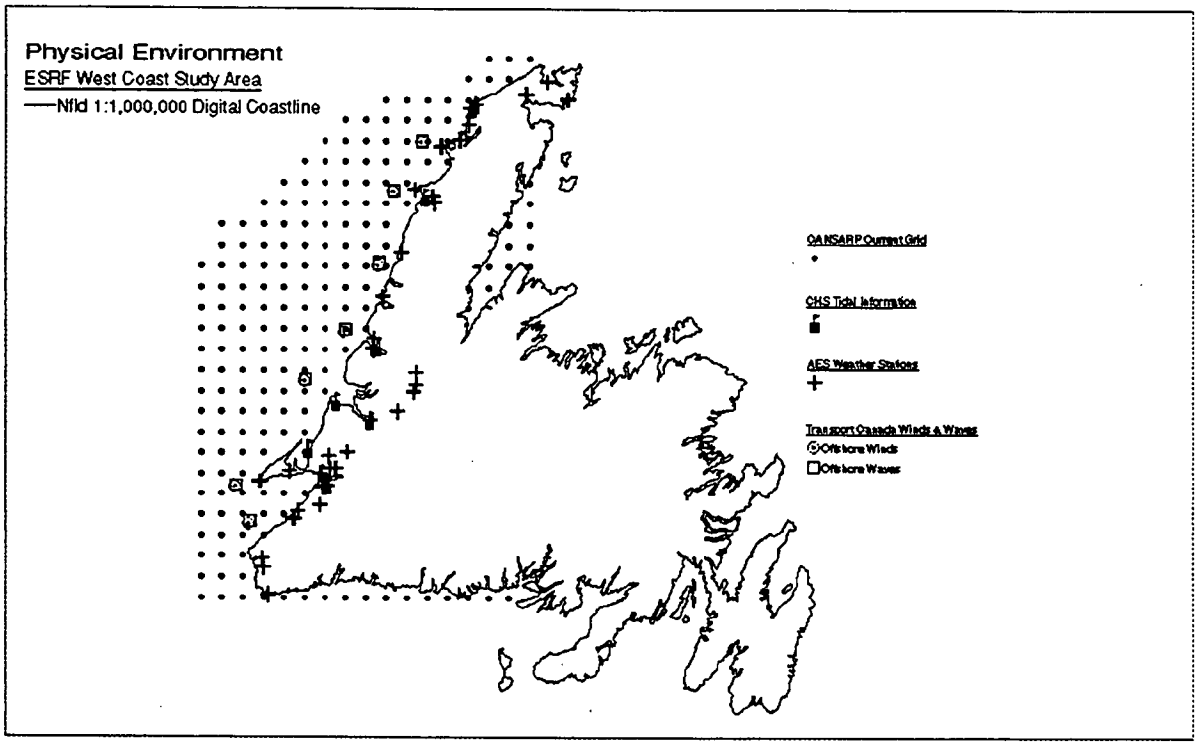

Fig. 8.1 Physical Environmental Data Points.

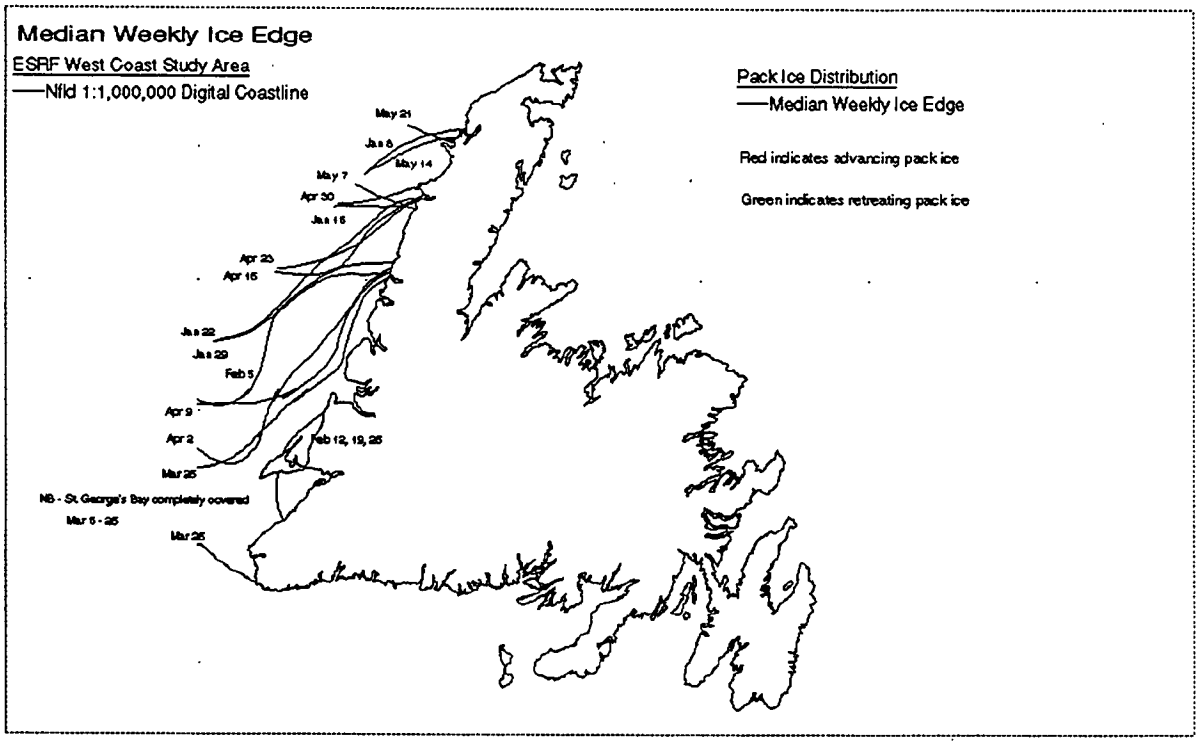

Fig. 8.2. Weekly Median Ice Edge.

The advance and retreat of offshore pack ice is presented for the entire study area in terms of the weekly median ice edge in the Gulf of St. Lawrence. This information has been digitized from the *Ice Climatology of Newfoundland Bays* (Seaconsult, 1985). Pack ice data are found in the ICEDGE vector files. The classification of data is described in Appendix 4. A summary of all weekly ice edges is presented here in Fig. 8.2.

8.4 Coastal Flooding

Flooding in Newfoundland has been surveyed over several years under the Canada-Newfoundland Flood Reduction Damage Program, a joint venture of the Federal Department and the Newfoundland Department of Environment and Lands. Under this program, low-lying areas which have had a traditional flooding problem have been surveyed so that flood risk maps showing 20 and 100 year flood zones can be published. Included in the mandate of this program is flooding from both fresh water and salt water sources.

Flood risk maps for the west coast of Newfoundland have been reviewed and areas where distribution of oil from a marine oil spill might be affected by local flooding have been identified. Flood areas are defined in the coastal regions of the atlas by shoreline segments that fall within the flood zones defined in the flood risk maps. Severity of flooding is classified in terms of the terrestrial extent of marine flooding as shown in Table 8.2 below.

Flood risk areas are found in the FLOODLEV vector files. The classification of data is described in Appendix 4. A sample of this data layer in map form is presented in Plate 13 in Appendix 3.

Table 8.2

Flood Risk Classification

CLASS	DESCRIPTION
1	Surveyed but no flooding
2	Flooding area extends 0-100m in from shore
3	Flooding area extends >100m in from shore
4	Flooding area extends >500m in from shore

9. LOGISTICS FACILITIES

Logistics facilities of the study area are described in the atlas. Included are details on coastal and marine access, air transport, fuel storage, and waste disposal. The atlas is not intended to be used directly for navigation and road transportation. Published road maps, topographic sheets (see Appendix 9), and hydrographic charts (see Appendix 9) should be used for these purposes.

9.1 Harbour Facilities

There are many small harbours along the west coast of the island. In many cases, developed wharf facilities exist at these locations. DFO facilities are operated by the Small Craft Harbours and Infrastructure Branch. Harbour facilities have been developed to meet the needs of the local fishery and vary in size and complexity depending upon location and purpose. Eighty-eight such facilities are found in the atlas study area. Because of the direct link to the fishery, the location of the wharf in the atlas is often the same as the atlas location of DFO fish landing sites. Transport Canada maintains harbour operations at three locations (Stephenville, Corner Brook, and St. Barbe) in the atlas study area. These facilities are usually suitable for larger ships. Private wharves include all ferry wharves, industrial or oil loading terminals and wharf locations noted on the representative NTS sheets or fish plants that have not already been identified.

A description of the field structure of the HARBOUR database is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 12 in Appendix 3.

9.2 Aircraft Landing Sites

Runway and helicopter landing sites are documented in the AIRPORT point database. Technical information for each controlled facility including runway specifications, lighting, maintenance facilities, and the airport responsible for controlling traffic has been compiled from several Transport Canada documents (Transport Canada 1992a, 1992b, and 1992c). As well, a few rough landing strips close to the coast have been identified and are included in the database.

A description of the field structure of the AIRPORT database is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 12 in Appendix 3.

9.3 Road System

The road system can be viewed in two ways in the digital atlas. All roads are included in the composite human development (DEVELOP see 3.1) land use layer processed from the LANDSAT satellite imagery. This vector layer can be used directly in the SPANS Map GIS system in conjunction with any other vector or point data. In cases where there is little other development and width of the cleared area is close to the resolution of the satellite imagery, the

roads can be clearly identified. The road is lost where the cleared area is narrow or obscured overhead by forest and the track falls below the minimum LANDSAT resolution. In communities, near industrial sites, or at other locations where there are buildings and pavement, the individual roads are obscured by the total development. In cases where the effective roadway width approaches the resolution of the imagery, it is possible to roughly interpret the subtleties of satellite image signatures and the logic of signature patterns to discriminate the road system from other development. The road system can be seen in some detail in the processed satellite data images that are appended to each region in the form of .PCX bitmap files.

The classification of the DEVELOP vector files is described in Appendix 4. Sampled of this data layer in map form are presented in Plates 6.2, 7.1, 8, and 12 in Appendix 3.

9.4 Beach Access

A list of beach access points has been compiled and included in the atlas. Beach access is defined as any point where a pick-up truck can be driven close to the water's edge for the delivery of equipment. In addition to wharves serviced by the road system, a number of rough roads have been identified in the AGC aerial videos and past observations of the study team.

Beach access locations are found in the BEACHACC point data base. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plates 6.2 and 12 in Appendix 3.

9.5 Oil Storage Facilities

Large volume oil storage can be found close to shore at some of the main harbour facilities of the west coast. Oil storage facilities are located at major industrial sites and at dedicated facilities operated by the major oil distribution companies.

Oil storage locations are found in the OILSTORE point data base. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 12 in Appendix 3.

9.6 Waste Disposal Facilities

Municipal waste disposal sites are presented in the atlas in the WASTEDIS point database. Of primary interest to coastal oil spill countermeasures operations are the registered landfill sites as documented in the LUM atlas are included. The DOEL Environmental Investigations Division has also identified several undeveloped sites that are suitable for disposal of oiled materials resulting from a coastal clean up. The locations of these sites are confidential and so are not included in this atlas.

10. COUNTERMEASURES OPTIONS

It is not the purpose of this atlas to present a comprehensive plan for the implementation of countermeasures in the study area. It is anticipated that measures will be implemented for specific sections of the west coast as part of the contingency planning process for any future offshore drilling program. The data found in this atlas will greatly assist planners in assessing risk and in identifying sensitive areas requiring protection. The atlas will also provide information that will be useful in the planning of the types and placement of equipment to be used.

A data layer has been included in the atlas which suggests points along the coast where protective equipment might be placed for the containment and removal of surface oil before it reaches the coastline.

10.1 Countermeasures Techniques

Shoreline protection techniques included for each coastal region are listed in Table 10.1. These techniques are discussed in considerable detail in Owens et. al. (1992). Brief descriptions of these techniques along with the environmental limitations of each are included in Table 10.1.

10.2 Reference to the Study Area

Following all environmental data classification, the entire study area coastline was evaluated subjectively by study team members for possible countermeasures applications. In each region, several locations suitable for use of the techniques listed in Table 10.1 were identified. The selection criteria included the sensitivity of the area to an offshore oil spill approaching the shore and the physical conditions which would limit the implementation of countermeasures techniques.

In this atlas, locations of countermeasures applications are mapped as points in standard database COUNTER files for each coastal region. A description of the field structure of this file is presented in Appendix 5. A sample of this data layer in map form is presented in Plate 14 in Appendix 3.

Table 10.1

Summary of Shoreline Protection Techniques (after Owens et. al., 1992)

Class	Technique	Description	Environmental Limits
1	Containment Booming	Boom is deployed in a "U" shape in front of the oncoming slick. The ends of the booms area held in place by work boats or drogues. The oil is contained within the "U" and prevented from reaching shore.	- High winds - Swells > 2 m - Breaking waves > 0.5 m - Currents > 0.75 m/s
2	Exclusion Booming	Boom is deployed across or around specific sensitive areas. Approaching oil is deflected or contained by the boom.	- Water depths > 20 m - Breaking waves > 0.5 m - Currents > 0.5 m/s
3	Deflection Booming	Boom is deployed from the shoreline away from the approaching slick and anchored or held in place by a work boat. The oil is not contained but is deflected away from the shoreline	- Currents > 0.75 m/s - Breaking waves > 0.5 m
4	Diversion Booming	Boom is deployed from the shoreline at an angle towards the approaching slick and anchored or held in place by a work boat. The oil is diverted towards the shoreline for recovery.	- Currents > 0.75 m/s - Breaking Waves > 0.5 m
5	Beach Berm	The upper intertidal zone is protected by a berm constructed along the top of the mid-intertidal zone from sediments excavated from the down gradient side. The outer face of the berm should be covered with plastic of geotextile sheeting to minimize wave erosion and to limit penetration by floating oil	- High wave energy - Large tidal range - Strong alongshore currents
6	Inlet Dam	A dam is constructed across a channel using local soil or beach materials to prevent floating oil from entering the channel. Water flow through the channel is maintained by a culvert placed below the level of surface oil.	- Waves > 0.25 m - Tidal range > dam height - Strong freshwater outflow
7	Geotextiles	A layer of impermeable geotextile or plastic sheeting is spread over a local sensitive resource such as the supratidal zone of a beach and secured to prevent oiling caused by spray.	- Low beach slope (=large area) - High spring tides - Storm surge
8	Sorbent Barrier	A barrier constructed along a beach or the surface of a shallow channel entrance. The barrier is constructed of two parallel fences with a layer of loose sorbent material between.	- Waves > 0.25 m - Currents > 0.5 m/s - Tidal range > barrier height
9	Collection Point	A point where skimmers can be operated close to shore inside a diversion boom or at the apex of a containment boom. Oil collected by the skimmer to be transferred to tanks onboard a nearby vessel, barge, or shore facility.	- High winds - Swells > 2 m - Breaking waves > 0.5 m - Currents > 0.75 m/s

11. FUTURE ENHANCEMENTS

The Seaborne atlas is naturally limited by the budget made available for its development. Specifically, little specific survey work has been undertaken as part of this project. The primary focus of the atlas has been to provide a comprehensive physical description of the coastline and to provide as much environmental, human use, and logistics information as possible. The data included in the atlas are limited to what was available in the public domain at the time of assembly. Operators interested in providing detailed information to support specific offshore operations will likely only need data for a limited area and will, therefore, be able to limit data collection costs.

As drilling activities are planned, it is anticipated that individual offshore operators will have a requirement for detailed coastal environmental information for inclusion in oil spill and emergency response contingency plans. The atlas structure lends itself to further development and it is hoped that the atlas will grow with use.

Following are a number of features that would enhance the atlas and make it more useful as part of a dedicated environmental program to support drilling activities. All of the noted enhancements can be incorporated into the present atlas using existing SPANS or SPANS Map utilities. Many of these items have not been included in the present version of the atlas because of the cost of providing uniform coverage throughout the west coast study area.

11.1 Physical Data

11.1.1 Shoreline Dynamics

The beach geomorphology included in the atlas, although comprehensive, is limited to a snap-shot view documented in the 1985 AGC aerial video. No effort has been made to include information on beach stability, sediment transport, or any other physical changes to the shoreline that might affect the residence time of oil on the beach. At this time, no such data are available so a specific field survey would have to be undertaken.

11.1.2 Tidal Predictions

During an oil spill response operation, the ability to quickly predict tides for various locations in the study area will be very useful. A tidal prediction program, can be run in OS/2 in a window parallel to the SPANS Map application. Because the tidal program will be independent of the mapping software, the prediction software can be either a commercial product or a custom-built application.

11.2 Biological and Fisheries Data

Over such a large study area, the amount of existing biological data varied considerably from region to region. It was found that considerable information was available for the Gros Morne and Bay of Islands regions and less information was available for other regions with distance from the centre. As well, the limited budget did not allow for a detailed review of the commercial fishery. Further biological data can be added in the future as available or as required for individual drilling operations.

11.2.1 Further Habitat Mapping

Intertidal and subtidal habitats have been mapped for both the Gros Morne and the Bay of Islands regions only. It would be desirable to extend the range of habitat mapping as these data are useful as an overall biological index. Site-specific field surveys will be required to do this in the future.

11.2.2 Detailed Commercial Fishing Locations

In the present version of the atlas, there are no data which describe the actual location of commercial fishing activities. Such information is expensive to gather and so was outside the budget of this atlas. The locations of nearshore fishing activities, especially fixed gear operations (lobster pots, trap berths, and gill nets) would be very useful in considering oil spill response operations. In preparation for an offshore drilling program, detailed surveys of ongoing fishing operations should be undertaken with the assistance of regional development associations and local fisherman's committees.

11.3 Human Data

11.3.1 Detailed Census

To keep within the budget of this project, information on the distribution of population was limited to the 1991 census data for incorporated municipalities available in the public domain. Detailed georeferenced census data can be purchased directly from Statistics Canada for direct inclusion in the atlas.

11.3.2 Road System

If required, an accurate road system can be incorporated as a GIS layer in the atlas. The roads can be digitized from the 1:50,000 NTS sheets for the study area. This is a time-consuming process as each NTS sheet should be updated from aerial photographs and road maps to represent the current road system and only portions of each road are found on each map sheet.

11.3.3 Emergency Services

A useful inclusion in the atlas would be information on public emergency services such as police, fire departments, and hospitals. All information could be contained in a single database which includes location, equipment, and personnel complement, and contact details.

11.3.4 Support Services

Commercial services such as gas stations, truckers, lumber yards, hotels, restaurants could be contained in a single database.

11.5 Oil Spill Response

11.5.1 Spill Predictions

Part of the preparation for any offshore drilling program will be the modelling of oil spill trajectories. The data output from such an exercise can be incorporated into the atlas in a number of ways.

In the most simple application, digital plots of oil concentrations can be formatted for use in SPANS and imported as vector files directly into the existing SPANS Map atlas universes for graphic representation in the digital atlas.

Given the prevailing environmental conditions and the locations of offshore drilling lands, it can be expected that the model will predict that floating oil will reach the beach somewhere along the west coast of Newfoundland. Using the output from the spill trajectory model, the volume of oil expected to reach individual shoreline segments can be determined in SPANS. With improved oil characteristics and the existing geology and wave exposure information, a revised ORI can be determined.

11.5.2 Countermeasures Plan

As discussed in 10., a countermeasures plan my be required as part of an offshore drilling program contingency plan. The placement of equipment and the related logistics can be determined based on the physical environment and the assessed risk and sensitivity of the shoreline and mapped in the atlas.

11.6 Enhancements Within SPANS Map

SPANS Map has been developed specifically for the review of georeferenced data and so has a suite of presentation utilities. For instance, as described in 4.6, the combined spreadsheet/map/histogram feature of the is particularly useful in the interpretation of the master

database. These presentation features can be further exploited to incorporate future data.

11.6.1 Attribute-Specific Icons

The atlas now relies on the icons provided in SPANS Map for the classification of database information in prepared maps. For most applications, colour-coded geometric shapes such as circles or squares are used to locate data points. Wherever possible, appropriate specific symbols are used to indicate the location of resources. As SPANS Map was developed for generic terrestrial applications, the custom symbols available are limited to areas of human development or logistics. For example, an oil drum is used for oil handling facilities, a picnic table for picnic site, an anchor for a harbour facility, and a house for coastal cabin sites.

Custom icons can now be digitized for specific applications using a recent SPANS Map utility. This would be particularly useful for the identification of biological resources such as seabirds, salmon rivers, or aquaculture sites.

11.6.2 Other Attached Data

As described in 4.7, text and graphics data can be attached to a georeferenced database. Future site-specific graphics data that could be attached to the atlas using this utility include large scale aerial photographs, detailed town road maps, harbour plans, or technical drawings that may be of use to the user. Attached text might include tables of biological data, operational notes checklists, or contact information.

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Appendix 1

Catalogue Of Atlas Data Files

File Name	ANGUILLE	PAUXPORT	BAYISLND	GROSMORN	PORTLAND	PORTSAUN	BELLISLE
1. General							
AIRPORT	X	X	X	X	X	X	X
AQUACULT	X	X	X	X	-	X	X
BEACHACC	X	X	X	X	X	X	X
BOATYARD	-	-	X	X	-	X	X
CABIN	X	X	X	X	X	X	X
CENSUS	-	X	X	X	X	X	X
COUNTER	X	X	X	X	X	X	X
FISHPLAN	X	X	X	X	X	X	X
HARBOUR	X	X	X	X	X	X	X
INDUST	-	X	X	X	-	X	X
OILSTORE	X	X	X	X	X	-	-
RECREAT	X	X	X	X	X	X	-
SALMON	X	X	X	X	X	X	X
SEABIRD	X	X	X	X	X	X	X
SEGMENT	X	X	X	X	X	X	X
SPECIAL	X	X	X	X	X	X	X
WASTEDIS	X	X	X	X	X	X	X
2. Place Names							
BATHNAME	X	X	X	X	X	X	X
COASNAME	X	X	X	X	X	X	X
COMMNAME	X	X	X	X	X	X	X
FWNAME	X	X	X	X	X	X	X
INDNAME	-	-	X	-	-	-	-
MARINAME	X	X	X	X	X	X	X
PARKNAME	X	X	X	X	X	X	X
TOWNAME	-	X	X	X	-	X	X

X data available and file present in atlas
\- no data available

File Name	ANGUILLE	PAUXPORT	BAYISLND	GROSMORN	PORTLAND	PORTSAUN	BELLISLE
3. Catch Data							
JANCATCH	X	X	X	X	X	X	X
FEBCATCH	X	X	X	X	X	X	X
MARCATCH	X	X	X	X	X	X	X
APRCATCH	X	X	X	X	X	X	X
MAYCATCH	X	X	X	X	X	X	X
JUNCATCH	X	X	X	X	X	X	X
JULCATCH	X	X	X	X	X	X	X
AUGCATCH	X	X	X	X	X	X	X
SEPCATCH	X	X	X	X	X	X	X
OCTCATCH	X	X	X	X	X	X	X
NOVCATCH	X	X	X	X	X	X	X
DECCATCH	X	X	X	X	X	X	X
TOTCATCH	X	X	X	X	X	X	X
4. Seabirds							
JANBIRD1	X	-	X	X	X	X	X
JANBIRD2	X	-	X	X	X	X	X
JANBIRD3	X	X	X	X	X	X	X
FEBBIRD1	-	-	-	X	-	-	-
FEBBIRD2	-	-	-	X	-	-	-
FEBBIRD3	X	X	X	X	X	X	X
MARBIRD1	-	X	-	X	-	-	-
MARBIRD2	-	X	-	X	-	-	-
MARBIRD3	X	X	X	X	X	X	X
APRBIRD1	X	X	-	-	-	-	-
APRBIRD2	X	X	-	X	-	-	-
APRBIRD3	X	X	X	X	X	X	X

X data available and file present in atlas
\- no data available

File Name	ANGUILLE	PAUXPORT	BAYISLND	GROSMORN	PORTLAND	PORTSAUN	BELLISLE
4. Seabirds (cont.)							
MAYBIRD1	X	X	-	X	X	X	X
MAYBIRD2	X	X	-	X	X	X	X
MAYBIRD3	X	X	X	X	X	X	X
JUNBIRD1	X	X	X	X	X	X	X
JUNBIRD2	X	X	X	X	X	X	X
JUNBIRD3	X	X	X	X	X	X	X
JULBIRD1	X	X	X	X	X	X	X
JULBIRD2	X	X	X	X	X	X	X
JULBIRD3	X	X	X	X	X	X	X
AUGBIRD1	X	X	X	X	X	X	X
AUGBIRD2	X	X	X	X	X	X	X
AUGBIRD3	X	X	X	X	X	X	X
SEPBIRD1	X	X	X	X	X	X	X
SEPBIRD2	X	X	X	X	X	X	X
SEPBIRD3	X	X	X	X	X	X	X
OCTBIRD1	X	X	X	X	X	X	X
OCTBIRD2	X	X	X	X	X	X	X
OCTBIRD3	X	X	X	X	X	X	X
NOVBIRD1	X	X	X	X	X	-	X
NOVBIRD2	X	X	X	X	X	-	X
NOVBIRD3	X	X	X	X	X	X	X
DECBIRD1	X	-	X	X	X	-	X
DECBIRD2	X	-	X	X	X	-	X
DECBIRD3	X	-	X	X	X	X	X
ANNBIRD1	X	X	X	X	X	X	-
ANNBIRD2	X	X	X	X	X	X	X
ANNBIRD3	X	X	X	X	X	X	X

X data available and file present in atlas
\- no data available

File Name	ANGUILLE	PAUXPORT	BAYISLND	GROSMORN	PORTLAND	PORTSAUN	BELLISLE
ANNCATCH	X	X	X	X	X	X	X
ARCHCODE	-	X	-	X	X	X	X
BACKSHOR	-	-	X	X	X	-	-
BARE	X	X	X	X	X	X	X
BASEMAP	X	X	X	X	X	X	X
BOULDER	X	X	X	X	X	X	X
CAPLIN	X	X	X	X	X	X	X
DEPOSITN	-	-	X	X	X	-	-
DEVELOP	X	X	X	X	X	X	X
EXPOSURE	X	X	X	X	X	X	X
FLOODLEV	-	X	X	X	X	-	-
FOREST	X	X	X	X	X	X	X
GEOCLASS	X	X	X	X	X	X	X
GEOCODE	X	X	X	X	X	X	X
GRASS	X	X	X	X	X	X	X
HERRING	X	X	X	X	X	X	X
HUMANU	X	X	X	X	X	X	X
ICE	-	-	X	X	X	-	-
INTERTID	-	-	X	X	X	-	-
ORI	X	X	X	X	X	X	X
REVEXP	X	X	X	X	X	X	X
SAND	-	X	-	-	-	-	-
SCRUB	X	X	X	X	X	X	X
SEABIRDS	X	X	X	X	X	X	X
SUBTIDAL	-	-	X	X	X	-	-

X data available and files present in atlas
\- no data available

1. Database files

ANNBIRD3
CURRENT
ICEEDGE
SUMCURR
TIDES
WINCURR
WINDWAVE
WXSTNSUM

2. Spans data points

5LC4022P
6LC4021P
6LC4022P
7LC4021P
7LC4022P
8LC4021P
8LC4022P
WHALES

3. Tabular data in text format

8400153
8400430
8400570
8401102
8401286
8401300
8401302
8401335
8401400
8401500
8401501
8401524
8401565
8401583
8401585
8401642
8402078
8402100
8402563
8402945
8402958
8402968
8402975
8403040

3. Tabular data in text format (cont.)

8403096
8403400
8403401
8403402
8403448
8403450
8403693
8403800
8403815
8403870
8404210
8404320
8700570
WAVEMTLY
WINDMTLY

1LC4021
1LC4022
2LC4021
2LC4022
3LC4021
3LC4022
4LC4021
4LC4022
5LC4021
5LC4022
6LC4021
6LC4022
7LC4021
7LC4022
8LC4021
8LC4022
9LC4022
COAST
ICEEDGE
SOUTHICE

Appendix 2

Composition Of All Pre-determined Maps

West Coast Newfoundland Oil Spill Sensitivity Atlas
Appendix 2
Composition of All Pre-Determined Maps

Map Name	Vector Files					Point Files				
ARCHCODE	ARCHCODE									
BACKSHOR	BACKSHOR									
BASEMAP										
BOULDER	BOULDER									
CAPELIN	CAPLIN									
COUNTER	DEVELOP					COUNTER	SPECIAL			
DEPOSITN	DEPOSITN									
EXPOSURE	EXPOSURE									
FISHERY	ANNCATCH					FISHPLAN	TOTCATCH	SALMON	AQUACULT	
FLOODLEV	FLOODLEV									
GEOCLASS	GEOCLASS									
GEOCODE	GEOCODE									
HERRING	HERRING									
HUMANUSE	HUMANU	DEVELOP	ARCHCODE			RECREAT	CENSUS	CABIN		
ICE	ICE									
INTERTID	INTERTID									
LANDUSE	FOREST	SCRUB	GRASS	BARE	DEVELOP					
LOGISTIC	DEVELOP					CABIN	BEACHACC	HARBOUR	OILSTORE	WASTEDIS
MAPLABEL						BATHNAM	COMMNAM	COASNAM	MARINAM	FWNAM
ORI	ORI									
REVEXP	REVEXP									
SEABIRDS	SEABIRDS					ANNBIRD1	ANNBIRD2			
SUBTIDAL	SUBTIDAL									

NB All maps include the vector file BASEMAP

Appendix 3

Colour Map Plates

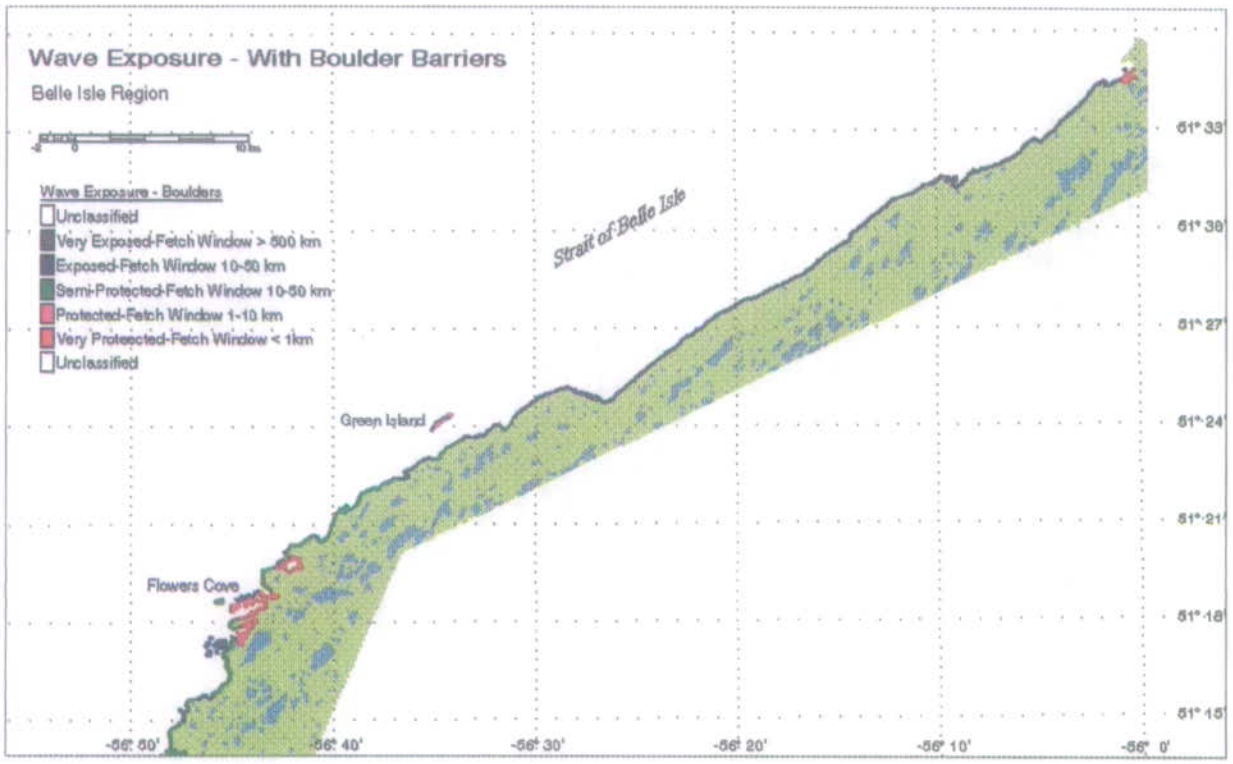

Plate 1.1. Strait of Belle Isle Northern Sub-Region. Wave Exposure With Nearshore Boulders.

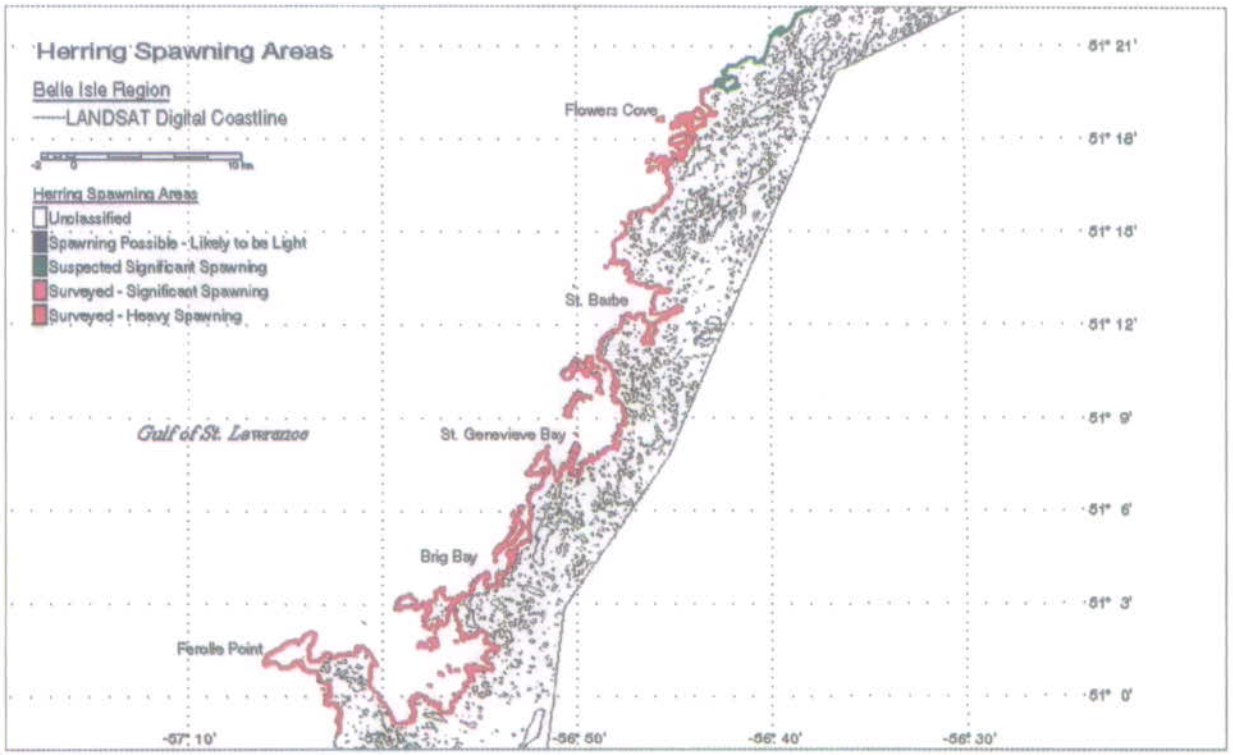

Plate 1.2 Strait of Belle Isle Southern Sub-Region. Herring Spawning Areas

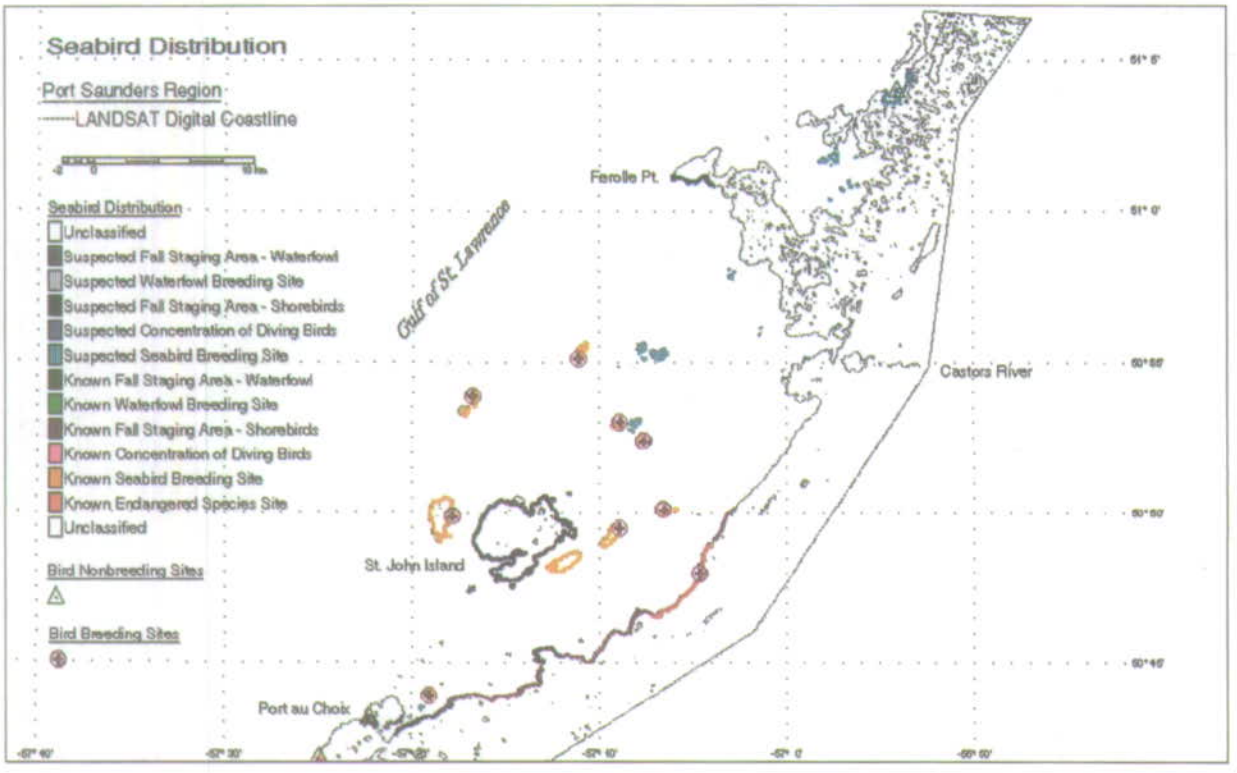

Plate 2.1. Port Saunders Northern Sub-region. Coastal Seabird Distribution.

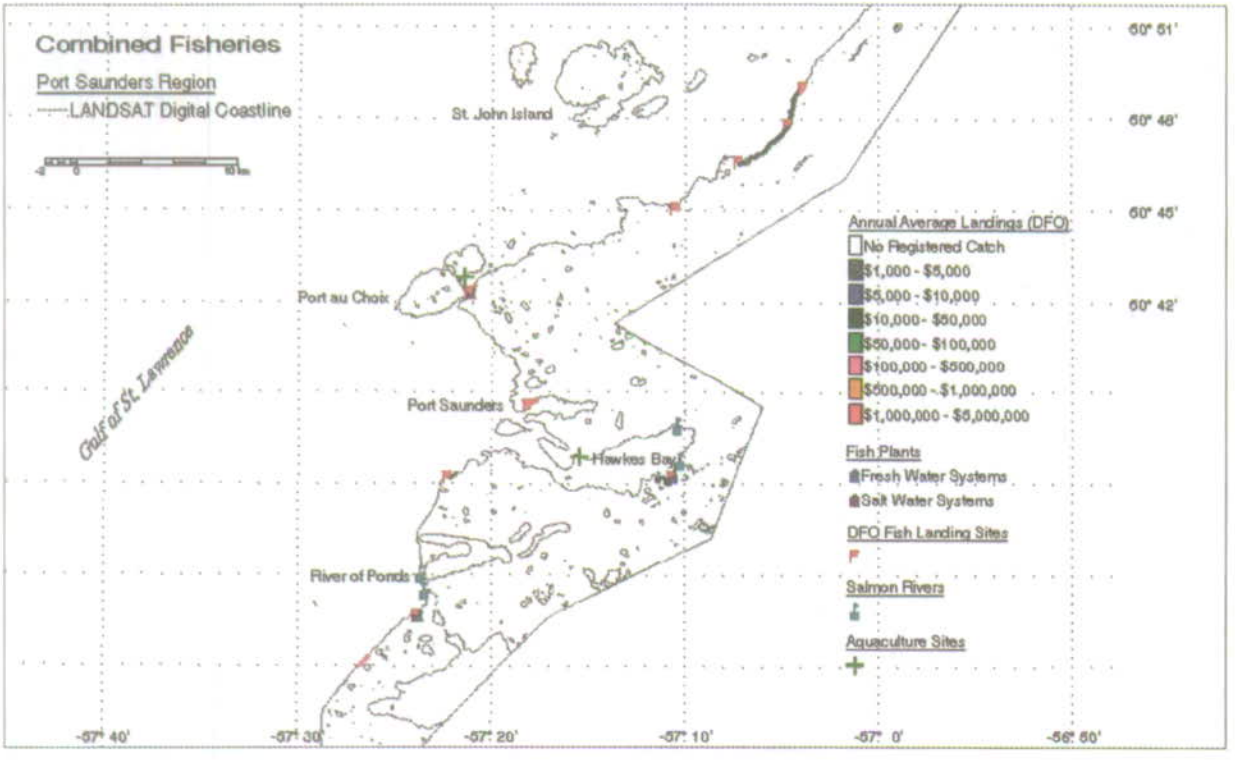

Plate 2.2. Port Saunders Southern Sub-Region. Combined Fisheries.

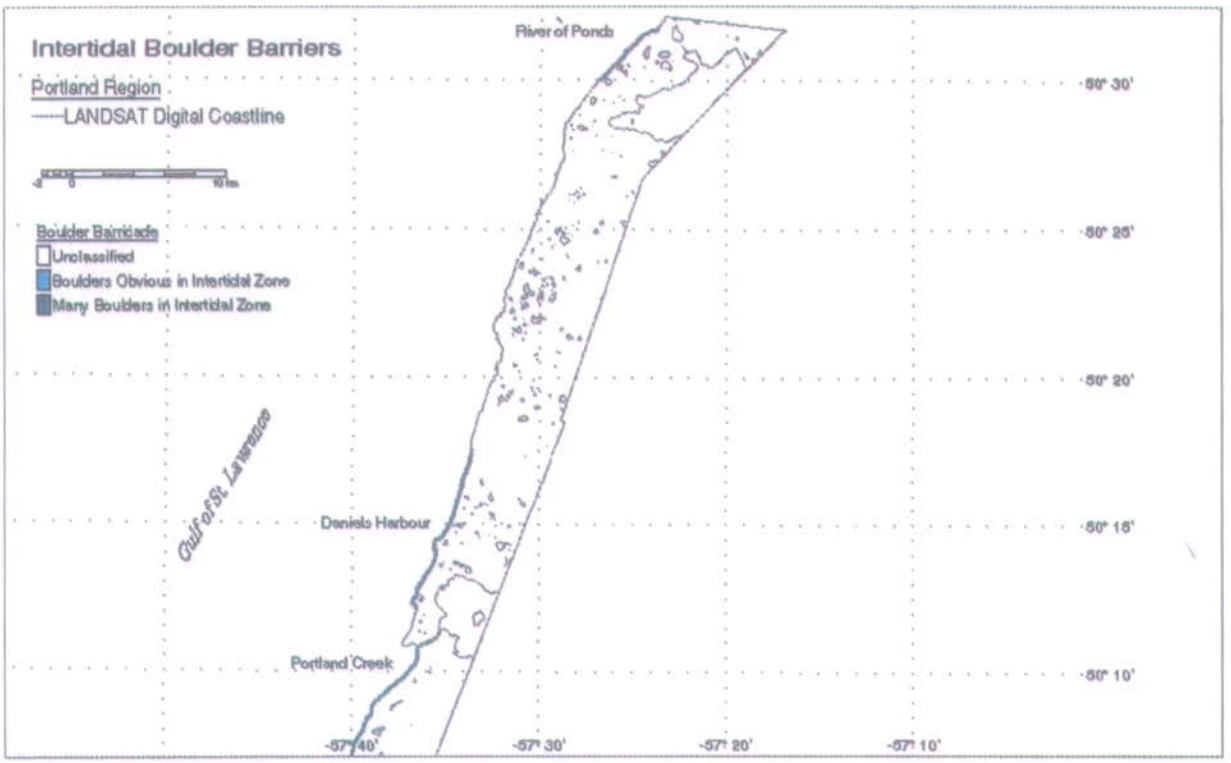

Plate 3.1. Portland Creek Northern Sub-Region. Nearshore Boulder Barriers.

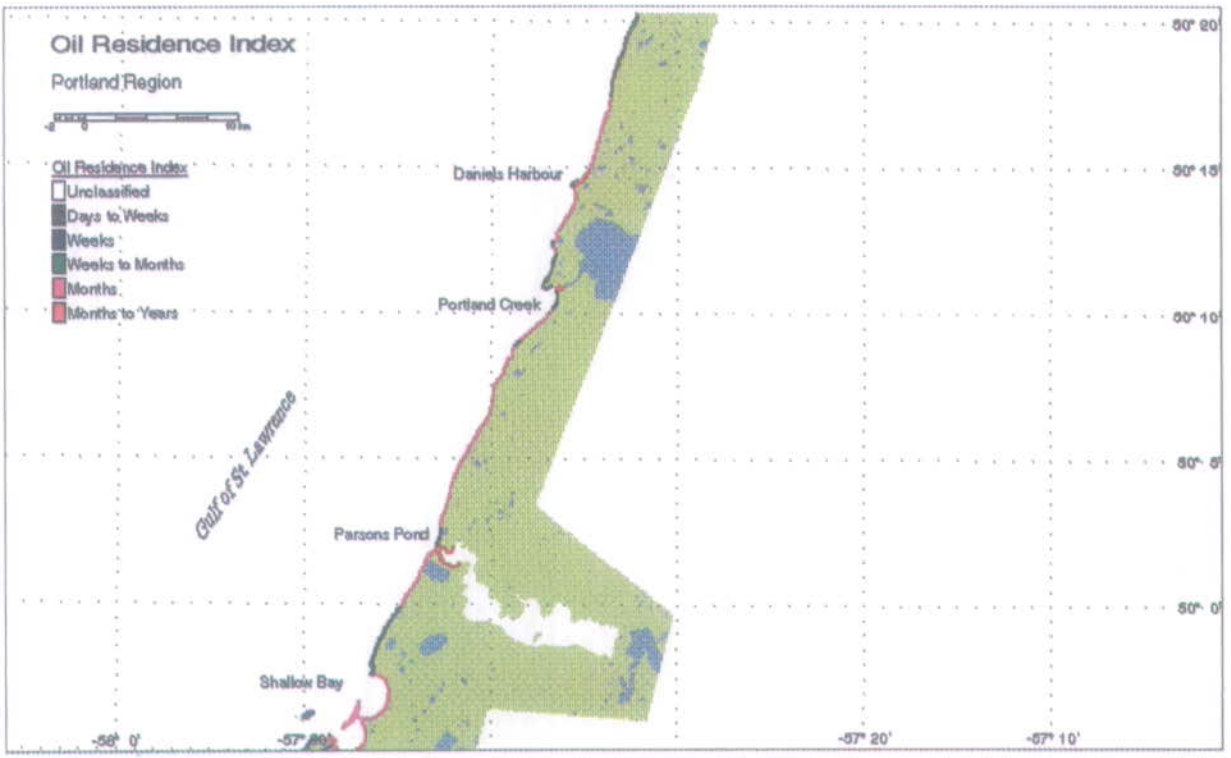

Plate 3.2 Portland Creek Southern Sub-Region. Oil Residence Index.

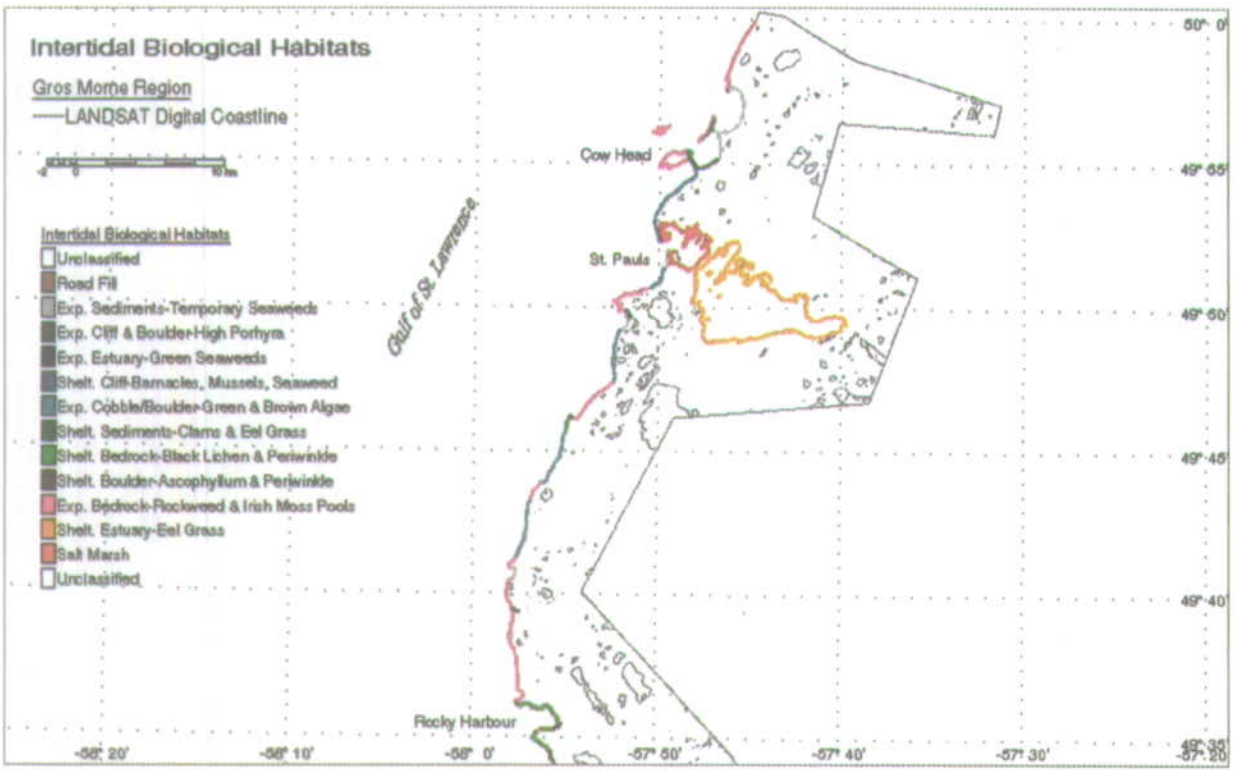

Plate 4.1. Gros Morne Northern Sub-Region. Intertidal Biological habitats.

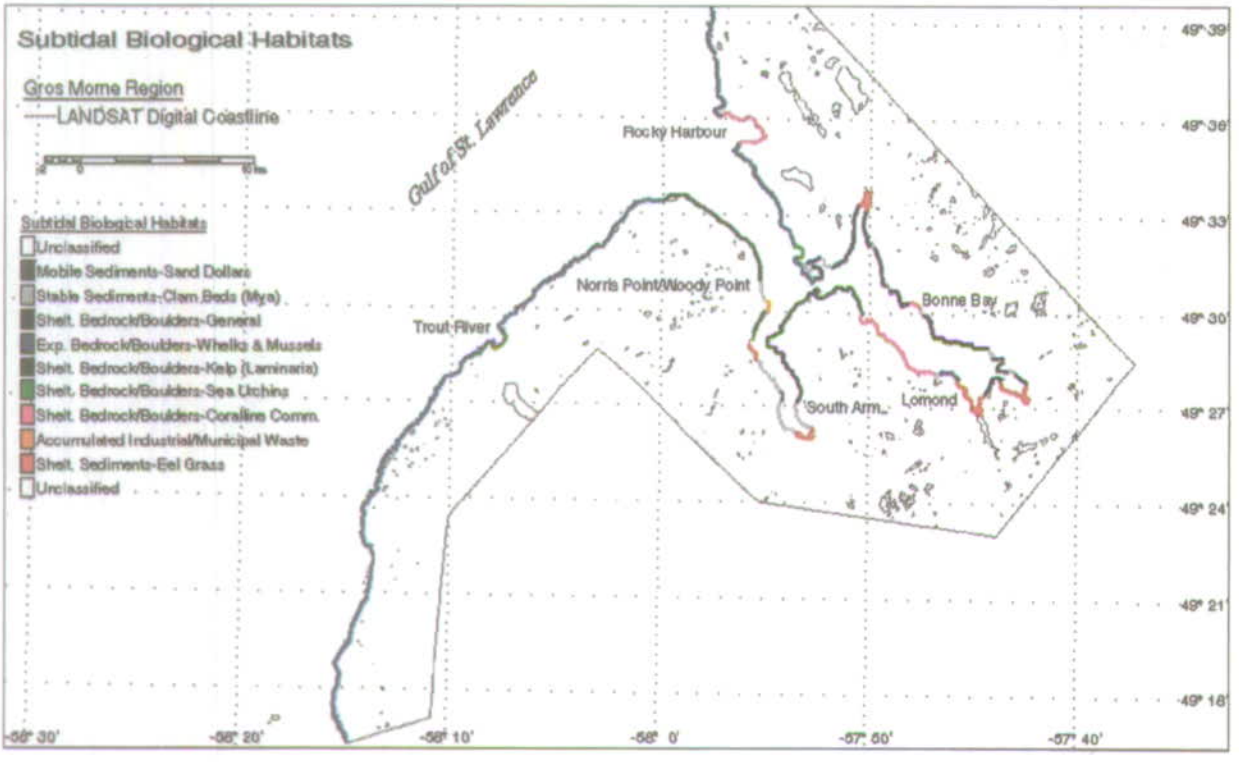

Plate 4.2. Gros Morne Southern Sub-Region. Subtidal Biological Habitats.

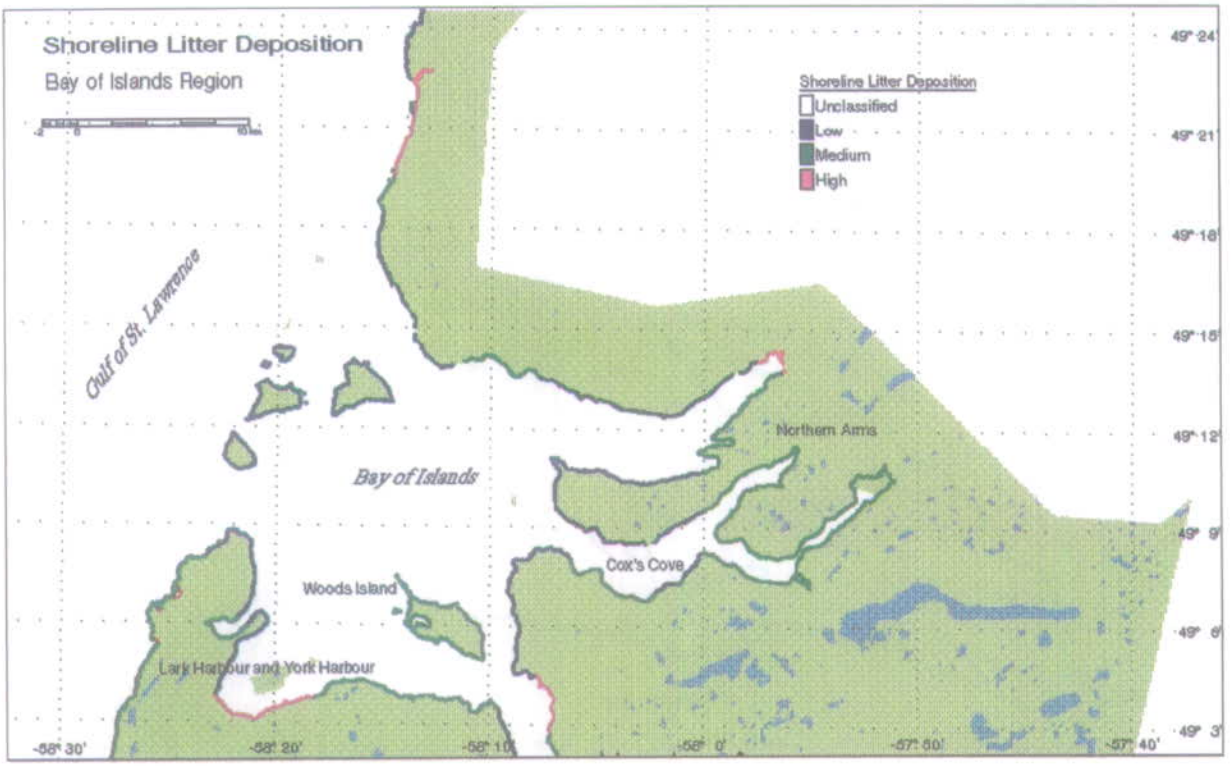

Plate 5.1. Bay of Islands Northern Sub-Region. Shoreline Litter Deposition.

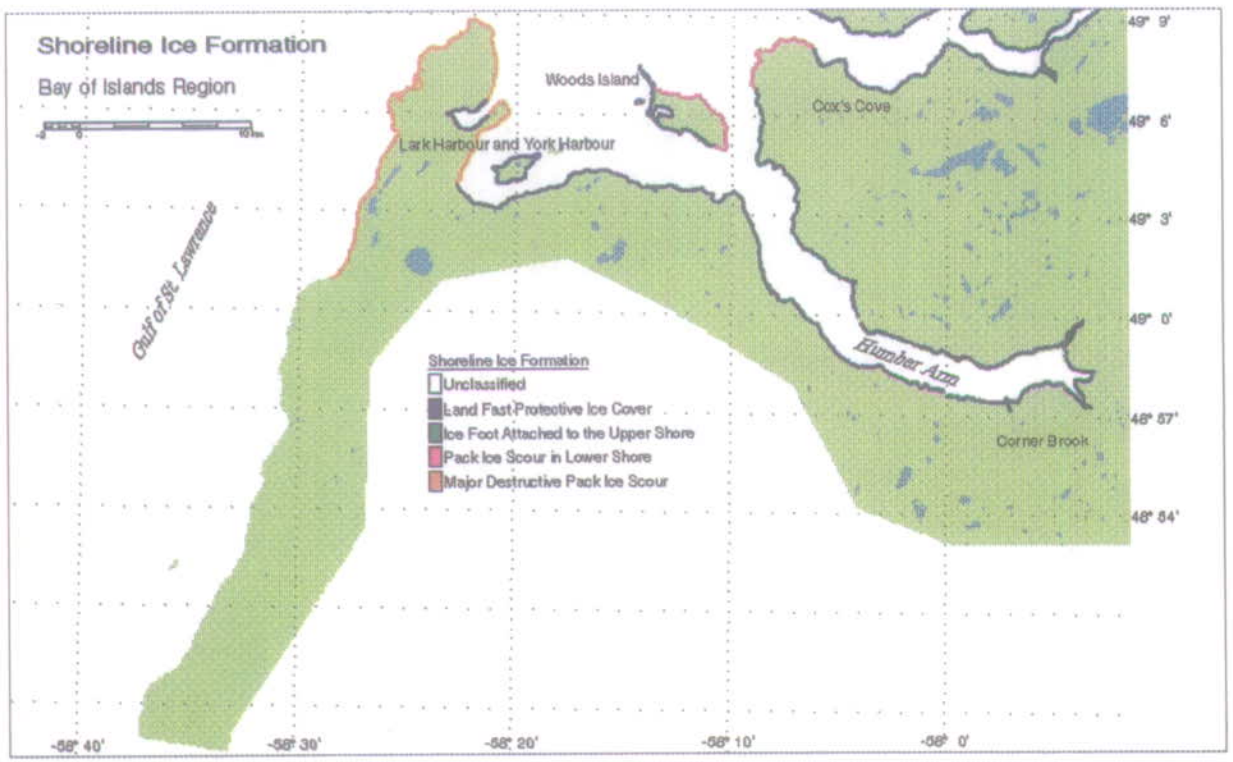

Plate 5.2. Bay of Islands Southern Sub-Region. Shoreline Ice Development.

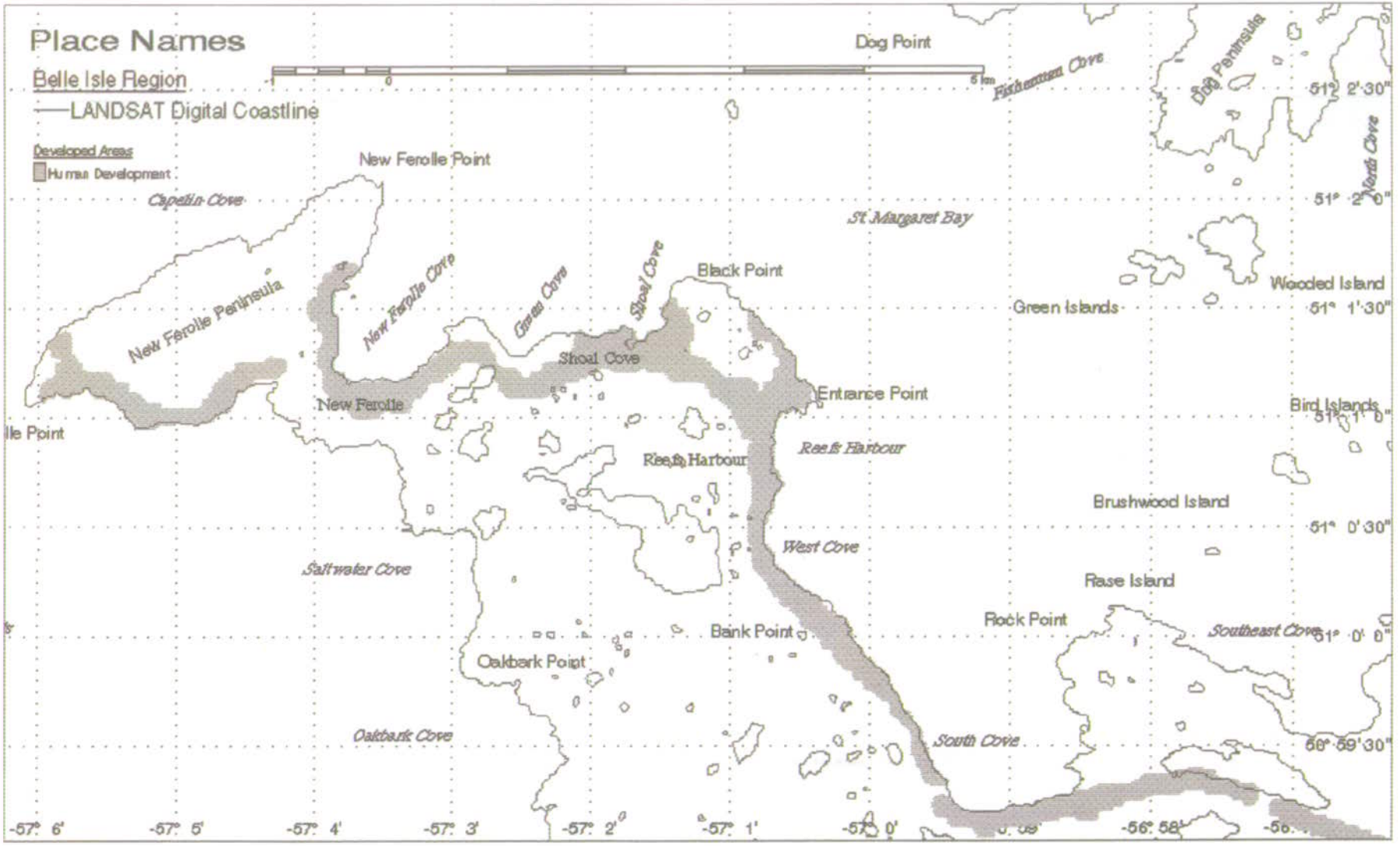

Plate 8. Strait of Belle Isle Region (Ferolle Point area). Map Labels.

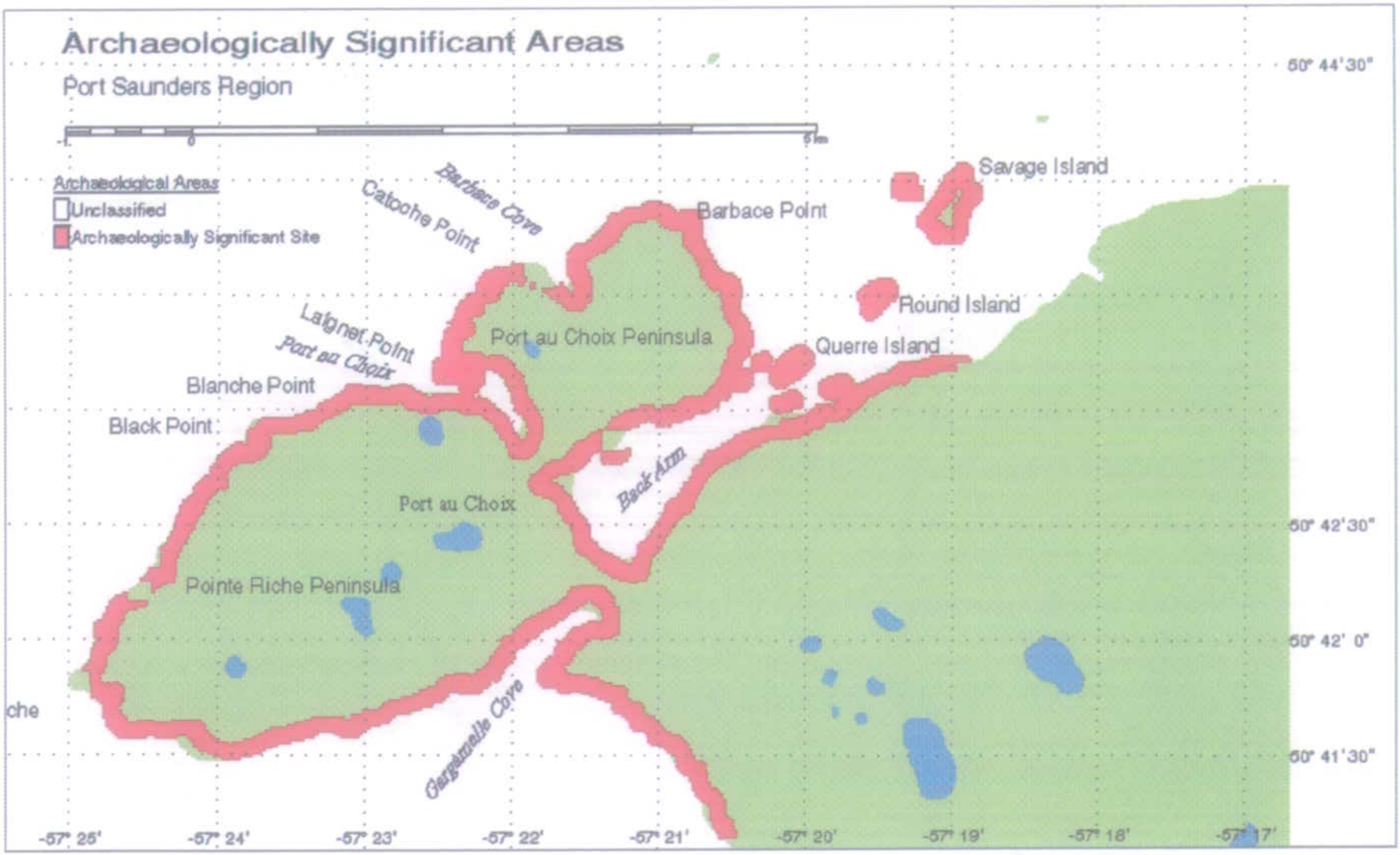

Plate 9. Port Saunders Region (Port aux Choix Area). Areas of Archaeological Interest.

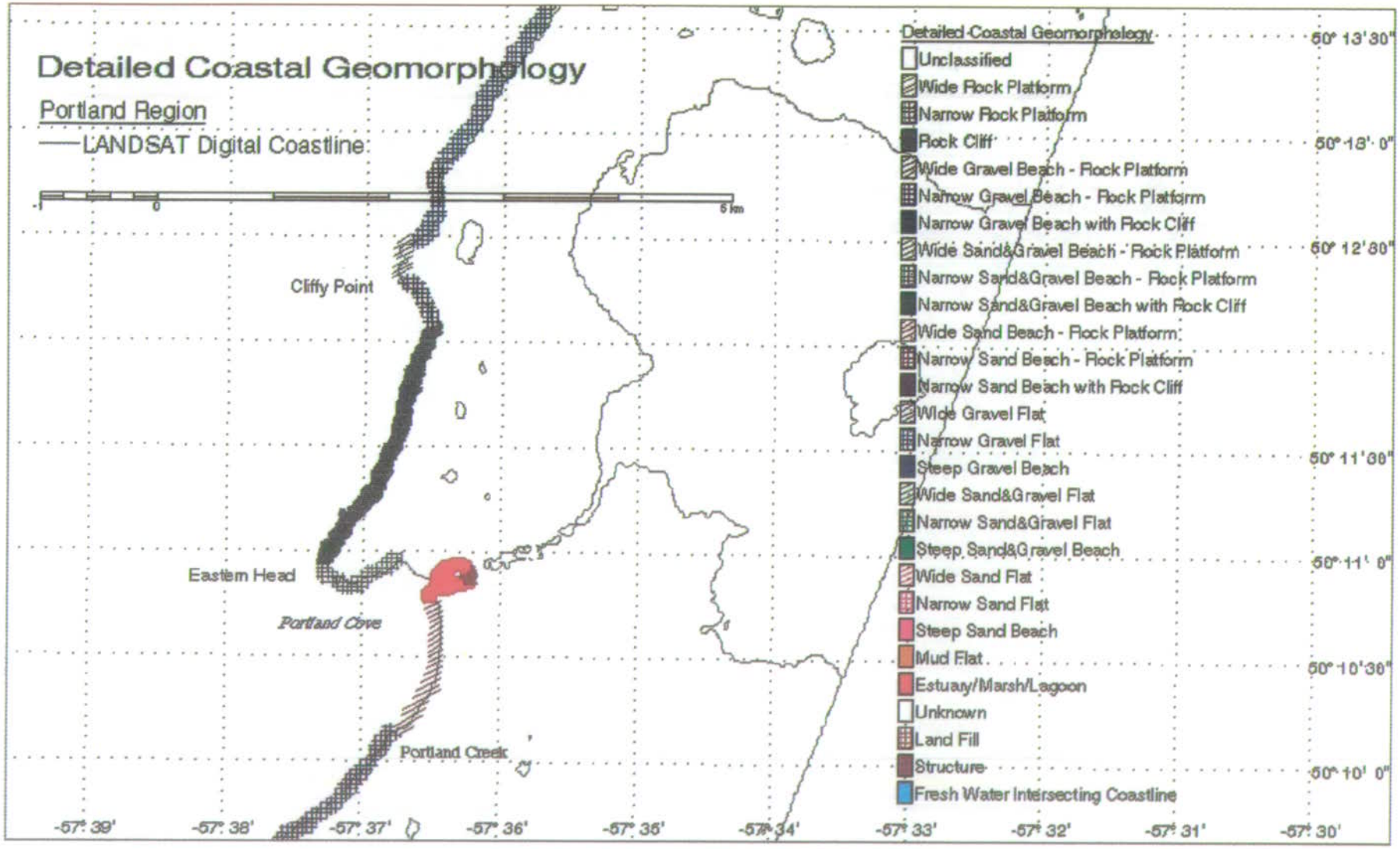

Plate 10. Portland Creek Region (Portland Creek Area). Detailed Coastal Geomorphology.

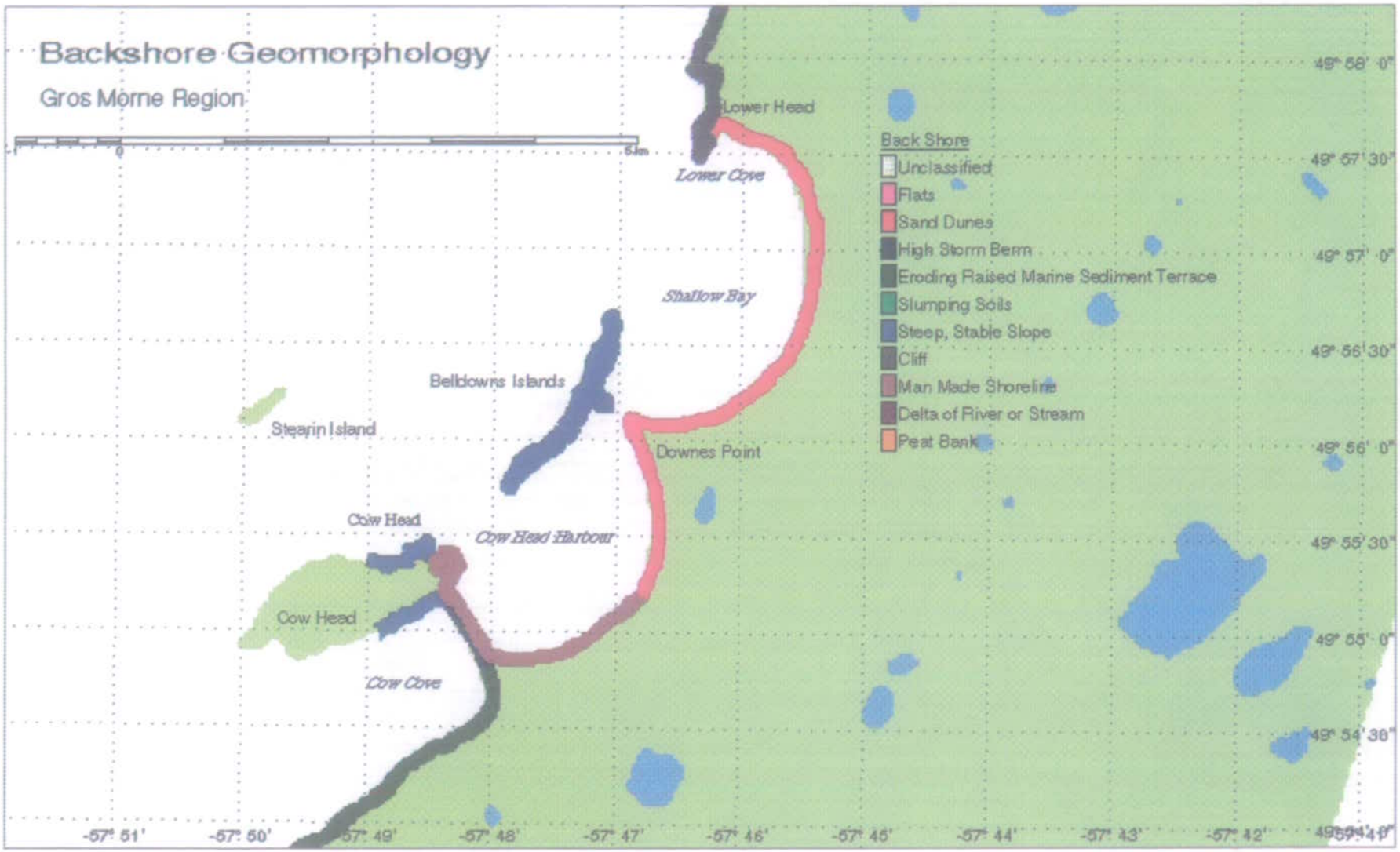

Plate 11. Gros Morne Region (Cow Head Area). Backshore Geomorphology.

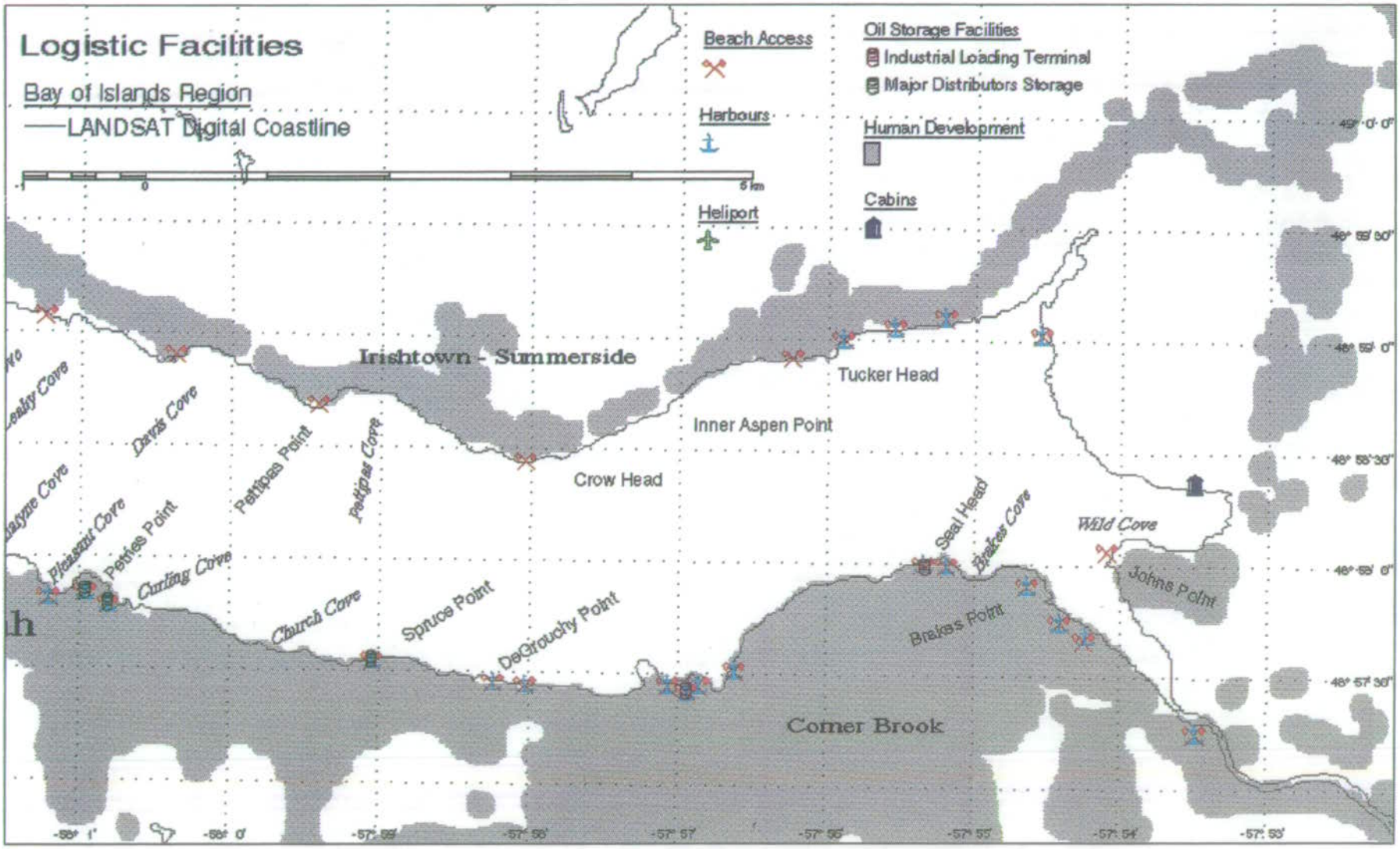

Plate 12. Bay of Islands Region (Corner Brook Area). Logistics Facilities.

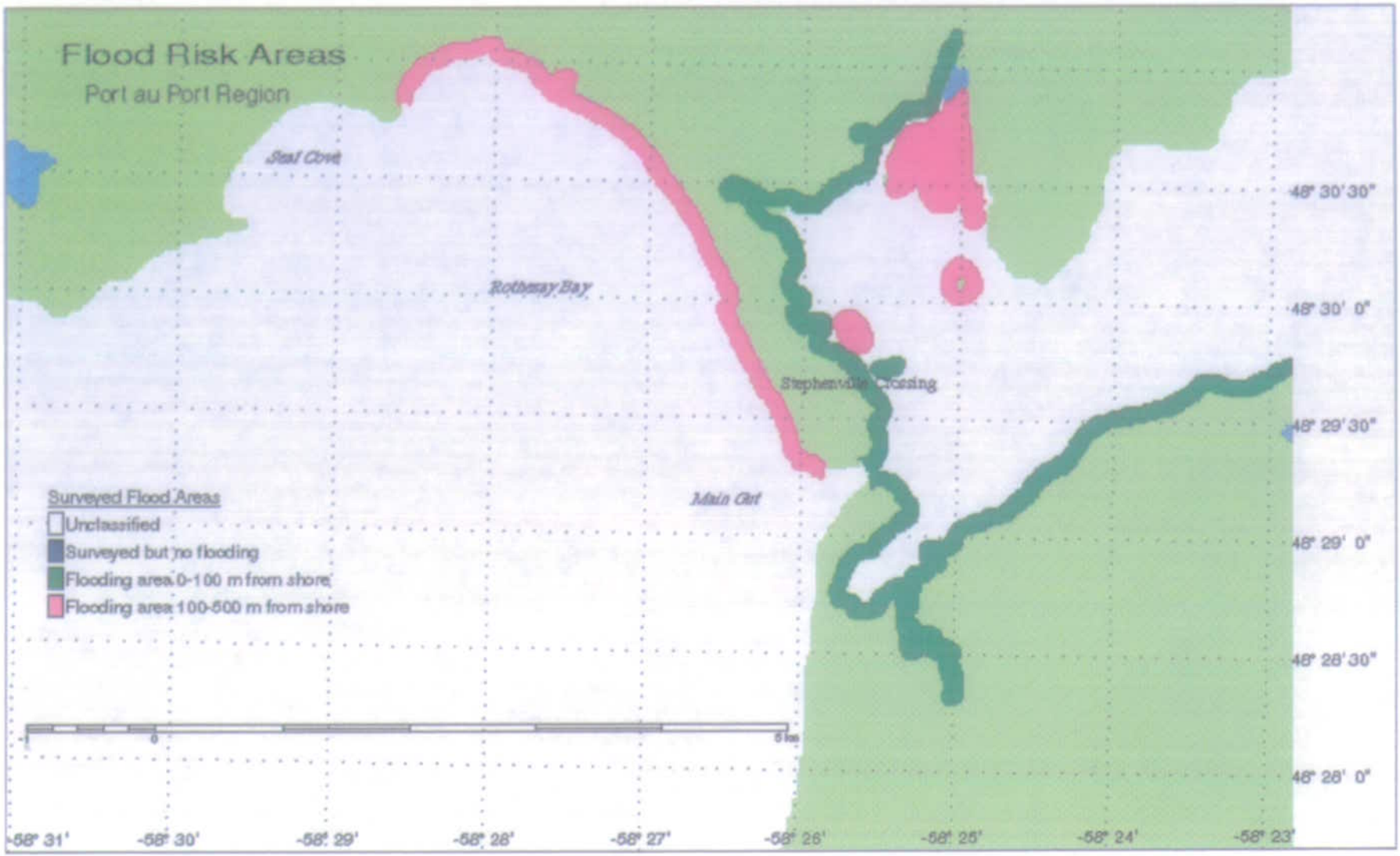

Plate 13. Port au Port Region. (Stephenville Crossing Area). Coastal Flood Zones.

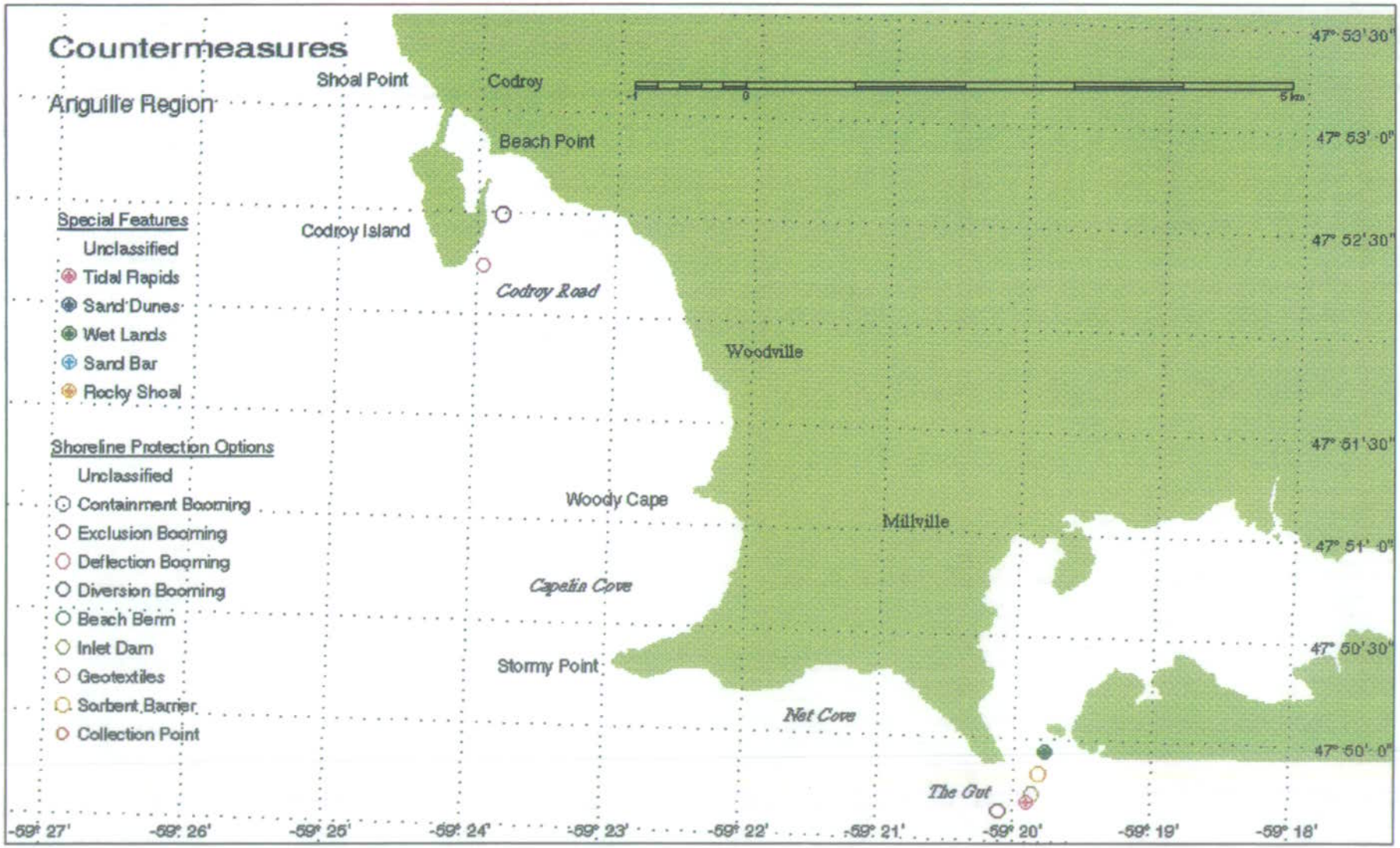

Plate 14. Anguille Region (Codroy Area). Countermeasures Options.

Appendix 4

Classification Scheme For All Segment-Based Coastal Data Files

Raw File Names: ANNCATCH.VEC, VEH
SPANS File Names: ANNCATCH.VTX, TOP, TBB
File Contents: Landed fish values

- The values attributed to each segment are annual averages combined for all species landed at registered DFO communities between 1984 and 1990.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION	
0	Annual Landings	$0 - $999
1	Annual Landings	$1,000 - $4,999
2	Annual Landings	$5,000 - $9,999
3	Annual Landings	$10,000 - $49,999
4	Annual Landings	$50,000 - $99,999
5	Annual Landings	$100,000 - $490,999
6	Annual Landings	$500,000 - $999,999
7	Annual Landings	$1,000,000 - $4,999,999

Raw File Names: ARCHCODE.VEC, VEH
SPANS File Names: ARCHCODE.VTX, TOP, TBB
File Contents: Archaeologically significant sites

- Areas identified by the Newfoundland museum as having significant archaeological value.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
1	Archaeologically significant site

Raw File Names: BACKSHOR.VEC, VEH
SPANS File Names: BACKSHOR.VTX, TOP, TBB
File Contents: Backshore Geomorphology

- General description of the GROSMORN backshore as documented during the 1992 Gros Morne Park intertidal biology survey.
- The area covered was extended to include BAYISLND because of the similarities to GROSMORN and the familiarity of the study team with the Bay of Islands area.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Flats
2	Sand dunes
3	High storm berm
4	Eroding raised marine sediment terrace
5	Slumping soils
6	Steep, stable slope
7	Cliff
8	Manmade shoreline
9	Delta of river or stream
10	Canyon of river or stream
11	Peat bank

Raw File Names: BOULDER.VEC, VEH
SPANS File Names: BOULDER.VTX, TOP, TBB
File Contents: Nearshore or intertidal boulder barriers

- Boulder fields identified in AGC aerial video, on NTS 1:50,000 maps, and from direct observation by members of the study team.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Level 1 - Some boulders obvious in intertidal zone
2	Level 2 - Many boulders in intertidal zone

Raw File Names: CAPLIN.VEC, VEH
SPANS File Names: CAPLIN.VTX, TOP, TBB
File Contents: Intertidal capelin spawning habitats

- In the absence of direct capelin spawning survey information, the coastline was classified in terms of spawning habitat preference based on the detailed coastal geomorphology layer.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Least preferred spawning substrate
2	
3	
4	
5	Most preferred spawning substrate

Raw File Names: DEPOSITN.VEC, VEH
SPANS File Names: DEPOSITN.VTX, TOP, TBB
File Contents: Distribution of floating garbage on beaches

- General description of the distribution of marine litter accumulated on the beach in GROSMORN as documented during the 1992 Gros Morne Park intertidal biology survey.
- The area covered was extended to include BAYISLND because of the similarities to GROSMORN and the familiarity of the study team with the Bay of Islands area.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	High
2	Medium
3	Low

Raw File Names: EXPOSURE.VEC, VEH
SPANS File Names: EXPOSURE.VTX, TOP, TBB
File Contents: Wave exposure as determined by fetch

- An index of wave exposure based on the fetch calculated for the area's prevailing SW winds.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Very exposed - fetch window >500 km
2	Semi-exposed - fetch window 50 - 500 km
3	Semi-protected - fetch window 10-50 km
4	Protected - fetch window 1-10 km
5	Very protected - fetch window <1 km

Raw File Names: FLOODLEV.VEC, VEH
SPANS File Names: FLOODLEV.VTX, TOP, TBB
File Contents: Flood risk in coastal areas as documented by the Canada-Newfoundland Flood Damage Reduction Program

- An indication of likely marine flooding due to storm surge.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Surveyed but no flooding
2	Flooding area 0-100 m from shore
3	Flooding area 100-500 m from shore
4	Flooding area >500 m from shore

Raw File Names: GEOCODE.VEC, VEH
SPANS File Names: GEOCODE.VTX, TOP, TBB
File Contents: Detailed Coastal Geomorphology

- Entire study area coastline classified into segments of homogeneous beach structure
- Data obtained from Atlantic Geoscience Centre videos and worksheets as well as from personnel experience of atlas study team.
- Data transcribed to 1:50,000 map sheets and digitized in SPANS format
- The shoreline segments described during by this classification have become the standard units for all natural coastline classification.

CLASS	DESCRIPTION
0	Unclassified
1	Wide rock platform
2	Narrow rock platform
3	Rock Cliff
4	Wide gravel beach on rock platform
5	Narrow gravel beach on rock platform
6	Narrow gravel beach with rock cliff
7	Wide sand and gravel beach on rock platform
8	Narrow sand and gravel beach on rock platform
9	Narrow sand and gravel beach with rock cliff
10	Wide sand beach on rock platform
11	Narrow sand beach on rock platform
12	Narrow sand beach with rock cliff
13	Wide gravel flat
14	Narrow gravel flat
15	Steep gravel beach
16	Wide sand and gravel flat
17	Narrow sand and gravel flat
18	Steep sand and gravel beach
19	Wide sand flat
20	Narrow sand flat
21	Steep sand beach
22	Mud flat
23	Estuary/marsh/lagoon
24	Unknown
25	Land fill
26	Structure
27	Fresh water intersecting shoreline

Raw File Names: GEOCLASS.VEC, VEH
SPANS File Names: GEOCLASS.VTX, TOP, TBB
File Contents: Simplified Coastal Geomorphology

- Revised version of detailed geomorphology, simplified through the removal of width considerations.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Rock platform or cliff
2	Gravel beach on rock platform
3	Sand and gravel beach on rock platform
4	Sand beach on rock platform
5	Gravel beach or flat
6	Sand and gravel beach or flat
7	Sand beach or flat
8	Mud flat
9	Estuary/marsh/lagoon
10	Unknown
11	Manmade
12	Fresh water

Raw File Names: HERRING.VEC, VEH
SPANS File Names: HERRING.VTX, TOP, TBB
File Contents: Nearshore herring spawning habitats

- Known shallow subtidal herring spawning areas based on a 1987 DFO survey of the west coast of Newfoundland.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Spawning possible - likely to be light
2	Suspected significant spawning
3	Surveyed - significant spawning
4	Surveyed - heavy spawning

Raw File Names: HUMUSE.VEC, VEH
SPANS File Names: HUMUSE.VTX, TOP, TBB
File Contents: Registered land use areas

- Shoreline boundaries of registered areas.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Icorporated Municipality
2	National Park
3	Provincial Park
4	Municipal Park
5	Ecological Reserve
6	Agricultural Reserve
7	Wildlife Reserve

Raw File Names: ICE.VEC, VEH
SPANS File Names: ICE.VTX, TOP, TBB
File Contents: Shoreline ice development

- General description of development of landfast and sea ice in GROSMORN as documented during the 1992 Gros Morne Park intertidal biology survey.
- The area covered was extended to include BAYISLND because of the similarities to GROSMORN and the familiarity of the study team with the Bay of Islands area.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Land fast protective ice cover
2	Ice foot attached to the upper shore
3	Pack ice scour in lower shore
4	Major destructive pack ice scour

Raw File Names: INTERTID.VEC, VEH
SPANS File Names: INTERTID.VTX, TOP, TBB
File Contents: Description of intertidal biological habitats

- General description of the intertidal biology in GROSMORN as documented during the 1992 Gros Morne Park intertidal biology survey.
- The area covered was extended to include BAYISLND because of the similarities to GROSMORN and the familiarity of the study team with the Bay of Islands area.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION	
	Substrate	Biological Community
0	Unclassified	
1	Road Fill	
2	Exposed sediments	Temporary seaweeds
3	Exposed cliff and boulder	High *Porhyra* and spray zone
4	Exposed estuary	Green seaweeds
5	Sheltered cliff	Barnacles, mussels, Seaweed zonation
6	Exposed cobble/boulder	Green and Brown algae
7	Sheltered sediments	Softshell clams and eel grass
8	Sheltered bedrock	Black lichen and periwinkle
9	Sheltered cobble/boulder	*Ascophyllum* and Red Periwinkle
10	Exposed bedrock platform	Rockweed and Irish Moss pools
11	Sheltered estuary	Eel grass
12	Salt marsh	Hybrid subarctic saltmarsh
13	Unclassified	

Raw File Names: ORI.VEC, VEH
SPANS File Names: ORI.VTX, TOP, TBB
File Contents: Oil Residence Index determined from revised wave exposure and detailed coastal geomorphology

- An indication of the likely residence time of spilled oil on any shoreline segment.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Days to weeks
2	Weeks
3	Weeks to months
4	Months
5	Months to years

Raw File Names: REVEXP.VEC, VEH
SPANS File Names: REVEXP.VTX, TOP, TBB
File Contents: Wave exposure as determined by fetch and modified by sheltering boulder barricades

- An index of wave exposure based on the fetch calculated for the area's prevailing SW winds and modified by the presence of nearshore boulder barricades.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Very exposed - fetch window >500 km
2	Semi-exposed - fetch window 50 - 500 km
3	Semi-protected - fetch window 10-50 km
4	Protected - fetch window 1-10 km
5	Very protected - fetch window <1 km

Raw File Names: SEABIRDS.VEC, VEH
SPANS File Names: SEABIRDS.VTX, TOP, TBB
File Contents: Significant coastal seabird sites

- Compiled from Memorial University Newfoundland seabird species distribution and breeding site data bases.
- Other likely seabird habitats are indicated as possible seabird sites in the absence of complete survey coverage.
- This is a summary for all seasons combined.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION
0	Unclassified
1	Suspected fall staging area for waterfowl
2	Suspected waterfowl breeding site
3	Suspected fall staging area for shorebirds
4	Suspected concentration of diving birds
5	Suspected seabird breeding site
6	Known fall staging area for waterfowl
7	Known waterfowl breeding site
8	Known fall staging area for shorebirds
9	Known concentration of diving birds
10	Known seabird breeding site
11	Known endangered species site

Raw File Names: SUBTIDAL.VEC, VEH
SPANS File Names: SUBTIDAL.VTX, TOP, TBB
File Contents: Description of subtidal biological habitats

- General description of the subtidal biology in GROSMORN as documented during the 1992 Gros Morne Park intertidal biology survey.
- The area covered was extended to include BAYISLND because of the similarities to GROSMORN and the familiarity of the study team with the Bay of Islands area.
- The standard shore segments in which each community falls are classified using the criteria listed below.

CLASS	DESCRIPTION	
	Substrate	Biological Community
0	Unclassified	
1	Mobile sediments	Sand dollars
2	Stable sediments	Clam beds (*Mya*)
3	Sheltered bedrock and boulders	General - cordweed and cunner
4	Exposed bedrock and boulders	Whelks and horse mussels
5	Sheltered bedrock and boulders	Kelp beds (*Laminaria*)
6	Sheltered bedrock and boulders	Sea urchin beds
7	Sheltered bedrock and boulders	Rhodolith and coralline communities
8	Accumulated industrial or municipal waste	
9	Sheltered sediments	Eel grass meadows

Raw File Names: BARE.VEC, VEH
DEVELOP.VEC, VEH
FOREST.VEC, VEH
GRASS.VEC, VEH
SCRUB.VEC, VEH

SPANS File Names: BARE.VTX, TOP, TBB
DEVELOP.VTX, TOP, TBB
FOREST.VTX, TOP, TBB
GRASS.VTX, TOP, TBB
SCRUB.VTX, TOP, TBB

File Contents: Land use in the coastal corridor as determined from LANDSAT imagery.

- Using the AGC aerial video and personal observations for groundtruthing, the LANDSAT imagery was classified for general landuse categories. Each category is presented as an individual data layer.
- As groundtruthing throughout the area was limited, the categories presented are composites of similar feature types.
- Each data layer file consists of many polygons all having similar land use characteristics.
- The classified data have been cropped for the narrow coastal corridors defined by the basemaps.

FILE	DESCRIPTION
BARE	Bare surfaces including exposed bedrock, gravel, and sand
DEVELOP	A composite of all features which characterize human development (asphalt, concrete, buildings, cut grass)
FOREST	A composite of coniferous and deciduous forests
GRASS	Open areas having low vegetation which is predominantly grass.
SCRUB	Open areas having low vegetation which is some mixture of bog or bushes.

Appendix 5

Classification Scheme For All Point-Based Coastal Data Files

Raw File Name: \AIRPORT.DBF
SPANS File Name: \AIRPORT.TBB
File Contents: Locations and descriptions of all aircraft landing facilities in the region.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
CODE	10	0	Classification of data point by type of landing facility (see CODEREF field)
CODEREF	10		Description of coded class type in previous field 1 = Asphalt (concrete) 2 = Gravel 3 = Water (float plane facility) 4 = Heliport
ORIENT	10		Runway orientation in degrees True
SIZEFT	20		Runway length in feet
CONTROL	20		Transport Canada air traffic control centre responsible for the air field
LIGHTS	10		Presence of lights on the runway 0 = none 1 = lights present
FUEL	10		Availability of aircraft fuel at the facility 0 = no fuel available 1 = fuel available
NAVAID	10		Presence of navigational aids serving the facility 0 = no navigational aids 1 = navigational aids present
REMARKS	25		Comments on the operation of the facility
DATE	10	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \AQUACULT.DBF
SPANS File Name: \AQUACULT.TBB
File Contents: Locations of registered aquaculture sites and saltwater lobster pounds.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
CODE	5	0	Classification of data point by type
CODEREF	10		Description of coded class type in previous field 1 = Mussels 2 = Scallops 3 = Lobsters
LEASINFO	35		Brief details of the aquaculture site lease
DATE	10	0	Year in which data point attributes were current
SOURCE	35		Brief reference to the source of the data point attributes
CONTACT	25		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \BEACHACC.DBF
SPANS File Name: \BEACHACC.TBB
File Contents: Points where a pick-up truck can be brought to the water's edge from a roadway.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMCODE	10		DFO fish landing site community code (where applicable)
CODE	5	0	Classification of data point by type
CODEREF	25		Description of coded class type in previous field 1 = Rough road 2 = Fish Plant 3 = Fish Plant and DFO H&I facility 4 = DFO H&I facility 5 = Boat yard/Marine Centre 6 = Boat Launch 7 = Private wharf
DATE	10	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \BOATYARD.DBF
SPANS File Name: \BOATYARD.TBB
File Contents: Locations of facilities where small boats can be hauled out or repaired.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
CODE	5	0	Classification of data point by type
CODEREF	15		Description of coded class type in previous field 1 = Marine Centre 2 = Private yard 3 = Yacht club
DATE	10	0	Year in which data point attributes were current
SOURCE	25		Brief reference to the source of the data point attributes
CONTACT	30		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \CABIN.DBF
SPANS File Name: \CABIN.TBB
File Contents: Locations of isolated cabins with access to the shoreline.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMCODE	10		DFO fish landing site community code (where applicable)
DATE	10	0	Year in which data point attributes were current
SOURCE	30		Brief reference to the source of the data point attributes
CONTACT	10		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	10		Telephone number that can be used in contacting the data agency

Raw File Name: \CENSUS.DBF
SPANS File Name: \CENSUS.TBB
File Contents: Populations of incorporated municipalities according to 1991 Canada Census.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	40		Name of the community nearest the data point
POPULAT	10	0	Population from 1991 Canada Census
CODE	5	0	Classification of data point by type
CODEREF	10		Description of coded class type in previous field 1 = 0 - 99 2 = 100 - 499 3 = 500 - 999 4 = 1,000 - 1,999 5 = 2,000 - 4,999 6 = 5,000 - 9,999 7 = 10,000 - 19,999 8 = 20,000+
DATE	10	0	Year in which data point attributes were current
SOURCE	25		Brief reference to the source of the data point attributes
CONTACT	50		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \COUNTER.DBF
SPANS File Name: \COUNTER.TBB
File Contents: Areas where specific countermeasures techniques might be considered.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	4	Decimal Latitude of the data point
LONG	10	4	Decimal Longitude of the data point
	10	0	Arbitrary - indication that the location of the selected point is general
LOCATION	25		Name of the geographic feature nearest the data point
CODE	10	0	Classification of data point by type
SHOREPRO	20		Description of coded countermeasure technique type in previous field 1 = Containment Booming 2 = Exclusion Booming 3 = Deflection Booming 4 = Diversion Booming 5 = Beach Berm 6 = Inlet Dam 7 = Geotextiles (plastic sheeting) 8 = Sorbent Barrier 9 = Oil Collection Point
SOURCE	45		Brief reference to the source of the data point attributes
DATE	5		Date that data were incorporated into atlas

Raw File Name: \FISHPLAN.DBF
SPANS File Name: \FISHPLAN.TBB
File Contents: Locations of all fish plants licensed by the Newfoundland provincial Department of Fisheries.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
COMMCODE	10		DFO fish landing site community code (where applicable)
COMPCODE	10		DOF fish plant licensing code
COMPNAME	40		Name of company operating the fish plant
COMPREF	45		Name of a contact at the fish plant
COMPTEL	15		Telephone number for the fish plant contact
CODE	5	0	Classification of data point by type
CODEREF	20		Description of coded class type in previous field 1 = Freshwater system 2 = Saltwater system
DATE	10	0	Year in which data point attributes were current
SOURCE	25		Brief reference to the source of the data point attributes
CONTACT	30		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \HARBOUR.DBF
SPANS File Name: \HARBOUR.TBB
File Contents: Location of all Transport Canada, DFO, and private harbour facilities.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
COMMCODE	10		DFO fish landing site community code (where applicable)
HICODE	10		DFO Harbours & Infrastructure Branch facility code (where applicable)
WHARF	10	0	Wharf facilities 1 = Wharf present 0 = No wharf
BREAKWAT	10	0	Breakwater protecting harbour 1 = Breakwater 0 = No breakwater
LAUNCH	10	0	Small boat launch ramp 1 = Launch ramp 0 = No launch ramp
SLIPWAY	10	0	Slipway or haul out ramp 1 = Slipway 0 = No slipway
WINCH	10	0	Winch for hauling vessels 1 = Winch 0 = No winch
HOIST	10	0	Hoist for lifting vessels 1 = Hoist 0 = No hoist
LIGHTS	10	0	Lights on wharves 1 = Lights 0 = No lights
NAVLIGHT	10	0	Transport Canada navigation lights 1 = Lights 0 = No lights
FUEL	10	0	Refuelling facilities 1 = Fuel 0 = No fuel

Field Name	Field Width	Decimals (numeric)	Field Description
POWER110	10	0	110 VAC power available 1 = 110 VAC power 0 = No power
POWER220	10	0	220 VAC power available 1 = 220 VAC power 0 = No power
DATE	10	0	Year in which data point attributes were current
SOURCE	10		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \INDUST.DBF
SPANS File Name: \INDUST.TBB
File Contents: Locations of coastal industrial sites.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
CODE	5	0	Classification of data point by type
CODEREF	35		Description of coded class type in previous field 1 = Coastal industry 2 = Marine loading terminal 3 = Pulp mill 4 = Ferry wharf
INDUSTRY	35		Name of industry
DATE	9	0	Year in which data point attributes were current
SOURCE	35		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \OILSTORE.DBF
SPANS File Name: \OILSTORE.TBB
File Contents: Location of all shoreline oil loading and oil storage facilities.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
COMPANY	30		Name of facility operator
CODE	5	0	Classification of data point by type
CODEREF	30		Description of coded class type in previous field 1 = Industrial oil off loading facility 2 = Oil distributor bulk oil storage
DATE	10	0	Year in which data point attributes were current
SOURCE	30		Brief reference to the source of the data point attributes
CONTACT	25		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \RECREAT.DBF
SPANS File Name: \RECREAT.DBF
File Contents: Locations of established recreation facilities.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
CODE	5	0	Classification of data point by type
CODEREF	15		Description of coded class type in previous field 1 = Outfitter 2 = View point 3 = Picnic site 4 = Hiking trail 5 = Campground 6 = Golf Course
DESCRIPTION	45		Name and type of facility
DATE	9	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	45		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \SALMON.DBF
SPANS File Name: \SALMON.TBB
File Contents: Locations of the mouths of all registered salmon rivers.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
DFOCODE	10		DFO identification code for registered rivers
RIVERNAM	25		Name of the registered river
DATE	10	0	Year in which data point attributes were current
SOURCE	25		Brief reference to the source of the data point attributes
CONTACT	20		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \SEABIRD.DBF
SPANS File Name: \SEABIRD.TBB
File Contents: Location of all seabird observation points.

Field Name	Field Width	Decimal	Field Description
LAT	10	4	Decimal Latitude of the data point
LONG	10	4	Decimal Longitude of the data point
CODE	5	0	Classification of data point by behaviourial group of birds (see SPECIES field) 1 = Raptor 2 = Gulls & terns 3 = Waterfowl 4 = Shorebirds 5 = Diving birds
SPECIES	25		Common Name for species observed
RANK	5	0	Sensitivity Rank of species 6 = Known fall staging area for waterfowl 7 = Known waterfowl breeding site 8 = Known fall staging area for shorebirds 9 = Known concentration of diving birds 10 = Known seabird breeding site 11 = Known endangered species
MONTH	5	0	Month of observation coded 1 - 12
BREEDER	10	0	Number of breeding pairs of the observed species
TOTALNO	10	0	Total number of observed birds of this species
DATE	10	0	Year in which data point attributes are current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	25		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Scheme for Coding Seabirds by behaviour and Species (see SEABIRD.DBF/TBB)

CODE	BEHAVIOUR GROUP	SEABIRD SPECIES
1	Raptor	Bald Eagle
		Osprey
2	Gulls & Terns	Arctic Tern
		Black-Legged Kittiwake
		Common Black-Headed Gull
		Common Tern
		Glaucous Gull
		Great Black-Backed Gull
		Herring Gull
		Iceland Gull
		Ring-Billed Gull
3	Waterfowl	American Widgeon
		Black Duck
		Blue-Winged Teal
		Canada Goose
		Common Eider
		Common Goldeneye
4	Shorebirds	Black-Bellied Plover
		Great Blue Heron
		Greater Yellow Legs
		Pectoral Sandpiper
		Piping Plover
		Red Knot
		Sanderling
		Semi-Palmated Plover
		Semi-Palmated Sandpiper
		White-Rumped Sandpiper
		White-Winged Scoter
		Willet

CODE	BEHAVIOUR GROUP	SEABIRD SPECIES
5	Diving Birds	Common Merganser
		Red-Breasted Merganser
		Atlantic Puffin
		Black Guillemot
		Double-Crested Cormorant
		Dovkie
		Great Cormorant

Raw File Name: \SEGMENT0.DBF
SPANS File Name: \SEGMENT.TBB
File Contents: Summary of all attributes attached to each standard shore segment.

Field Name	Field Width	Decimals (numeric)	Field Description
FILENAME	8		Original geomorphology digitized data file
UNIQUEID	5	0	Unique identifier for each segment
MAPSHEET	10		NTS 1:50,000 map from which the segment was digitized
SEGID	4	0	Original NTS map-based identifier for the segment
LATCENT	8	4	Latitude of the segment centroid point
LONGCENT	8	4	Longitude of the segment centroid point
SHORT	2	0	Scalar value (12) for use with general (GEOCLASS) geomorphology representation
LONG	2	0	Scalar value (27) for use with detailed (GEOCODE) geomorphology representation

Field Name	Field Width	Decimals (numeric)	Field Description
GEOCODE	4	0	Detailed coastal geomorphology 1 = Wide rock platform 2 = Narrow rock platform 3 = Rock cliff 4 = Wide gravel beach on rock platform 5 = Narrow gravel beach on rock platform 6 = Narrow gravel beach with rock cliff 7 = Wide sand and gravel beach on rock platform 8 = Narrow sand and gravel beach on rock platform 9 = Narrow sand and gravel beach with rock cliff 10 = Wide sand beach on rock platform 11 = Narrow sand beach on rock platform 12 = Narrow sand beach with rock cliff 13 = Wide gravel flat 14 = Narrow gravel flat 15 = Steep gravel beach 16 = Wide sand and gravel flat 17 = Narrow sand and gravel flat 18 = Steep sand and gravel beach 19 = Wide sand flat 20 = Narrow sand flat 21 = Steep sand beach 22 = Mud flat 23 = Estuary/marsh/lagoon 24 = Unknown 25 = Land fill 26 = Structure 27 = Fresh water intersecting shoreline
GEOCLASS	2	0	Simplified coastal geomorphology 1 = Rock platform or cliff 2 = Gravel beach on rock platform 3 = Sand and gravel beach on rock platform 4 = Sand beach on rock platform 5 = Gravel beach or flat 6 = Sand and gravel beach or flat 7 = Sand beach or flat 8 = Mud flat 9 = Estuary/marsh/lagoon 10 = Unknown 11 = Manmade 12 = Fresh water

Field Name	Field Width	Decimals (numeric)	Field Description
BACKSHOR	2	0	Backshore geomorphology 1 = Flats 2 = Sand dunes 3 = High storm berm 4 = Eroding raised marine sediment terrace 5 = Slumping soils 6 = Steep, stable slope 7 = Cliff 8 = Manmade shoreline 9 = Delta of river or stream 10 = Canyon of river or stream 11 = Peat bank
EXPOSURE	2	0	Wave exposure based on fetch 1 = Very exposed - fetch window >500 km 2 = Semi-exposed - fetch window 50 - 500 km 3 = Semi-protected - fetch window 10-50 km 4 = Protected - fetch window 1-10 km 5 = Very protected - fetch window <1 km
BOULDER	1	0	Nearshore and intertidal boulder barriers 1 = Level 1 - Boulders obvious in intertidal zone 2 = Level 2 - Many boulders in intertidal zone
REVEXP	2	0	Revised exposure based on fetch but modified by boulder barriers 1 = Very exposed - fetch window >500 km 2 = Semi-exposed - fetch window 50 - 500 km 3 = Semi-protected - fetch window 10-50 km 4 = Protected - fetch window 1-10 km 5 = Very protected - fetch window <1 km
ORI	1	0	Oil Residence Index 1 = Days to weeks 2 = Weeks 3 = Weeks to months 4 = Months 5 = Months to years
FLOODLEV	2	0	Surveyed flood levels 1 = Surveyed but no flooding 2 = Flooding area 0-100 m from shore 3 = Flooding area 100-500 m from shore 4 = Flooding area >500 m from shore
ARCHCODE	2	0	Archaeologically significant areas 1 = Archaeologically significant site

Field Name	Field Width	Decimals (numeric)	Field Description
ICE	2	0	Shoreline ice development 1 = Land fast protective ice cover 2 = Ice foot attached to the upper shore 3 = Pack ice scour in lower shore 4 = Major destructive pack ice scour
DEPOSITN	2	0	Deposition of floating garbage on the shoreline 1 = High 2 = Medium 3 = Low
INTERTID	2	0	Intertidal biological habitats 1 = Road Fill 2 = Exposed sediments - Temporary seaweeds 3 = Exposed cliff & boulder - High *Porhyra* 4 = Exposed estuary - Green seaweeds 5 = Sheltered cliff - Barnacles, mussels, Seaweed 6 = Exposed cobble/boulder - Green and Brown algae 7 = Sheltered sediments - Softshell clams and eel grass 8 = Sheltered bedrock - Black lichen and periwinkle 9 = Sheltered cobble/boulder - *Ascophyllum* and Red Periwinkle 10 = Exposed bedrock platform - Rockweed and Irish Moss pools 11 = Sheltered estuary - Eel grass 12 = Salt marsh - Hybrid subarctic saltmarsh
SUBTIDAL	2	0	Subtidal biological habitats 1 = Mobile sediments - Sand dollars 2 = Stable sediments - Clam beds (*Mya*) 3 = Sheltered bedrock and boulders General - cordweed and cunner 4 = Exposed bedrock and boulders - Whelks and horse mussels 5 = Sheltered bedrock and boulders - Kelp beds (*Laminaria*) 6 = Sheltered bedrock and boulders - Sea urchin beds 7 = Sheltered bedrock and boulders - Rhodolith and coralline communities 8 = Accumulated industrial or municipal waste 9 = Sheltered sediments - Eel grass meadows

Field Name	Field Width	Decimals (numeric)	Field Description
SEABIRDS	2	0	Surveyed or suspected coastal seabird sites 1 = Suspected fall staging area for waterfowl 2 = Suspected waterfowl breeding site 3 = Suspected fall staging area for shorebirds 4 = Suspected concentration of diving birds 5 = Suspected seabird breeding site 6 = Known fall staging area for waterfowl 7 = Known waterfowl breeding site 8 = Known fall staging area for shorebirds 9 = Known concentration of diving birds 10 = Known seabird breeding site 11 = Known endangered species site
CAPLIN	2	0	Intertidal capelin spawning habitats 1 = Least preferred spawning substrate 2 3 4 5 = Most preferred spawning substrate
HERRING	2	0	Surveyed or suspected herring spawning sites 1 = Spawning possible - likely to be light 2 = Suspected significant spawning 3 = Surveyed - significant spawning 4 = Surveyed - heavy spawning
SALRIVER	1	0	Registered salmon rivers 1 = Salmon river mouth
AQUASITE	1	0	Registered aquaculture sites 1 = Lobster 2 = Scallops 3 = Mussels
ANNCATCH	1	0	Summary of registered fish catches 1 = Annual landings $1,000 - $5,000 2 = Annual landings $5,000 - $10,000 3 = Annual landings $10,000 - $50,000 4 = Annual landings $50,000 - $100,000 5 = Annual landings $100,000 - $500,000 6 = Annual landings $500,000 - $1,000,000 7 = Annual landings $1,000,000 - $5,000,000
FISHPLNT	1	0	Registered coastal fish plants 1 = Fresh water system 2 = Salt water intake at plant

Field Name	Field Width	Decimals (numeric)	Field Description
INDUSTRY	1	0	Coastal Industrial sites 1 = Coastal industry 2 = Marine loading terminal 3 = Pulp mill 4 = Ferry Wharf
SMLLCRFT	1	0	DFO small craft harbours
MUNICIPL	1	0	Surveyed incorporated municipalities
NATPARK	1	0	Surveyed national parks
PROVPARK	1	0	Surveyed provincial parks
MUNPARK	1	0	Surveyed municipal parks
ECORES	1	0	Surveyed ecological reserve areas
AGRES	1	0	Surveyed agricultural reserve areas
WILDRES	1	0	Surveyed wildlife reserve areas

Raw File Name: \SPECIAL.DBF
SPANS File Name: \SPECIAL.TBB
File Contents: Special features which may affect implementation of countermeasures techniques

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
LOCATION	25		Name of the geographic feature nearest the data point
CODE	10	0	Classification of data point by type 1 = Tidal rapids 2 = Sand dunes 3 = Wet lands 4 = Sand bar 5 = Rocky shoal 6 = Other
SPFEATURE	20		Description of special feature coded in the previous field
DATE	5		Year of incorporation into atlas

Raw File Name: \WASTEDIS.DBF
SPANS File Name: \WASTEDIS.TBB
File Contents: Location of municipal waste disposal sites.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
LOCATION	20		Name of the community or feature nearest the data point
CODE	5	0	Classification of data point by type
CODEREF	10		Description of coded class type in previous field 1 = Outfall 2 = Landfill
DATE	12	2	Year in which data point attributes were current
SOURCE	35		Brief reference to the source of the data point attributes
CONTACT	30		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \BATHNAME.WK1
SPANS File Name: \BATHNAME.TBB
Derived File Name: \BATHNAM.TBB (SPANS Map label file edited to cover the ESRF study area coastline only and with positions adjusted to level of detail of the atlas)

File Contents: A series of files which form a subset of the Canadian Geographic Data Base which are used to provide place names for the geographic area of the ESRF atlas.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	4	Decimal Latitude of the data point
LONG	10	4	Decimal Longitude of the data point
FEATURE	25		Name of the geographic feature

The following files, all with the above structure, cover the scope of place names displayed in the atlas:

BATHNAME	Seabed features such as shoals, banks, etc.
COASNAME	Coastal features such as islands, headlands, points, capes, beaches, etc.
COMMNAME	Coastal communities
FWNAME	Rivers lakes, and marshes adjacent to the coastline
INDNAME	Large coastal industries
MARINAME	Salt water features such as bays, coves, channels, arms, harbours, etc.
PARKNAME	Provincial and national parks
TERRNAME	Terrestrial features such as hills, mountains, valleys, etc.
TOWNAME	Coastal towns (generally larger than communities)

Raw File Name: \JANCATCH.DBF
SPANS File Name: \JANCATCH.TBB
File Contents: Monthly (prefix = JAN, FEB, MAR, etc.) and annual (prefix = ANN) files of the average of 7 years (1984-90) of fish landings at DFO registered communities.

Field Name	Field Width	Decimals (numeric)	Field Description
COMMNAME	25		Name of registered community (NB this site may or may not be inhabited)
MONTH	5		Month for which average has been computed
COD	1	0	Ranked* cash value of average cod landings
LOBSTER	1	0	Ranked* cash value of average lobster landings
SHRIMP	1	0	Ranked* cash value of average shrimp landings
HERRING	1	0	Ranked* cash value of average herring landings
SCALLOPS	1	0	Ranked* cash value of average scallops landings
CAPELIN	1	0	Ranked* cash value of average capelin landings
CRAB	1	0	Ranked* cash value of average crab landings
PLAICE	1	0	Ranked* cash value of average plaice landings
MACKEREL	1	0	Ranked* cash value of average mackerel landings
FLOUNDER	1	0	Ranked* cash value of average flounder landings
REDFISH	1	0	Ranked* cash value of average redfish landings
OTHER	1	0	Ranked* cash value of average of other landings
SCALE	1	0	Constant value of 7 which provides a maximum scale for SPANS Map histograms of catch data
LAT	8	4	Decimal Latitude of the data point
LONG	8	4	Decimal Longitude of the data point
COMMCODE	6		DFO Region/Statistical Section/Community code
MONTHNUM	2	0	Numeric code for month of observation

* The following 7-point ranking scheme has been used to classify 7-year average DFO-registered fish landings:

1	$1,000 - $4,999
2	$5,000 - $9,999
3	$10,000 - $49,000
4	$50,000 - $99,999
5	$100,000 - $499,999
6	$500,000 - $999,999
7	$1,000,000 - $5,000,000

Raw File Name: \JANBIRD1.DBF
SPANS File Name: \JANBIRD1.TBB
File Contents: Monthly (JAN, FEB, MAR, etc.) and annual (ANN) files of observed coastal seabird breeding activity as documented in Memorial University of Newfoundland databases.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	4	Decimal Latitude of the data point
LONG	10	4	Decimal Longitude of the data point
SPECIES	25		Species observed at the site
VALUE	12	0	Number of breeding birds observed at the site
MONTH	10	0	Numeric code for month of observation
DATE	10	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	25		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Appendix 6

Classification Scheme For All Offshore Line Segment Data Files

Raw File Names: 1LC4021.VEC, VEH
SPANS File Names: 1LC4021.VTX, TOP, TBB
File Contents: Seabird Breeding

- General extents of coastal seabird breeding for the northern section of the west coast region
- Data have been transcribed from Brown et al. (1975, 1986) and Cairns et al. (1989)

CLASS	DESCRIPTION
1	Important concentrations of seabirds and marine mammals due to high biological productivity of the Strait of Belle Isle area
2	Breeding range of seabirds

Raw File Names: 1LC4022.VEC, VEH
SPANS File Names: 1LC4022.VTX, TOP, TBB
File Contents: Seabird Breeding

- General extents of coastal seabird breeding for the southern section of the west coast region
- Data have been transcribed from Brown et al. (1975, 1986) and Cairns et al. (1989)

CLASS	DESCRIPTION
1	Breeding range of seabirds

Raw File Names: 2LC4021.VEC, VEH
SPANS File Names: 2LC4021.VTX, TOP, TBB
File Contents: Pelagic Fishes

- General extents of pelagic fishes for the northern section of the west coast region
- Data have been transcribed from Scarratt (1982) and Grosslein and Clarke (1976)

CLASS	DESCRIPTION
1	Herring general spawning areas
2	Herring key spawning areas
3	Herring general distribution
4	Herring known concentrations of juveniles
5	Atlantic Mackerel

Raw File Names: 2LC4022.VEC, VEH
SPANS File Names: 2LC4022.VTX, TOP, TBB
File Contents: Pelagic Fishes

- General extents of pelagic fishes for the southern section of the west coast region
- Data have been transcribed from Scarratt (1982) and Grosslein and Clarke (1976)

CLASS	DESCRIPTION
1	Herring general spawning areas
2	Herring key spawning areas
3	Herring known concentrations of juveniles
4	Atlantic Mackerel

Raw File Names: 3LC4021.VEC, VEH
SPANS File Names: 3LC4021.VTX, TOP, TBB
File Contents: Groundfish (flatfish)

- General extents of groundfish for the northern section of the west coast region
- Data have been transcribed from Scarratt (1982)
- Line segments which describe the ranges of these species often overlap.

CLASS	DESCRIPTION
1	American Plaice and Greenland Halibut (general)
2	Witch Flounder (general)
3	American Plaice, Greenland Halibut, and Witch Flounder (general)
4	Witch Flounder (summer)
5	Greenland Halibut (winter)
6	Witch Flounder (summer) and Greenland Halibut (winter)
7	American Plaice, Greenland Halibut, and Witch Flounder (general) and Greenland Halibut (winter)
8	Groundfish (general) and Witch Flounder (summer)

Raw File Names: 3LC4022.VEC, VEH
SPANS File Names: 3LC4022.VTX, TOP, TBB
File Contents: Groundfish (flatfish)

- General extents of groundfish for the southern section of the west coast region
- Data have been transcribed from Scarratt (1982)
- Line segments which describe the ranges of these species often overlap.

CLASS	DESCRIPTION
1	American Plaice and Greenland Halibut (general)
2	Witch Flounder (general)
3	American Plaice, Greenland Halibut, and Witch Flounder (general)
4	Witch Flounder (summer)
5	Greenland Halibut (winter)
6	Witch Flounder (summer) and Greenland Halibut (winter)
7	American Plaice, Greenland Halibut, and Witch Flounder (general) and Greenland Halibut (winter)
8	Groundfish (general) and Witch Flounder (summer)

Raw File Names: 4LC4021.VEC, VEH
SPANS File Names: 4LC4021.VTX, TOP, TBB
File Contents: Groundfish

- General extents of groundfish for the northern section of the west coast region
- Data have been transcribed from Scarratt (1982), Atkinson (1991), and Frechet et al. (1991)
- Line segments which describe the ranges of these species often overlap.

CLASS	DESCRIPTION
1	Redfish summer distribution
2	Redfish summer distribution
3	Unassigned
4	Atlantic Cod summer distribution
5	Atlantic Cod winter distribution
6	Atlantic Cod spawning area
7	Unassigned
8	Unassigned
9	Unassigned
10	Redfish survey area boundary

Raw File Names: 4LC4022.VEC, VEH
SPANS File Names: 4LC4022.VTX, TOP, TBB
File Contents: Groundfish

- General extents of groundfish for the northern section of the west coast region

CLASS	DESCRIPTION
1	Redfish summer distribution
2	Redfish summer distribution
3	Unassigned
4	Atlantic Cod summer distribution
5	Atlantic Cod winter distribution
6	Atlantic Cod spawning area
7	Unassigned
8	Unassigned
9	Unassigned
10	Redfish survey area boundary

Raw File Names: 5LC4021.VEC, VEH
SPANS File Names: 5LC4021.VTX, TOP, TBB
File Contents: Marine Mammals

- General extents of groundfish for the northern section of the west coast region
- Data have been transcribed from Sergeant (1976), Stenson et al. (1991a), Stenson et al. (1991b), and Lien (1985, 1992).
- Line segments which describe the ranges of these species often overlap.

CLASS	DESCRIPTION
1	Blue Whale general distribution
2	Harp Seal general breeding ground
3	Harbour Seal general distribution
4	Blue Whale winter/spring entrapment area

Raw File Names: 5LC4022.VEC, VEH
SPANS File Names: 5LC4022.VTX, TOP, TBB
File Contents: Marine Mammals

- General extents of groundfish for the southern section of the west coast region
- Data have been transcribed from Sergeant (1976), Stenson et al. (1991a), Stenson et al. (1991b), and Lien (1985, 1992).
- Line segments which describe the ranges of these species often overlap.

CLASS	DESCRIPTION
1	Blue Whale general distribution
2	Harp Seal general breeding ground
3	Harbour Seal general distribution
4	Blue Whale winter/spring entrapment area

Raw File Names: 6LC4021.VEC, VEH
SPANS File Names: 6LC4021.VTX, TOP, TBB
File Contents: Marine Invertebrates (crab and lobster)

- General extents of crab and lobster for the northern section of the west coast region
- Data have been transcribed from Squires (1990) and Anon (1975)
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION		
1	general distribution of	American Lobster,	Rock Crab, and Hermit Crab

Raw File Names: 6LC4022.VEC, VEH
SPANS File Names: 6LC4022.VTX, TOP, TBB
File Contents: Marine Invertebrates (crab and lobster)

- General extents of crab and lobster for the southern section of the west coast region
- Data have been transcribed from Squires (1990) and Anon (1975)
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION		
1	general distribution of	American Lobster,	Rock Crab, and Hermit Crab

Raw File Names: 7LC4021.VEC, VEH
SPANS File Names: 7LC4021.VTX, TOP, TBB
File Contents: Marine Invertebrates (shrimp)

- General extents of shrimp for the northern section of the west coast region
- Data have been transcribed from Savard and Hurtubise (1991)
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION
1	Shrimp (*Pandalus borealis*) general distribution
2	Shrimp (*Crangon septemspinosus*) general distribution

Raw File Names: 7LC4022.VEC, VEH
SPANS File Names: 7LC4022.VTX, TOP, TBB
File Contents: Marine Invertebrates (shrimp)

- General extents of shrimp for the southern section of the west coast region
- Data have been transcribed from Savard and Hurtubise (1991)
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION
1	Shrimp (*Pandalus borealis*) general distribution
2	Shrimp (*Crangon septemspinosus*) general distribution

Raw File Names: 8LC4021.VEC, VEH
SPANS File Names: 8LC4021.VTX, TOP, TBB
File Contents: Marine Invertebrates (bivalve molluscs)

- General extents of bivalves for the northern section of the west coast region
- Data have been transcribed from Dunbar et al. (1980)***
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION
1	Iceland Scallop spawning area
2	Iceland Scallop general distribution
3	Giant Scallop general distribution
4	Iceland Scallop spawning area

Raw File Names: 8LC4022.VEC, VEH
SPANS File Names: 8LC4022.VTX, TOP, TBB
File Contents: Marine Invertebrates (bivalve molluscs)

- General extents of bivalves for the southern section of the west coast region
- Data have been transcribed from Dunbar et al. (1980)***
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION
1	Giant Scallop general distribution

Raw File Names: 9LC4022.VEC, VEH
SPANS File Names: 9LC4022.VTX, TOP, TBB
File Contents: Marine Invertebrates (decapod molluscs)

- General extents of squid for the southern section of the west coast region
- Data have been transcribed from ***
- Line segments which describe the ranges of these species often overlap

CLASS	DESCRIPTION
1	Short Fin Squid summer distribution

Appendix 7

Classification Scheme For All Offshore Point-Based Data Files

Raw File Name: \TIDES.DBF
SPANS File Name: \TIDES.TBB
File Contents: Tidal ranges at CHS-surveyed locations.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
MEANRNGE	10	0	Mean tidal range at the site in metres
LRGRNGE	10	0	Large tidal range at the site in metres
MWL	5	0	Mean Water Level in metres
DATE	10	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Name: \WXSTNSUM.DBF
SPANS File Name: \WXSTNSUM.TBB
File Contents: Locations of all weather stations. Climate normal data is appended as text tables.

Field Name	Field Width	Decimals (numeric)	Field Description
LAT	10	5	Decimal Latitude of the data point
LONG	10	5	Decimal Longitude of the data point
COMMNAME	20		Name of the community nearest the data point
AESCODE	5	0	AES identification for each site
OPERATOR	10		Agency responsible for the operation of the station
DATARCH	15		Number of years of data archived for the site
AIRTEMP	10	0	Air temperature measurements 1 = Air temperature measured 0 = Air temperature not measured
PRECIP	10	0	Preciptiation measurements 1 = Precipitation measured 0 = Precipitation not measured
PRERATE	10	0	Precipitation rate measured 1 = Rate measured 0 = Rate not measured
WIND	10	0	Wind measurements 1 = Anemometer on site 0 = No anemometer
SOILTEMP	10	0	Soil temperature 1 = Soil temperature measurements 0 = No soil temperature measurements
EVAPOR	10	0	Evaporation measurements 1 = Evaporation measurements 0 = No evaporation measurements

SUNSHINE	10	0	Sunshine measurements 1 = Total sunshine measurements 0 = No sunshine measurements
RADIAT	10	0	Radiation measurements 1 = Radiation measurements 0 = No radiation measurements
OZONE	10	0	Ozone 1 = Ozone measurements 0 = No ozone measurements
SNOW	10	0	Total snowfall measurements 1 = Snowfall measurements 0 = No snowfall measurements
AIRQUAL	10	0	Air quality measurements 1 = Air quality measurements 0 = No air quality measurements
DATE	10	0	Year in which data point attributes were current
SOURCE	45		Brief reference to the source of the data point attributes
CONTACT	35		Office of agency responsible for archiving source data that may be contacted for further information
TELEPHONE	15		Telephone number that can be used in contacting the data agency

Raw File Names: 5LC4021P.TBA
SPANS File Names: 5LC4021P.TBB
File Contents: Marine Mammals

- Specific point locations of repeated marine mammal sightings for the northern section of the west coast region
- Data have been transcribed from Lien (1985, 1992) and Lynch, (1986)

CLASS	DESCRIPTION
1	Fin Whales
2	Killer Whale
3	Pilot or Pothead Whales
4	Minke Whales
5	Humpback Whales

Raw File Names: 5LC4022P.TBA
SPANS File Names: 5LC4022P.TBB
File Contents: Marine Mammals

- Specific point locations of repeated marine mammal sightings for the southern section of the west coast region
- Data have been transcribed from Lien (1985, 1992) and Lynch, (1986)

CLASS	DESCRIPTION
1	Fin Whales
2	Killer Whale occasional sightings off Cape Ray
3	Pilot or Pothead Whales
4	Minke Whales
5	Humpback Whales

Raw File Names: 6LC4021P.TBA
SPANS File Names: 6LC4021P.TBB
File Contents: Marine Invertebrates (crab and lobster)

- Specific point locations of crab sampling for the northern section of the west coast region
- Data have been transcribed from Hooper (1986) and Squires (1990)

CLASS	DESCRIPTION
1	Snow Crab

Raw File Names: 6LC4022P.TBA
SPANS File Names: 6LC4022P.TBB
File Contents: Marine Invertebrates (crab and lobster)

- Specific point locations of crab sampling for the southern section of the west coast region
- Data have been transcribed from Hooper (1986) and Squires (1990)

CLASS	DESCRIPTION
1	Snow Crab

Raw File Names: 7LC4021P.TBA
SPANS File Names: 7LC4021P.TBB
File Contents: Marine Invertebrates (shrimp)

- Specific point locations of shrimp sampling for the northern section of the west coast region
- Data have been transcribed from Savard and Hurtubise (1991)

CLASS	DESCRIPTION
1	Shrimp (*Pandalus borealis*)
2	Shrimp (*Pandalus montagui*)

Raw File Names: 7LC4022P.TBA
SPANS File Names: 7LC4022P.TBB
File Contents: Marine Invertebrates (shrimp)

- Specific point locations of shrimp sampling for the southern section of the west coast region
- Data have been transcribed from Savard and Hurtubise (1991)

CLASS	DESCRIPTION
1	Shrimp (*Pandalus montagui*)

Raw File Names: 8LC4021P.TBA
SPANS File Names: 8LC4021P.TBB
File Contents: Marine Invertebrates (bivalve molluscs)

- Specific point locations of bivalve sampling for the northern section of the west coast region
- Data have been transcribed from Dunbar (1980) ***

CLASS	DESCRIPTION
1	Iceland Scallop

Raw File Names: 8LC4022P.TBA
SPANS File Names: 8LC4022P.TBB
File Contents: Marine Invertebrates (bivalve molluscs)

- Specific point locations of bivalve sampling for the souhern section of the west coast region
- Data have been transcribed from Dunbar (1980) ***

CLASS	DESCRIPTION
1	Iceland Scallop
2	Giant Scallop

Raw File Names: (AES ID #).TXT
SPANS File Names: (AES ID #).TXT
File Contents: Tabular presentations of AES weather normals

- AES weather parameter normals are contained in ASCII text files. Each file represents a summary of historical data for a specific station. Files are named after the AES identification number for the associated weather station.
- Data in the weather normal files can be viewed in SPANS Map by opening the atlas spreadsheet WXSTNSUM and using the SPANS Map *Append Text* function.

1. Weather Stations included in the 1990 Canadian Climate Normals

Data File	Weather Station Location
8401300.TXT	Corner Brook
8401400.TXT	Daniels Harbour
8401500.TXT	Deer Lake
8401501.TXT	Deer Lake A
8402975.TXT	Port aux Basques
8403400.TXT	St. Anthony
8403800.TXT	Stephenville A
8404320.TXT	Woody Point

2. Other Weather stations for which AES archive data are included

Data File	Weather Station Location	Data File	Weather Station Location
8400430.TXT	Bay St. George	8402100.TXT	Heatherton
8400570.TXT	Black Duck	8402563.TXT	Lockleven
8400153.TXT	Cape St. George	8402945.TXT	Picadilly
8401102.TXT	Cartyville	8402958.TXT	Plum Point
8401286.TXT	Cormack	8402968.TXT	Pointe Riche
8401302.TXT	Corner Brook - Avalon Telelephone	8403040.TXT	Port Saunders
		8403096.TXT	Rocky Harbour
8401335.TXT	Cow Head	8403635.TXT	Sandy Point
8401524.TXT	Doyles	8403693.TXT	South Brook Pasadena
8401565.TXT	Ferolle Point	8403448.TXT	St. Georges
8401583.TXT	Flower's Cove	8403450.TXT	St. Georges
8401585.TXT	Flower's Island	8403870.TXT	Tompkins
8401642.TXT	Gallants	8404210.TXT	Western Arm Brook
8402078.TXT	Hawke's Bay	8403815.TXT	Stephenville Crossing

Appendix 8

Description Of Standard Map Windows

Anguille Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Anguille - Entire Region	1:300,000
02	Codroy	1:50,000
03	St. Fintan's	1:50,000

Port au Port Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Port au Port - Entire Region	1:550,000
02	Port au Port - Northern Sub-Region	1:300,000
03	Port au Port - Central Sub-Region	1:300,000
04	Port au Port - Southern Sub-Region	1:300,000
05	Port au Port	1:50,000
06	Stephenville	1:50,000
07	Stephenville Crossing	1:50,000
08	St. Georges	1:50,000
09	St. Davids/Robinsons	1:50,000
10	Cape St. George	1:50,000
11	Lourdes	1:50,000
12	Long Point	1:50,000
13		
14	Shoal Point	1:50,000
15	Picadilly	1:50,000
16	Point au Mal	1:50,000
17	Fox Island	1:50,000

Bay of Islands Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Bay of Islands - Entire Region	1:500,000
02	Bay of Islands - Northern Sub-Region	1:300,000
03	Bay of Islands - Southern Sub-Region	1:300,000
04	Lark Harbour and York Harbour	1:50,000
05	Woods Island	1:50,000
06	Cox's Cove	1:50,000
07	Corner Brook	1:50,000
08	Humber Arm	1:100,000
09	Southern Bay	1:100,000
10	Northern Bay	1:100,000
11	Northern Arms	1:100,000
12	Humber Arm/Southern Bay	1:200,000

Gros Morne Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Gros Morne - Entire Region	1:625,000
02	Gros Morne - Northern Sub-Region	1:300,000
03	Gros Morne - Southern Sub-Region	1:300,000
04	Cow head	1:50,000
05	St. Pauls	1:50,000
06	Rocky Harbour	1:50,000
07	Norris Point/Woody Point	1:50,000
08	Lomond	1:50,000
09	South Arm	1:50,000
10	Trout River	1:50,000
11	Cow Head/St. Pauls	1:100,000
12	Bonne Bay	1:75,000

Portland Creek Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Portland - Entire Region	1:500,000
02	Portland - Northern Sub-Region	1:300,000
03	Portland - Southern Sub-Region	1:300,000
04	Parsons Pond	1:50,000
05	Portland Creek	1:50,000
06	Daniels Harbour	1:50,000
07	River of Ponds	1:50,000
08	Shallow Bay	1:50,000

Port Saunders Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Port Saunders - Entire Region	1:500,000
02	Port Saunders - Northern Sub-Region	1:300,000
03	Port Saunders - Southern Sub-Region	1:300,000
04	River of Ponds	1:50,000
05	Hawkes Bay	1:50,000
06	Port Saunders	1:50,000
07	Port aux Choix	1:50,000
08	St. John Island	1:50,000
09	Castors River	1:50,000
10	Ferolle Point	1:50,000

Strait of Belle Isle Region - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Belle Isle - Entire Region	1:500,000
02	Belle Isle - Northern Sub-Region	1:300,000
03	Belle Isle - Southern Sub-Region	1:300,000
04	Ferolle Point	1:50,000
05	Brig Bay	1:50,000
06	St. Genevieve Bay	1:50,000
07	St. Barbe	1:50,000
08	Flowers Cove	1:50,000
09	Green Island	1:50,000

West Coast Newfoundland Study Area - Standard Map Windows

Window	Area Description	Approximate Scale (on screen)
01	Western Newfoundland	
02	Strait of Belle Isle Region	
03	Port Saunders Region	
04	Portland Creek Region	
05	Gros Morne Region	
06	Bay of Islands Region	
07	Port au Port Region	
08	Anguille Region	

Appendix 9

Geographical Descriptions Of All Atlas Regions, Reference Maps, And Satellite Images

CHS No.	Chart Name	Latitude Northwest Corner	Longitude Northwest Corner	Latitude Southeast Corner	Longitude Southeast Corner
LC4022	Cabot Strait and Approaches	49.17	61.89	46.00	58.38
LC4021	Point Amour to Cape Whittle	51.50	60.20	48.42	56.53
LC4020	Strait of Belle Isle	52.25	57.17	51.17	55.00
4682	Larken Point to Cape Anguille	47.93	59.48	46.75	59.29
4885	Port Harmon and Approaches	48.61	58.83	48.34	58.25
4659	Port Au Port	*	*	*	*
4661	Bear Head to Cow Head	49.92	58.77	48.85	57.48
4653	Bay of Islands	49.32	58.52	48.95	57.85
4652	Humber Arm, Meadows Point to Humber River	49.00	58.07	48.92	57.89
4658	Bonne Bay	49.64	58.23	49.40	57.63
4663	Cow Head to Pointe Riche	50.82	58.25	49.77	56.97
4680	Hawkes Bay to St. Genevieve Bay	51.22	57.48	50.59	56.82
4679	Hawkes Bay, Port Saunders, Black Arm	50.74	57.50	49.59	56.16
4665	St. Margaret Bay and Approaches	51.09	57.16	50.98	56.90
4666	St. Barbe Point to Old Ferolle Harbour	51.21	57.09	51.06	56.75
4667	Savage Cove to St. Barbe Bay	*	*	*	*
4668	Anchorages in the Strait of Belle Isle	*	*	*	*
4509	Pistolet Bay	51.66	55.93	51.47	54.56

Image	File Name (Image quadrant)	Latitude NW Corner	Longitude NW Corner	Latitude SE Corner	Longitude SE Corner	Atlas Universe in which image can be found
Anguille	ANGNW	48°13'N	59°29'W	48°02'N	59°06'W	ANGUILLE
	ANGSW	48°02'N	59°29'W	47°50'N	59°06'W	ANGUILLE
	ANGNE	48°13'N	58°06'W	48°02'N	58°42'W	ANGUILLE/PAUXPORT
	ANGSE	48°02'N	58°06'W	47°02'N	58°42'W	n/a
Port au Port	PRTNW	48°53'N	59°19'W	48°33'N	58°46'W	PAUXPORT
	PRTSW	48°33'N	58°46'W	48°13'N	58°46'W	PAUXPORT
	PRTNE	48°53'N	59°19'W	48°33'N	58°14'W	BAYISLND/PAUXPORT
	PRTSE	48°33'N	58°46'W	48°13'N	58°14'W	PAUXPORT
Humber	HUMNW	49°37'N	58°35'W	49°15'N	58°05'W	GROSMORN/BAYISLND
	HUMSW	49°15'N	58°35'W	48°53'N	58°05'W	BAYISLND
	HUMNE	49°37'N	58°05'W	49°15'N	57°35'W	GROSMORN/BAYISLND
	HUMSE	49°15'N	58°05'W	48°53'N	57°35'W	BAYISLND
Gros Morne	GRONW	50°19'N	58°06'W	49°57'N	57°45'W	GROSMORN
	GROSW	49°57'N	58°06'W	49°34'N	57°45'W	GROSMORN
	GRONE	50°19'N	57°45'W	49°57'N	57°21'W	PORTLAND/GROSMORN
	GROSE	49°57'N	57°45'W	49°34'N	57°21'W	GROSMORN
Port Saunders	SAUNW	51°01'N	57°39'W	50°39'N	57°11'W	PORTSAUN
Saunders	SAUSW	50°39'N	57°39'W	50°17'N	57°11'W	PORTSAUN/PORTLAND
	SAUNE	51°01'N	57°11'W	50°39'N	56°42'W	PORTSAUN
	SAUSE	50°39'N	57°11'W	50°17'N	56°42'W	n/a
Belle Isle	BELNW	51°37'N	56°09'W	51°18'N	55°32'W	BELLISLE
	BELSW	51°18'N	56°09'W	50°58'N	55°32'W	BELLISLE/PORTSAUN
	BELNE	51°37'N	55°32'W	51°18'N	54°54'W	BELLISLE
	BELSE	51°18'N	55°32'W	50°58'N	54°54'W	n/a

NTS No.	Map Name	Latitude Northwest Corner	Longitude Northwest Corner	Latitude Southeast Corner	Longitude Southeast Corner
12 P/9	Big Brook	51.75	56.50	51.50	56.00
12 P/8	Eddies Cove	51.50	56.50	51.25	56.00
12 P/7	Flower's Cove	51.50	57.00	51.25	56.50
12 P/2,P/3	Brig Bay	51.25	57.00	51.00	56.50
12-I/15	Castors River	51.00	57.00	50.75	56.50
12-I/14	St. John Island	51.00	57.50	50.75	57.00
12-I/11	Port Saunders	50.75	57.50	50.50	57.00
12-I/6	Bellburns	50.50	57.58	50.25	57.00
12-I/4	Portland Creek	50.25	58.00	50.00	57.50
12 H/13	St. Pauls Inlet	50.00	58.00	49.75	57.50
12 H/12	Gros Morne	49.75	58.00	49.50	57.50
12 G/9	Skinner Cove	49.75	58.50	49.50	58.00
12 H/5	Lomond	49.50	58.00	49.25	57.50
12 G/8	Trout River	49.50	58.50	49.25	58.00
12 H/4	Pasadena	49.25	58.00	49.00	57.50
12 G/1 W	Bay of Islands -	49.25	58.50	49.00	58.25
12 G/1 E	Bay of Islands -	49.25	58.25	49.00	58.00
12 A/13	Corner Brook	49.00	58.00	48.75	57.50
12 B/16	Georges Lake	49.00	58.50	48.75	58.00
12 B/15	Shag Island	49.00	59.00	48.75	58.50
12 B/9	Harrys River	48.75	58.50	48.50	58.00
12 B/10	Stephenville	48.75	59.00	48.50	58.50
12 B/11	Mainland	48.75	59.50	48.50	59.00
12 B/8	Main Gut	48.50	58.50	48.25	58.00
12 B/7	Flat Bay	48.50	59.00	48.25	58.50
12 B/6	Cape St. George	48.50	59.50	48.25	59.00
12 B/2	St. Fintans	48.25	59.00	48.00	58.50
12 B/3	Little Friars Cove	48.25	59.50	48.00	59.00
11-O/14	Codroy	48.00	59.50	47.75	59.00

Each coastal region covers a section of coastline of about 30 - 35 nautical miles from north to south. The coastline includes all islands, bays, and inlets. A narrow swath, about 5 km in width presents terrestrial features adjacent to the coastline.

Universe Common Name	Directory	North Latitude	South Latitude
Strait of Belle Isle	BELLISLE	51°35'50"N	50°57'21"N
Port Saunders	PORTSAUN	51°06'27"N	50°27'08"N
Portland Creek	PORTLAND	50°32'11"N	49°54'57"N
Gros Morne	GROSMORN	50°00'06"N	49°16'14"N
Bay of Islands	BAYISLND	49°24'31"N	48°46'38"N
Port au Port	PAUXPORT	48°49'51"N	48°06'47"N
Anguille	ANGUILLE	48°13'07"N	45°50'07"N

Appendix 10

Combined Lengths Of Comparable Data Segments

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
AGRES	0	357.4	513.3	201.4	412.9	690.0	437.0	156.8	2504.6
AGRES	1	0.0	0.0	7.9	0.0	0.0	106.2	20.1	114.1
ANNCATCH	0	313.7	470.6	193.5	380.4	641.4	445.1	167.4	2364.6
ANNCATCH	1	1.3	0.0	0.0	3.6	8.9	14.5	0.0	25.8
ANNCATCH	2	1.8	0.2	0.0	2.4	14.4	6.9	0.0	25.7
ANNCATCH	3	3.9	15.7	0.7	10.9	20.5	43.0	1.0	90.8
ANNCATCH	4	3.0	3.5	10.3	6.2	1.9	12.0	0.0	29.4
ANNCATCH	5	26.1	19.2	4.1	7.5	0.9	21.0	3.3	60.8
ANNCATCH	6	5.5	1.9	0.6	2.0	2.0	0.6	0.0	12.0
ANNCATCH	7	2.1	1.1	0.0	0.0	0.0	0.0	5.3	8.5
ANNCATCH	8	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.091
AQUASITE	0	357.0	510.6	209.2	412.0	681.3	534.0	175.3	2595.0
AQUASITE	1	0.0	1.1	0.0	1.0	0.0	0.0	0.0	2.1
AQUASITE	2	0.0	0.0	0.0	0.0	8.7	9.2	0.0	17.9
AQUASITE	3	0.5	1.6	0.0	0.0	0.0	0.0	1.6	3.7

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
ARCHCODE	0	346.7	412.1	187.8	381.5	690.0	531.6	176.9	2461.4
ARCHCODE	1	10.7	101.2	21.5	31.4	0.0	11.5	0.0	157.3
BACKSHOR	0	357.4	513.3	157.7	43.6	246.5	543.2	176.9	1819.7
BACKSHOR	1	0.0	0.0	0.0	4.1	1.1	0.0	0.0	5.2
BACKSHOR	2	0.0	0.0	8.5	12.2	0.8	0.0	0.0	13.0
BACKSHOR	3	0.0	0.0	0.4	9.4	2.3	0.0	0.0	11.7
BACKSHOR	4	0.0	0.0	0.0	151.7	115.8	0.0	0.0	260.2
BACKSHOR	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BACKSHOR	6	0.0	0.0	30.7	51.4	134.5	0.0	0.0	200.8
BACKSHOR	7	0.0	0.0	7.7	116.5	151.8	0.0	0.0	250.2
BACKSHOR	8	0.0	0.0	4.3	9.8	19.5	0.0	0.0	29.3
BACKSHOR	9	0.0	0.0	0.0	10.0	11.0	0.0	0.0	21.0
BACKSHOR	10	0.0	0.0	0.0	4.3	6.6	0.0	0.0	7.5
BACKSHOR	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
BOULDER	0	252.1	310.5	153.9	301.0	566.4	482.5	167.4	2049.4
BOULDER	1	105.4	202.8	55.4	84.4	120.7	60.7	9.5	538.9
BOULDER	2	0.0	0.0	0.0	27.5	2.9	0.0	0.0	30.4
CAPLIN	0	41.8	92.3	65.8	101.8	258.0	106.4	75.9	700.9
CAPLIN	1	2.6	2.7	6.4	22.7	30.3	23.5	6.5	87.5
CAPLIN	2	195.2	240.7	41.2	123.5	165.1	118.8	48.9	795.9
CAPLIN	3	0.0	1.3	11.0	10.0	0.0	13.1	0.0	26.0
CAPLIN	4	4.3	53.1	5.2	58.2	104.1	225.4	19.1	450.7
CAPLIN	5	113.6	123.2	79.6	96.8	132.5	56.0	26.5	557.7
DEPOSITN	0	357.4	513.3	157.7	38.9	244.4	543.2	176.9	1815.4
DEPOSITN	1	0.0	0.0	30.0	129.4	220.7	0.0	0.0	349.2
DEPOSITN	2	0.0	0.0	11.6	179.8	193.4	0.0	0.0	368.3
DEPOSITN	3	0.0	0.0	10.0	64.9	31.6	0.0	0.0	85.8
ECORES	0	332.8	513.3	180.3	412.9	672.0	504.9	176.9	2519.5
ECORES	1	24.6	0.0	28.9	0.0	18.0	38.3	0.0	99.1

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
EXPOSURE	0	0.8	0.8	37.8	0.0	158.2	0.0	0.0	196.7
EXPOSURE	1	0.0	27.2	92.1	107.0	38.0	0.0	0.0	217.5
EXPOSURE	2	171.2	182.1	28.4	64.1	100.9	262.9	92.2	804.8
EXPOSURE	3	33.6	99.0	2.0	8.1	130.3	98.6	0.5	345.9
EXPOSURE	4	68.6	140.9	40.8	212.6	205.3	76.9	84.2	683.6
EXPOSURE	5	83.4	63.4	8.1	21.2	57.2	104.9	0.0	370.2
FISHPLNT	0	342.1	506.0	206.5	409.9	685.7	537.9	171.6	2578.0
FISHPLNT	1	15.4	7.3	2.7	3.0	4.3	5.3	5.3	40.6
FISHPLNT	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FLOODLEV	0	357.4	513.3	201.7	412.6	621.2	501.1	176.9	2500.0
FLOODLEV	1	0.0	0.0	0.0	0.0	9.8	0.0	0.0	9.8
FLOODLEV	2	0.0	0.0	3.9	0.3	42.0	26.4	0.0	72.6
FLOODLEV	3	0.0	0.0	3.6	0.0	17.0	15.7	0.0	36.3
FLOODLEV	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
GEOCLASS	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GEOCLASS	1	195.2	240.7	41.2	123.5	165.1	118.8	48.9	795.9
GEOCLASS	2	72.1	86.2	72.2	56.1	121.1	45.2	23.6	418.7
GEOCLASS	3	4.1	21.4	0.0	10.3	59.2	69.3	10.9	167.0
GEOCLASS	4	0.0	0.0	2.6	0.9	0.0	2.0	0.0	4.6
GEOCLASS	5	41.5	37.1	7.5	39.7	11.4	10.9	3.0	137.9
GEOCLASS	6	0.2	31.7	5.2	47.9	44.9	156.1	8.2	283.7
GEOCLASS	7	0.0	1.3	8.5	9.0	0.0	11.1	0.0	21.4
GEOCLASS	8	0.0	0.0	0.0	0.0	9.2	0.0	0.0	9.2
GEOCLASS	9	2.2	1.3	5.7	75.6	8.1	14.2	5.1	106.5
GEOCLASS	10	41.7	92.1	65.7	39.3	257.9	106.3	75.8	638.0
GEOCLASS	11	0.4	1.4	0.8	10.5	13.0	9.3	1.5	35.2
GEOCLASS	12	0.0	0.2	0.1	0.1	0.1	0.1	0.0	0.5
GEOCODE	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GEOCODE	1	138.8	152.1	19.9	26.7	4.5	9.1	3.0	267.1
GEOCODE	2	37.7	71.7	17.4	19.9	55.5	11.0	9.5	192.6
GEOCODE	3	18.6	17.0	3.9	77.3	105.1	98.7	36.4	336.2

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
GEOCODE	4	0.2	2.0	4.4	0.0	0.0	2.9	6.7	15.7
GEOCODE	5	67.3	80.5	67.7	25.7	56.5	11.0	7.5	271.9
GEOCODE	6	4.6	3.7	0.0	30.3	64.5	31.3	9.4	131.2
GEOCODE	7	0.0	0.0	0.0	0.0	2.8	0.0	1.6	4.4
GEOCODE	8	4.1	21.4	0.0	8.6	27.7	9.4	3.4	71.6
GEOCODE	9	0.0	0.0	0.0	1.7	28.7	59.9	5.6	91.0
GEOCODE	10	0.0	0.0	1.6	0.0	0.0	0.0	0.0	1.6
GEOCODE	11	0.0	0.0	0.9	0.9	0.0	0.0	0.0	0.9
GEOCODE	12	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0
GEOCODE	13	7.2	13.1	3.0	2.8	1.6	0.5	0.0	26.3
GEOCODE	14	33.8	19.2	4.4	22.9	9.8	10.3	3.0	93.2
GEOCODE	15	0.5	4.0	0.0	14.0	0.0	0.0	0.0	18.4
GEOCODE	16	0.0	10.3	0.0	8.5	10.3	45.5	2.4	76.2
GEOCODE	17	0.2	16.1	5.2	33.4	33.1	108.9	4.1	193.0
GEOCODE	18	0.0	5.4	0.0	6.0	1.5	1.7	1.7	14.5
GEOCODE	19	0.0	0.0	6.3	6.9	0.0	9.0	0.0	14.9
GEOCODE	20	0.0	1.3	2.2	2.2	0.0	3.1	0.0	6.5
GEOCODE	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
GEOCODE	22	0.0	0.0	0.0	0.0	9.2	0.0	0.0	9.2
GEOCODE	23	2.2	1.3	5.7	75.6	8.1	14.2	5.1	106.5
GEOCODE	24	41.7	92.1	65.7	39.3	257.9	106.3	75.8	638.0
GEOCODE	25	0.0	0.3	0.0	9.3	10.5	7.5	0.9	28.1
GEOCODE	26	0.4	1.1	0.8	1.2	2.5	1.8	0.5	7.1
GEOCODE	27	0.0	0.2	0.1	0.1	0.1	0.1	0.0	0.5
HERRING	0	0.0	3.4	1.3	15.4	171.0	29.2	18.3	215.6
HERRING	1	50.7	77.7	194.9	192.1	136.2	129.3	141.1	843.9
HERRING	2	43.0	80.8	1.5	158.2	382.8	223.7	0.0	871.2
HERRING	3	0.0	32.9	11.7	47.3	0.0	87.9	17.5	168.1
HERRING	4	263.8	318.5	0.0	0.0	0.0	73.0	0.0	519.9
ICE	0	357.4	513.3	157.7	71.4	249.0	543.2	176.9	1837.7
ICE	1	0.0	0.0	0.0	166.7	282.7	0.0	0.0	449.1
ICE	2	0.0	0.0	13.2	40.9	24.6	0.0	0.0	65.4
ICE	3	0.0	0.0	1.9	58.0	61.9	0.0	0.0	119.8
ICE	4	0.0	0.0	36.5	76.0	71.8	0.0	0.0	146.7

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
INDUSTRY	0	356.0	511.0	209.2	411.6	681.1	537.1	176.9	2599.4
INDUSTRY	1	0.7	0.7	0.0	1.1	1.1	0.0	0.0	2.8
INDUSTRY	2	0.8	0.3	0.0	0.3	0.0	0.0	0.0	1.3
INDUSTRY	3	0.0	1.3	0.0	0.0	7.8	6.1	0.0	15.2
INDUSTRY	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INTERTID	0	357.4	513.3	157.7	31.4	229.9	543.2	176.9	1790.8
INTERTID	1	0.0	0.0	0.0	7.3	12.0	0.0	0.0	19.3
INTERTID	2	0.0	0.0	2.2	11.8	2.3	0.0	0.0	14.7
INTERTID	3	0.0	0.0	0.4	77.9	112.6	0.0	0.0	172.5
INTERTID	4	0.0	0.0	0.0	2.5	0.9	0.0	0.0	3.3
INTERTID	5	0.0	0.0	0.0	21.3	39.6	0.0	0.0	60.8
INTERTID	6	0.0	0.0	0.4	35.7	30.2	0.0	0.0	59.4
INTERTID	7	0.0	0.0	3.2	29.9	79.7	0.0	0.0	109.6
INTERTID	8	0.0	0.0	8.8	30.0	51.5	0.0	0.0	81.4
INTERTID	9	0.0	0.0	0.0	7.1	78.6	0.0	0.0	85.6
INTERTID	10	0.0	0.0	36.4	50.4	15.9	0.0	0.0	81.5

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
INTERTID	11	0.0	0.0	0.0	83.8	35.9	0.0	0.0	115.9
INTERTID	12	0.0	0.0	0.0	23.9	0.0	0.0	0.0	23.9
MUNICIPL	0	303.5	373.6	149.0	305.2	550.8	374.9	176.9	1999.4
MUNICIPL	1	54.0	139.7	60.2	107.7	139.2	168.3	0.0	619.3
MUNPARK	0	357.4	513.3	202.6	406.3	683.2	532.8	176.9	2594.9
MUNPARK	1	0.0	0.0	6.6	6.6	6.8	10.4	0.0	23.8
NATPARK	0	357.4	491.5	184.7	152.4	690.0	543.2	176.9	2336.5
NATPARK	1	0.0	21.8	24.5	260.5	0.0	0.0		282.2
ORI	0	43.4	93.0	65.8	101.8	266.2	106.4	80.3	715.1
ORI	1	0.0	4.0	18.7	7.4	1.5	0.0	0.0	30.4
ORI	2	49.1	46.8	20.8	72.4	12.8	82.9	44.7	289.9
ORI	3	65.8	133.4	27.2	11.3	82.2	113.3	17.0	384.4
ORI	4	151.7	124.6	65.1	109.5	165.1	166.4	27.0	699.4
ORI	5	47.5	111.5	11.7	110.0	161.7	73.9	8.0	498.6

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
PROVPARK	0	357.4	513.3	206.8	412.9	666.0	524.8	176.9	2573.9
PROVPARK	1	0.0	0.0	2.4	0.0	24.0	18.4	0.0	44.7
REVEXP	0	0.8	0.8	37.8	0.0	158.2	0.0	10.6	207.3
REVEXP	1	0.0	14.7	48.4	23.3	12.7	0.0	0.0	80.3
REVEXP	2	112.5	109.7	64.7	117.0	51.3	203.6	80.1	656.7
REVEXP	3	86.6	171.5	7.3	26.1	188.7	157.9	9.5	580.0
REVEXP	4	46.0	71.6	42.8	213.4	220.3	75.5	0.0	626.0
REVEXP	5	109.1	145.1	8.1	33.2	51.2	106.3	76.7	458.3
REVEXP	6	2.4	0.0	0.0	0.0	7.7	0.0	0.0	10.099
SALRIVER	0	350.0	494.2	204.5	401.8	675.0	490.5	108.2	2448.9
SALRIVER	1	7.5	19.1	4.7	11.2	15.0	52.7	68.8	169.7
SEABIRDS	0	232.0	294.8	129.6	235.0	491.8	272.0	34.4	1470.3
SEABIRDS	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEABIRDS	2	10.9	0.0	0.0	3.2	0.0	0.0	0.0	14.1

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
SEABIRDS	3	50.3	100.2	0.0	10.9	49.9	125.5	8.0	337.8
SEABIRDS	4	19.9	0.0	0.0	0.0	0.6	0.0	0.0	20.5
SEABIRDS	5	28.6	30.8	0.0	21.9	50.7	36.7	51.5	203.9
SEABIRDS	6	0.0	5.9	0.0	28.8	0.0	0.0	0.0	34.7
SEABIRDS	7	0.0	0.0	65.0	15.0	8.7	0.0	0.0	88.7
SEABIRDS	8	7.7	26.0	6.3	34.3	0.0	85.5	0.0	153.3
SEABIRDS	9	8.1	0.0	0.0	11.8	15.1	0.0	0.0	34.9
SEABIRDS	10	0.0	44.7	8.4	47.8	73.1	23.6	82.2	244.5
SEABIRDS	11	0.0	11.0	0.0	4.2	0.0	0.0	0.9	16.1
SMLLCRFT	0	319.5	483.8	193.8	392.4	679.7	490.3	169.9	2473.6
SMLLCRFT	1	37.9	29.5	15.4	20.6	10.3	52.8	7.0	145.0
SUBTIDAL	0	357.4	513.3	157.7	48.7	251.1	543.2	176.9	1825.9
SUBTIDAL	1	0.0	0.0	1.5	14.4	4.7	0.0	0.0	19.0
SUBTIDAL	2	0.0	0.0	4.7	27.5	45.3	0.0	0.0	72.7
SUBTIDAL	3	0.0	0.0	6.3	42.8	99.1	0.0	0.0	141.8
SUBTIDAL	4	0.0	0.0	35.9	134.9	99.0	0.0	0.0	223.9

	Region	BELLISLE	PORTSAUN	PORTLAND	GROSMORN	BAYISLND	PAUXPORT	ANGUILLE	WESTCOAST
	Coastline Length (km)	357.4	513.3	209.2	412.9	690.0	543.2	176.9	2902.9
Segment Parameter	Attribute Code	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)	Combined Length (km)
SUBTIDAL	5	0.0	0.0	0.0	28.2	48.0	0.0	0.0	76.1
SUBTIDAL	6	0.0	0.0	0.0	2.0	61.0	0.0	0.0	63.0
SUBTIDAL	7	0.0	0.0	0.0	17.4	17.3	0.0	0.0	34.7
SUBTIDAL	8	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2
SUBTIDAL	9	0.0	0.0	3.2	95.6	52.1	0.0	0.0	147.6
SUBTIDAL	10	0.0	0.0	0.0	1.2	12.6	0.0	0.0	13.7
WILDRES	0	357.4	513.3	209.2	412.9	663.2	543.2	176.9	2591.9
WILDRES	1	0.0	0.0	0.0	0.0	26.8	0.0	0.0	26.8
		357.4	513.3	209.2	412.9	690.0	543.2	176.9	