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Production Definition Study for a Canadian Ocean Information Centre

Marine Environmental Data Services Branch
Department of Fisheries and Oceans
Ottawa, Ontario K1A 0E6

September 1988

Canadian Contractor Report of Hydrography and Ocean Sciences No. 33

Fisheries and Oceans
Pêches et Océans

Canada

Canadian Contractor Report of Hydrography and Ocean Sciences

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Regional and headquarters establishments of Ocean Science and Surveys ceased publication of their various report series as of December 1981. A complete listing of these publications and the last number issued under each title are published in the *Canadian Journal of Fisheries and Aquatic Sciences*, Volume 38: Index to Publications 1981. The current series began with Report Number 1 in January 1982.

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Cette série se compose des rapports non publiés réalisés dans le cadre des projets scientifiques et techniques par des entrepreneurs travaillant pour le service des Sciences et Levés océaniques (SLO) du ministère des Pêches et des Océans.

Le contenu des rapports traduit les opinions de l'entrepreneur et ne reflète pas nécessairement la politique officielle du ministère des Pêches et des Océans.

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Les établissements des Sciences et Levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports depuis décembre 1981. Vous trouverez dans l'index des publications du volume 38 du *Journal canadien des sciences halieutiques et aquatiques*, la liste de ces publications ainsi que le dernier numéro paru dans chaque catégorie. La nouvelle série a commencé avec la publication du Rapport n° 1 en janvier 1982.

Canadian Contractor Report of Hydrography and Ocean Sciences # 33

August 1988

PRODUCT DEFINITION STUDY FOR A CANADIAN OCEAN INFORMATION CENTRE

by

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EXECUTIVE SUMMARY

The users of ocean information in Canada have asked for faster, easier access to that information. They have also asked for better quality control in the data they receive, and want attention paid to these concerns before there is effort placed towards development of new data products.

A survey conducted of 167 users of ocean information across Canada from government, industry and universities showed that, although users are in general reasonably happy with the quality of service and products they receive, there is room for improvement in the service.

These improvements can be made initially with a relatively small amount of effort. Regionally based 'Ocean Information Centres', linked in a computer communications network, will be an effective vehicle for providing these improvements. They will also be an important means of promoting and developing new ocean information products, specifically those produced from Radarsat and other remote sensing platforms. The activities of these centres will be coordinated and linked so that, to the requestor of information or data, there will appear to be a single 'Ocean Information Centre' (OIC) that is able to satisfy all his needs for ocean information.

The OIC will operate a network of databases held by government, universities and private industry, will maintain an inventory of these databases and synopses of the data in them, will coordinate and oversee maintenance and quality control of the databases, will encourage development of commercially viable databases by private industry and integrate them into the archive network and will facilitate interconnection with American and other international oceanic databases.

Interest is highest in those oceanic parameters related to safety of operations: marine weather, hydrography, tides, waves and currents. Although interest in biological parameters is expected to increase in the future, demand for them is low enough that inclusion of them in a national data base system should not be a high priority.

From the user requests and an analysis of the availability of data and the ease of product production, we recommend a sequence of tasks for the OIC . The general concept is clear: upgrade and enhance the existing service first ... then develop new products. These services and products are:

1. An on–line catalogue of MEDS data holdings and products: user friendly, with rigid, defined quality control applied to all data in the archive. Included in this directory is a data synopsis facility designed to operate in a map–like "live atlas" form. Implicit as well in this catalogue is on–line ordering of the data or product for off–line delivery in a timely fashion.

2. A similar catalogue of all other Canadian data, products and services relevant to Canadian ocean interests. This catalogue needs to refer explicitly to the marine climatic holdings of AES, and to the hydrographic and tidal archives of CHS. An interconnection with American systems like NODS, GOLD and CDMS is also essential at this time.

3. On–line access to data and products listed above.

4. Development of new products such as charts of surface currents, waves and wave forecasts, marine wind fields, sea surface temperature, sea ice, water levels, sediments, chlorophyll; and ocean features.

5. Development of archiving facilities for real–time, synoptic and derivative products for climatological purposes.

This service should be implemented as a number of data collection, archiving and dissemination facilities located all over the country, each under local direction and control, but linked in a network. Users of the data and products will need only to be able to connect to any node in order to have access to all information in the entire network. An 'expert system' environment should be provided to access the data and create products on demand. Data and product delivery will be available either on or off–line.

Not a lot of money is being spent in Canada now to obtain ocean information. The information most critical to most users is presently made available free or nearly free in the interests of safety and the preservation of human life. Although potential users of an ocean information network should expect to pay a small amount to access data, it is unreasonable to believe that they will pay the relatively large amounts that would be required to cover the full commercial costs of production of new ocean data products, specifically those from satellites.

Efforts have been made in other countries to commercialize the production of satellite data products. Large government subsidies are required to keep these organizations in operation. MEDS should tread carefully in this area if it is expecting to be able to fully recover expenditures from products and services. In our opinion, the results of the survey clearly demonstrate that for a commercially viable service, improvement of existing services should come before an expensive move into high technology. There are however, impelling reasons (sovereignty, improved weather and seastate forecasting, and the potential at least for improved fisheries management) why Canada should be improving her capabilities in the area of remote sensing. Many of these uses will be by the government itself. Canada could clearly benefit from a well funded demonstration of the use of ocean remote sensing technology, but it is unrealistic to expect this to be "user driven" from the beginning.

SOMMAIRE

Les utilisateurs de données sur les océans au Canada ont demandé à avoir accès plus rapidement et plus facilement à ces données. Ils ont également souhaité obtenir un meilleur contrôle de la qualité des données qu'ils reçoivent, et qu'on se soucie des préoccupations exprimées avant d'axer les efforts sur le développement de nouvelles données.

Une enquête effectuée auprès de 167 utilisateurs de données sur les océans au Canada, du gouvernement, de l'industrie et des universités a indiqué que, bien qu'ils soient dans l'ensemble relativement satisfaits de la qualité du service et des produits qu'ils reçoivent, l'on pouvait encore améliorer la qualité du service.

Au départ, on peut apporter ces améliorations au prix d'efforts relativement minimes. Des centres régionaux d'information sur les océans, reliés par un réseau de communications informatisées, constitueront un mécanisme efficace qui permettra d'apporter ces améliorations. Ces centres constitueront également un important moyen de promotion et de développement de nouveaux produits d'information sur les océans, notamment ceux produits par le satellite Radarsat et d'autres plate–formes de télédétection. Les activités de ces centres seront coordonnées et reliées, de sorte que pour le demandeur d'information ou de données, il semblera n'y avoir qu'un seul centre d'information sur les océans qui puisse satisfaire tous ses besoins d'information en la matière.

Le centre exploitera un réseau de bases de données du gouvernement, des universités et de l'industrie privée, tiendra un répertoire de ces bases et de résumés des données qu'ils renferment, coordonnera et supervisera la maintenance et le contrôle de la qualité de ces bases de données, favorisera la conception par l'industrie privée de bases de données viables sur le plan commercial, et les intégrera au réseau d'archives et en facilitera l'interconnection avec les bases américaines de données sur les océans et d'autres bases de données internationales.

Les utilisateurs s'intéressent le plus aux paramètres océaniques relatifs à la sécurité des opérations comme les conditions météorologiques en mer, l'hydrographie, les marées, les vagues et les courants. Bien que l'on s'attende à un intérêt accru envers les paramètres biologiques dans l'avenir, la demande en ce qui les concerne est assez faible, de sorte que leur intégration à un système national de bases de données ne devrait pas être prioritaire.

D'après les demandes des utilisateurs, et une analyse de la disponibilité des données et de la facilité avec laquelle on peut les produire, nous recommandons pour le centre d'information sur les océans une série de tâches. La notion d'ensemble est claire: améliorer et valoriser d'abord le service actuel ... puis concevoir de nouveaux produits. Ces services et produits sont les suivants:

1. Un répertoire en direct du fonds de données et des produits du SDMM: convivial, assorti d'un contrôle rigide et défini de la qualité appliqué à toutes les données d'archives. Est compris dans ce répertoire un résumé des données fonctionnant comme une carte et un véritable atlas en direct. Implicitement, ce répertoire permettrait de commander en direct des données ou des produits et de les livrer en différé, en temps opportun.

2. Un répertoire semblable de tous les autres produits, services et données canadiens pertinents aux intérêts canadiens dans le domaine océanique. Ce répertoire doit faire référence explicitement aux fonds de données climatiques en mer du SEA et aux archives du SHC sur les données hydrographiques et les marées. À cette étape, une interconnection avec les systèmes américains NODS, GOLD et CDMS est également essentielle.

3. Un accès en direct aux données et aux produits énumérés ci–dessus.

4. La conception de nouveaux produits comme des cartes des courants de surface, des vagues et des prévisions des vagues, des champs de vents marins, de la température de la surface de la mer, des glaces en mer, des niveaux de l'eau, des sédiments, de la chlorophylle, et des caractéristiques océaniques.

5. La conception d'installations d'archivage pour l'obtention de produits en temps réel, synoptiques et dérivés pour les besoins de la climatologie.

Ce service devrait être donné par l'entremise d'établissements de cueillette, d'archivage et de dissémination de données situés dans l'ensemble du pays, chacun dirigé et contrôlé localement, mais relié à un réseau. Les utilisateurs de données et de produits n'auraient qu'à se brancher à un noeud du système pour avoir accès à toute l'information de l'ensemble du réseau. Il conviendrait de fournir un "système expert" pour permettre l'accès aux données et la création de produits sur demande. Les données et les produits pourront être livrés en direct ou en différé.

Peu de ressources financières sont actuellement consacrées au Canada à l'obtention de données sur les océans. Cette information, essentielle pour la plupart des utilisateurs, est maintenant donnée gratuitement, ou presque, dans l'intérêt de la sécurité et pour préserver la vie humaine. Bien que les utilisateurs éventuels d'un réseau d'information sur les océans doivent s'attendre à verser une petite somme pour y avoir accès, il serait illogique de croire qu'ils voudront payer les sommes relativement élevées qu'exigerait le financement de l'ensemble des frais commerciaux de production de nouvelles données sur les océans, notamment celles produites par satellite.

Des efforts ont été déployés dans d'autres pays en vue de commercialiser la production de données obtenues par satellite. D'importantes subventions gouvernementales sont requises pour assurer le fonctionnement de ces organisations. Le SDMM devrait s'aventurer avec prudence dans ce domaine s'il compte être en mesure de recouvrer l'ensemble des dépenses résultant des produits et des services. Selon nous, le résultat de l'enquête démontre clairement que pour obtenir un service viable sur le plan commercial, il conviendrait d'améliorer les services existants avant de prendre des mesures coûteuses pour s'engager dans le secteur de la haute technologie. Toutefois des raisons impérieuses, (souveraineté, amélioration des prévisions des conditions atmosphériques et de celles sur l'état de la mer, et la possibilité d'améliorer la gestion des pêches), justifient le fait que le Canada doive améliorer ses capacités dans le domaine de la télédétection. Bon nombre de ces techniques seront exploitées par le gouvernement lui-même. Le Canada pourrait profiter de toute évidence d'une démonstration bien financée de l'utilisation de la technologie de la télédétection axée sur les océans, mais il n'est pas réaliste de compter sur les utilisateurs pour prendre l'initiative dès le départ.

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ACKNOWLEDGEMENTS

We thank all of the individuals who responded to our questionnaire and those who took the time to be interviewed for yet another survey. Several took our inquiries very seriously and spent additional time to solicit responses from others within their organizations.

Dawson Truax and Dr. Paul LeBlond participated in planning of the project and formulation of the survey. Paul also conducted interviews. Lynne Armstrong and Reiko Gurney provided essential and much appreciated technical help in collation of the data and in preparation of the document.

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1. INTRODUCTION AND STATEMENT OF PROBLEM

In order to rationally exploit our oceans, Canada has begun to develop a coordinated Oceans Strategy (DFO, 1987). Any coherent and intelligent development and management scheme will be driven by information and knowledge. However, the extensive Canadian oceanic and coastal territories are currently the subject of more than 75 programs through 14 federal departments (DFO, 1987), and many more provincial agencies since all but 2 provinces border the sea. Ocean related data and information is scattered through a myriad of government, university and private agencies, in a variety of formats and is difficult to access. There is as yet no coordinated storage, collection and exchange of ocean data and information, although the need has been recognized and some regional efforts have begun.

Added to the current situation is the complication that the space programs of several countries including Canada, will spawn a tremendous increase in the amount of ocean related information during the next decade through remote sensing satellites. A good deal of remotely sensed data is now being acquired and processed in Canada. However the applications are mostly land related, primarily because there has been a government sponsored agency, the Canada Centre for Remote Sensing (CCRS) which was given the task and budget to develop and encourage the technology. This included setting up a system to collect, archive and distribute LANDSAT data. A very large back-log of data now exists, and this large database is accessible for historical studies. Until recently there has been no coordinated push for oceans applications. Thermal infra-red and visible data from the NOAA/TIROS series satellites have been the most commonly used satellite data for oceanography during the last decade, although experimental use of a number of other sensors is increasing. In Canada, NOAA-AVHRR data have been routinely collected by the Atmospheric Environment Service since the early 1970s, but because of their operational mandate, they only archive the data for 30 days. Until recently, individual researchers at Fisheries and Oceans, University of British Columbia and a few companies made special ad hoc arrangements to obtain data from the temporary AES archives by providing magnetic tapes. CCRS began to collect NOAA data from its Prince Albert receiving station in 1983. The Department of Oceanography at UBC began to collect NOAA-AVHRR data with its own receiving station in 1983.

Within the RADARSAT development there is however, a very significant oceans component with sensors having very large data rates. Oceans remote sensing will become very important in the next decade, both in Canada and abroad. There is some urgency to address the problems of data handling and delivery of this data.

The Marine Environmental Data Service of DFO, Canada's national centre for oceanographic data and information, has perceived a need in Canada for the development, routine generation and dissemination of advanced products which incorporate remotely sensed data and conventionally collected observations. The object of the current study was to examine the problems associated with development of new oceanographic products associated with the development of a Canadian Ocean Information Centre. We were also asked to recommend products and services which would maximize the success of an OIC.

Since the success of any commercial enterprise follows from its ability to fulfill and to anticipate the requirements, knowledge and concerns of its customers, it was necesary to examine in some detail just who the 'users' of a Canadian OIC might be. The study therefore first sought to determine who the users of ocean information in Canada are, what their present and projected uses are or will be, and how best to meet their needs. We interpreted "ocean information" in the broadest sense and did not ask specifically about their needs for remotely sensed data. However, the question about how best to meet these needs required consideration of how remotely sensed data could be integrated into information products, what resources will be required to do this, and how the service could be delivered. Our approach centred on 56 personal interviews and a 167 responses from a mail-survey of 400 selected users of ocean information. Our conclusions and recommendations herein are in very large part drawn directly from survey responses regarding present and projected uses, and include suggestions and recommendations from the users themselves.

2. OCEAN INFORMATION CENTRE DFO/MEDS SURVEY METHODOLOGY

The mailing list for questionnaires and the lists for interviews were assembled from the MEDS database of existing clients and interested parties; from UPDATA Inc.'s proprietory databases of oceanic industries, remote sensing and value-added consulting firms, shipping interests, fisheries , aquaculture, offshore exploration, the Geographic Information Systems sector and municipal, provincial and national government organizations; and from additional names provided to our project team. The additions filled in certain gaps in present MEDS market coverage, as represented in the database provided for the survey.

A total of 400 establishments, companies, associations, cooperatives and other group interests was selected. As distinct from a random survey, our methodology ensured that all user interests would be covered, geographically and by sector. At least one representatives was included from all organizations known to us in the exploration industry, remote sensing, shipping, GIS and advanced technology oceanic users, and known MEDS clients or prospects in universities and governments.

The MEDS database was updated to eliminate firms no longer in business and to correct errors and omissions in names, addresses, postal codes, etc..

A high proportion of the corporate, association and interview respondents represented much larger numbers of their members. i.e. fishing fleets; aquaculture groups; native users; university communities; scientists in government institutes. Thus, the data obtained are valid for a much larger total number of users.

The data and information requested by DFO/MEDS were such that it was necessary to devise two questionnaires and to double the number of questions. The mail questionnaire required 7 pages. Four additional pages were needed for interviews. These were prepared in English and French.

Input from the entire team was required to make the questions as brief as possible and easy to understand without compromising the survey objective. To allow accurate classification of the respondents, questions were structured to overcome the anticipated reluctance to provide often proprietary or classified information.

Both absolute and scaled questions were employed to force specific, rather than general, answers. In addition, ordinal scale questions were deliberately biased to generate absolute responses in such categories as client time requirements and data delivery systems. To encourage a high response rate despite the unusual range and complexity of the information sought, a covering letter from DFO was included with each questionnaire. The letter solicited cooperation from respondents and stressed the benefits to be derived in future products and services from MEDS.

The survey was a combination of mail questionnaires and in-depth interviews of selected, critical users. Interviews included all types of large users and user groups. Many interviews were conducted in person. However, in order to save time and expense, most were conducted by telephone. The responses to the survey questions were tabulated and analysed in dBase III.

The very short time available for the project made it essential to fix a two-week deadline for receipt of mailed responses. This was emphasized by red rubber-stamping both the envelopes and the forms with a request for return by the deadline. First class mail was used. The available funding did not allow the customary and desirable provision of stamped return envelopes.

The 167 returns received by the deadline of February 26 represented a very high return rate of 38.44 percent. The list of organizations which were interviewed or which responded by mail is presented in abbreviated form in Appendix A, as well as on dBase III files on 5.25" diskettes delivered separately.

3. PROFILES OF THE CANADIAN OCEANOGRAPHIC COMMUNITY

3.1. The Respondents to this Survey

The tabulated responses to the 'short form' questionnaire, for which we have 167 separate respondents, are presented in Appendix B.1. Selected cross–tabulations between questions dealing with organization type, areas of interest, expenditures, means of collecting data etc. are included in Appendix B.2.

The numbers of industry and government respondents in our database are about equal, each representing about 43% of the returns. Industry and government users are also about equal in number to a similar survey of satellite data users by Europe's Earthnet Program Office in 1986 (NRSC, 1987). However, in that survey academic users represented 50% of the returns, whereas in our survey academic users represent only 13% of the responses. This may be a result of a survey of a wider community in the European survey (all disciplines, not just oceanography and ice studies), and the relatively small university population in Canada.

Operational users are almost equally divided between government and industry, with industry having about 12% more operational users. Academia does not perceive ocean data as operational to its needs and correspondingly, have the greatest proportion of research users.

Our respondents are fairly evenly divided by geographic region. Atlantic and Pacific users represented each about 25% of the total, while Ontario–Quebec users made up about 38%. Prairie and territory users represent 13% of the respondents.

The questionnaire asked users to describe their principal use of ocean data in general. A breakdown indicates an overwhelming use in research (40%) and lesser use in operations (24%). The remaining 33% of use is shared, in decreasing order of importance, by engineering, 'other', regulatory requirements, education and resale. It is worth noting that only one organization identified its prime use of ocean data as for resale, whereas many industry users requested access to ocean data for resale, as shown in the free–form section of the questionnaire. This presumably means that most of these groups are using ocean data to solve problems (ie for research), and do more routine processing only as a side line.

Consulting companies represent by far the largest group in our sample of the industry sector, followed by marine transportation. Within government organizations, Federal agencies make up about 72% of the database. Education was most represented by oceanographic groups with biology a close second in the academic sector.

About 25% of industry respondents represented relatively small firms (less than $100,000 annual sales) and a similar fraction answered for larger firms (more than $10 million sales) The remainder have annual sales between these two extremes.

Again, about 50% of the survey respondents represented groups of either less than 10 employees (20% response) or more than 100 employees (31% response). About 20% of the respondents have NO staff that work with ocean related data. About the same proportion are unsure or do not know how many in their organization work with ocean data. It seems, in general, that 50% of the respondents employ 6–20 who work with ocean data.

The Arctic, though not the single, PRIMARY geographic area of interest to most respondents (only most important to 11%), was an area in which many users are still interested (54%). The same relationship appears true, if not more so, of the open ocean, that is in oceans outside Canada's EEZ. Only two organizations surveyed make their living primarily in the open oceans, though the interest is definitely there, probably as opportunities make themselves available. The large number of respondents indicating an OTHER primary area of interest is a result of organizations in Quebec, probably referring to the Gulf of St. Lawrence (not inland waters and not Atlantic)

As anticipated, Atlantic respondents are most interested in the Atlantic, those in B.C. most interested in the Pacific, and those in Ontario–Quebec most interested in Inland Waters.

Most users currently obtain data by themselves or from government, and mostly in the form of paper charts, plots or listings. The status quo seems to be generally maintained in user preferences for future data, though more users seem to want computer media and electronic means of communication.

A large majority of users spend little or next to nothing for ocean data (31%). Many users are unsure how much they spent on ocean data, most likely because they have not itemized this information in their accounting procedures.

Ocean users want to be informed about what goes on in their business. A resounding 98% respondents want to be kept informed on present and future uses and applications of ocean information. A similar 98% foresee a future application or need for ocean information in their organization.

3.2. Ocean Information Requirements Identified

3.2.1. Ranking by parameters

As pointed out in chapter 2, it was not practical or desirable to conduct wide and numerically representative sampling in this study. We have not weighted the tabulated responses from each sector by their gross annual sales, or their national security, sovereignty or safety importance, although that could be done. Rather, the parameters are ranked according to the number of responses within and by sector (Table 3.1). We did not ask the respondants for descriptions of their problems or tasks which generated their need for ocean information since the survey questionnaire was already very long and detailed, but where it was evident from the interviews, we briefly discuss information requirements in the light of the problems faced by the user.

When all survey responses from both the mail survey and the personal interviews are considered together, and ordered by the number of 'NOW' responses for each parameter, the most important parameters are mostly physical operational concerns. Hydrography, currents, weather, tides, waves, temperature, sea level, ice and salinity drew positive response from more than 85 (50%) of the 167 respondents. This response is understandable considering the problems faced by those who actually operate at sea, regardless of their sector or 'category'.

Advance knowledge of severe weather (fog, freezing rain, high winds) and wind generated waves, are of critical importance to mariners, since the efficiency and safety of their operations are strongly affected by the visibility, stability and sea–worthiness of their vessels. These parameters were discussed by Morin et al., (1987) who prepared the in–depth study of the weather information requirements on the British Columbia coast referred to in section 3.3.2.

The depth of water and navigational hazards are obviously important for vessel operators, but these do not normally change quickly. In this case, spatial information is more important than temporal resolution.

In some regions, the presence of sea ice or icebergs will determine whether vessels can operate safely or at all. Although the requirement for this information did not rate highly on a national basis, in the Atlantic and Arctic regions, it is critically important and therefore cannot be discounted from national concerns.

The importance or economic impact of the first several 'operational' parameters (hydrography, currents, weather, tides, waves and ice) is much greater than the numbers suggest, since they are safety related. A single search and rescue operation, or loss at sea has an enormous cost out of all proportion to what might be the annual budget of an OIC. Estimation of the actual economic or national importance of this information was out of the scope of this project.

When 'FUTURE' requirements are added, fish and suspended sediments are important to more than 50% of those surveyed.

Table 3.1 Present Canadian ocean information requirements by parameter and by sector, according to the OIC survey

	Number of responses									
	TOTAL	ED	GOVT	IND	INDUSTRIAL SECTORS					
					CONSULT	AQ+ FISH	TRANS	OIL+ GAS	ENG	OTHER
Responses in each sector	167	22	74	71	31	11	8	5	5	10
RANK PARAMETER										
1 Hydrography	122	17	52	53	27	9	7	4	3	3
2 Currents	117	18	52	47	26	10	5	3	1	2
3 Marine Weather	106	11	46	49	24	9	7	4	3	2
4 Tides	105	17	42	46	23	10	7	3	1	2
5 Waves	103	15	42	46	24	9	6	4	1	2
6 Sea Temperature	100	15	46	39	20	9	3	4	1	2
7 Water Level	89	10	45	34	21	2	4	4	1	2
8 Ice	88	11	37	40	22	4	6	4	3	1
9 Salinity	85	14	39	32	21	3	3	3	1	1
10 Fish	62	11	29	22	10	10	0	1	0	1
11 Suspended Sediments	60	11	26	23	15	2	1	3	1	1
12 Navigational Hazards	58	6	27	25	9	5	7	2	0	2
13 Water Qualit	57	11	30	16	10	1	2	0	1	2
14 Plankton	57	12	28	17	9	5	0	2	1	0
15 Water Chemistry	51	10	26	15	9	2	0	2	1	1
16 Coastal Erosion	48	10	17	21	16	1	1	1	2	0
17 Ship Location	46	5	16	25	10	4	6	2	1	2
18 Icebergs	44	5	18	21	12	2	4	2	0	1
19 Water Colour	41	6	19	16	8	6	0	0	1	1
20 Shellfish	39	8	19	12	7	4	0	1	0	0
21 Birds and Mammals	34	4	19	11	6	3	0	2	0	0
22 Seaweeds	30	7	16	7	3	3	0	1	0	0

The pattern is somewhat different if responses are examined according to organization type, and of course is related to the tasks each organization faces in its operations. As expected, educational interests are widest and more evenly distributed across the parameter list, with relatively less interest in weather and water level. The task of educators requires use of abundant ocean information as examples and illustrations of ocean phenomena, and as data for research. By and large, their requirements are not immediate. This sector is not well funded in Canada, and will probably not be major purchasers of data.

Government and Industry requirements are narrower, with government showing more interest in biological and chemical parameters such as plankton, fish, chemistry, water quality and seaweeds than industry. This interest is related to government's role in "understanding the offshore environment and its resources" and "protecting the common resource base and the marine environment" (DFO, 1987). Respondants to the survey told us that this research is often very specific, and requires collection of most of the data by the researchers themselves. An OIC would have a role to play however, in making available supplemental data collected by others on related or co-located problems. Such information is often of significant importance in the detective job required to solve a particular problem. In this case, it is essential that the investigator have easy, quick and inexpensive access to a wide variety of archived information. Research users also have use for synoptic weather (cloud cover, air temperature, wind speed and direction), climate and environmental data (water temperature, salinity, plankton concentration for example) for use in models or to place their own data in context.

Many government agencies are involved with planning and managing either a resource or its exploitation. An example of the data requirements of a provincial ministry is discussed in detail in section 3.3.3.

The Canadian Coast Guard is required to provide the infrastructure for safe navigation as well as with Search And Rescue. In their SAR capacity, the operational safety concerns noted above will be important, as will knowledge of surface currents and water mass movements (to predict where to search for drifting vessels or debris).

The Navy's task in preserving Canadian sovereignty requires operational data on weather and seastate, but their anti-submarine capability depends in large measure on acoustic remote sensing. This in turn, requires good knowledge of the density structure of the coastal areas since sound transmission can be greatly affected by the vertical and horizontal temperature and salinity structure of the water column, as well as by the character of the bottom.

Our 'Industry' group is diverse and has wide requirements for ocean data. Included in this grouping are Fisheries and Aquaculture, Marine Shipping, the Offshore Oil and Gas companies, Engineering and Construction, and the Consultants. While the consultant group was numerically large in our sample, it largely reflects the needs of their clients – governments and other industries. Overall, the industry responses for ice and ship location are much greater than those from government or education.

Because their principal activity is directed at ocean biology, the responses from Aquaculture and Fisheries showed much greater need for information concerning fish, plankton, water colour and salinity. In British Columbia for example, the interest in plankton, colour and salinity is driven by the very large plankton blooms which occur off that coast, both on the continental shelf and in protected coastal waters. The distribution and or catch-rates of wild salmon are affected by these blooms in outer waters, while blooms in coastal areas have been responsible for about $15 million losses of penned salmon in aquaculture establishments during the last two years. Salinity is of interest in coastal waters where the onset of blooms may be a result of intermittent mixing, fresh water induced stratification and nutrient enrichment from the farms themselves.

The requirement for ship location information was only identified as a major interest by the transportation sector, who also of course need weather and seastate forecasts. However, it is clear from interviews that several other types of organization will also have very great need for this information. It is critical for defense, sovereignty, search and rescue and fisheries management. At least for the first three uses, the costs of not having the information could be much greater than the cost of obtaining it.

Our interpretation of comments made during the interviews suggest that Canadian fisheries management currently uses little oceanographic or biological information. Fleet distribution, as obtained via radar or visual observation from aircraft, combined with catch information derived from fisheries observers and officers who 'hail' or board representative vessels within the fleet are used to derive estimates of harvest rates. The airborne surveillance system is limited by the amount and coverage possible.

The offshore oil and gas industry is a major user of ocean information. There were only five respondents in this survey from this industry, but they showed a remarkable consistency of need for information.

There are four types of need for ocean information in the offshore exploration industry. First is the operational need for physical data on marine weather, waves, currents and ice on a local and regional, real-time (within one to 24 hours) basis. The second is a strategic operational need where monthly and annual mean and extreme climatologies of weather seastate, water properties, ice and biological parameters are required for operational planning and wellsite licencing. There is an engineering need for very detailed historical time series of physical parameters and for reliable extreme values for design of offshore structures. Finally, for the preparation of environmental statements and for contingency planning, general knowledge of the whole spectrum of ocean data from physical to socio–economic is required.

Generally speaking, within the Oil and Gas sector, the frequency of requests for data can be expected to decrease significantly from the tactical to the environmental needs. The tactical information is required daily, while requests for environmental information may only occur once a year on an industry wide basis.

3.2.2. Delivery time, temporal and spatial resolution

The responses of 56 individuals personally interviewed regarding their requirements for data delivery time (time between data collection and delivery to the user), temporal and spatial resolution are presented in tables and plots in Appendix C and D. In each case the total is further broken down according to 'Education, Government, and Industry' categories, since the requirements of each organization type sometimes differ. In the tables, the parameters are ordered within columns according to the number of positive responses, allowing a rapid impression of which parameters dominate each delivery time, temporal response etc.. For example, 13 of the 56 individuals interviewed said that their organization required weather information immediately, 8 said within 6h, 2 within 12h etc. Negative or uncertain responses are not shown and account for the difference between the sum of the responses and the total number of interviewees (56). The split within each major column between Education, Government and Industry shows for example, that Education has almost no requirement for real–time weather information. From these tables, 'profiles' of the requirement of any sector for any parameter can be derived. For this study, time constraints did not allow detailed analysis, and the requirements are derived from the summed responses for all organization types.

Table 3.2 summarizes the required delivery times, spatial and temporal resolution, area of interest and present and preferred source and medium for each parameter (according to the response totals). For most of the more popular parameters, there are relatively clear maxima in the distributions (easily seen in the plots in Appendix D) and these are tabulated here. For less popular parameters the small number or dispersed nature of responses did not always allow selection of clear preferences. Examination of tables C.1 to C.8 shows that the education, government and industrial organizations often have very different interests.

In almost all cases educational interests are broader, and less urgent, with a clear preference for computer compatible data. Most government agencies generally reported coast–wide requirements for daily and weekly summaries, while industrial interests are more local and immediate.

3.2.3. Projected uses/users of data

We attempted to assess whether our data showed any evidence of a future shift of the present requirements for information types, by comparing the answers to the NOW and FUTURE questions of both the mail survey and interviews. Table 3.3 suggests that there will be a general increase in requirement for all forms of ocean information. The largest increases, calculated from the sum of NOW plus FUTURE responses divided by NOW responses for each parameter, will mostly be a widening of interests. That is, the least popular parameters at present will see the greatest increase in interest in future. This pattern is most marked in industry, where shellfish, birds and mammals, and seaweed show the largest increases. Within government, the strongest increases will come in ship location and sediment concentration. The smaller number of responses from education make the trends less reliable, but there will apparently be some growth in interest in icebergs and water colour.

Table 3.2. Summary of Canadian Ocean–Data User requirements, from summed survey responses.

Rank	Parameter	Delivery Required	Temporal Resolution	Spatial Resolution	Area of Interest	Present Source	Preferred Source	Present Medium	Preferred Medium
1	Hydrography	Y	Y	1Km-10m	L,R,C	Gov't	Gov't	Paper	Paper
2	Currents	M,I[1]	I	1-10Km	R[1],C[2]	Self	Self(-)	Other	Computer
3	Weather	I	3H	10-100Km	R[1],C	Gov't	Gov't?	Paper	Computer
								Radio	Phone
4	Tides	Y,I	1H[3],6H[1]	10-100Km	C	Gov't	Gov't	paper	Computer
								other	Other
5	Waves	I[1],M	3H	<10Km	C	Self	Self	Other	Other
						Gov't	Gov't	Radio	Computer
6	Temperature	D[2],M,I[1]	D	1-10Km	C	Self	Self	Computer	Computer
								Computer	Other
7	Water level	M	D,M,1H	10-100Km	L[1],R[1],C[2]	Gov't	Gov't	Other	Computer
8	Ice	D	D	1-10Km	C	Self	Self	Paper	Phone
						Gov't	Gov't		Paper
9	Salinity	M[1],I	W	1-10Km	C	Self	Self	Other	Other
								Computer	Other
10	Fish	D[2],W[1]	D[2],W[1],M	10Km	C	Self	Self	Other	Other
						Pers	Pers		
11	Sediments	M,I[1]	D[3]-M	<10m-10Km	L	Self	Self	Other	Paper
								Paper	Computer
12	Hazards	I	D[2],Y[2]	<100m	C	Gov't	Gov't	Paper	Paper
13	Quality	(D,M,I)	W	10m-10Km	R[2]	Self	Self	Other	Other
14	Plankton	M,I	D-M	10Km	R	Self	Self	Other	Other
15	Chemistry	(M,D,I)	(D-W)	10m,1-10Km	R,C	Self	Self	Other	Computer
									Phone
16	Erosion	Y	M,Y[1]	1-10Km	L[1]	Gov't	??	Paper	Paper
						Pers			
17	Ships	D,I	12H[3],D[1]	10Km	R,C	Self	??	??	??
									Pers
18	Icebergs	(D,I)	(3H,12H[2])	1-10Km	(R[1],C[2],B[3])	Self	Self	Paper	??
19	Colour	D,M	D[3],W[1],M[2]	1-10Km	C	Self	??	Computer?	Satellite
20	Shellfish	D-M	W-M	1-10Km	L,R	Self	Self	Other	Other
21	Birds	(D,M)	M	<10Km	R	Self	Self	??	??
	Mammals					Pers	Pers		
22	Seaweeds	(M,D)	M	1-10Km	R	Self	Self	Other	Other

I = Immediately, Real–time
D = Daily
W = Weekly

M = Monthly
Y = Annually

L = Local
R = Regional
C = Coast–wide

B = Basin–wide
G = Global

Superscripts indicate differences between organization types. [1] = Industry, [2] = Government, [3] = Education

Some lower ranked parameters having a small number of responses do not show clear preferences and generalizations are not possible (bracketed or ??).

Table 3.3 Apparent increase in demand for ocean information, by parameter according to results of the OIC survey

PARAMETER	Number of responses									
	TOTAL	ED	GOVT	IND	INDUSTRIAL SECTORS					
					CONSULT	AQ+ FISH	TRANS	OIL+ GAS	ENG	OTHER
Hydrography	1.10	1.06	1.08	1.13	1.15	1.00	1.00	1.25	1.67	1.00
Currents	1.16	1.00	1.12	1.28	1.23	1.00	1.20	1.33	5.00	1.50
Marine Weather	1.17	1.18	1.09	1.24	1.25	1.11	1.00	1.25	2.33	1.00
Tides	1.13	1.00	1.05	1.26	1.22	1.00	1.14	1.33	5.00	1.50
Waves	1.21	1.00	1.17	1.33	1.29	1.11	1.17	1.25	5.00	1.50
Sea Temperature	1.20	1.07	1.15	1.31	1.30	1.11	1.67	1.25	3.00	1.00
Water Level	1.20	1.10	1.09	1.38	1.24	1.50	1.25	1.25	5.00	1.50
Ice	1.23	1.09	1.14	1.35	1.36	1.00	1.17	1.00	2.00	3.00
Salinity	1.26	1.14	1.18	1.41	1.24	2.00	1.67	1.33	2.00	2.00
Fish	1.21	1.09	1.14	1.36	1.40	1.10		2.00		1.00
Suspended Sediments	1.40	1.09	1.35	1.61	1.47	2.00	3.00	1.33	3.00	1.00
Navigational Hazards	1.21	1.00	1.07	1.40	1.67	1.00	1.00	1.50		1.50
Water Quality	1.26	1.00	1.10	1.75	1.60	3.00	1.50		2.00	1.00
Plankton	1.23	1.08	1.11	1.53	1.56	1.60		1.00	1.00	
Water Chemistry	1.31	1.10	1.12	1.80	1.44	3.00		1.50	2.00	1.00
Coastal Erosion	1.35	1.00	1.24	1.62	1.50	1.00	2.00	1.00	2.50	
Ship Location	1.37	1.00	1.38	1.44	1.60	1.25	1.17	1.50	2.00	1.50
Icebergs	1.36	1.40	1.11	1.57	1.58	1.00	1.25	1.00		2.00
Water Colour	1.32	1.33	1.11	1.56	1.75	1.17			1.00	1.00
Shellfish	1.41	1.13	1.21	1.92	1.86	1.50		2.00		
Birds and Mammals	1.38	1.00	1.21	1.82	1.83	1.33		1.50		
Seaweeds	1.37	1.14	1.00	2.43	2.67	1.67		2.00		

3.2.4. Present and preferred means of data collection

Questions 6 and 7 of the long questionnaire were directed at the present and 'preferred' media and sources of ocean data. A comparison of responses in tables C.5 and C.6 allows us to identify some areas where the respondents would like to see changes, although the inferences drawn must be tempered by the small number of responses for most parameters. The last two columns of table 3.2 summarize tables C.5 and C.6.

A consistently large number of responses show a strong desire to maintain government supply of hydrography and tidal information. The need or desire to 'collect it ourselves' is strongest for the biological and chemical parameters (the least popular parameters) as well as temperature, salinity and currents.

There were many comments to the effect that all forms of data should be available in computer compatible format, although there were also comments to the effect that the move to computers should not exclude paper products. The summed response from the interview questions concerning media also showed this preference. However, examination of the breakdown by organization type showed that this requirement was mostly from university and government users.

Increased delivery of weather data by telephone is also apparently desired, although this demand comes mostly from industry who would also prefer telephone access to several other parameters. The telephone category was ambiguous, since it could have been interpreted to mean verbally or by modem.

For most parameters there was a small decrease in the desire to 'collect it ourselves'. There was also an apparent wish to decrease the amount of data obtained from government, since most but not all parameters showed fewer positive answers for 'Government' in question 7 than in question 6. This may be a function of the wording of the question ('purchase' from government), since there was not an increase in one of the other sources listed.

Other differences of only 1 or 2 responses may not be significant. The summarized comments may give a better picture of requirements than this part of the long questionnaire.

3.2.5. Users as possible sources of data

Each individual interviewed was asked if his organization 'was willing to make' ..data on each individual parameter..'available to other users'. Not all respondents answered the question, in part because not all parameters applied to all users. However, of those who answered the question, the large majority said they would supply data to other users (selling was implied).

The negative answers we did get were mostly from industry. We received comments from fisheries representatives that since they are in a competitive situation, they are unwilling to share information which may help them find fish easier or faster than others. Examination of the ranking of parameters reveals that they are 50% more willing to share the safety related parameters (waves, currents and weather) than the nearest other parameter, in this case temperature.

3.3. Other Studies of Ocean Information Requirements

3.3.1. Requirements for remote sensing data

Several recent user surveys are applicable to a Canadian Ocean Information Centre (Oceans Working Group, 1985; EOSAT/NASA, 1987; NASA, 1988c; and, Lapp and Lapp, 1981; DFO, 1980)).

In a recently published series of reports as part of the Eos Earth Observing Program (NASA, 1988c), NASA divided users of satellite data into three broad groups, based on data needs. The groups are:

Instrument Specific and Real Time Users

Archival Users whose requirements are known and

Archival Users whose attributes are known.

The real time users are operational users such as NOAA and DoD, instrument research users who are validating sensors, algorithms or applications, and the 'spectacular event monitoring group', (i.e. those working on catastrophic events such as storms, earthquakes, floods, volcanic eruptions, El Nino, etc.). This group requires on-line data processing and display, quick-look data, and raw to fully-processed data. NASA estimates about 20 users in this first group.

The archival users who know their requirements by instrument, geographic area or time of data acquisition, require access to a catalogue of data. NASA estimates 1,000 to 10,000 users in this second group, with about 5% active at any one time.

The archival users who address scientific problems require visual browse facilities and catalogue listings, custom processing and description of the data. About 500 to 10,000 users are estimated to belong to this third group. Although NASA (1988c) does not specifically focus on ocean users, ocean users are considered part of the expected satellite data user community. Other reports in the series detail ocean satellite capabilities (NASA a–j, 1988.)The users referred to in these NASA studies were primarily research oriented groups in all disciplines. More directly related to this study, ocean user needs related to ocean colour have been recently investigated by EOSAT and NASA (1987). Table 3.4 summarizes the results of extensive surveys and meetings with users and user panels. Users were broken into two broad classes: commercial and operational; and research. Results of the survey are tabulated by discipline/application, recommended spatial and temporal resolution, and perceived required data access time.

In light of the large increase in satellite data which will become available in the next decade, the Oceans Working Group (1985) examined Canadian user requirements for ocean satellite data. User requirements were broadly categorized by parameter into: ocean colour; sea surface temperature; waves; wind; ocean features; circulation/sea level; clouds/precipitation; and ship detection. Data delivery was considered by associating real-time and archival data needs with federal government departments and application with expected satellite data source. The report also discussed data handling and storage and recommended options for satellite data management in Canada. A summary of the user requirements identified in this survey are summarized in Table 3.5. There was no priorization of data products.

Table 3.4. Commercial and operational users' recommendations regarding data delivery time and spatial and temporal resolution for an ocean colour satellite (EoSat/NASA; 1987).

Discipline and Application	Resolution (Nominal at Nadir) (km)	Satellite Revisit Interval (hr)	Data Access Time (hr)
Fishing Industry			
Fish Location	1	48	24 max
Currents	1 and 4	48	24 max
Visibility	1 and 4	24 max	ASAP
Fisheries Research			
Development of Applications	1 and 4	48	24
Monitoring Larval Transport	1 and 4	48	24
Habitat Studies	1 and 4	48	N/A
Monitoring Unusual Environmental Events	1	48	24 max
Pollution Detection/Monitoring	1	48	24 max
Research and Development	1 and 4	48	24 max
Offshore Oil and Gas Industry			
Currents	1	48	24 max
Fronts/Eddies	1	48	24 max
Ice-Edge Location	1 and 4	48	24 max
Sediment	1 and 4	48	12-24
Pollution Detection/Monitoring	1 and 4	24 max	12 max
Research and Development	1 and 4	48	N/A
Marine Transportation Industry*			
Currents	1 and 4	24 max	24 max
Fronts/Eddies	1	24 max	12-24
Ice-Edge Location	1	24 max	12-24
Visibility	1 and 4	24 max	12-24
U.S. Navy**			
Sea Ice Cover	25	24	12
Sea-Surface Temperature	10/25	12/72	3/12
Turbidity (Differential Attenuation Coefficient)	0.5/25	3/12	0.25/3
Bioluminescence	5	24/72	6/12
Ocean Color (Chlorophyll)	1	24/72	6/12
Atmospheric Visibility (Aerosols)***	10	1	0.25
Littoral Sediment Transport***	10m	3/12	0.5/3
Shallow Water Bathymetry***	10/300m	1/3	0.25/24

* To improve centralized ship routing, SeaWiFS data covering all areas where these services are provided will be required. Daily global data at a resolution of 4.5 km will satisfy this requirement. Data of this resolution will enable routing services to improve their strategic advisories to take advantage of ocean currents and eddies. However, vessels at sea will require higher resolution data in real time to tactically position their vessels to take full advantage of these currents.

** If there are two parameters in the columns, the first is for a 4200 x 4200 km coverage, and the second is for global coverage.

*** In conjunction with other sensors.

Table 3.5. Summary of Canadian ocean information requirements which can be met by satellite sensors, according to Oceans Working Group (1985).

Data Type	Ocean Colour	Sea Surface Temperature	Waves	Winds	Ocean Features	Circulation Sea Level	Clouds/ Precipitation	Ship Detection
a) Clients/ Applications	DFO, UNV/ ocean productivity	AES, DND/ marine forecasting	DND, AES, IND/ marine forecasting	AES, DND, IND/ marine forecasting	DND, AES, DFO, UNV/ocean fronts	DND, DFO, UNV,IND/ currents	AES, IND/ marine forecasting	DOT, DND/ ship routing
b)	DFO, UNV/ ocean research	DFO, UNV/ ocean features	DFO, IND/ climatology	AES, DND, DFO UNV/research	DFO, UNV/ research	DFO, UNV/ research	DFO, UNV/ ocean heat flux	DOT, DND/ vessel traffic
c)	DFO/ocean features	DFO, UNV/ ocean climate	DFO, UNV/ research	AES, DND, DFO IND/ice drift	DFO, UNV/ internal waves	DFO, UNV/ ocean geoid		DFO/fishing activity
d)	DFO, UNV/ sediment distribution	DFO, UNV/ fisheries		DFO, IND/ wave climatology	DFO, UNV/ bottom features	DFO, UNV/ tides		
e)	DFO, UNV/ coastal habitat			DFO, UNV/ ocean circulation		DFO, UNV/ bottom features		
f)				DFO, UNV/ heat flux				
Lead Agency	DFO	CFWS, AES	DFO	AES	DFO	DFO	AES	DOT
Sensors	CZCS AVHRR	AVHRR VISSR	SAR Altimeter	Scatterometer SSMI Altimeter	Radiometer SAR	Altimeter	SSMI	SAR
Data Delivery								
real-time:	a	a,b,d,e	a	a,c			a	a,b,c
archival:	b,c,d,e	b,c	b,c	b,d,e,f	a,b,c,d	a,b,c,d,e	b	
Data Source	SATCOM RADARSAT CCRS	SATCOM RADARSAT	RADARSAT/ERS-1 SATCOM	SATCOM RADARSAT/ ERS-1	SATCOM RADARSAT/ ERS-1	SATCOM ERS-1 TOPEX	SATCOM	RADARSAT/ERS-1

In a contract report to Canada's Radarsat office, Lapp and Lapp (1981) detailed user requirements of ice and ocean information. User–groups noted in the report were: the Canadian Coast Guard and General Shipping; Offshore Drilling and Production; Oil and Gas Shipping; Fisheries; Meteorology; Defense; and Research. Needs were divided into planning, tactical and strategic needs. Parameters investigated were weighted towards ice (type, concentration, thickness, edge location, ridges, leads, icebergs, etc.). Ocean parameters reported on include: wave and swell height and period, wind speed and direction, sea surface temperature, surface currents, ocean colour, salinity and chlorophyll. Critical user groups were identified; that is, those users whose needs force critical ice/ocean information requirements for accuracy, resolution, repetition, and turnaround time. According to this report there exist only three critical user groups; namely, the Canadian Coast Guard and General Shipping; Oil and Gas Shipping; and Offshore Drilling and Exploration. The other groups did not force critical needs on ice information. As far as ocean information is concerned the same three user groups dominated critical needs of this data. The critical user group of ocean colour was Research. Fisheries were identified as the critical user group of ocean salinity and chlorophyll data. Tables 3.6 summarize critical ice information and critical ocean information requirements.

An interdepartmental study team (DFO, 1980) investigated the problems with Canadian ocean information services at that time and made several recommendations regarding the role of MEDS, interdepartmental coordination, improvement of information services, and planning for future data collection platforms. They pointed out that new developments in remote sensing and communications technology were creating significant possibilities for improvement in the collection of ocean related data, but that there was a lack of man–power for development. They also recommended an up–to–date directory of Canadian oceanographic data holdings, improved access to ocean services, and a more comprehensive information service in general. Data requirements identified are shown in table 3.8.

3.3.2. Requirements for marine weather information

The '1986 West Coast Weather Information Services Study' (Morin et al, 1986) was a very thorough study done by an inter– departmental task force (Departments of Environment, Transport and Fisheries and Oceans) set up to coordinate improvements in marine weather services on the British Columbia coast following several losses at sea on that coast. Even though as the name implies, the work dealt mainly with weather and sea state requirements, the questionnaire and interviews did ask about sea temperature, fronts and plankton. The size and depth of the study makes its findings important to our present investigation. Table 3.7 summarizes the relevant findings.

3.3.3. General requirements of a provincial ministry

The information needs of any organization mirror their mandate and or operations. As an example of provincial requirements for ocean information, the following summary of an interview with Mr. Bob Langford, BC Ministry of Environment and Parks (MoEP), Planning and Assessment Branch is included. This discussion highlighted the problems with the burgeoning information problem. The Coastal Information Working Group (CIWG) within that ministry recently finished an internal review of the information needs of the ministry concerning the coastal zone (CIWG, 1987). They found that at least in BC, no single agency had responsibility for this zone, and as a result information was scattered throughout several provincial and federal organizations, in a variety of formats. Much information is not even written down because inventory studies now have a very low priority within governments. This proliferation of separate and sometimes obscure ocean related databases was also commented on by several other interviewees.

While their recommendations are provincially focused, the conclusions of the CIWG are relevant to a wider Canadian OIC. CIWG recommended that:

1. A directory of coastal information be established, to lead investigators to reports, data holdings, data archives and individuals with special expertise. This implies that all information be geo–coded.

Table 3.6.1. Critical ocean information requirements identified by Lapp and Lapp (1981).

PARAMETRIC REQUIREMENTS		PARAMETRIC SPECIFICATIONS							
PARAMETER	TYPE OF INFORMATION REQUIRED	ACCURACY		SPATIAL RESOLUTION		REPETITION OF COVERAGE		TURNAROUND OF INFORMATION	
		S	T	S	T	S	T	S	T
SEA STATE	height	1 m	0.5 m	50 km^2	< 1 m	6 hr	1 hr	<6 hr	instantaneous
	period	5 sec	0.5 sec	50 km^2	50 km^2	6 hr	1 hr	<6 hr	instantaneous
	direction	–	5°	–	–	–	6 hr	–	1 hr
SWELL	height	–	<1 m	–	<1 m	–	<3 hr		<<3 hr
	period	–	NS	–	NS		<3 hr		<<3 hr
WIND	velocity	1 m/s	0.5 m/s	100 km^2	–	6 hr	1 hr	<6 hr	instantaneous
	direction	20°	5°	–	–	6 hr	1 hr	<6 hr	instantaneous
SURFACE CURRENTS	velocity	–	0–0.25 m/s ± 5%	–	–	–	3 hr	–	1 hr
SEA SURFACE TEMPERATURE	°C	2°	NS	100 km^2	–	6 hr	6 hr	<6 hr	<<3 hr

Table 3.6.2. Critical tactical ice information requirements identified by Lapp and Lapp (1981)

PARAMETRIC REQUIREMENTS		PARAMETRIC SPECIFICATIONS				
PARAMETER	TYPE OF INFORMATION REQUIRED	ACCURACY	SPATIAL RESOLUTION	REPETITION OF COVERAGE	TURNAROUND OF INFORMATION	NUMBER OF GROUPS MAKING SPECIFICATION
LEADS	% of area	2 %	20 m	3 hr	2 hr	2
	width	25 m	5 m	continuous	instantaneous	2
	pattern	25 m	25 m	3 hr	<3 hr	1
	separation	<500 m	500 m	continuous	instantaneous	1
PRESSURE	convergence	positive sign	10 km²	3 hr	2 hr	1
ICEBERGS	detection	1 km	1 km	1 hr	<1 hr	1
	location	20 m	100 m	continuous	instantaneous	3
	movement direction	5°	5°	1 hr	<1 hr	1
	size	5 m	5 m	continuous	instantaneous	3
	height	<3 m	3 m	continuous	instantaneous	3
ICE ISLANDS	size	<20 m	20 m	continuous	instantaneous	3
	height	<1 m	1 m	continuous	instantaneous	3
	location	20 m	100 m	12 hr	2 hr	2
SNOW COVER	yes/no thickness	0.2 m	10 m	continuous	instantaneous	2
TYPE	% of area	2 %	25 m	continuous	instantaneous	3
CONCENTRATION	% of area	5 %	10 m	continuous	instantaneous	3
THICKNESS	m	1 m	20 m	12 hr	2 hr	1
EDGE/BOUNDARY	location	100 m	100 m	1 hr	instantaneous	1
LANDFAST ICE	location	50 m	500 m	12 hr	2 hr	1
FLOES	size	10 m²	20 m	continuous	instantaneous	3
RIDGES	height	0.25 m	1 m	continuous	instantaneous	3
	density	5 %	20 m	12 hr	<12 hr	1
	width	1 m	10 m	12 hr	<12 hr	1
	keel depth	1 m	1 m	24 hr	<24 hr	1
	type	FY/MY	10 m	continuous	instantaneous	2
	separation	<30 m	30 m	continuous	instantaneous	1
MOTION	magnitude	1km/day	1 km	continuous	instantaneous	2
	margin	1km/day	1 km	continuous	instantaneous	1
	direction	5°	5°	continuous	instantaneous	1

Table 3.6.3. Critical strategic ice information requirements identified by Lapp and Lapp (1981).

PARAMETRIC REQUIREMENTS		PARAMETRIC SPECIFICATIONS				
PARAMETER	TYPE OF INFORMATION REQUIRED	ACCURACY	SPATIAL RESOLUTION	REPETITION OF COVERAGE	TURNAROUND OF INFORMATION	NUMBER OF GROUPS MAKING SPECIFICATION
LEADS	orientation	10°	25 m	6 hr	2 hr	2
	% area	2 %	20 m	6 hr	2 hr	3
	width	25 m	25 m	12 hr	3 hr	2
	separation	500 m	500 m	12 hr	3 hr	1
PRESSURE	convergence	positive sign	2 km	6 hr	2 hr	2
ICEBERGS, BERGY BITS, GROWLERS	size	5 m	10 m	6 hr	2 hr	3
	height	3 m	3 m	6 hr	2 hr	1
	location	20 m	100 m	12 hr	6 hr	2
FLOES	size	10 m	20 m	12 hr	3 hr	3
ICE ISLAND FRAGMENTS	size	20 m	20 m	12 hr	3 hr	3
	height	1 m	1 m	12 hr	3 hr	1
	location	20 m	100 m	24 hr	6 hr	2
SNOW COVER	thickness	0.2 m	10 m	12 hr	3 hr	2
DETERIORATION	% meltponds	5 %	10 m	7 days	7 days	
SURFACE CHARACTERISTICS		10 m	10 m^2	6 hr	2 hr	1
BOUNDARY/EDGE	location	100 m	100 m	6 hr	2 hr	3
TYPE	% by area	5 %	25 m	6 hr	2 hr	3
CONCENTRATION	% by area	5 %	10 m	6 hr	2 hr	3
THICKNESS	m	0.2 m	0.2 m	24 hr	6 hr	3
LANDFAST ICE	location	1.5 km	500 m	24 hr	6 hr	1
MOTION	margin	1 km/day	1 km	24 hr	6 hr	1
	magnitude	1 km/day	25 m	12 hr	6 hr	2
RIDGES	height	<1 m	1 m	6 hr	2 hr	3
	density	5 %	20 m	6 hr	2 hr	2
	orientation	10°	–	6 hr	2 hr	1
	separation	<20 m	20 m	6 hr	2 hr	1
	type	FY/MY	–	12 hr	<3 hr	1

Table 3.7. Summary of findings of the West Coast Weather Study bearing on ocean information requirements (as of February–April, 1986):

Communications equipment on BC vessels:
- essentially all marine vessels have radio (CB, VHF, AM/FM)
- 35% fishing vessels have TV, 60% of towboats
- 10% fishing vessels and towboats have FAX
- 14% fishing vessels, 8% towboats have computers

Sources of weather information:
- Continuous marine broadcasts 82–92%
- Local Coast Guard radio 75–80%
- Other mariners (esp for fishing vessels)

Requirements for marine information:

Weather:
- hourly reports met and sea state from buoys
- 20–26% said present marine weather forecast was 'good'

Tidal information
- 88–90% said present tide books were good enough

Sea state
- 88–93% said this was important
- 87–93% said wave height important
- 60–75% said wave direction important
- 18 to 40% said wave period important

Sea temperature
- 52% fishermen said SST is important to their operation
- 5 to 20% other users regarded SST as important

Plankton
- 52% of fishermen said 'positions of plankton concentrations' would be of use
- 5 to 14% other users said this was important.

Thermal fronts
- 56% fishermen said that 'information of positions of ocean thermal fronts' would be of use
- 18–35% other users indicated this was important information.

Education/refresher courses
- 65–85% all users said they would take refresher courses
- 75–85% said they would like a brochure about weather

Table 3.8. Comparison of ocean information requirements identified in this and other studies.

This Study	Oceans WG (1985)	Eosat/NASA (1987)	Lapp+Lapp (1981)	Morin et al (1986)	CACRS (1980)
Hydrography		'shallow water bathymetry'			
Currents	X	X	X		X
Weather	X	'visibility'	X	X	X
Tides			X		
Waves	X		X	X	X
Temperature	X	X	X	X	X
Level	X				
Ice	?	X	X		X
Salinity					
Fish		X			
Ships	X				
Colour	X				
Plankton		X	Chlorophyll	X	
Sediments		X			
Other	ocean features	fronts eddies		fronts	fronts

2. There was a need to improve the presentation of information, possibly through the use of Geographical Information Systems (GIS) which would allow staff to have 'hands on' capability to map information without having to work with inflexible hard copy maps, charts etc.

According to Langford, BC is now computerizing their referral systems and bringing them together. He feels that there is a strong need for a federal provincial coordinating committee to develop an information system (for the west coast), to insure that new systems are compatible with existing ones and to develop priorities for new directions (that is to respond to new requirements leading from development on the coast). This is presumably the case in other jurisdictions also.

The information needs of the BC provincial MoEP are as varied as the mandates of the various branches. Most of the work is planning, assessment and development of guidelines. For these uses, it is important to have ready access to large amounts of varied archived information, but a rapid delivery after data collection is not needed. There are however, immediate needs where health concerns are involved. The Waste Management Branch for example, requires water quality information such as colliform counts immediately, and therefore conducts them themselves.

Responding to a question regarding the amount of money spent on ocean information. Langford said it would be very difficult to estimate this, because it is buried in regional office budgets within individual branches. This comment was also heard during other interviews.

He was of the opinion that regional managers were making decisions based on inadequate data because of the lack of inventory studies and the current difficulty in accessing existing data because of its dispersed nature.

An analysis of 8 MoEP questionnaires provided by Bob Langford reflects the mandate of the provincial agencies polled. Descriptive, geographic information such as location, vegetation, elevation and bathymetry, and derived estimates such as productivity and sensitivity were identified as being most widely used.

3.3.4. Comparison of ocean information requirements identified in this and other studies

The above review of other studies having relevance to Canadian Ocean Information requirements reinforces the findings of our survey. Except for hydrographic and tidal information, the need for which appears to be adequately met at present (see tables C.5 to C.8 and 3.2), currents, weather, waves, temperature, ice, and colour were all identified by 3 or more of the other studies as important parameters (Table 3.8). Ship location, Salinity, and Fish were identified by only one other study (Ocean Working Group,1985; Lapp and Lapp, (1981; and Eosat/NASA, 1987); DFO (1980). Comparing our findings with those of the 1980 interdepartmental study (DFO, 1980) indicate that the needs have not changed substantially.

3.4. Monitoring the Community

Elsewhere in this document we recommend establishment of an on-line system of access to catalogues, databases, inventories, bibliographies, and directories of scientists and experienced personnel and companies. If such a system were in place and widely advertised, we think that it would see wide use and could be the means by which MEDS could keep in touch with the technical user community. A hardcopy newsletter should also accompany such a service.

In addition to a national marketing campaign aimed at the technical users of our oceans, there is a need for a wider education campaign to make the public (including the technical users) aware of the science and technology of the sea, and the potential advantages of exploiting the existing information about the sea. One possibility is a short 'marine' section of the nightly television weather report in all areas, but especially in marine provinces. This should be short but could include colourful enhanced sea surface temperature images, wave height charts and an ongoing discussion about the derivation of products. We have not investigated this in detail but are personally aware of this type of presentation in the US state of Virginia and in the Peoples Republic of China. The object of such a project would not be to transfer large amounts of information in any one presentation, but rather to raise the national awareness of the sea and the availability of technical information about it. This system would be consistent with the recently announced Oceans Policy for Canada (DFO, 1987) and would greatly enhance the public profile of MEDS, DFO, the Canadian Ocean Industry in general and contractors whose work was being presented.

3.5. Summary of Comments Received During the Survey

3.5.1. New products/services, and use and provision of information

Analysis of the free-form 'comments' section of the questionnaire reinforces many of the conclusions drawn from the tabulated responses to the survey itself.

The responses to this questionnaire were first separated into sectors, government, industry and education, then further sub-divided, each into operational and research users. Despite these divisions, the responses appeared to re-group themselves naturally into seven common themes; namely,

1. Data storage and communications
2. Data format and display/presentation
3. Data integration
4. Supply of data to an OIC by non-MEDS groups
5. Specific product/services requests
6. Comments on MEDS
7. Comments on the OIC survey

3.5.2. Data storage and communications

Comments indicated a growing demand in all sectors for on-line access to stored ocean data and an electronic data transfer service. A number of Government researchers requested real-time or on-line products, and access to ocean databases through machine-readable means such as electronic mail or other electronic transfers. Downloading ocean data via Datapac to a PC was suggested for real-time, operational data such as regular ice observations and forecasts. Operators of the CHS Permanent Tide Gauge Network in Atlantic Canada note that "the future trends seem to be towards more use of electronic means with a greater variety of raw and processed data, including fairly sophisticated presentation, such as time-stepped current 'chartlets', storm surge warning, and simplified systems such as TIDE-A-PHONE (902)426-5494 or (506)648-4429".

Not everyone, it seems, finds access to ocean data very easy. Industry operations groups particularly expressed more problems here than any other group. They were more vociferous in their request for rapid and easy access to ocean data, preferably through various means such as facsimile and electronic data transfers. Hardcopy has its place and will be used for some time to come according to one industry user, though they too are moving slowly towards computer media and on-line database access. There are several users who would like "raw" data. However, according to one government researcher, "raw data should be kept in separate but, perhaps, less accessible archives which require the original collector's permission for use".

Some researchers want standardized data formats while others want a variety of formats, several forms of data transfer, and various levels of processing. Standardized storage and level of processing should be set by MEDS and reviewed with industry. "If I have one bitch about DFO regarding fish stocks/harvesting", said one user, "it is that the data are not standardized". Further, industry feels the data products should contain an assessment of quality and be accompanied by more complete documentation. A government operations group wants better government coordination of collection, storage and exchange of data, within and between departments.

Two interesting archives were suggested. These are: "live atlases"; and, a database of fish processors by species processed, location, and export capability. The latter is to assist in market data analysis such as volumes, prices, export and forecasts. Another recommended archive is a digital bathymetric grid for all inland waters and shelf waters, with selective retrieval by area.

3.5.3. Data format and display/presentation

What becomes clear here is NOT the need for one, single format or type of data but a variety of formats and types. Forms similar to AES, MAST, LAST, CONAN, CRISP products, charts, plots, images, continuous records, individual values, monthly/annual summaries, and statistical summaries were suggested. CRISP was noted as a useful format for on-line databases. Charts still have their place. Hydrographic charts, updates and NOTAMS are quite acceptable. Most fishermen get their information on marine VHF broadcasts, marine FAX, or through verbal contacts. One should note, however, that the number of plotters being used in fleet is increasing rapidly. An interesting suggestion was made to post graphical summaries of sea surface temperature charts at fishpacking plants and DFO offices. Principal users must be involved, according to one user, in setting formats for products or services to which they subscribe.

A common request was to see ocean data made available on computer diskettes.

Government R&D and industry operations groups in particular expressed strong views on data format and presentation standards. Standardization, assurance of data quality, and a knowledge of data processing history seemed to be a major requirement by these groups. " More standardization is required", and "there is room for several standards". One user pointed out that there was NO standard at present for time series data, even within his own organization. All archived data must include with it a complete history describing all processing already carried out on the data and the algorithms used, calibrations made, and calculated accuracy and precision. One user pleaded to have MEDS implement standard formats with internal documentation for ALL conventional data, within MEDS, before pursuing "high tech glamour", such as imagery, real-time data, etc. An on-line electronic mail format was asked for by several users. The data must be consistently collected, stored and analyzed within an acceptable turnaround time. The data must be adequately described, to ensure that users understand the limitations of the product.

No matter what the form of data, ease of access was stressed.

3.5.4. Data integration

The most common recurring request was for integration of satellite and in-situ data. Integration into on-going analyses such as plankton surveys or CTD plotting, was mentioned. One researcher wanted to explore combinations of data not previously available, including charts, plots, images, individual values and continuous records. A government operations user suggested integration of monthly and annual sea surface temperatures based on data from all sources. Another user wanted to establish links between available and future ocean observations and numerical models. This is probably a fertile area of research.

A long-standing requirement of the offshore oil and gas industry was an integrated database system that clients could access, through a single 'window', for physical, chemical, biological, hydrographic, ice, climate and other data. One user asked for integrated data products for Canadian trawler fisheries that were geo-coded and geo-referenced and pre-interpreted through expert systems (high likelihood of fish occurrence). Education groups also requested co-registered and geo-referenced archived datasets. Two users asked that such integrated data be of acceptable quality, while warning that "it was dangerous at the moment to trust anyone to integrate in-situ and image data", implying that the data should be prepared in a form capable of integration but the actual integration should be left up to the user. Users want data that has been geo-referenced, calibrated and time-referenced.

3.5.5. Supply by non-MEDS groups

Several respondents, in industry, government and universities, said that they collect or generate their own data, are building their own databanks and do not want others eg. MEDS "to take over". One such user said that their group had no need for "outside" databanks. Perhaps, as one user said, there is a need for a central archive, and that special archives could be indexed for other users. More than one contractor felt that they should be a node within a network of an Ocean Information Centre. One consultant felt the same way, but refused to participate in the survey on the grounds that supplying any information would only help the marketing efforts of their biggest competitor MEDS. Yet another expressed similar sentiments and would only participate in the survey for a $60.00 per hour fee.

There exist many systems and data banks. Granted, they may not be networked in any organized way but each requires examination for possible contribution to an OIC. There are several research companies collecting or processing data that should be made available to others, according to these respondents, and preferably via MEDS. One user asked that arrangements be made "to keep data out of the cupboards and hiding places". Another asked that data they have collected be bought and placed into a central archive. In essence, databases exist in industry and these should form part of the MEDS data network. One goes so far as to say that this should be MEDS policy. One suggested that MEDS act as a directory to databanks of co-registered data.

Data and databanks are available from many sources. One user has a network of DCPs and provides the data to AES and Canada Water Survey. One large fish packing company has dispatchers who tell fishermen where to fish. One industry association is instituting a 'Plankton Watch' in 1988, counting and identifying plankton samples, recording surface temperature, secchi depths, and water colour, and relaying this information to subscribed aquaculturalists via radio/telephone on a weekly basis. Other systems exist and were proposed by respondents. Use of lighthouses, aquaculture farms and other existing services should form part of the overall provision of ocean information. Many types of similar reporting services are "already in vogue", as one respondent states. Additional data of vital importance, however, despite some unavoidable duplication, is preferred to not having enough. One user felt that "raw data" should be wholesaled by a government agency and be made available to value-added industrial groups for resale to users. Another felt that the monitoring and collection of data should be the responsibility of the private sector, although it is necessary for government to act as 'custodian and distributor' of such data and information.

Whatever system is set up a warning is given: "do not create a monster that will use our time to feed it information". This comment was heard more than once and stems from the fact that no organization wishes to commit resources to tasks it sees as not directly benefiting themselves (ie. archiving data for others to use). This probably will require that an OIC have its own budget for reformatting other peoples' data for entry into databases.

3.5.6. Requests for specific products and or services

Relatively few respondents asked specifically for remote sensing data, or similar information. Remote sensing data was viewed by two government respondents as "not very useful or useless". However, they both mentioned using MEIS and LARSEN data. To most respondents, remote sensing data will be "increasingly needed", and some users have quite advanced needs, such as LIDAR, active and passive microwave satellite data, and integrated imagery with currents and winds. The response was limited on this topic.

Ocean data suggestions were numerous and as varied as the number of respondents. It is best to group these requests and present them in tabular form (Table 3.9). Not everyone suggested new data products/services. Some suggested several. The list is only to be taken as a guide as specific items mentioned by users in the free-form part of the questionnaire or in interviews.

Table 3.9. Ocean data product/service areas mentioned in comments

	Number of Suggestions			
	Government	Industry	Education	TOTAL
Waves	7	13	7	27
Currents	11	13	2	26
Temperature	11	12	2	25
Vessel	8	9		17
Fish	6	8	1	15
Wind	3	10	1	14
Ice	4	8	1	13
Transport	2	3	3	8
Bottom	4	1	2	7
Weather	2	5		7
Tide		4	1	5
Climate		4	1	5
Plankton	2	3		5
Chlorophyll	4			4
Salinity	3	1		4
Water quality	1	2		3
Sea level	1	1	1	3
Water level		3		3
Precipitation	2			2
Visibility		2		2
Mixed layer	1		1	2
Shellfish			1	1
Sea state	1			1
Hazards		1		1
Upwelling	1			1
Colour		1		1
Circulation	1			1
Plumes	1			1
Icebergs	1			1
Mammals			1	1
Salinity				0

An important point here – more than one representative of the commercial fishing industry made a comment to the effect that safety related information (eg. improved charts of wind speed and direction, wave height from satellite sensors) should be supplied "free by the government", or "can not morally be witheld, since taxpayers money will be going to pay for it". It may be possible to add a widely applicable 'user–fee' to licences, but it seems unlikely that a subscription fee would be well received.

3.5.7. Comments on MEDS

MEDS, in general, appears to be viewed favourably by its users and has "done a relatively good job". Many users, moreover, have asked for increased MEDS marketing. It appears that MEDS is not reaching all potential users or meeting its full market potential. One user wanted to know who to contact for information. Another was not even aware that DFO provided information on ocean products and services. Their interest was in inland waters. Yet another asked for more information about MEDS. More publicity was requested, in the form of information publications, a publicist or marketer of services/products. One user said that the MEDS system "works" but that MEDS products/services were essentially unknown to "fringe user groups". MEDS "needs to be more aggressive in their publicizing" according to one user. One suggested setting up a user group in the European–style "college" structure, to make users more aware on a continuing basis of new and existing products/services, techniques, suppliers, and so on. The capabilities of new data and the demonstration of their value could be presented through MEDS.

Some users want MEDS to take on a more aggressive role in the ocean information market. "MEDS can act as a coordinating body for resource information collection, storage and dissemination", and, according to another, "provide needed leadership (on the westcoast) for bio–resource information collection, storage and dissemination". One user recommends that MEDS act "as intermediary between data source and users or specialists". Yet another wants MEDS to "take on a higher profile" in coordinating environmental information collection and dissemination, such as that done by government in the North Sea operations. One user asked that MEDS take over supply of METOC charts. Another wanted increased data analysis services by MEDS to produce data products from data collected by the user, while another user was satisfied with the present services, in their present form and method of transmittal. As referred to elsewhere in this report, while some users were asking for increased data analysis services from MEDS, many consultants were concerned about increased competition in what they regard as their role in Canadian oceanography.

At least one interviewee said that MEDS should arrange to make available access to ocean–related satellite image archives in Canada. He commended MEDS on its distribution of GEOSAT data.

Several of those interviewed made the point that there are many researchers who would find little of use in a centralized information service. These are individuals or organizations which have for instance, small or localized study sites which consequently require high spatial resolution (50m), temporal resolutions on the order of minutes (for instance solar irradiance), or information highly specific to a particular problem. For some, their sites vary from year to year and can not be predicted.

MEDS has its problems too, such as missing data (quality control), long response times, and the problem with inputting all research data into MEDS. "It takes quite a long time to see turnaround of data into MEDS reports", states one, and further adds, that they have "heard some horror stories on the length of time data takes to be input into the MEDS system". Others identify some inadequacies, such as Beaufort Sea information, and are quite comfortable to use data sources outside of MEDS, such as from the Coast Guard and Harbour Commissions. One user feels that AES is doing a better job than MEDS and that MEDS should "learn from AES on how to do it right", implying data delivery. One "occasional" user commented that "Americans at Boulder seem to see their data users as a more important constituency than we do in Canada". This user would apparently like to be able to consult someone at BIO. Without such a person they are then "forced to shop by mail or, if you can afford it, by long distance telephone", putting them at a (competitive) disadvantage.

An important view is that MEDS should be seen as a well organized source that makes its data acquisition easy, cheap, reliable and accurate, and that there be a single MEDS ocean information point of contact, one in each region at best, for both collectors and users of data.

3.5.8. Comments on this survey

There have been a host of surveys in recent years. The public and especially civil servants are tired of "yet another damned questionnaire or survey". We met with a number of hostile or barely polite responses, because people feel they have already made their views known repeatedly. This survey was not viewed favourably by some. Several industry users were quite hostile to the survey or to the interviewers. One user did not want to spend time on "more government bullshit", while others refused to participate at all. One respondent resented having to do a similar survey with another government agency, as he had done in late 1987. In the more constructive criticisms, one user suggested referring to a study done for the Director of Planning and Development, Canadian Hydrographic Service, on a similar survey. Another pointed out that the survey did not ask about purchase or sale of data on a contractual basis. One indicated that comments on the survey would follow, after consultation with their deputy minister. The interviewer noted that this respondent appeared quite antagonistic towards DFO. Another user noted that they had already prepared ocean information recommendations in a proposal prepared by BIO in 1987. One user felt that the survey did not adequately reflect inland water users.

Several asked (or insisted) to see the results of this questionnaire since it would have a direct effect on their organization.

3.6. Summary of recommendations arising from the survey

3.6.1. Data quality

The strongest points made both by interviewees and respondents to the mailed survey concerned data quality and ease of access. Quality control of existing and future data services must be good; this presumably means enough knowledgeable people (i.e. budgets) must be available to accomplish the appropriate work within the prescribed delivery times.

3.6.2. On–line access

Again and again we heard requests from the technical users for easy on–line access to MEDS databases, but more often to other Canadian or American archives. For many respondents an ideal system would be one where a user anywhere in Canada could access the OIC via a local data–link or an 800 number, view an on–line catalogue or directory of products and services, and download data of interest (accompanied by information on its level of preprocessing, accuracy and format). The user would define the data by specified time intervals and geographic area, and pay next–to–nothing for public data (except royalties to those who supply the OIC access to their database). Where appropriate, private databases or summaries of their holdings could also be accessed, with a charge both for access and for data. Small datasets and quick–look summaries of larger ones could be obtained on–line, with off–line delivery of large volumes of data as hardcopy products, magnetic tape or floppy disk. Users would be invoiced by OIC.

The wish to access other databases seems to be widespread among the technical users. It appears that a MEDS–sponsored 2–day workshop on an Ocean Information system in Canada is warranted to discuss issues NOT about what types of data are required (there will be no consensus here), but to survey existing/proposed databases, to agree upon standards for data storage, archives, integration, communications, and presentation, and to find ways to fully utilize existing/proposed databases and deliver data to users.

Non–technical users should also be able to access an OIC verbally through a regional representative or an 800 telephone number. Certain selected graphics products such as the METOC sea surface temperature charts and wave forecasts, and the AES synoptic weather charts could also be supplied via modem and personal computer at packing plants or DFO offices. This could have great public relations benefit to DFO.

3.6.3. Role of consultants in an OIC

MEDS must carefully consider the relative roles of government, university and industry in Canadian ocean science. It is clear from the survey that industrial consultants will (justifiably we think) resist any attempt by a government or university organization to compete in offering analyzed products. Many respondents suggested that consultants be nodes or suppliers to an OIC. We suggest that an OIC could act as a catalogue store, supplying some data produced by government labs (lighthouse data, current meter records and CTD profiles for example), but largely selling other people's data and products. Such data could be from other Departments (AES regional weather centres, Ice Central), produced for OIC on contract, or by companies acting privately. It seems to be a widely held opinion within the respondents to the survey that MEDS should not duplicate capabilities currently in the Canadian private sector, or available through American systems. It should build on Canadian industrial competence to assist companies in marketing both within Canada and abroad. As such, the mandate of an OIC would largely be for archiving, inventory and marketing of ocean information. It would act as a catalyst for Canadian industry, not as a competitor.

3.6.4. Regional OIC representatives

There also appears to be a strong requirement for regional Ocean Information representatives, who can help users access the OIC system, take responsibility for getting data created both by government staff and contractors into the system, and act as liason between regional users and suppliers of the data. The present situation in which IOS and BIO have staff with these responsibilities should therefore be maintained and reinforced.

3.6.5. Products for the immediate future

Many of the highest ranked parameters on our immediate list are already produced by or for federal departments including DFO (eg. hydrographic charts, marine weather forecasts and climatologies, tide tables, ice charts, sea surface temperature charts, wave forecasts). These should be made available on-line in digital form. As far as new and different products for the immediate future are concerned, our reading of the survey responses and comments leads us to believe that products dealing with currents, waves and temperature will be most successful. At present, access to wave buoy, and lighthouse temperature and salinity data in near real-time, as well as statistical summaries of these data would be a great use to many people. There is a need for improved sea surface temperature charts, maps and images, and near future products could include satellite image data for temperature and sea level (AVHRR and GEOS) which are already being produced for DFO by several companies.

3.7. Options for Future Products and Services from an OIC

The Ocean Working Group (1985) report made a strong recommendation to establish an OIC with considerable resources for indirect reception of satellite data from CCRS and AES, direct receiving facilities for link to SATCOM, hardware, software and personnel resources to permit handling and display of satellite data and integration of traditional ocean data and a dedicated distribution network for the resultant operational and delayed mode information products. Several deficiencies with the status quo were identified: the lack of a central Canadian focus for acquisition of ocean satellite data which would also act as a central DFO facility and centre of expertise for post-image processing; the lack of plans and arrangements to archive and process SAR data of the oceans; the lack of provision to acquire data from the US Shared Processing Data system. The need to develop means by which to access the large volumes of remote sensing data in an efficient manner was also pointed out.

The OIC system proposed by the Oceans Working Group (1985) anticipates the future needs of Canadian users (largely government) by several years, and is in our opinion a useful exercise at a time when technology is changing very rapidly. However, it is very clear from the survey and interviews that conventional oceanographic data must be well handled and distributed first. Very few of the individuals we interviewed during this study had any understanding of what remote sensing data will become available in the future. When we asked specifically about remote sensing data, even after describing several future possiblities, we often met with scepticism or disinterest. This was particularly true from non-technical users, although even some DFO scientists were hostile to the idea of greatly expanding MEDS. In the absence of a Canadian Space Agency, there may be a requirement therefore, for an Ocean Remote Sensing Development Program such as was undertaken in the 1970's for land applications by CCRS. Such a role could be accomplished by expansion of the present regional capabilities within DFO and increased contracting to build up existing capabilities in Canadian industry.

The recommendation from the Oceans Working Group that a central facility be established was strongly opposed by many of those we interviewed. At least one interviewee made the comment that "Canadian oceans are around the outside of Canada, not at Ottawa". The sense we get from our interviews is that the regional centres should be built up – that is the Ocean Information and remote sensing laboratories at BIO, FWI and IOS. This is happening at present and should in our opinion continue.

A link with the US Shared Processing Network, while not mentioned specifically in our survey responses, would we think be viewed favourably, since users want access to a wide variety of data sources and products which would not necessarily be available in Canada.

Processing and archiving of SAR ocean image data for waves, ocean features and ship detection will also be desirable, and research should be underway at present to develop procedures to produce products.

4. AN OCEAN INFORMATION SERVICE

4.1. Some Existing On–Line Systems

In this section we give an overview of existing systems for delivery of ocean information in Canada and the United States. From this information we can glean features that are or are not perceived to be useful by the users and the operators of these systems and hence determine how to design a system that will be useful in the Canadian context.

4.1.1. NODS

4.1.1.1. Description of NODS

The NASA/JPL Ocean Data System (NODS) is a system intended to provide the oceans research community with data management capabilities and data analysis tools to deal with remotely sensed measurements of the oceans. Its objective is "to archive and distribute data sets from space–borne ocean viewing sensors and, to a limited extent, from in–situ measurement systems". It is the finished product of a system called "PODS", the Pilot Ocean Data System, that JPL began developing in 1980. The data banks that compose its archive contain:

Satellite data
Supporting in–situ data
A Bibliography
A Catalogue

The system is based on Digital Equipment Corporation VAX architecture and operating systems. It offers its users access to the data banks through the terminals operating at 300 or 1200 bps via Telenet or a public telephone connection. The service is offered 24 hours a day, 7 days a week, with the exception of maintenance time weekly and any exceptional shutdowns for repairs and improvement.

The system tries to be a one–stop information outlet to let users determine the existence of RS data, review the literature concerning the subject of interest, look at some of the data, produce some graphics and images and place orders for large amounts of data and reprints of documents. All these services are available on–line, almost continuously.

The Integrated User Interface provides the users with a common system of menus, so that an infrequent user can find his or her way to the required information quite easily. A contextual help facility is provided by pressing "?" at any point. A "Command mode" allows the user to bypass the menus.

The Bibliography provides a data base of abstracts of documents which may be of interest. It covers edited papers, internal and contract reports and User Manuals for various sensors. The bibliography can be searched by combination of author, subject, year of publication, project, sensor, etc..

The Archive Subsystem contains the data identification criteria and the mass storage system. It consists of the Satellite Data Archive Subsystem and the In Situ Data Archive Subsystem. Through it the users can select and retrieve data. The retrieved data can be obtained on computer tapes, listings, disk files, plots and images. In order to reduce the volume of data to be stored, streamlining of the data by removing ancillary information is performed. Data are normally received at Level 2 (see description following), and are kept without modification except for the date/time which is converted and stored as seconds from January 1st, 1950 at 00:00:00. The data can also be "binned" or "gridded" to provide even coverage from randomly distributed observations.

The Graphics subsystem (PODSGRAF) provides the capability to display data in a variety of plot formats on a plotter or terminal.

The Image subsystem (NOIDS) produces pseudo-color images on monitors or on tape. It also generates land mask and histogram overlays.

The Catalog (Global On Line Data or GOLD) contains information related to the observations and allows a search using different criteria: Platform, Measurements, Location and Time. Within each of these criteria, subcriteria are selectable to pinpoint the useful information. The information about the selected data sets can be printed on-line, and an order can be entered for the data.

Other services available to the users are $MAIL and $NEWS which allow users to exchange messages and to find out about new product development.

4.1.1.2. GOLD

GOLD contains information about satellite remote sensing missions. It has been built to be user friendly. Menus guide even the inexperienced user in a quick and effective search for data. For new users there is an instruction menu that describes the operations and the help facility. It can take no more than 5–10 minutes to pinpoint data. Even an inexperienced user of GOLD can expect to spend most of his time browsing data rather than trying to find them.

In spite of the previous comments about ease of access, GOLD is built for the research community, not general users. The user is expected to know what banks exist and what measurements are of interest. The system is also, as was described in section 4.1.1.1 for NODS, made for remote sensing information. Very few in-situ data are included.

The system lacks the elegance in display that is offered on menu- driven systems on microcomputers. The system is built on VAX computers and it shows its heritage in the way the display is tailored to terminals. The display is line oriented, so that information scrolls up from the bottom of the screen, and text from previous operations remains on the screen until it is scrolled off the top.

The information that GOLD contains should be available to users of a Canadian OIC, and conversely, the holdings in a Canadian oceanic database should be accessible through GOLD.

4.1.1.3. NASA processing levels

NASA has assigned numerical labels for the different levels of processing of remote sensing data, which make both the procedures and data themselves easier to discuss:

0: Raw Spacecraft Telemetry

1: Decommutated, earth located data in Engineering units (e.g. volts)

1.5: Physical observables as measured by the sensor with sensor calibration applied (e.g. microwave brightness temperatures)

2: Geophysical observables corrected for environmental factors (e.g. Sea Surface Temperature)

2.5: "Streamlined" data, same as 2 but with most supporting data removed

3: Same as level 2 but reorganized onto regular earth-fixed grid("gridded").

4.1.1.4. Observations on NODS as it relates to a future OIC

The philosophy of NODS is very important: "ONE STOP ACCESS". Users, more specifically the users that an OIC wants to service, should have to make only one stop for their services. The services offered: catalog, bibliography, data, plots, images, mail and newsletter are very useful and the use of a standard access method to all of them makes for very quick user training.

NODS as it is presently implemented is not exactly what is required for a Canadian OIC. It contains only in–situ data that directly supports RS observations. While this split is reasonable in the American context of a split responsibility for oceans data archiving between NOAA and NASA, in the Canadian situation where the responsibility rests within one department a proportionally larger bank of in–situ observations data will need to be handled. Another shortcoming is that the service is biased towards technical users. It is, as described in Brown (1984), a service to the oceans research community, which has the facilities to handle the data in real–time. Considering that the potential clients of an OIC are not all computerized and that a majority of vessels in Canada do not have a computer on board, other access methods will be required as well.

On–line access to Information, Data and Services is extremely important. Several users have asked for it specifically. More users have asked for on–line catalogs, for information about new products, for one–stop access, etc. Interest is sufficient in the Canadian community to keep a concept such as NODS in the foreground.

In chapter 5, the means and content of an on–line inventory will be elaborated. An electronic connection between OIC and NODS should also be investigated to permit Canadian users access to the information contained in GOLD.

4.1.2. ODIS

4.1.2.1. System Description

The Ocean Data Information System (ODIS) is an on–line data location and quality assessment facility put together for the Ocean Information Division of the Institute of Ocean Sciences, Sidney, B.C.. It provides information on all known physical, chemical and biological data sets ever collected in the Canadian Beaufort Sea and on the Canadian West Coast. It is the computerized version of the multi–volume printed catalogs of the Arctic Data Cataloging and Appraisal Program (ADCAP) and the West Coast Cataloging and Appraisal Program (WESCAP).

The system is resident on a Micro–VAX operating as a node on the IOS PACX network. As such, it is available to all terminals on the network, and to dial–up terminals connecting into it. Future interconnection of all DFO computing sites across the country will make it potentially available to all those who are authorized to access DFO–Net.

The system does not contain data but rather provides information on data sets: what measurements were taken, how, when, where and by whom they were taken. An assessment of the quality of the data is provided and sufficient information is given for the user to obtain the data sets themselves.

ODIS is fully menu–driven, and is relatively easy for non– computer experts to operate. These menus guide the user in the selection of a set of data sets, chosen by geographical location, by data type, and data criteria such as timing of collection, collecting agency, collecting and analyzing method, and data quality. Data sets involving ocean currents, temperature, salinity, water level, fish, zoobenthos, marine chemistry and harmonic constituents are at present in the ODIS databases. It provides summary and detailed tabular information, and if it is being run from a graphics terminal, maps of locations of the selected data.

ODIS is presently written in System 2000 for the Sperry 1100/60 formerly used at IOS, with a display manager written in FORTRAN, but is currently being rewritten and enhanced in ORACLE, an SQL database language available for VAX and MS–DOS machines as well as others.

Catalogue information on about 2000 NOAA and CZCS data tapes archived at IOS is being added to the system at the present time, and a quick look facility for the imagery is being created.

4.1.2.2. Features of ODIS useful for an OIC System

ODIS has many features that will be required if a Canadian OIC is set up with an on–line data base system. These features are:

1. The system is menu–driven and relatively easy to use.

2. The system provides information on the quality of data.

3. It is written in a standard language that is readily transportable between different machines.

4. It is accessible on a cross–Canada data network.

4.1.2.3. Enhancements of ODIS that would make it more useful for OIC

For ODIS to be useful as the prototype OIC database system, it needs to enhanced with the following features:

1. It must contain data, not just pointers to data. If not all data can be put on–line at first, at least a "quick look" facility for the data should be provided.

2. It must provide some basic analysis tools for the data.

4.1.3. CAMDI

The Canadian Marine Data Inventory (CAMDI) is a computerized database containing information on the data holdings of MEDS and some other government departments and some industry and university holdings. The inventory is searchable by geographic area, time and type of measurement. Its output is a data set descriptor that can be given to MEDS for off–line retrieval of the data, wherever its location within the MEDS system of data archives.

CAMDI is presently not widely used, even though it contains much of what users have requested. This lack of use might be due to lack of ease of access to it, or to its lack of a user–friendly interface.

4.1.4. Other Canadian Oceanic Databases

There exist many Canadian ocean databases that may be tapped by an OIC. Table 4.1 lists some of these. The OIC survey indicated that many users wanted to either be able to enter their own information into existing databases more readily, to make available their own separate databases, or to be able to access existing national, regional, local or specialized databases more conveniently .

An OIC requires a complete inventory and understanding of existing Canadian ocean–related databases, formats, access procedures, time and costs. Listed here are but a few of the known databases. In order to search for others, an oceans database workshop would be useful.

4.1.5. CDMS

The Cryospheric Data Management System (CMDS) is a database operated by the National Snow and Ice Data Center, University of Colorado with support from NASA's Polar Oceans Program. The system software and hardware are a version of NODS. This system exists primarily to produce and archive sea ice data products from the SSM/I sensors on DMSP satellites. Data products will include first year, multi–year and total sea ice concentration on a 50km^2 grid and archived on a 100km^2 grid and ice edge location on a 12.5km^2 grid. Data products will be archived on an optical disk system and are available through the NASA Space Physics Analysis Network (SPAN), through regular dial–up service to the University of Colorado Computing Center, and through the Telenet Packet Switching Network.

TABLE 4.1 Selected existing Canadian ocean databases

CSIIS:	CANADIAN SEA ICE INFORMATION SYSTEM A database of abstracted ice information from consultant, industry and government reports and routine ice reconnaissance operations. This system runs on VAX11/785 hardware, and is fully menu driven to be user friendly. Data are available on sea ice distribution, movement, physical and mechanical properties and morphology (C-CORE OEIC, MUN St.John's, Newfoundland)
CRISP:	Climate Research in Ice Software Package. Operated by the Canadian Climate Centre of the AES in Downsview, ON, this system is designed to manipulate ice information taken from archived AES weekly ice charts.
IDIADS:	INTERACTIVE DATA INPUT ANALYSIS AND DISPLAY SYSTEM Manages the database, vehicle performance and trafficability program of the MV Arctic. (de Bastiani and Wells, 1987)
AGC GSC:	ATLANTIC GEOSCIENCE CENTRE, BIO Geophysical database of the Atlantic Geoscience Centre, Bedford Institute of Oceanography, incorporated with DBDB5, NAVOCEANO digital bathymetric database, 1984, of the US Naval Oceanographic Office, NSTL, MS. (Verhoef, et al., 1987; Macnab, 1983)
SMDB:	SURVEY AND MAPPING DATA BASE operated by the Department of Forestry and Geodesy of Laval University (Dr. A. J. Brandenberger, pers. comm.) contains information on the status of the world's cartographic program. Of interest to the Canadian Ocean Community is the section of the data base that considers the status of hydrography. This data base is not directly accessible to the public, but specific searches of it may be conducted by the University's researchers on behalf of clients.
ARCTEC:	ARCTEC CANADA MACINTOSH SYSTEM 15-kilometer grid cells of 26 ocean parameters, representing 8 variables for each of 4340 cells over the ocean for each month. The database and GIS is on an Apple MacIntosh and has some modelling and statistical output. (Perchanock, et al., 1987)
PCOD:	PERSONAL COMPUTER OCEANOGRAPHIC DATABASE A database for the ARGOS PTT on an IBM PC/AT (SEIMAC Ltd., Bedford, Nova Scotia)
SINSS:	SHIPBOARD ICE NAVIGATION SUPPORT SYSTEM Shipboard ice information sources integrated with satellite and airborne remotely sensed data to provide historical ice/climatology studies.
EDBS:	ENVIRONMENTAL DATA BASE SYSTEM. An on-line set of physical environmental data bases for the Labrador Shelf, the Grand Banks and the Scotian Shelf assembled by Petro-Canada Exploration Ltd. on behalf of the Labrador Group of Companies and its partners in other areas of the Canadian East Coast Offshore. These data bases included all publicly available information on waves, currents, marine meteorology, sea ice, icebergs and water properties as well as data proprietary to the Group. It was written in IMS with a RAMIS user interface to run on Petro-Canada's IBM 3090 mainframe. All data were on-line, but were accessible only to those who understood RAMIS programming. Ancillary information, including data quality assessment were maintained off line in an extensive library. Extensive libraries of analysis routines were created using RAMIS and SAS.

CMDS has some importance for a Canadian OIC, since it shows that the NODS formalism can be relatively easily ported into another style of database, and that massive on-line optical storage can be attached to the system for inclusion of newly collected data as well as archives of historical data.

4.1.6. NECSYS

NECSYS is an on-line inventory and order placement service for digital data held by the Satellite Data Services Division of NOAA's National Climatic Center in Washington, D. C. The system presently allows remote access to SDSD's catalogue of NOAA polar orbiter data (NOAA-AVHRR). An inventory of DMSP SSM/I holdings is under development. Data can be searched by data type, date, range, satellite, area and direction of orbit. in a system which is menu driven and in which contextual on-line help is available. A print-out of an exploratory on-line session is found in Appendix E.

There is currently no information about cloud cover built into NECSYS. This could be added but would require human evaluation of every scene in the archive. No quick look capability presently exists to ameliorate the situation. It is not yet linked to other systems, but SDSD expects it to be part of SPAN and GOLD eventually.

4.2. Recommended Products and Services

4.2.1. Recommended products

Based on the requests made by those we surveyed, and on the criteria of what is relatively straightforward to produce, we recommend the following list of products and services be developed in an Ocean Information Centre.

The sequence of tasks is clear: upgrade and enhance the existing service first ... then develop new products.

1. An on-line catalogue of MEDS data holdings and products: user friendly, with rigid, defined quality control applied to all data in the archive. A quick-look data summary is required at this level. This quick look facility should be of a chart-like nature, a GIS product generically called a "live atlas". Implicit in this catalogue is on-line ordering of the data or product for off-line delivery in a timely fashion. Data and products of most importance are marine weather, currents, tides, waves, hydrography.

2. A similar catalogue of other Canadian and foreign data, products and services relevant to Canadian interests.

3. On-line access to data and products listed above.

4. Development of new products and services such as:

a. Near-real time surface current images/charts based on altimeter data and geostrophic analysis, and on models using satellite derived wind fields.

b. Images/charts of wind speed and direction over coastal seas, probably derived from scatterometer or altimeter data.

c. Near real-time significant wave height, direction and period images/charts based on altimeter / scatterometer data with 3.5km resolution.

d. Wave forecasts.

e. Near real time surface temperature images of 1km resolution and lower spatial resolution chart derivatives (4km and 10km averages, front locations).

f. Near real time images/charts of sea ice distribution, edge location and type from altimeter, microwave radiometer with 1km resolution.

g. Sea, lake and reservoir levels from altimeter.

h. Images/charts of sediments from visible sensors, 1km resolution for shelf areas and beyond, 25m resolution in nearshore regions.

i. Phytoplankton chlorophyll from blue/green ratios and fluorescence. Resolution as in h. above.

j. Images/charts of ocean features such as internal waves, fronts, waves, eddies.

k. Archiving facilities for real–time, synoptic and derivative products for climatological purposes.

4.2.2. Satellites as sources of ocean data

Over 100 earth–observation satellites, existing, planned and proposed, have been accounted for at the time of this writing. Almost 70 are described, by satellite, sensor or mission, in an appending document to this report (see Earth Observation Satellites and Sensors: from 1988–2005). Included with each description is a list of mission objectives, measurement capabilities and applications. Still others exist, are planned or are proposed, several of which have ocean applications. It is felt, however, that those having some measure of possible impact within the next 15 years on the Canadian ocean community have been included here. This appending document requires continual updating to remain relevant and current.

A number of existing reports and publications detail satellite ocean measurement capabilities (Beal, et al., 1986; Brown, 1986; Gower and Apel (eds.), 1986; NASA, 1984; NCAR, 1981; Oceans Working Group, 1985; Thomas, 1986; and, Weaver, et al., 1987). The Oceans Working Group (1985) reported on oceanographic satellite systems expected to be in place within the 1984–2000 year time frame, and summarized the sensor performance in tabular form (Table 4.2). These results have been incorporated into the appending document, Earth Observation Satellites: from 1988–2005. Since the publication of that report there are several changes and new developments that have taken place. Significant in these changes and new developments, as far as ocean observations are concerned, include: cancellation (at latest report) of N–ROSS; plans to launch Sea–WiFS; successful launches of SSM/I, SPOT–1, SIR–A and –B, and MOS–1; plans to develop and launch a new suite of ocean–observing sensors as part of NASA's Eos Program; renewed support in U.S. satellite earth observation (Ride, 1987); delay in launch of SIR–C and many other shuttle–dependent missions due to the 26 Jan 1986 shuttle failure; piggybacking of the X–SAR mission with SIR–C; and, postponement of the Canadian Radarsat satellite to about 1994.

Listing satellite ocean measurement capabilities can be done in several ways: by instrument/sensor; by required ocean observations; by parameters to be measured; by ocean applications; satellite availability; or, by some other way. A computerized, database management system, such as dBASE, rBASE or ORACLE, should be set up and maintained to allow users to query these satellite capabilities. A user may wish to find out for example, when satellite precipitation, surface wind and temperature measurement capabilities exist simultaneously within the next 10 years, and how and in what form they might receive the data.

In this report, ocean measurement capabilities are tabulated first by generic instrument/sensor, then by geophysical units, derived ocean parameters, secondary and subsequent ocean parameters/applications and sensor limitations (see Table 4.3).

Table 4.4 summarizes in tabular form the ocean–measurement capabilities of satellites according to the classes of survey questions in the OIC. The table has been compiled, further, with reference to a number of other studies and reports (Atlas, et al., 1986; Brown, 1986; Gower and Apel, eds., 1986; NASA, 1984; NCAR, 1981; Weaver, et al., 1987) It is apparent from this table that satellites having visible, near IR and thermal IR sensors support the majority of ocean data needs. Primary source are those that would most likely be first used in addressing a particular data need. It does not indicate that the satellite sensor can meet the need completely. A secondary source is one that would usually complement a primary source or be used in place of the primary source if necessary. The major sensor groups on board various existing, planned or proposed satellites, are shown in Table 4.5. The scheduled launch date and mission life are noted as well. By reference to Tables 4.2 through 4.5, the OIC can formulate plans to take advantage of a particular sensor for an ocean measurement capability within a specified time frame. One can see that sensors in the Visible, near–IR and thermal–IR region are well represented by satellites, launches and time of data availability.

A major weakness of present remote sensing capabilities in ocean measurements is the ability to measure near–surface air temperature and air–sea temperature differences. This is particularly important in air–sea interaction studies. Future sensor capabilities include the ability to measure atmospheric near–surface profile properties that may be related to ocean conditions. Specifically, atmospheric wind, temperature and water vapour profiles, integrated profiles, and precipitation may be measured using doppler lidar and radar instruments (Atlas, et al., 1986). This is an area of future research and is not seen to affect a Canadian Ocean Information Centre within the next five years.

Typical sensor data rates will affect reception, use and storage of the data. Tabulated below are data rates from the broad class of satellite sensors having oceanographic applications.

Table 4.2. Oceanic satellite sensor performance (from Oceans Working Group, 1985).

Sensor Type	VIS/IR Radiometer			Passive Microwave Radiometer		Radar Altimeter		Radar Scatterometer		Synthetic Aperture Radar		
Satellite	Ocean Features (km)	Sea Surf. Temp. (°C)	Chloro-phyll a (μg/L)	Sea Surf. Temp. (°C)	Precipitable Water (g/cm²)	Sea Level (m)	Sig.Wave Ht. (m)	Wind Speed (m/s)	Wind Dir. (°)	Wave Length (m)	Wave Dir. (°)	Ship Det. % Prob
NIMBUS-7			CZCS 30%	SMMR ± 1.5	SMMR ± 0.21cm							
SEASAT	VIRR 5x5	VIRR 1.5°rel. 2° abs.		SMMR ± 0.75	SMMR ± 0.25	ALT 0.05	ALT ± 0.3 (1-5)	SASS ± 1.6 (3-16)	SASS ± 18°	SAR ± 15%	SAR 10	SAR 50
TIROS-N NOAA		AVHRR ± 0.6	ACZCS (OCl) 50% (0.01-10)	MSU 1-1.5								
LANDSAT	MSS 0.08x0.08 TM 0.03x0.03											
GOES	VISSR 8x8	VISSR 1.2° VAS 1.0°										
DMSP	OLS 3x3				SSMI ± 0.2							
GEOSAT						RA 0.02						
SPOT (F)	HRV 0.01x0.01											
IRS-1 (I)	LISS 0.03x0.03											
MOS-1 (J)	MESSR 0.05 x 0.05 VTIR 3x3			MSR 0.5								
ERS-1 (E)		ATSR/IR ± 0.5			ATSR/M 10%	RA 2 abs. ± 0.1 rel.	RA ± 0.5 or 10%	AMI ± 2 or 10% (4-24)	AMI 20°	AMI 20%	AMI ± 15°	
N-ROSS				LFMR ± 0.5	SSMI ± 5	RA ± 0.08	RA ± 0.5	N SCAT ± 2(3-30)	N SCAT ± 16°			
TOPEX						T ALT ± 0.02	T ALT ± 0.02					
RADARSAT (C)	MOMS 0.03x0.03	AVHRR + 0.6						R SCAT ± 2(3-30)	R SCAT 16°	SAR ± 15%	SAR ± 10°	SAR 75
ERS-1 (J)	VNIR 0.025x0.025									SAR ± 15%	SAR ± 10%	
Space Station	MIA IRIS	CSMR	CSMR	PMR ± 1	AMIS	RA ± 0.08	RA ± 0.5	RS ± 1.3 (4-26)	RS ± 16°	SAR ± 15%	SAR ± 10%	

Table 4.3 Capabilities of satellite sensors

Instrument: **Microwave Scatterometer**

Level 0 Normalized Backscatter Coefficient
Level 1 Wind Speed
    Wind Direction
    Wind Stress on the Sea Surface
    Wind Stress Curl
Level 2 Sea State
    Long Wave Propagation
    General Circulation
        Currents
        Fronts
        Eddies
        Upwelling
Level 3 Coupling with Atmosphere
    Open Water in Pack Ice
    Weather Forecasts
    Wave Forecasts
    Climatologies

LIMITATIONS Wind spectra estimates can be improved with knowledge of wave spectra and sea surface temperatures. Low and high wind speed estimates are poor to date and require further research, especially at high wind speeds and in rain.

Table 4.3 continued. Capabilities of satellite sensors

Instrument: **Altimeter (Microwave or Laser)**

Level 0 Return Pulse Delay
- Return Pulse Shape/Size
- Power Level of Return Signal
- Variance in Shape of Return Pulse

Level 1 Surface Topography
- Surface Wave Height
- Surface Slope
- Small–Scale Surface Roughness

Level 2 Ocean Circulation
  - Currents
  - Fronts
  - Eddies
  - Upwelling
  - Cold/Warm Core Rings
- Significant Wave Height
- Geoid Shape
- Ice Surface
  - Topography
  - Extent and Variability
  - Ridges
- Wind Speed
- Feature Detection and Tracking

Level 3 Weather Forecasts
- Climate Predictions
- Tides
- Navigation
- Ship Routing
- el Nino Observations
- Military Cover
- Calibration/Validation of Other Sensors

LIMITATIONS Accurate knowledge of ocean geoid limits accuracy of range measurements.

Table 4.3 continued. Capabilities of satellite sensors

Instrument: **Passive Microwave Radiometer**

Level 0 Microwave Brightness Temperature
- Microwave Emission

Level 1 Water Vapour and Liquid Water Content in Sensor's Field of View
- Surface Temperature
- Surface Roughness

Level 2 Atmospheric Moisture
- Profile/Distribution
- Sea Ice
  - Extent
  - Type
  - Concentration
  - Edge Location
  - Motion
- Wind Speed
- Sea State
- Precipitation over Water

Level 3 Sea Ice Forecasts
- Navigation
- Ship Routing
- Weather Forecasts
  - Hurricanes, Cyclones, Storms
- Climate Predictions
- Surface Films/Slicks
- Military Cover

LIMITATIONS

Table 4.3 continued. Capabilities of satellite sensors

Instrument: **Synthetic Aperture Radar**

Level 0 Microwave Image
- Image Intensity Spectrum

Level 1 Feature Detection/Observation/Tracking
- Surface Waves
- Internal Waves
- Circulation
  - Currents
  - Fronts
  - Eddies
  - Upwelling
- Current Boundaries
- Near–Surface Bathymetry
  - Sea Mounts/Troughs
  - Wave Refraction
- Oil Slicks
- Target Detection
  - Vessels/Icebergs/Offshore Structures
  - Location/Size/Movement
- Surface Wind Fluctuations
- Tidal Bores
- Sea Ice
  - Extent
  - Concentration
  - Edge Location
  - Type
  - Floe Size
  - Movement
  - Surface Condition
- Wave Length
- Wave Direction
- Directional Wave Spectra

Level 2 Sea Ice Forecasts
- Weather Forecasts
- Climate
- Military Cover
- Navigation
- Ship Routing
- Coastal Erosion

LIMITATIONS Estimates of waves can be improved with knowledge of wind, currents and boundary layer stabilities. Wave direction ambiguity can, thus, be minimized.

Table 4.3 continued. Capabilities of satellite sensors

Instrument: **Visible/Near–Infrared/Thermal Scanners/Radiometers**

Level 0 Visible/Near–IR Spectral Reflectance
- Surface Thermal Emission

Level 1 Image (Visible/Near–IR/Thermal/Spectral)
- Ocean Colour
- Sea Surface Temperature
- Surface Heat Flux

Level 2 Observations of Clouds/Aerosols/Haze
- Type
- Extent
- Movement

Sea Ice
- Extent
- Concentration
- Edge Location
- Type
- Floe Size
- Movement

Feature Detection and Tracking
- Circulation
- Currents
- Fronts
- Eddies
- Upwelling
- Cold/Warm Core Rings

Near–Surface Phytoplankton Biomass
Fluorescence at 685nm
Bioluminescence
Suspended Sediments

Level 3 Weather Forecasts
- Climate Prediction
- Precipitation
- Navigation
- Ship Routing
- Military Cover
- Coastal Bathymetry/Bottom Type
- Surface Films/Slicks
- Primary Productivity
  - Patterns/Variability
- Water Quality

LIMITATIONS Clouds limit observation of the ocean surface. In addition, darkness further limits visible/near–IR sensor observations. Thermal IR and passive microwave synergism can help provide surface temperatures in cloudy and clear areas.

Table 4.3 continued. Capabilities of satellite sensors

Instrument: **In–Situ (with satellite relay)**

Level 0 Currents (Surface/Profile)
Temperature (Surface/Profile)
Biomass
Fluorescence
Moored/Drifting Buoys (Wind/Wave)

Level 1 Physical Processes
Productivity

Level 2 Tracking of Features
Characterize Surface below Effective Sampling Depth of Satellite
Exchange Between Surface and Deep Water
Vertical Mixing Rates

LIMITATIONS Integration of in–situ and remotely sensed data is at present the major limitation; integration in time, space, algorithm and application.

Table 4.4. Summary of satellite data sources versus ocean data requirements.

SATELLITE SENSOR DATA SOURCES: Visible, near-IR Radiometers	Thermal Radiometers	Altimeters	Passive Microwave Radiometers	Synthetic Aperture Radars	Scatterometers	DATA NEEDS
●	●	○	○	○	●	Marine weather
●				○		Hydrography
●				○		Navigational Hazards
	●		○			Sea Temperature
			●			Salinity
●						Suspended Sediments
●						Water Colour
●						Water Chemistry
●	○					Water Quality
●						Plankton
●						Seaweeds
●						Shellfish
●	●					Fish
●	○					Birds and Mammals
		●				Water Level
○		●		●	●	Waves
		●		○		Tides
○	●	●		●	●	Currents
●				○		Coastal Erosion
○	○	○	●	●	○	Ice
				●		Icebergs
				●		Ship Location

● PRIMARY (most likely used) SOURCE
○ SECONDARY (complementary) SOURCE

Table 4.5. Launch schedule and expected life for ocean related satellites.

Altimeters

Satellite/sensor	Launch Date	Mission Life
EOS	1993/4 +7	
ERS-1	1990	3 years
ERS-2	1993	3 years
ESA-EOS	1997	
GEOSAT		
MOS-2	1990	3 years
N-ROSS	1990	3 years
RADARSAT	1994	5 years
SPOT-3	1990	2 years
SPOT-4	1992	3 years
SRA		
TOPEX/POSEIDON	1992	3-5 years

Scatterometers

Satellite/sensor	Launch Date	Mission Life
DMSP	1987-	indefinite
ERS-1	1990	3 years
ERS-2	1993	3 years
ESA-EOS	1997	
N-ROSS	1990	3 years
NSCAT	1991	
RADARSAT	1994	5 years
TOPEX/POSEIDON	1992	3-5 years

Table 4.5. Launch schedule and expected life for ocean related satellites.

Passive Microwave Radiometers

Satellite/sensor	Launch Date	Mission Life
DMSP	1987–	indefinite
EOS	1993/4 +7	
ERS–1	1990	3 years
ERS–2	1993	3 years
GOES–next		5 years
J–EOS	1998	
MOS–1	1987	3 years
MOS–2	1990	3 years
N–ROSS	1990	3 years
POES		
RADARSAT	1994	5 years
SPOT–3	1990	2 years
SPOT–4	1992	3 years
SSM/I	1987	1–2 years
TOPEX/POSEIDON	1992	3–5 years
TREM	1994	

Synthetic Aperture Radar

Satellite/sensor	Launch Date	Mission Life
EOS	1993/4 +7	3 years
ERS–1	1990	3 years
ERS–2	1993	3 years
ESA–EOS	1997	
J–ERS–1	1991	3 years
RADARSAT	1994	5 years
SIR–C	1991–92	8 days
TREM	1994	
X–SAR	1991–92	8 days

Table 4.5. Launch schedule and expected life for ocean related satellites.

Visible, near IR and Thermal -IR radiometers

Satellite/sensor	Launch Date	Mission Life
ADEOS 1994		
DMSP	1987–	indefinite
EOS	1993/4 +7	3 years
ERS–1	1990	3 years
ERS–2	1993	3 years
ESA–EOS	1997	
FILE		
GMS–3	1984	5 years
GMS–4	1989	5 years
GOES	1987	indefinite
GOES–next		5 years
IRS	1987	3 years
J–EOS	1998	
J–ERS–1	1991	3 years
LANDSAT–4	1984	5 years
LANDSAT–5	1984	5 years
LANDSAT–6	1989	5 years
LANDSAT–7	1991	5 years
METEOR–2		5 years
METEOSAT	1995	
METEOSAT P2	1998	
MOP–1	1988	
MOP–2	1990	
MOP–3	1991	
MOS–1	1987	3 years
MOS–2	1990	3 years
OCI	1990–93	
POES		
RADARSAT	1994	5 years
SeaWifs	1991	3 years
SPOT–1	1986	3 years
SPOT–2	1988	2 years
SPOT–3	1990	2 years
SPOT–4	1992	3 years
TREM	1994	
UARS	1991	

Table 4.6. Data rates from satellite sensors having oceanographic applications.

SENSOR	RELATIVE DATA RATE
MICROWAVE SCATTEROMETER	LOW
ALTIMETER	LOW
SYNTHETIC APERTURE RADAR	EXTREMELY HIGH
PASSIVE MICROWAVE RADIOMETER	MEDIUM
VIS/NEAR-IR/THERMAL	MEDIUM TO HIGH
IN-SITU SATELLITE RELAY	LOW

An ocean community demanding synthetic aperture radar and related products, for example, can place a heavy burden on an Ocean Information Centre.

Satellite sensor ocean measurement capabilities can be improved through synergism; that is, the process of combining two or more data sets to derive information unattainable through use of the individual data sets alone. To combine data sets into a synergism one must consider simultaneity requirements such as applications, time scale, and synergistic instruments. Table 4.7 lists synergism capabilities in satellite ocean measurements and applications.

4.2.3. Geographic Information Systems as related to an OIC

The requirement most frequently identified in our survey was for computer access to databases. One obvious way to organize that access and to present overviews of the data is through a Geographical Information System (GIS) which will combine geographically referenced data of all sorts and present them in map-like form on a computer terminal or off-line.

Barth (1987) estimates that the worldwide 1986 Geographic Information System (GIS) market represents about 15% ($40 million in revenue) of the worldwide mapping market, with projected increases of 15% in 1987, and could represent up to 30-40% of the total worldwide revenue in mapping. A revolution of sorts, then, seems to be taking place in mapping, as computer power, geo-referenced databases, ways of handling the data improve, and as applications of GIS increase. The emerging importance of integrated spatial information in Canada shows itself, for example, in newly-created groups (CanLab.INSPIRE, 1988) and systems (EMR, 1987; Game, 1988).

The term "GIS" has no single, clear, agreed-upon definition. The terms CAD (Computer-Aided Design), DBMS (Data Base Management System), AM/FM (Automated Mapping and Facilities Mapping), LIS (Land Information Systems) and GIS, are often used interchangeably, though each may serve very different functions. In this report GIS is distinguished by what Cowen (1987) notes is GIS' capacity to conduct spatial searches and create overlays that actually generate new information. A GIS is not simply limited to the storage and sophisticated display of information.

A true GIS must have the capability to capture and edit input data into digital form, store spatial descriptions and attributes in a database management system, and output user-specified maps, reports or responses to queries.

An ocean GIS must be unlike a typical land-based GIS. Oceans are dynamic and changing: their databases must be also. Not only are static data such as bathymetry important but so are dynamic data, such as temperatures, salinity, sea state, vessel locations, fish stocks, and oil spills. A truly complete ocean GIS must also deal with the three dimensions of the ocean as well as data that is often sparse and uncertain.

TABLE 4.7: Synergism in satellite ocean measurements

APPLICATION	TIME SCALE	SYNERGISTIC INSTRUMENTS	REQUIRED SIMULTANEITY
CURRENTS	DAYS	SAR + VIS/IR (High Res) + VIS/IR (Low Res) + SCATTEROMETER	2 DAYS
PHYTOPLANKTON	HOURS	VIS/IR (High Res) + VIS/IR (Low Res)	HOURS
SURFACE STATE	HOURS	VIS/IR (High Res) + VIS/IR (Low Res)	2 HOURS
WETLANDS MAPPING	DAYS	VIS/IR (High Res) + SAR	1 DAY
SEA ICE	HOURS	VIS/IR (High Res) + VIS/IR (Low Res) + SAR	1 HOUR
ALTIMETRY CALIBRATION		ALTIMETER + MICROWAVE RADIOMETER + SCATTEROMETER + LASER (GLRS)	
PRECIPITATION RATE		ALTIMETER + MICROWAVE RADIOMETER OR VIS/IR (Mod Res) + MICROWAVE RADIOMETER	
SURFACE LAYER DYNAMICS (OCEAN CIRCULATION)		ALTIMETER + SCATTEROMETER OR ALTIMETER + SAR	
SEA-ICE ALTIMETRY		LASER ALTIMETER + RADAR ALTIMETER	
NEAR-SURFACE TEMPERATURE PROFILES		MICROWAVE RADIOMETER + IR RADIOMETER (High Res)	
RUNOFF		IN-SITU + MICROWAVE RADIOMETER + VIS/IR (High Res)	
ICE MORPHOLOGY		SAR + VIS/IR (High Res) OR SAR + LASER ALTIMETER (GLRS)	
FRONTAL BOUNDARIES		SAR + VIS/IR (High Res) + VIS/IR (Mod Res)	
SURFACE ICE MELT		SAR + IR RADIOMETER (High Res)	
WIND SPEED & VARIABILITY		SAR + MICROWAVE RADIOMETER	

Almost 50 GIS contacts, vendors and developers of GIS systems, were made in this study in order to obtain information on present operations, plans or research in ocean-related/applicable GIS. This survey showed that there exists not one GIS system developed solely for ocean applications. Land-based GIS systems are being adapted to ocean applications.

Much of the work to date in ocean GIS appears to be in marine ecology and related areas. Berry (personal communication, 1988) markets pMAP, Professional Map Analysis Package, and aMAP, Academic Map Analysis Package. He provides services in computer-assisted map analysis to include data base development, modeling, analysis and training, and has used GIS in marine ecosystem populations, and investigated the land/water interface for tropical islands. Goulet, et.al. (1981), compared and evaluated spatial and temporal distribution patterns of zooplankton populations and their environments. A cartographic database of the continental shelf off northeast USA and ship survey data were integrated to map the distribution of three zooplankton species and the gradients of their abundance. Berry and Sailor (1981) integrated ship survey data and GOES satellite thermal imagery to a common map projection to describe joint occurrence among variables, such as the relationship between surface chlorophyll and satellite-derived surface temperature. Penton (personal communication, 1988) is presently defining new GIS capabilities and developing an advanced spatial data management and analysis system to support "The Gulf of Mexico Initiative", an ecological management program of the Gulf of Mexico between NASA/ERL and the US Environmental Protection Agency, beginning in 1988 and continuing through to 1995. Withee (personal communication, 1988) indicates that the US National Oceanographic Data Centre will use GIS to study the aerial distribution and time change of sub- aquatic vegetation in the Chesapeake Bay, as part of The Chesapeake Bay Program. Design and management of the US National Marine Fisheries Service large ecosystem database using a commercial, scientific database management system is described in Steiger (1986). The US Army Corps of Engineers, New York District, is currently using TerraPak GIS (Walklet, personal communication, 1988) to identify impact areas associated with offshore waste disposal and will be expanding the ocean-related applications of the GIS software. Holsmuller (personal communication, 1988) reports on ERSI'spcARC/INFO and newly-merged ERDAS image analysis systems. He indicates that projects have been conducted in mapping terrestrial and aquatic vegetation communities, and vegetation change detection mapping around the Marco Island area of Florida for US Fish and Wildlife Service. Hock (personal communication, 1988) has attempted to create a marine GIS to monitor and control coastal pollution and to exploit fishery resources. Projects on coastal estuaries have been performed by NOAA NESDIS in the US, to identify blooms and suspended sediments, in the Philippines, to delineate areas of high fishing (tuna) potential, and in West Africa, to track nutrient-rich upwelling zones.

Hydrography appears to be a second major user of GIS capabilities to date, though much of the use described has not taken advantage of fully-functional GIS described by Cowen (1987). Speight and McCourt (1985) integrated interpreted colour surveillance air photos and bathymetric chart data to a common map base using Geobased GIS to assist monitoring the lobster fishery off Nova Scotia by relating lobster buoy location to water depth and/or bottom type. GeoVision's AMS, Automated Mapping System, HIS, Hydrographic Information System, and Autochart (Wilkinson, personal communication, 1988) have been used largely in high-volume hydrographic work, displaying "chart-resident" features and their attributes. Doyle (personal communication, 1988) with the Royal Australian Navy uses GIS to collect and manage on-shore, near-shore and oceanic data in areas of Australian interest, including hydrographic data. His concerns for an ocean GIS are: what information will an OIC contain (topographic, hydrographic), is the OIC concept endorsed by IHO and IOC (World Data Centres A and B), and what is the inshore limit of the data in an OIC.

Other ocean areas in which GIS seems to have been used are varied. The USGS is planning to integrate sonar image maps taken up to 200 miles offshore with existing surface and geological data into a GIS and store the data set on CD ROMs (Withee, personal communication, 1988). The US Navy/NOAA Joint Ice Centre currently analyzes all of its ice products manually. However, by the fall of 1988, a Digital Ice Forecasting and Analysis System (DIFAS) is to be installed to assist in producing ice analyses and forecasts digitally (Kniskern, personal

communication, 1988). The system will integrate satellite imagery, gridded data and charts from other ocean data centres, and observations/reports from ships, buoys and aircraft.

Time and space does not allow a comprehensive statement on GIS use, capabilities, plans and potential in Canada. The potential ocean data base for GIS use is massive, but three major problems affecting advancement in an Ocean GIS are likely to be those noted as in Berry (1987); namely, data availability (standardized data bases, storage requirements), data characterization (exchange formats, resolution, projections), and, modeling uncertainty (using "best estimates" for variables, parameters and functions). Perchanock, et al., (1987) illustrated the problem quite well when they developed a sea ice climatology map using a probabilistic data base of arctic marine environmental conditions. A significant effort was expended in locating and formatting more than 30 individual data sources. They recommend standardization of observation and sampling techniques.

In order to store and make sense of the mass of GIS data, new data management technologies are being explored. Star (personal communication, 1988) and Robinson (personal communication, 1988), among others, are working on expert-systems, or knowledge-based techniques to sift through the data. Yet others, such as Withee (personal communication, 1988), Game (1988), Wilkinson (personal communication, 1988), Wald (personal communication) and Steiger, ed.,(1986) are concerned with integrating data from various sources. Advanced topological standards are needed in an ocean GIS to incorporate volumetric, vertical profile, temporal and other data sets unique to ocean users.

Based on the brief GIS survey done in this study, data types and sources for input to a GIS are listed in Table 4.8 and preliminary functional requirements for an ocean GIS are described in Table 4.9. For a fully-functional OIC ocean GIS to be properly established, these preliminary requirements need to be refined, state-of-the-art GIS and research directions needs to be reviewed, hardware and software options need to be examined and identified along with major functions of an OIC ocean GIS, and markets need to be developed.

Table 4.8. Data input type and sources for an ocean GIS.

DATA INPUT TYPE AND SOURCES FOR AN OCEAN GIS

POINT

- Ship/buoy
- Scatterometer
- Altimeter
- Passive Microwave Radiometers
- Charts–maps

LINE/PROFILE

Horizontal
- Charts–maps
- Profiling sensors
- Sounders

Vertical
- XBTs and similar probes
- Sounders
- Profiling sensors

POLYGON

Horizontal
- Charts–maps

Vertical
- Derived charts–maps/database

RASTER

- SAR imagery
- Visible/near–IR/thermal–IR imagery
- Passive microwave radiometer imagery

VECTOR

- Ship/buoy
- Scatterometer
- Charts–maps

SPECTRA

- Optical/digital 2–D FFT

TABLE 4.9. Preliminary functional requirements for an Ocean GIS

1. Capability to accept the following ocean data types:

    point (surface or at depth)
    line (horizontal/vertical)
    polygon (horizontal/vertical)
    raster/pixel
    vector (surface or at depth)
    volume
    time series
    spectra

2. Ability to both spatially–reference and time–reference data and topologically and chronologically relate data sets.

3. Ability to continually modify/update ocean measurement data and merge existing/future data within specified turnaround times.

4. Allow rapid query and data retrieval of the data base, based on userspecified point, line, polygon or cross–section, or identification of ocean features meeting certain data attribute criteria.

5. Ability to integrate data of diverse types, from various sources, at various entry times, and at different scales, projections and orientations; and, to interpolate between points, lines, surfaces and time intervals.

6. Capability to display spatial and non–spatial/report information, and create new database entries (information) based on user–models, according to user needs and specifications.

7. Ability to communicate with and transfer data between existing/future databases and GIS systems, with known levels of security/license, and data processing and property history.

4.3. Data Required for Data Product Generation

The users have indicated diverse interests in ocean parameters. In order to produce the products that are required by the users, many different sources of data will have to be tapped.

Data can come from either remotely–sensed or in–situ observations. The status of processing varies depending on the product requested. In the following paragraphs we list the data needed to produce some of the products. We will not elaborate on the processing to be done as that is part of a following chapter.

The descriptions follow the order of importance of the products.

4.3.1. Data/information/services inventory

Information required :

* List of data banks for different types of data
* List of cruises, platforms, buoys, etc.. archived in each bank
* Information by parameter, time, area, platform
* Information on the quality of each parameter in each data set
* List of experts in different fields
* List of companies involved in Oceans Data / Information / Services and their expertise
* Bibliography of related subjects: Oceanography, Hydrography, Remote–sensing, GIS, Data management, etc...

Time factor:

The access time varies with the data's time factor: daily for real–time products, yearly for yearly products.

Resources required:

A relational data base running on a minicomputer with good communications facilities to permit access through telephone connections, Datapac connections or dedicated links. Depending on the method of entering the information, it will require a person–year to maintain a system with a fully automated data entry, for verifying the input, running diagnostics and producing regular reports. Another half person–year could be dedicated to answering telephone inquiries and producing and sending reports to requestors. Two PY divided among 4 persons will be required for regional representatives who will administer contracts, locate databases and assess data quality for the inventory, and act as liason between the users and suppliers of data in the region.

4.3.2. Live atlas

Data required:

The atlas will contain data distributed chronologically along cells on the surface of the oceans and in depth. The exact size and contents of the atlas will have to be determined in a subsequent study, but it is conceivable to have data distributed in 10' squares along the coast, widening to 1 degree squares further offshore, 10m at the surface, increasing to 100m intervals at depth. The time interval of the data stored in each cell will also be on a sliding scale with short term observations kept at a short interval, while monthly, seasonally or yearly means will be sufficient for older data.

Resources required:

The system will require the power of a main-frame to process and retrieve the data in a reasonable amount of time. The system will also convert the input data to the cellular mode. One PY will be required to update the atlas using highly automated systems. Two or three more will be required for quality control.

4.3.3. Hydrography products

Hydrography represents the area of highest interest in our survey. It is understandable that anyone who navigates the oceans will consider hydrographic charts extremely important. Hydrographic surveys and chart production represent a large part of the mandate of the Canadian Hydrographic Service, who provide a service most users are quite satisfied with. The use of airborne sensors to conduct bathymetry surveys will increase the speed of collection of data for the compilation of the charts. The production of charts is already heavily computerized so that all new charts are or should in principle be available in digital as well as paper form.

There should be a CHS node on an OIC network to allow users to select and order charts on–line. Notices to mariners and chart updates should also be available in the same manner. Electronic charts were not seen as a high priority by users, so conversion of existing paper charts to digital form is not recommended at this time. However, such charts as CHS has already in digital form, and those that are produced in this form should be available on–line, in order to eventually generate a demand for the product.

Resources needed:

CHS has the mandate to provide charts and Notices to Mariners. If a Memorandum of Agreement can be set in place with CHS to have them provide their products through a node on an OIC network, an OIC should require few resources explicitly to maintain the information directories on the catalogue. We estimate that 0.1 PY should be sufficient to take care of the maintenance of this system.

4.3.4. Ocean current charts

Daily synopses

Weekly Synopses

Data required:

In–situ data:

Current meter observations are needed to obtain current speed and direction. Values at hourly intervals or less are expected. Tidal information or predictions are needed to compute the residual currents.

Remote sensing:

Scatterometer and Altimeter data (level 2) will provide observations of surface anomalies and slope that will be used to compute the currents.

SAR (level 1) data will detect the boundaries of different oceans features, including the currents and gyres. This data can be used to produce qualitative charts of currents without speed and direction.

Historical information:

In order to use altimeter data to obtain the height potential used to compute currents, the shape of the geoid has to be well known. This is accomplished by long periods of observations.

Time factor:

For the production of daily synopses, the data have to be received by the processing centres daily. A schedule will have to be determined to allow processing and dissemination within a day.

Resources required:

A minicomputer will be needed for processing of the data and production of the charts. The use of a dedicated supermicrocomputer with a floating point math coprocessor will also increase effectiveness. In order to permit the distribution throughout the country, communications means relative to the data volumes and to distances from the processing centre(s) to the users will have to be determined. Due to its daily production, these products will require between one and three persons to produce the charts on a regular basis, depending on the areas that will be covered.

Other products:

Maps of Upwelling
Maps of drifter tracks
Tables of drifter velocities

4.3.5. Marine weather

The products offered by AES are satisfactory in general, but are not tailored to the needs of oceans users according to the surveyees. Since AES has the mandate to collect and provide this information, an OIC should not require extra resources to duplicate an AES function. OIC does however need to be able to access the data that AES uses for preparing its forecasts, and to the marine data holdings of the Canadian Climate Centre. Although their data and analyzed products are available through other means, they should also be made accessible to the ocean user community through OIC.

The weather product most often mentioned is a map of wind speed and direction. This product will be most conveniently produced from remotely sensed data, and should be routinely available from AES.

Resources required:

Since provision of the products is an AES responsibility, OIC will need only the resources to keep the catalog information of the database holdings up to date. About 0.1 PY should be sufficient for this task.

4.3.6. Tides, water levels and surges

The primary product that is important to users is tide tables. The survey indicates that users are in general happy with the book form that is presently produced by CHS. CHS also produces on request detailed tide tables for specific locations not listed in the general tables, and hourly tidal elevation data instead of the times of high and low water as appears in the tide tables. These products could be presented through an OIC by providing a database of harmonic constituents on–line, and a set of analysis facilities to provide the required products. In this sense, OIC would be a marketing representative of CHS.

There is also a requirement for observed tides and water levels in the sea and in large lakes. Hydrologists, who are normally considered outside of oceanography, have indicated that they would be interested in the possibility of using altimeters to monitor water level in reservoirs. Because of the 2 to 5 km swath width of the present generation of scatterometers, and the need to have at least 3 measurements over the water surface however, this will probably only be possible over water bodies larger than 10 to 15 km in diameter.

Data required:

In–situ observations:

Tide and water level gauges recording digitally.

Remote sensing:

Altimeter (level I) data for mean sea level and water level.

Time factor:

Data is required at hourly intervals. While the predicted tides are required immediately for navigation decisions, the observed levels are required on a monthly basis for water resources management by Hydro companies.

Resources required:

Processing water level data and predicting tides will require a minicomputer for operational processing of the data. Three PYs will be required for the input and quality control of the data.

4.3.7. Sea state, waves

Wave heights, Sea–state maps
Real–time wave forecasts
Swell
Directional waves
Spectra in machine readable form

Data requirement:

The real–time need is high (23%) for observations and forecasts, but there is also a need for archived data from long–term wave stations.

In–situ:

Wave buoys (directional and scalar), wave staff gauges.

Remote sensing:

SAR (level 2) data for surface wave height and direction Altimeter (level 2) data for significant wave height

Time factor:

Sampling rates of one observation every 3 hours. The requirement for operational purposes is for near real–time data delivery, but there is also a requirement for long–term studies. Weekly maps of significant wave height are also of interest.

Resources required:

For data processing of observed data minicomputers or supermicros are required. The recording method has been analog in the past. However, digital recording is becoming more common and this will reduce the personnel resources required. Three PYs are required for data conversion, input, data quality and preparation of regular reports.

4.3.8. Temperature and salinity

Sea surface analysis: synoptic charts
Real–time SST
Ocean thermal profiles
Bottom temperature
Mixed layer depth

Data required:

Remote sensing:

Near–infrared/thermal scanners/radiometers (level 2) for sea surface temperature

In–situ:

CTD (moored buoys or shipborne); Bottom thermographs; XBT and Aerial XBT; Ship of opportunity XBT observations relayed via radio (IGOSS); coastal light house observations.

Time factor:

There is a requirement for real–time temperature observations in the form of SST charts of the oceans. Weekly synoptic charts are also a useful product. The real–time requirements require that a schedule be established for the delivery of data to the processing centre(s).

Resources required:

Minicomputer image–processing capabilities with plotting facilities to produce charts in real–time. Dedicated microcomputers are also an option for the production of daily charts for dissemination. 2–3 PY are required for processing and quality control of temperature and salinity data.

4.3.9. Ice and icebergs

Ice condition:
edge location,
type of ice
Freezing and thawing dates
Maps of Icebergs

Data Required:

In–situ:

Visual observations

Remote sensing:

Scatterometer (level 2) for open water in pack ice Passive microwave radiometer (level 2) for ice extent, type, and concentration. SAR (level 2) for sea ice cover, floe size and movement. Visible scanner, thermal infra–red (level 2) for ice cover, type, and floe size.

Time factor:

Daily observations of the ice conditions is needed for producing charts of ice movement and the growth or decay of the ice pack. A schedule of delivery of the remote sensing and in–situ data to the processing centre(s) has to be implemented to insure that the product is available for distribution within a day.

Resources required:

AES has an existing Ice Central (ICEC) responsible for processing ice observations. They supplement data from satellite remote sensing by aerial reconnaissance during part of the year. Ice Central should be encouraged to make their data and analyses available through OIC as well as through their traditional distribution networks.

4.3.10. Water colour

The variations of water colour caused by suspended inorganic sediments and living phytoplankton can delineate water masses where temperature differences are small. The phytoplankton standing crop and fluorescence (which can be used to derive an estimate of phytoplankton growth rates) should be important for fisheries research. Salmon trollers and other fishermen use visual observations of water colour in their operations.

Water Colour map
Chlorophyll Distribution map
Chlorophyll fluorescence map
Suspended sediments map

Data required:

In–situ:

Water Colour measurements
Chlorophyll sampling
Suspended sediment sampling

Remote sensing:

Visible Image data(level 1) from LANDSAT, AVHRR and ocean colour sensors on Satellites yet to be launched.

Time factor:

As often as possible during the spring and summer seasons, probably weekly composites except daily during periods of clear weather.

Resources required:

A supermicrocomputer or mini–computer to derive pigment concentrations, image processing capability required for quality control. A quarter of a PY to operate highly automated procedures. Merger with in–situ data should be left to users.

4.3.11. Vessel location

Fishing and shipping organizations surveyed indicated they would very much like to know the position of their vessels as well as those of others. This is extremely important information for Canadian fisheries management also. Both DFO and the large commercial fishing companies now collect this information themselves, through aerial reconnaissance. Coast Guard, MoT and DND also have a current mandate for SAR and defence purposes and use aircraft and coastal radar. As with other information requested by users that is being collected by other agencies, this information should be made available on-line through an OIC.

Data required:

In-situ:

Sightings from aircraft, coastal radar (VTMS).

Remote sensing:

SAR (level 1) provides target detection facilities

Time factor:

Daily reports are required by most survey respondents.

Resources required:

If the SAR imagery is processed elsewhere and vessel locations are determined by other processing facilities, then this product requires a large micro or small minicomputer to access and archive all incoming data. Since the actual volume of data is relatively small, no massive processing or archiving facilities are required. If this facility is co-located with other archiving facilities then it requires relatively little interference or monitoring, probably no more than 0.25 PY.

4.3.12. Other products

There is interest in several other products including fish stocks and water quality. These requirements are sufficiently specialized and appeal to a sufficiently small user group that they do not warrant use of the limited resources of an OIC for their production. Private industry should be encouraged to consider producing these products and to market them through OIC where they feel the products might be commercially viable.

4.4. Associated Information Requirements

For every data product there is a large amount of background information that is neither required for the casual user nor needed for interpretation of the information. Such information might be calibration specifications for individual satellite sensors, algorithms used in preparing higher level data products, descriptions of the projects that caused the data to be collected. A directory to this information should be available as a database accessible in an OIC, and the information itself should be accessible either on-line where feasible, or on printed material kept in regional OIC centres. Use of such information should not be required even for serious users of the data since the level of quality control and data accuracy should be an integral part of the catalogue entry for the data, and hence be up-front when the data are accessed.

Figure 4.1. ERS-1 product support team (British National Space Agency) brochure for ocean products the AMI:wind scatterometer.

ERS-1 Users PST ERS-DC

Product Support Team

AMI : Wind Scatterometer

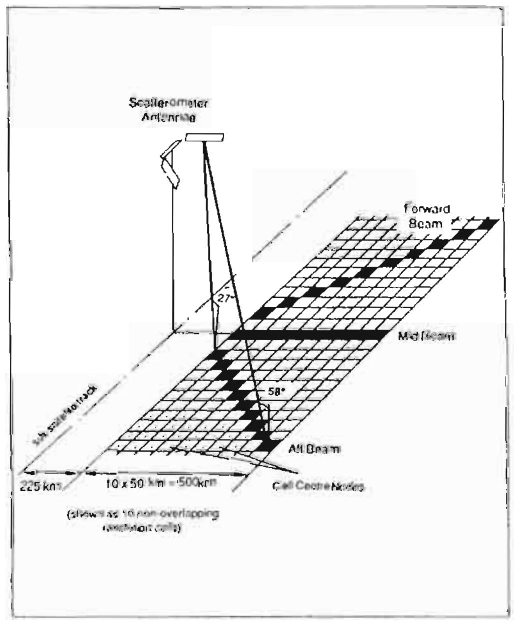
The Active Microwave Instrument (AMI) on board ERS-1 will be capable of operating as a Wind Scatterometer or a Synthetic Aperture Radar (SAR). Since the SAR and Wind Scatterometer share elements of the AMI hardware they cannot be operated simultaneously. However, SAR Wave Mode operation and the Wind Scatterometer Mode can be interleaved.

In wind scatterometer mode, three sideways looking antennae direct forward, mid and aft beams at a swath 500km wide. The antenna beams successively sweep a continuous swath as the platform advances along its orbit. The beams are inclined so that the footprints of the forward and aft beams are at an angle of 45° to the mid beam footprint.

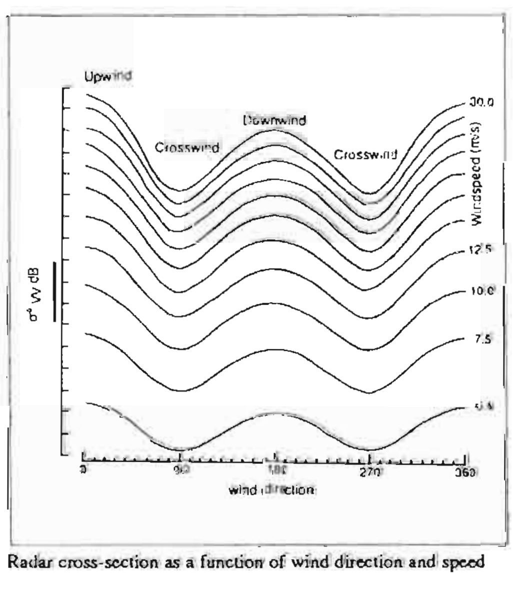
The scatterometer operates by recording the change in radar reflectivity of the sea due to the perturbation of the small ripples by the wind close to the surface. This is possible because the radar backscatter (σ^o) returned to the satellite is modified by wind-driven ripples on the ocean surface and since the energy in these ripples increases with wind velocity, backscatter increases with wind velocity.

Each beam provides one measurement of the radar reflectivity from each cell. Three measurements, separated by a short time delay, can be extracted from each cell (referred to as 'Triplets'). The best-fit of these measurements to a pre-defined family of curves for all wind speeds determines wind speed and direction.

However, anomalies may occur when determining wind direction due to the functional relationship between ocean backscatter, wind speed and direction (see opposite). For this reason, the wind scatterometer produces a ranking of four wind vectors for each cell. In the great majority of cases, the first of these vectors will be appropriate for use.



Wind Scatterometer Geometry



Radar cross-section as a function of wind direction and speed

Parameter	Characteristic
Swath Width	500 km
Spatial Resolution	50 km
Grid Spacing	25 km
Wind Speed Accuracy	4-20 m/s (±2 m/s or ±10%)
Wind Direction Accuracy	0° to 360° (±20°)
Frequency	5.3 GHz
Polarisation	Vertical

Technical Characteristics (not verified)

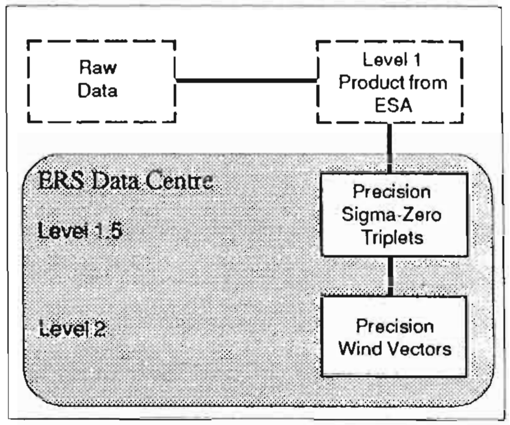
Wind Scatterometer Products

The main off-line wind scatterometer ocean data products to be generated at the UK ERS-DC (Levels 1.5 and 2) are shown in the diagram opposite, and are summarised as follows:-

i) Conversion of the return power for each cell into backscatter coefficient estimates (Level 1.5).

ii) Conversion of the three backscatter coefficient estimates per cell (corresponding to the three viewing directions) into ranked wind vector estimates (Level 2).

iii) Other organisations may incorporate wind vector data into models, global statistics, and climatological data sets (Level 3+).

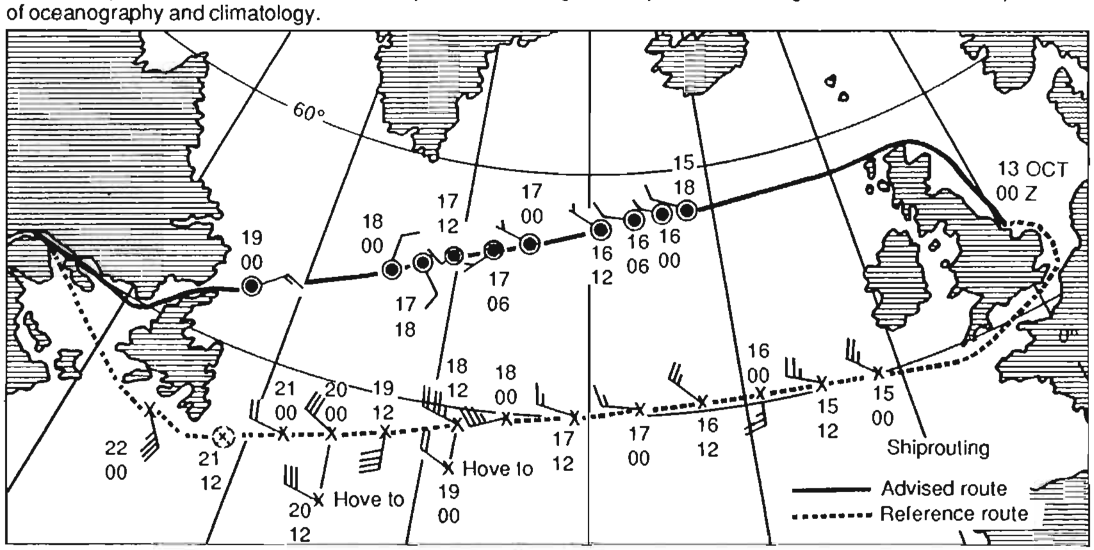


Applications of Wind Scatterometer Data

Weather and Sea State Forecasts - The wind-field information derived from the AMI wind scatterometer will be used on an operational basis by weather and sea state forecasting centres as an input to meteorological models. This will greatly improve the quality and accuracy of forecasting.

Commercial and Scientific Uses - The continuous monitoring of ocean wind-fields and the measurement of sea surface winds, which profoundly influence the exchange of heat between the atmosphere and the sea, will also allow for the establishment of a data-base providing statistical information for a number of commercial and scientific applications.

This will benefit activities in the fields of offshore exploration, ship routing (see below), fish resource management and the design and construction of ships and offshore equipment. In addition, information provided by the wind scatterometer is likely to increase significantly understanding in the scientific disciplines of oceanography and climatology.



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Some responses in the OIC survey indicated that MEDS should make their products/services better known to ocean users, particularly "fringe users". The British Product Support Team of ERS–1 very efficiently illustrates their planned products from the ERS–1 satellite in a series of single–page brochures. Figure 4.1 is one example from their catalogue. For each satellite sensor, background information on the sensor/instrument is given, with supporting instruments if applicable, its ocean measurement capabilities, levels and types of products from the instrument, potential user applications, and a sample product. A Canadian OIC should provide similar, associated information for all of its products including those derived from remotely sensed data.

4.5. Ranking of Products and Services

The products and services that we have recommended in section 4.2.1 are ranked according to our assessment of survey results and user comments, not by estimates of potential revenues and costs.

We conclude that the acceptance of OIC products will be assured by demonstrating the reliability of quality assurance programs, and by offering speedy and easy access to data and services. While we feel that new remote sensors offer considerable potential, it is clear that any new products will have to be demonstrated to be of high quality. A well accepted organization will provide the solid basis required upon which to develop new data products.

It will be better to begin by offering a few simple products and services which people will come to trust absolutely, than to hastily move to new 'geewhiz' products.

The concept of user pay for access to the data should be accepted by users, but in the case of data collected by the government, the fees should reflect only the cost of operating the retrieval system, since some users at least believe that they have already paid for the data collection in their taxes. Where the data or product have involved some significant contribution by a non–governmental organization, the access fees may represent the true commercial nature of the product. Users will require some education and inducement to accept these higher priced products.

We feel that a Canadian OIC could be a viable organization, one that is useful to and used extensively by both the Canadian oceanographic community and the general community of ocean users.

5. DELIVERING THE SERVICE

5.1. A Definitive Ocean Information Service for Canada

5.1.1. A Picture of how it might be

The time is two years hence. A potential user of ocean information dials a local phone number with his computer and is connected either to a local computer, or, through a packet switching network, to a main computer located somewhere in Canada. The computer asks the user a few simple questions about what he wants: where is his region of interest, from when does he want the information and approximately what sort of information is he interested in. The computer then locates the information and presents the user with a summary of what is available, a map of where it is located, what its quality is and gives him a synopsis of the results. The user decides from this summary that the information in the data banks is what he wants, so he asks the computer to give him the complete set of information. Since the volume of information is rather small in this particular case, the computer sends it on–line directly to the user's computer. If the information volumes had been significant, the user could have chosen to have the information sent to him on charts, images, listings, tapes or diskettes.

5.1.2. Implementation of the system

Behind the preceding simple user/computer interaction is a complex network of on–line databases accessed through a main user interface program that combines an 'expert system' for interpreting data requests with a database of summaries of all databases in the network.

The individual databases would not need to be centrally located: indeed it is probably better from an administrative and scientific point of view if each database resides in the care of those who created it and are interested in maintaining it and keeping it current. The databases would appear as 'nodes' on a network that connects them. Such a philosophy is in general agreement with the MEDS policy of regional archiving, and lends itself to the inclusion of databases from other federal and provincial government departments, and commercial 'value–added' archives. This network could also provide an interface with international databases such as NODS.

Each node in this system can be essentially independent. Each one will have any or all of the following functions:

1. Data Collection

2. Data Processing

3. Data/Product Archiving

4. Query capability for data/products located

    a. On the same node

    b. On any other node in the system

5. Response capability to requests for data/products stored:

    a. On the same node

    b. On any other node in the system

Typical nodes range in scale from:

1. A personal computer located in a fisheries office somewhere on the coast. No data are input here, and no data are stored. The purpose of the unit is for fishermen to be able to get a look at the

most recent marine weather, seastate and surface temperature charts in their region, in a manner similar to briefings for aircraft pilots.

2. A mainframe computer that prepares wave forecasts. It requires data from many other nodes, assimilating information on wind forecasts, lower atmospheric stability fields, satellite determined seastate, and many surface observations of seastate, wind and air–sea temperature difference. The node would require massive computing power and data storage capacity for the generated information.

3. A mini–computer or major micro computer located in one of the government institutes. Its primary function is the archival of the collected data of the institute. It would require gigabytes of on–line storage, probably in optical disk form, and an efficient data base manager.

All nodes could be equipped with a catalog of data and products kept on the other nodes: possibly a reasonable amount of summary data could also be kept on mass storage in each node.

An OIC would operate a central node that would be aware of the content of all other nodes updated on a frequent basis, would maintain the database of databases, the detailed data overview facility (the "Live Atlas") and the connections to international archives.

MEDS would be responsible for the operation of the archive system, and would provide some control over standards of product quality control and operating procedures of the various archives.

To satisfy the requests of occasional users, and those of users not equipped to communicate directly with the computers, a central and regional offices need to be provided with a staff prepared to handle verbal or written requests for information and to deal with general problems with the system.

The system would work in a manner similar to commercial database operations in that every on–line user would have an account and would be billed for connect time on a monthly basis. There might also be an access charge for individual databases. Such charges would allow the government to recoup its operating costs for the archive network, and would encourage the industrial scientific community to develop and maintain databases of value–added products, access to which would be charged at commercial rates.

The OIC should become Canada's focal point for the dissemination of data concerning the oceans. This does not imply that the data should reside at the OIC. It is our view that the data should be stored close to the experts who collect or massage it. It is impossible, or at least very unlikely in these days of financial restraints that the OIC would be able to acquire at the same time the necessary broadness of expertise and the necessary depth of knowledge while keeping the global view necessary to manage such a diversified service as discussed in this report. Whether, even assuming a rapid growth, it is desirable to build such an organization is questionable. We agree with the point of view strongly expressed in the survey that it is better to have specialists that stay close to the foci of their speciality, whether these are universities, government research facilities or industrial research and development organizations.

The managerial and marketing side of this enterprise should remain centralized, in order to respond quickly to the changes of direction of the government and client wishes. The Oceans Data/Information/Services Inventory and data summary facility should be maintained and serviced by the main office of the OIC.

The OIC should use the services of science generalists who will be able to maintain a close contact with the work done in the research establishments, direct the work done under contract and plan the implementation of future products. It is also desirable that the OIC be represented in the regions by one or several individuals, whether these are part of the staff or under contract.

These "Liaison officers" would participate in the planning meetings of the OIC and keep a direct contact with the officers of the OIC. At the same time, they will maintain contact with the activities of their regions, go to work meetings of the Institutes, to seminars at the Universities, have informal meetings with the executives of the Oceans industries in their regions. In this way they will be able to insure that the necessary information finds its way to the OIC on time to maintain an up-to-date inventory and that the different participants in the Oceans Community know what the objectives of the OIC are and how they change.

5.2. Data Storage Requirements

Data will be stored according to several general principles. All data eventually will be archived on optical disk. Two types of optical storage technology exist right now, Compact disk (CD, similar to the audio CD) and WORM disk(Write Once, Read Many times). The 5.25 inch size CD holds up to 400 megabytes of data. The larger 12 inch size stores up to 2000 megabytes. These disks cannot be produced with equipment available at rational cost; they must be produced in a CD factory at an approximate cost of $5,000. for the master disk. Once a master is created, copies cost only a few dollars each. Readers of computer CDs cost $1,200 and up.

WORM disks read and write data at about one quarter the density of CDs. They may be written and read with equipment that is within the price range of virtually all business computer users (about $5,000.).

As the technology of optical mass storage matures in the next few years and the market for them increases, these prices should decrease significantly as they have for audio CDs.

An OIC should consider putting the data/ information /services directory and summary data on a CD for distribution to all nodes within the system. This disk would then be the primary resource for all searches for data within the system.

Each data collection or processing node within the system is responsible for storing its own archive data or making arrangements to have the information stored in another archiving centre. WORM drive technology is appropriate for these archive centres to store data for the databases.

In general, all data will be kept on-line where possible. No data should be discarded. Historical data in raw or nearly raw form may be kept off-line if summary information at a level where the information is usually used is kept accessable.

The volumes of storage for these data are given in detail in CACRS, 1985, and so are not dealt with explicitly here. The general form of storage for each of the recomended data products is given in the following sections.

5.2.1. Data/information/services inventory

Storage requirements: This information will be stored in a two-tiered archive. A relational data base will contain the necessary information required to retrieve the adequate datasets. A 4GL query system will insure that the retrieval of information is made as easy as possible. A menu and contextual help facility will guide the novice user through the intricacies of the system, while a keyword approach will let the expert find the required information in an effective way.

The second part of the archive contains more elaborate information: abstracts from the items in the bibliography, short histories of remote-sensing platforms operations, description of sensors, etc. This information can be retrieved on-line to speed research or off-line to reduce the costs.

5.2.2. Live atlas

Storage requirements: This live atlas falls under the broad category of Geographic Information Systems (GIS), and would have to use the techniques developed in this new field. While it is conceivable to use a relational data base management system to store the information and to retrieve it, the advances of the fields of GIS and Artificial Intelligence should be brought into use in order to make the process as easy to implement and modify as possible.

The four-dimension cellular concept of storing the information has been used to describe the concept of the atlas, but it would probably not be the most effective for storage and retrieval purposes.

5.2.3. Hydrography products

Data storage: The data will be kept in a sequential file on tape or disk. It will also represent the first data to go into the Live Atlas.

5.2.4. Ocean current charts

Data storage: The current speed and direction (level 3) can be computed from the scatterometer and altimeter data on a grid of 5 km in areas close to shore and 10km further offshore for the use of product generation. Computed current speed and direction will be stored for a year after the production of the different maps to be used to answer requests for data and to generate monthly reports. Afterwards the data will be integrated into the Atlas in a summarized fashion. Current meter observations will be kept in raw form in the area of collection for two years minimum. Afterwards, they will be copied onto optical storage for permanent archiving. The edited, summarized data will be integrated into the live Atlas.

5.2.5. Marine Weather

The data storage of bulk weather data will remain the responsibility of AES. OIC will store only level 3 data in their live Atlas.

5.2.6. Tides, water levels and surges

Data Storage: The level 2 data from the altimeter: water level relative to the Chart datum, will be stored on a grid of 10 km inshore, 100km offshore, in hourly intervals where possible, in a geographically coded file. The data will be integrated with in-situ observations to produce a monthly report of water levels(remote-sensing), with daily and monthly means. The present reports of water levels from in-situ data will continue being used to produce hourly heights and daily means. Both sets of data should be retrievable to answer requests and for tidal analysis. The integrated water levels will be inserted in the Live Atlas. The level 1 data will be copied to optical disk for preservation.

5.2.7. Sea state, waves

Data storage: The remote sensed data will be used to compute significant wave height, wave spectrum and directional spectrum on a grid of 10km at intervals of 3 hours. The wave field will be computed and plotted for use in daily and weekly synopsis. This data will be kept for a year after which it will be integrated with the in-situ data, summarized and inserted in the Live Atlas. The in-situ data from the buoys will be processed as it is now and put in a format that will permit its integration with the RS data. The level 2 data and the in-situ observations will be copied to optical disk yearly.

5.2.8. Temperature and Salinity

Data storage: The requirements for data products are for daily, monthly and historical delivery. A plot of SST will be compiled from the temperature extracted from the radiometer data (level 2) for daily distribution. The temperature data will be stored in a sequential file for producing the monthly synopsis map. It will be integrated with sea surface temperature obtained from classical sources for this product. All the temperature data will be gridded to be introduced in the Live Atlas. Once a year, the data will be recorded on an optical disk for archiving.

5.2.9. Ice and Icebergs

Data storage: The Ice Data Integration and Analysis System (IDIAS) of the Ice Centre Environment Canada is being implemented to handle ice data from satellites and integrate it with data from their aircraft reconnaissance to produce different products: ice analysis charts, ice condition and forecast messages, composite ice charts, special forecasts, 30 day forecast and seasonal outlook. They will also produce iceberg forecast distribution charts from the Berg Analysis and Prediction System. Only general dataset information is kept in the Inventory.

5.2.10. Water Colour

Data storage: Data on water colour, chlorophyll and sediments will have to be extracted from cloud-free images. The data will be gridded on a sliding scale from 100m close to shore to 10km offshore. Weekly and monthly averages or composites will be produced. Raw data will be kept for a period of one year. Afterwards the data will be integrated into the Live Atlas. Level 1 data will be archived on optical disk.

5.2.11 Vessel Location

Data storage: The identified vessel will be recorded in a database containing the ship identity, date, time, location in lat-long. Reports will be produced from this database.

5.3. Data Product Delivery

Delivering the products to the users is one of the crucial aspects of the Information business. From the point of view of the client/user, all the procedures that are built into producing a product are of secondary interest if they cannot get the information they need, on time and in a shape they can use. Following government policy, the OIC will have to charge the user for the costs of the products they get plus the delivery. An accounting procedure should be instituted from the start-up of the OIC to simplify the charging and the paying of the services, and to insure that the payments are made. In the following paragraphs, we will try to describe different delivery methods, the costs attached to them, and the products that they are most suitable for. We will follow a path that goes from the simplest to the more complicated to install, and the order should not be taken as being an order of importance. When a charge to the users is mentioned, it is for delivering the products, not for the creation of the product. If there is no mention of a charge, it is assumed that no charge should be levied on the service.

5.3.1. Mail

5.3.1.1. Description of the service

Canada Post services will be used to receive enquiries from the users and to send out those off-line products whose delivery time is not critical. It does not require any set-up. It has universal reach and is very simple to use.

5.3.1.2. Products potentially delivered

Mail is used for the delivery of any data on a solid support: listings, graphs, maps, images, plots, magnetic tapes, diskettes,etc...

5.3.2. Telephone service

The OIC needs to offer its users telephone service through a toll free 800 number for data/information enquiries and orders, to enquire about the status of an order, and for complaints and suggestions. A person has to serve the 800 number from 7:30 to 19:30 EST to offer 9-5 service to all users in the country. The person handling the number should be generally knowledgeable about the Oceans data/information to understand the subject of the request. The person should also know how to access the Oceans Data/Information/Services Inventory (ODISI), and have high speed access to the inventory. She/he will also have access to the Request management data base to find out the person responsible for the request. Because the line has to be freed for other callers, no long services should be done from this post. Instead, whenever a long request for information, request for status or complaints are received, an alternate telephone service should be used: the name and phone number of the caller and the reason for calling should be taken, the name and phone number of another member of the staff or management that will call back should be given to the caller, and this staff member advised about the call and asked to call back.

5.3.2.1. Products potentially delivered

This method dispenses two services: one is to deliver a product, the second for product delivery management: taking requests, status of processing and complaints. The product delivered is from the Data/Information/Services database. This service should be limited to short requests: name of experts, existence of data or information, existence of literature on a subject. The service will be provided free. If a person has a long request, or would like somebody to do data or literature searches for them, alternate telephone service should be used. These longer requests will be provided at the cost of the service.

5.3.2.2. Cost of set–up

An 800 telephone number has to be ordered from Telecom Canada. Inquiries at the time of installation will have to be made about the installation costs. A PY has to be designated for this function. More than one person has to be assigned to cover the hours and for backup.

5.3.2.3. Cost of operation

A monthly charge and usage charge will have to be estimated after estimating the volume. This service is part of the operating cost of the OIC and cannot be explicitly passed on to users.

5.3.3. Electronic mail

5.3.3.1. Description of the service

Electronic mail will be used to receive requests from users. It will also be used to deliver products to the users. The electronic mail service will include: Envoy100, Infomail, Envoypost and Telex. An address has to be selected that will indicate the purpose of the OIC for persons who may use the directories to find the service. Electronic mail is a service offered by telecommunications companies to clients having the service of a terminal (or terminal emulating computer) and a communications gateway (modem, X.25 gateway, Telex gateway). Messages are entered from the computer to a local telephone number. The message is held until retrieved by the client to which it is addressed. Availability is almost instantaneous across the country. Agreements have been reached between Canada Post and the telecommunications carriers for delivery of electronic mail to non–subscribers through the postal channels of the delivery zone. Delivery is usually the next day.

5.3.3.2. Products potentially delivered

This service is useable to deliver products and information that can be typed in a reasonable time. Small files can also be uploaded if they are short (less than 10 pages) and in ASCII text format. Results of searches from the inventory can be sent through this type of exchange.

5.3.3.3. Cost of set–up

The telecommunications companies charge a fee to get a corporate subscription of less than $100.00. A terminal as described earlier has also to be installed and connected. The service is also offered by the Government Telecommunications Agency under the name of GEMS.

5.3.3.4. Cost of operation

There is a monthly fee for the use of the service, which is of approximately $20.00, plus an extra cost for individual users in the organization. Charges are then levied on the usage at a certain price per thousand characters (less than $0.50).

5.3.4. Packet switching networks

5.3.4.1. Description of the service

Canada has two public networks using the CCITT X.25 packet-switching protocol. These networks permit the transfer of data at different speeds up to 19.2 kbps with error detection and correction. This allows the transfer of large amounts of data without worrying about the quality of the data transmitted. Access to these networks can be done in two fashions: from a terminal (or a terminal-emulating computer) access can be made using Asynchronous communications through a dial-up modem. This service is slightly limited in its scope as it does not allow incoming communications to be established and it allows only the transmission of ASCII text files. Speeds are limited to 1200 bps in most locations, with 2400 bps service in the larger cities. From a terminal connected to a PAD (Packet Assembler-Disassembler), or a computer with internal PAD, through a synchronous modem using a dedicated line (dial up access is also available). Higher speeds can be attained and special characters can also be transmitted over the network. More that one connection source-destination can be established on "virtual circuits" using the same cable. The network management software will select the route to be followed by the packet between source and destination to balance the load between circuits and to avoid circuits with problems. From the user's point-of-view, all the network switching and error detection and correction is transparent until the performance becomes extremely poor, because of extreme loads of traffic or too many damaged circuits, both unlikely conditions.

5.3.4.2. Products potentially delivered

The Asynchronous access to the packet-switching networks is more adapted to interactive communications with the host computer at the OIC. Users could browse through the O.D.I.S.I. on-line to select the data or literature most adapted to their needs. The users could then enter their orders for data and information by leaving a message in a mail box. Access to the Live Atlas is also possible to extract statistics about certain areas of the oceans. Limited graphics can be handled through this method of communications. High speed synchronous connection will be used for transfer of files or reports between two computers. These computers can be of different sizes (e.g. sending a short file containing the significant wave height from a minicomputer to a user's microcomputer). The products most likely to be transferred by this method are data/information files. Reports will then be generated by the receiving computer using its own software.

5.3.4.3. Cost of set-up

The costs given as an example are for Telecom Canada's Datapac 3000 service. The installation charges include the provision of a modem for the selected speed. For any speed subscription the service charge is $200 including the switched virtual circuits. Other facilities would carry different service charges: reverse charge blocking, closed user group, etc...

5.3.4.4. Cost of operation

Monthly charges are:

Access charges including modem lease:
1200 bps $180
2400 bps $200
4800 bps $315
9600 bps $456

Switched virtual circuit: each SVC after 1st $3.80

There is also a charge for the total Kpackets depending on the distance.

Access through Datapac 3101 service through public dial is:

$0.03/min at 1200 bps,
$0.04/min at 2400 bps.

5.3.5. Facsimile

5.3.5.1. Description of the service

Facsimile is a method of transferring documents: text or graphics through a telecommunication channel. The document is optically scanned at the transmission end and retraced at the receiving end. The resolution is of 200 LPI (lines per inch). The connection between the transmitting and receiving stations is by telephone line on land or by radio for marine transmission. It is also possible through new products to send a formatted text and graphics directly from a computer file to a facsimile machine or to receive a document into a computer file from a facsimile machine.

5.3.5.2. Products potentially delivered

Aside from responses to urgent requests, this method of transmission is best suited for products that do not require a lot of details: SST maps, pressure map, large currents map, wave fields. Through the use of marine facsimile, it is possible to send this information directly to the ships.

5.3.5.3. Cost of set-up

The price of facsimile machines to be used on the telephone has been changing drastically over the last year. It is possible to obtain a machine from $1500. A board for use in a Personal Computer is approximately $1000 including software. An additional telephone line is needed to service the Fax. Installation of a commercial line is approximately $80.00.

5.3.5.4. Cost of operation

The cost of operating a Facsimile service is the telephone time used. Considering the long distance telephone costs, this solution is more suited to local broadcast of information.

5.3.6. Satellite communications

5.3.6.1. Description of the service

Telesat is a member of Telecom Canada that provides a satellite communications network for data, voice and video. The services they offer vary depending on the requirement of the users.

Anikom 100 is a point-to-multipoint service that permits a simultaneous broadcast from a central station to satellite stations. Telesat leases the transmission equipment and the space segment for speeds up to 19.2 kbps. The receiving stations can be purchased or leased. The receiving stations can be anywhere in Canada.

Anikom 200 is a service that allows point-to-point or point-to-multipoint two way communications using VSAT(very small aperture terminal). This service permits speeds up to 64 kbps synchronous, 19.2 kbps asynchronous. The area coverage is restricted to all of southern Canada and the southern part of the Territories and Northern Quebec.

Anikom 500 and Anikom 1000 are services allowing speeds up to 512 kbps and 1.544 Mbps respectively. The coverage is also that of the Ku-band as for Anikom 200. Usage of the service is similar to that of the public packet-switching networks, in that the user connects his/her computer to a modem, that is either connected to an earth-station on the premises or to a Telesat uplink station. Because of the distances involved there is a delay in the communications which has to be taken into account by the protocol. Protocols such as X.25 fit very well with this transmission method as it allows several packets to be sent before expecting an acknowledgement.

5.3.6.2. Products potentially delivered

The satellite links are suited for simultaneous transmission of data to several stations. The speeds allowed can be extremely high (up to 1.544 Mbps), so the transmission of large amounts of data takes a reasonable amount of time. Several schemes are possible:

* Interconnection of regional OIC facilities and the Processing facilities. Subcription to Anikom 200, 500 or 1000 will permit different speeds at different costs. This scheme will allow two-way communications between the regional centres. This system will allow the raw data to be transmitted to the processing facilities and will allow the products to be transmitted to all the centres simultaneously.

* Connection of OIC nodes that produce generally useful products through an Uplink to a large number of satellite stations using Anikom 100. The data transfer will be possible with speeds up to 19.2 kbps. The advantage is the small cost of a receiving station ($6000.00). The transmission is simultaneous to all the stations. It will be convenient for transmitting daily products to all the satellite stations which then could retransmit them via earth links to other stations.

5.3.6.3. Cost of set-up

For use of the Anikom 100 service every earth station would cost:

$6000 for a receiving station
$1200 for installation.
Initial cost for the network is $2500.00

5.3.6.4. Cost of operation

Anikom 100

Speed of 9600 bps
Transmission and space cost : $30,000/month
Receiving station maintenance cost : $42/month

Anikom 500 with multi-point service to three regional stations.

Speed of 64 kbps.
End-to-End rates : $ 10,570/month

5.3.7. Experiences in other countries

Some users prefer to receive ocean information off-line, as in the form of a catalogue. Pharos Scientific Ltd. of Scotland (Dr.R.D.Callison, personal communication, 1988) publishes SATMER, a monthly bulletin of oceanographic data from weather satellites and charges an annual subscription of 100 pounds sterling. A sample bulletin of 22 pages contains weekly and monthly average surface thermal structure and sea surface temperature charts in the Mediterranean and North Seas, and gridded thermal NOAA imagery of selected areas such as the Aegean Sea, Scoresby Sund and the west coast of Norway, along with brief, synoptic interpretations of temperature and ice conditions. An appendix is included showing ten-day periods of sea surface temperatures, and monthly averages, and associated thermal anomalies compared to a 16-year base, off the coast of France.

ESA has divided production of ERS-1 satellite data into PAFs, or (Processing and Archiving Facilities) in preparation for the launch of the ERS-1 satellite. There are four PAFs - French, British, West German, and

Italian. Each PAF is responsible for a pre-defined set of products which have been classed into three delivery modes: fast (generated within 3 hours of satellite observations), intermediate (stored on CCT's), and off-line. Fast-mode sensor products include: 100 X 100 km SAR imagery; 6 X 5 km power spectra of SAR image subscenes; 25 X 25 km gridded wind vectors over a 500 X 500 km area from scatterometer data; and wind speed and significant wave height estimates at 6.5 km spacing along the satellite ground track from radar altimeter data. Table 5.1 lists proposed PAF products. A Canadian OIC should consider participation in the ESA PAFs.

5.4. Cost of Services

Estimating costs of ocean data or products for ocean users is not an easy one. A study relevant to a regional OIC is one conducted off the east coast of New England, where satellite-derived sea surface temperatures were transmitted to fishermen. The estimate of dollars saved per annum per vessel ranged from US $8,000 for the commercial boats to about US $3,000 for the charter vessels. Most respondents to the survey indicated that they would use the service if available in the future but were typically willing to pay less than US $100 per year for such products. They felt it should be available in much the same way as government weather forecasts.

Results of a recent survey indicate that an average savings of 20 hours per voyage between the US and Japan due to routing services can be realized. A 7-day transit at US $25,000 per day in ship time can result in savings of about US $3,000 per day per ship given routing support.

5.5. Maximizing the success of a Canadian OIC

The success of the OIC depends on several factors: response to users need, quality of service and accessibility of service in that order. Exciting products, on their own will not guarantee the success. The steps that have to be taken to maximize the success within 1, 3 and 5 years are:

1. Clean-up of present data banks at MEDS.

Many of the interviewees had complaints about the time required to get data ready for exchange, or input to MEDS. MEDS can not expect to have anyone, including government scientists and technicians take the time to reformat and write out files of their data for MEDS archives. Most organizations do not have the time or manpower resources to do this very time consuming task. It would be a good public relations action for the OIC to insure that MEDS' data banks are completed with quality data before embarking on ambitious projects of collecting more data.

2. Build and maintain an inventory of Canadian oceans data, information, services and scientists.

3. Imbed quality control procedures in the compilation.

4. Make the inventory available through staff in the regions, and move quickly to on-line access.

5. Make a list of the phases of implementation and the tentative schedule.

6. Advertise the fact you are building an inventory, and of the phased approach with tentative available dates.

7. Keep the inventory up to date.

8. Introduce products for currents

Review the products presently available. Review the procedure to disseminate currents products. Take the necessary steps to make the dissemination operational, and the data more generally and easily available to the public.

9. Enter into agreements with AES in Downsview and Ice Central in Ottawa for exchange of data and access to their inventories and METSIS data delivery system.

10. Enter into agreements with NASA and NOAA in the United States for access to their data systems (SPAN, NODS).

11. Maintain good contacts with the client base by disseminating information about status of new products development and by listening to their comments. Maintain a good list of clients with history.

Table 5.1. European Space Agency PAFs (Processing and Archiving Facilities) products for ERS-1.

PROPOSED BRITISH - PAF PRODUCT LIST

PRODUCT NAME	DEFINITION
SAR regenerated FD 'Bulk' image	Imaged processed to ESA FD spec.
Geometrically and radiometrically corrected 'Ortho' image	Land image corrected for the effects of topography using digital elevation model
Sea ice derived product	Segmented/classified sea ice image showing ice type, location of leads/open water
Land surface derived product	Segmented/classified land image
Image directional wave spectrum from SAR wave mode.	2-Dimensional displays of image spectra on cartesian grid
Directional wave spectrum	Experimental type of estimate of wave spectra
Altimeter quick dissemination ice margin location	Latitude/longtitude of sea ice margin
Altimeter precision lake surface elevation	20 Hz data derived from waveform foundation product for restricted sections of ground track over large (500 km sq.) lakes
Altimeter sea ice measurements	Sea ice concentration, size distribution, ice margin, swell penetration, surface elevation
Altimeter land elevation and surface reflectivity	20 Hz data derived from waveform foundation product
Altimeter vertical position of transponders	Range to a specified sub-satellite transponder from a specified orbit position with all instrument corrections accounted for
ATSR corrected images	Brightness temperature geom. corrected and geolocated
ATSR SST images	Full resolution, multipath, multichannel SST
ATSR CCT images	Full resolution, cloud top temperature
ATSR precision SST	SST on 50 km grid
ATSR Cloud Classification	Cloud classification at 50 km resolution
ATSR total water vapour	Total water vapour at 50 km resolution
ATSR microwave data in physical units	Calibrated radiances
ATSR sea ice boundary/sea ice type	Microwave determination sea/ice boundary and type (first year/multi-year)
ATSR total water vapour/liquid water	Microwave measurement at 20 km resolution along sub-satellite track

Table 5.1. European Space Agency PAFs (Processing and Archiving Facilities) products for ERS–1.

PROPOSED WEST GERMAN – PAF PRODUCT LIST

PRODUCT	NAME DEFINITION
Slant range image	Image in slant range, real data, multi looks, for nominal and non–nominal SAR mode
Image matched to geographic system	SAR image in ground range, matched to a geographic system and rotated accordingly. Only system and satellite orbit/altitude data used.
Image fixed to geographic system	Same but with the aid of ground control points (GCPs)
Image optimal precision geocoded	SAR image geocoded to a geographic system and rectified with digital elevation models (DEM) of best quality (e.g. 30m resolution)
Image possible precision geocoded	Same as above but using interpolation of variable DEMs (not high quality)
Precision radar maps	SAR maps (200.000 scale) in Gauss–Kruger coordinate system using mosaic technique
Preliminary orbits	Satellite ephemerides in an earth fixed reference system (CTRS) and in the UTC time reference system; 2 min spacing
Precise orbits	Satellite ephemerides (position and velocity incl. time lag and altitude) in an earth fixed reference (CTRS) and the UTC time reference system; 30 sec spacing
ERS–1 gravity model	Set of fully normalized spherical harmonic coefficients C(1,m), S(1,m) of the geopotential up to a tbd degree and order; referred to CTRS
Sea surface height model	Point values of sea surface heights for specific time periods with respect to a reference ellipsoid, defined on equiangular grids (up to .25 x .25 deg)
Oceanic geoid	Point values of geoid undulations with respect to a reference ellipsoid, defined on equiangular grids (up to 1x1 deg)
Sea surface topography	Heights of the mean sea surface above the geoid (quasi–stationary)/seasonal) provided as low degree spherical harmonic series

Table 5.1. European Space Agency PAFs (Processing and Archiving Facilities) products for ERS–1.

PROPOSED ITALIAN – PAF PRODUCT LIST

PRODUCT	NAME DEFINITION
SAR image radiometrically corrected	Image processed to ESA FD spec.
SAR image geometrically corrected using GCPs	Accuracy in the order of one pixel. Slightly degraded radiometric values
SAR image geometrically corrected by DEM	Land images corrected for the effects of topography using DEM
Wind speed and direction	Realised precision wind vectors from wind scatterometer
SWH	Wave form slope measurement corrected for non linearity effects
Nadir wind speed	Backscattering coefficient at nadir converted to surface wind speed
Precision sea surface topography	The deviation of geoid and ocean height from reference ellipsoid
Image direction spectrum	Two dimensional Fourier transform of precision imagette presented as k–space power spectrum on cartesian grid
Directional wave spectrum	Estimate of ocean wave spectrum

PROPOSED FRENCH – PAF PRODUCT LIST

PRODUCT NAME	DEFINITION
SAR wave mode image spectrum	Directional spectrum constructed of Fourier transform of a 3–look 400 x 400 pixel imagette
Nadir wind speed	Backscattering coefficient at nadir converted to surface wind speed
Significant wave height	Calculated from waveform slope measurement and corrected for non–linear wave effects
AMI wind mode wind speed and direction	De–aliased precision wind vectors in a grid of 25km x 25km

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APPENDIX A

LIST OF ORGANIZATIONS RESPONDING TO THE SURVEY

BY MAIL

INTERVIEWED

APPENDIX A

By Mail

A.A. BOSCARIOL & ASSOCIATES, WINDSOR ONTARIO
ACRES INTERNATIONAL LIMITED, CALGARY AB
ACRES INTERNATIONAL LIMITED, RESOURCES DIVISION, NIAGARA FALLS ONTARIO
B.C. MINISTRY OF AGRICULTURE & FISHERIES AQUATIC RESOURCES, VICTORIA BC
B.C. MINISTRY OF ENVIRONMENT AND PARKS SURVEYS & RESOURCE MAPPING BRANCH, VICTORIA BC
BIOREX GROUPE CONSEIL INC., STE-FOY PQ
CANADIAN INSTITUTE OF FISHERIES TECHNOLOGY, HALIFAX NS
CANARCTIC SHIPPING CO., OTTAWA ONTARIO
CHALLENGER SURVEYS & SERVICES LTD., EDMONTON AB
C.O.G.L.A., EMERGENCY RESPONSE (ENV. PROTECTION BRANCH), OTTAWA ONTARIO
C.O.G.L.A., BIOLOGICAL ENVIRONMENT DIVISION, OTTAWA ONTARIO
C.O.G.L.A., PHYSICAL ENVIRONMENT DIVISION, OTTAWA ONTARIO
C.S.L., MONTREAL PQ
CSSA CONSULTANTS LTEE., MONTREAL PQ
CTF SYSTEMS INC., PORT COQUITLAM BC
DEPARTMENT OF COMMUNICATIONS, COMMUNICATIONS RESEARCH CENTRE, OTTAWA ONTARIO
DEPARTMENT OF NATIONAL DEFENCE, CAN. FORCES BASE KINGSTON ONTARIO
DEPARTMENT OF NATIONAL DEFENCE, CANADIAN FORCES FLEET SCHOOL, COMBAT DIVISION, HALIFAX NS
DEPARTMENT OF NATIONAL DEFENCE, DEFENCE RESEARCH ESTABLISHMENT PACIFIC, VICTORIA BC
DEPARTMENT OF NATIONAL DEFENCE, DEFENCE RESEARCH ESTABLISHMENT ATLANTIC, DARTMOUTH NS
DEPARTMENT OF NATIONAL DEFENCE, METOC, VICTORIA BC
DEPARTMENT OF NATIONAL DEFENCE, METEOROLOGICAL AND OCEANOGRAPHIC CENTRE, HALIFAX NS
DOMINION MARINE ASSOCIATION, MARINE OPS. & REGULATIONS, OTTAWA ONTARIO
DUPONT CANADA INC. KINGSTON SITE, KINGSTON ONTARIO
EASTERN ARCTIC SCIENTIFIC RESOURCE CENTRE, IGLOOLIK NT
EASTERN DESIGNERS & COMP. LTD., COASTAL ENGINEERING GROUP, HALIFAX NS
ENERGY, MINES & RESOURCES, ATLANTIC GEOSCIENCE CENTRE, DARTMOUTH NS
ENERGY, MINES & RESOURCES, GEODETIC SURVEY OF CANADA, SURVEY GROUP, OTTAWA ONTARIO
ENERGY, MINES & RESOURCES, GEOLOGICAL SURVEY OF CANADA, OTTAWA ONTARIO
ENERGY, MINES & RESOURCES, POLAR CONTINENTAL SHELF PROJECT, OTTAWA ONTARIO
ENVIRONMENT CANADA, ATMOSPHERIC ENVIRONMENT SERVICE, - SCIENCE SERVICES DIVISION, VANCOUVER BC
ENVIRONMENT CANADA, ATMOSPHERIC ENVIRONMENT SERVICE, ATLANTIC REGION, BEDFORD NS
ENVIRONMENT CANADA, AES, ONTARIO WEATHER CENTRE, TORONTO ONTARIO
ENVIRONMENT CANADA, ICE FORECASTING, OTTAWA ONTARIO

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ENVIRONMENT CANADA, NATIONAL WATER RESEARCH INSTITUTE, BURLINGTON, ONTARIO
ENVIRONMENT CANADA, PARKS NATIONAL PARKS SYSTEMS BRANCH, OTTAWA, ONTARIO
ENVIRONMENT CANADA, PARKS, CORNWALL, ONTARIO
ENVIRONMENT CANADA, WATER RESOURCES BRANCH (WSQ), GUELPH, ONTARIO
ENVIRONMENT CANADA, WATER RESOURCES BRANCH, HULL, PQ
FENCO NEWFOUNDLAND LIMITED OFFSHORE ENGINEERING DIVISION, ST. JOHN'S, NF
FISHERIES & OCEANS, PACIFIC BIOLOGICAL STATION, NANAIMO, BC
FISHERIES & OCEANS, CANADIAN HYDROGRAPHIC SERVICE, GEODESY & TIDES, OTTAWA, ONTARIO
FISHERIES & OCEANS, CANADIAN HYDROGRAPHIC SERVICE, TIDE SECTION, DARTMOUTH, NS
FISHERIES & OCEANS, WEST VANCOUVER LABORATORY, WEST VANCOUVER, BC
FISHERIES & OCEANS, CRIT. ARCTIC MARINE/ESTUARINE HABITAT PROGRAM, WINNIPEG, MB
FISHERIES & OCEANS, OFFSHORE DIVISION, VANCOUVER, BC
FISHERIES & OCEANS, GULF REGION SCIENCE BRANCH, MARINE & ANAD. FISH, MONCTON, NB
FISHERIES & OCEANS, COASTAL OCEANOGRAPHY, BEDFORD INSTITUTE, DARTMOUTH, NS
FISHERIES & OCEANS, OCEAN CIRCULATION DIVISION, BIO, DARTMOUTH, NS
FISHERIES & OCEANS, ARCTIC BIOLOGICAL STATION, STE-ANNE DE BELLEVUE, PQ
FISHERIES RESOURCE DEVELOPMENT LIMITED, RESOURCE OPTIMIZATION, HALIFAX, NS
GEOMARINE ASSOCIATES LTD., HALIFAX, NS
GEOTECH SURVEYS LIMITED, MARINE RESEARCH DIVISION, LOWER SACKVILLE, NS
GERMAN & MILNE INC., OTTAWA, ONTARIO
IDON CORPORATION, OTTAWA, ONTARIO
INSTITUTE OF FISHERIES & MARINE TECHNOLOGY, ST. JOHN'S, NF
INTERNATIONAL DATACASTING CORPORATION MARKETING, OTTAWA, ONTARIO
INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SECRETARIAT, VANCOUVER, BC
INUVIK SCIENTIFIC RESOURCE CENTRE, INUVIK, NWT
JASCO RESEARCH LTD., SIDNEY, BC
MANITOBA DEPARTMENT OF AGRICULTURE, THE MANITOBA WATER SERVICES BOARD, BRANDON, MANITOBA
MANITOBA DEPT. OF NATURAL RESOURCES, FISHERIES BRANCH, WINNIPEG, MB
MARSHALL MACKLIN MONAGHAN LIMITED, SURVEYING & MAPPING DIVISION, DON MILLS, ONTARIO
MCELHANNEY OFFSHORE SURVEYS LTD., MARINE & GEODETIC, ST. JOHN'S, NF
MEMORIAL UNIVERSITY OF NEWFOUNDLAND, DEPT. OF BIOLOGY, ST. JOHN'S, NF
MEMORIAL UNIVERSITY OF NEWFOUNDLAND, ENGINEERING & APPLIED SCIENCE, ST. JOHN'S, NF
METEOROLOGICAL AND ENVIRONMENTAL PLANNING LTD., THE MEP COMPANY, MARKHAM, ONTARIO
NORTECH SURVEYS (CANADA) INC., CALGARY, AB
NORTHERN TRANSPORTATION COMPANY LIMITED, MARINE OPERATIONS, EDMONTON, AB

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NOVA SCOTIA RESEARCH FOUNDATION CORPORATION, APPLIED SCIENCE DIVISION, GEOPHYSICS SECTION, HALIFAX, NS
OFFSHORE SYSTEMS LTD., NORTH VANCOUVER, BC
ONTARIO MINISTRY OF ENVIRONMENT, TECHNICAL SUPPORT SECTION, LONDON, ONTARIO
ONTARIO MINISTRY OF TRANSPORTATION STRUCTURAL SECTION, KINGSTON, ONTARIO
OSHAWA HARBOUR COMMISSION, OSHAWA, ONTARIO
PACIFIC TROLLING ASSOCIATION, RICHMOND, BC
PATERSON, MACDOUGALL BARRISTERS & SOLICITORS, TORONTO, ONTARIO
PÊCHES ET OCEANS, INSTITUT MAURICE LAMONTAGNE, MONT JOLI, PQ
PHILPOTT ASSOCIATES COASTAL ENGINEERS LIMITED, TORONTO, ONTARIO
PUBLIC WORKS CANADA, LAND SURVEYS & INVENTORIES, VANCOUVER, BC
REGIONAL MUNICIPALITY OF NIAGARA – PUBLIC WORKS WATER & POLLUTION CONTROL DIVISION, THOROLD, ONTARIO
RIVTOW STRAITS LTD., MARINE DIVISION, VANCOUVER, BC
ROBERT ALLAN LTD., VANCOUVER, BC
ROYAL ROADS MILITARY COLLEGE, PHYSICS DEPARTMENT, VICTORIA, BC
SANDWELL SWAN WOOSTER, DON MILLS, ONTARIO
SEAKEM OCEANOGRAHY LTD., SIDNEY, BC
SEAKU FISHERIES INC., MONTREAL, PQ
S.L. ROSS ENVIRONMENTAL RESEARCH LIMITED, OTTAWA, ONTARIO
ST. CLAIR REGION CONSERVATION AUTHORITY, WATER MANAGEMENT, STRATHROY, ONTARIO
TECHMARINE LIMITED, DARTMOUTH, NS
THE EASTCAN GROUP, LAND INFORMATION SYSTEMS, HALIFAX, NS
THE ST. LAWRENCE SEAWAY AUTHORITY, OPERATIONS & MAINTENANCE BRANCH, CORNWALL, ONTARIO
T.M. THOMSON & ASSOCIATES LTD., VICTORIA, BC
TRAVAUX PUBLICS CANADA ARCHITECTURE ET GENIE, QUEBEC, PQ
TYDAC TECHNOLOGIES INC. CANADIAN OPERATIONS, OTTAWA, ONTARIO
ULS INTERNATIONAL INC., TORONTO, ON
UNIVERSITY OF BRITISH COLUMBIA, DEPT. OF OCEANOGRAPHY, VANCOUVER, BC
UNIVERSITY OF CALGARY DEPT. OF BIOLOGICAL SCIENCES, CALGARY, AB
UNIVERSITE DU QUEBEC, INRS OCEANOLOGIE, RIMOUSKI, PQ
UNIVERSITE LAVAL, FACULTÉE DE FORESTRIE ET DE GEODESIE, STE-FOY, PQ
UNIVERSITE LAVAL, GENIE CIVIL, QUEBEC, PQ
UNIVERSITE DE SHERBROOKE, DEPARTEMENT DE GEOGRAPHIE, SHERBROOKE, PQ
UNIVERSITY OF TORONTO, ERINDALE CENTRE FOR SURVEYING SCIENCE, MISSISSAUGA, ONTARIO
UNIVERSITY OF VICTORIA, DEPT. OF BIOLOGY, VICTORIA, BC

APPENDIX A

By Interview

ARCTIC SCIENCES LTD., REMOTE SENSING & ICE, SIDNEY, BC
ASA CONSULTING LTD., DARTMOUTH, NS
B.C. HYDRO, HYDROTECHNICAL DEPARTMENT, VANCOUVER, BC
B.C. RESEARCH, VANCOUVER, BC
B.C. SALMON FARMERS' ASSOCIATION, WEST VANCOUVER, BC
BRITISH COLUMBIA PACKERS LTD., RICHMOND, BC
BRITISH COLUMBIA MINISTRY OF ENVIRONMENT PLANNING & ASSESSMENT BRANCH, VICTORIA, BC
CANADA-NEWFOUNDLAND OFFSHORE PETROLEUM BOARD, ST. JOHN'S, NF
CBCL LTD., HALIFAX, NS
CHEVRON CANADA, RESOURCES REGULATIONS AND ENVIRONMENT, CALGARY, AB
DALHOUSIE UNIVERSITY, DEPARTMENT OF OCEANOGRAPHY, HALIFAX, NS
DISCOVERY CONSULTANTS, WOLFVILLE, NS
DOME PETROLEUM, OFFSHORE ENGINEERING, CALGARY, AB 403
ENVIRONMENT CANADA, PARKS PACIFIC RIM NATIONAL PARK, UCLUELET, BC
ENVIRONMENT CANADA, NATIONAL WATER RESEARCH INSTITUTE, BURLINGTON, ON
F.G. BERCHA ASSOCIATES LTD., CALGARY, AB
FISHERIES & OCEANS, FRESH WATER INSTITUTE, WINNIPEG, MB
FISHERIES & OCEANS, PACIFIC BIOLOGICAL STATION, OCEAN ECOLOGY DIV., NANAIMO ,BC
FISHERIES & OCEANS, INSTITUTE OF OCEAN SCIENCES, SIDNEY, BC
FISHERIES & OCEANS, MANAGEMENT & ENFORCEMENT, VANCOUVER, BC
FISHERIES PRODUCTS INTERNATIONAL LTD., FLEET OPERATIONS, ST. JOHN'S, NF
G.A. BORSTAD ASSOCIATES LTD., SIDNEY, BC
GOUVERNMENT DU QUEBEC, DIRECTION DES EVALUATIONS ENVIRONNEMENTALES, STE-FOY, PQ
GOVERNMENT OF BRITISH COLUMBIA, MINISTRY OF AGRICULTURE & FISHERIES, VICTORIA, BC
GOVERNMENT OF ONTARIO, MINISTRY OF ENVIRONMENT, -WATER RESOURCES BRANCH, TORNTO, ON
GULF CANADA RESOURCES LTD., OCEAN ENGINEERING GROUP, CALGARY, AB
INDIAN POINT MARINE FARMS LTD., MAHONE BAY
ISOMETRICS CONSULTING LTD., CALGARY, AB
LAVALIN GROUP, MACLAREN PLANSEARCH LTD., HALIFAX, NS
LGL ENVIRONMENTAL RESEARCH ASSOCIATES LTD., KING CITY, ON
NATIONAL HYDROLOGY RESEARCH CENTRE, SURFACE WATER DIVISION, SASKATOON, SK
NATIONAL RESEARCH COUNCIL, INSTITUTE FOR MARINE DYNAMICS, ST. JOHN'S, NF
NATIONAL RESEARCH COUNCIL, ATLANTIC RESEARCH LABORATORY, HALIFAX, NS
NATIVE BROTHERHOOD OF B.C., BC
NORDCO LTD., ST. JOHN'S, NF
NORTHERN TROLLERS ASSOCIATION, PRINCE RUPERT, BC
NORTHWEST ATLANTIC FISHERIES ORGANIZATION (OCEANOGRAPHY SERVICE BRANCH DFO), DARTMOUTH, NS

APPENDIX A

NOVA SCOTIA DEPARTMENT OF FISHERIES DATA MANAGEMENT, HALIFAX, NS
PACIFIC GILLNETTERS' ASSOCIATION, CLOVERDALE, BC
PACIFIC SALMON COMMISSION, MANAGEMENT DIVISION, STOCK RACIAL ANALYSIS,
VANCOUVER, BC
PACIFIC TROLLERS ASSOCIATION, RICHMOND, BC
PÊCHES ET OCEANS, INSTITUTE MAURICE LAMONTAGNE, SCIENCES BIOLOGIQUES,
MONT JOLI, PQ
PETRO-CANADA, TERRA NOVA TASK FORCE, CALGARY, AB
PETRO-CANADA, FIELD SERVICES, CALGARY, AB
PH.D ASSOCIATES INC., NORTH YORK, ON
PUBLIC WORKS CANADA, HALIFAX, NS
RICHARD WELSFORD RESEARCH GROUP, HALIFAX, NS
RICHARDSON TERMINALS LTD., WINNIPEG, MB
ROYAL ROADS MILITARY COLLEGE, VICTORIA, BC
SEACONSULT MARINE RESEARCH LTD., VANCOUVER, BC
SEASPAN INTERNATIONAL LTD., MARINE OPERATIONS, NORTH VANCOUVER, BC
UNIVERSITE DU QUEBEC A RIMOUSKI, DEPT. OCEANOGRAPHIE, RIMOUSKI, PQ
UNIVERSITY OF BRITISH COLUMBIA, DEPT. OF OCEANOGRAPHY, VANCOUVER, BC
UNIVERSITY OF GUELPH, DEPARTMENT OF ZOOLOGY, GUELPH, ON
UNIVERSITE LAVAL, DEPT. BIOLOGIE, QUEBEC, PQ
UNIVERSITY OF VICTORIA, DEPT. OF BIOLOGY, VICTORIA, BC
W.F. BAIRD & ASSOCIATES, COASTAL ENGINEERS LTD., OTTAWA, ON

APPENDIX B

1. OCEAN INFORMATION DATA PRODUCTS AND SERVICES QUESTIONNAIRE

2. TABULATIONS AND SELECTED CROSS-TABULATIONS DESCRIBING ORGANIZATIONS AND THEIR INFORMATION REQUIREMENTS

OCEAN INFORMATION

DATA PRODUCTS AND SERVICES

STUDY

for

The Department of Fisheries & Oceans

CLIENT QUESTIONNAIRE

February 1988

Contractor: G.A. BORSTAD ASSOCIATES LTD.

Return to Subcontractor:

UPDATA Inc.
3047 Uplands Drive
Ottawa, Ontario
K1V 9Z4

OCEAN DATA QUESTIONNAIRE

INFORMATION & GUIDELINES

This questionnaire has been sent to you either because you are already listed with the Department of Fisheries & Oceans as having requested information about ocean data products and services or because we believe that you may be interested in the future.

If changes in your responsibilities or in personnel have occurred, it will help us to more accurately determine DFO client needs if you would pass this questionnaire to the person in your organization who currently has the major responsibility or interest in Ocean Data Products and Services.

Looking to the future, you can expect a considerable expansion in the amount, frequency and coverage of data that will become available, especially in remotely sensed data products from new satellites, including Canada's RADARSAT. The new data products and services may include the integration of satellite and in-situ data, environmental anomaly reports and such combinations as phyto-plankton abundance with mixed layer depths, for example. Please refer to Page 4 for a full list of data types. Enclosed is a background pamphlet which describes past products and services available from the Marine Environmental Data Service.

This study will help DFO to improve service and meet your requirements more efficiently. Please take advantage of this opportunity to make your needs known and provide any comments you wish about present and future services and products.

Please accept our thanks for your cooperation and assistance.

FOR MORE INFORMATION OR ASSISTANCE

Please call the Study Team Member for your Province.

YUKON, N.W.T., ALTA., B.C., MAN., SASK.:	Dr. Gary Borstad, Sidney, B.C.	604 656 5633
ONTARIO and QUEBEC:	Joseph Nasr, Ottawa, Ontario	613 744 4471
NFLD., N.S., N.B., P.E.I:	Edward Wedler, Lawrencetown, N.S.	902 584 2226

RETURN COMPLETED QUESTIONNAIRE BY WEDNESDAY, FEBRUARY 17, 1988 TO:

UPDATA Inc.
3047 Uplands Drive
OTTAWA ON K1V 9Z4

(Aussi disponible en français)

OCEAN DATA QUESTIONNAIRE

NOTE: All mentions of "oceans" apply also to inland waters.

[ ] = FOR UPDATA USE ONLY

[Record #'s: DB..............SU.............]

Please TYPE answers to questions 1 - 8:

1. NAME of individual filling out this form:

2. Your TITLE in your organization:

3. Name of your ORGANIZATION:

4. Name of your GROUP within your organization (if applicable):

5. Name/Title of SENIOR MANAGER of your group/organization:

6. ADDRESS (STREET):
   BOX # (if applicable):
   POSTAL CODE:

   CITY:
   PROVINCE:
   POSTAL CODE:

7. TELEPHONE CODE & NUMBER:

8. TELEX:
   FAX/ELECTRONIC MAIL:

Please circle ONE answer only to each of the following questions

9.[SU] CATEGORY of your organization:

INDUSTRY GOVERNMENT EDUCATION NON-PROFIT OTHER (please specify)................

10.[SU] for INDUSTRY only: What is your PRINCIPAL business activity? Please circle ONE category only.

MARINE TRANSPORTATION FISHERIES AQUACULTURE OFFSHORE OIL & GAS ENGINEERING+CONSTRUCTION

RECREATION CONSULTING VALUE-ADDED RESELLER OTHER (please specify).........................

11.[SU] for GOVERNMENT only: Which ONE category of the following describes your activity?

INTERNATIONAL NATIONAL PROVINCIAL REGIONAL MUNICIPAL

12.[SU] for EDUCATIONAL INSTITUTIONS only: Which ONE of the following describes your PRINCIPAL activity?

OCEANOGRAPHY HYDROGRAPHY/SURVEYING GEOLOGY GEOGRAPHY OCEAN ENGINEERING BIOLOGY CHEMISTRY

METEOROLOGY/CLIMATE ANIMAL RESEARCH ZOOLOGY REMOTE SENSING PHYSICS ECONOMICS ENVIRONMENT

RESOURCE STUDIES NAVAL ARCHITECTURE/MARINE STRUCTURES OTHER (specify).......................

13.[SU] for INDUSTRY only: What are your APPROXIMATE ANNUAL SALES $$? Please circle ONE below.
(Your answer is individually COMMERCIAL CONFIDENTIAL)

$ 50,000-100,000 101,000-200,000 201,000-300,000 301,000-400,000 401,000-500,000

$501,000-600,000 601,000-700,000 701,000-800,000 801,000-900,000 901,000-1 MILLION

$ 1 M - 5 M 5 M - 10 M 10 M - 15 M 15 M - 25 M MORE THAN 25 M

14.[SU] How many EMPLOYEES in your organization/group? Please circle ONE only.

LESS THAN 10 11 - 20 21 - 30 31 - 40 41 - 50 51 - 100 MORE THAN 100

15.[SU] Has your organization/group a PRESENT NEED for any information related to the oceans? YES NO

16.[SU] Does your organization/group foresee a FUTURE APPLICATION/NEED for ocean information? YES NO

17.[SU] Would you like to receive continuing information on the uses/applications of ocean information and on the development of new ocean information products and services as they become available? YES NO

IF YOU FEEL THAT YOU HAVE AT PRESENT NO ACTIVE INTEREST IN OCEAN INFORMATION, PLEASE GO TO THE COMMENTS SECTION ON THE LAST PAGE AND MAKE ANY SUGGESTIONS YOU WISH.

18.[SU] What is your PRIMARY USE of ocean information? Please circle ONE only:

OPERATIONS RESEARCH ENGINEERING RESALE EDUCATION REGULATORY RQMT. OTHER (specify)............

19.[SU] Please circle your ONE PRIMARY AREA OF INTEREST:

PACIFIC ARCTIC ATLANTIC INLAND WATERS OPEN OCEANS OTHER (specify)............................

20.[DB] Please circle ALL AREAS OF INTEREST, including your primary interest:

PACIFIC ARCTIC ATLANTIC INLAND WATERS OCEANS-outside Can. Economic Zone OTHER.................

21.[SU] How much do you SPEND annually to purchase ocean related data products/services? Circle ONE only.

LESS THAN $1,000 1,000-2,500 2,501-5,000 5,001-7,500 7,501-10,000 10,001-15,000 15,001-25,000

$25,001-50,000 50,001-100,000 100,001-250,000 MORE THAN 250,000 NOTHING DON'T KNOW/NOT SURE

22.[SU] How many of your STAFF work with ocean related data? Circle ONE only.

0 1-5 6-10 11-20 MORE THAN 20 DON'T KNOW/UNSURE

23.[DB] How do you presently OBTAIN ocean data?:
(Please circle ALL appropriate answers)

Collect it ourselves (own staff)	YES	NO
By contracting out	YES	NO
Purchase from government	YES	NO
Personal briefing	YES	NO
Paper charts, plots or listings	YES	NO
Electronic data transmission	YES	NO
Computer media	YES	NO
Public media (radio, TV, newspaper)	YES	NO
Other (specify)........................	YES	NO

24.[DB] How soon after collection do you need your data/information?:
(Please circle ALL appropriate answers)

immediately (specify)..........	1
within 6 hours	2
within 12 hours	3
daily (within 24 hours)	4
weekly	5
monthly	6
annually	7

25.[DB] How would you PREFER TO OBTAIN ocean data?:
(Please circle ALL appropriate answers)

Collect it ourselves (own staff)	YES	NO
By contracting out	YES	NO
Purchase from government	YES	NO
Personal briefing	YES	NO
Paper charts, plots or listings	YES	NO
Electronic data transmission	YES	NO
Computer media	YES	NO
Public media (radio, TV, newspaper)	YES	NO
Other (specify)........................	YES	NO

26.[SU] If you collect your own data, would you be willing to make them available to other users? YES NO

27.[SU] In which LANGUAGE would you prefer to receive the information? (Please circle ONE)

ENGLISH FRENCH BOTH

28.[DB] How IMPORTANT is ocean information to your organization?:
(Please circle ALL appropriate answers)

It is helpful to our operations	YES	NO
It is essential to our operations	YES	NO
It saves money	YES	NO
Needed for equipment safety	YES	NO
Needed for personnel safety	YES	NO
Required by regulation	YES	NO
Other (specify)...................	YES	NO

[DB] Which of the following is/are of interest to you? Please CHECK ✓ the appropriate space for each.

	DATA/INFORMATION	NOW	FUTURE	UNSURE/DON'T KNOW	NOT AT ALL
29.	Marine Weather........................	---	---	---	---
30.	Hydrography...........................	---	---	---	---
31.	Navigational Hazards..................	---	---	---	---
32.	Sea Temperature.......................	---	---	---	---
33.	Salinity..............................	---	---	---	---
34.	Suspended Sediments...................	---	---	---	---
35.	Water Colour..........................	---	---	---	---
36.	Water Chemistry.......................	---	---	---	---
37.	Water Quality.........................	---	---	---	---
38.	Plankton..............................	---	---	---	---
39.	Seaweeds..............................	---	---	---	---
40.	Shellfish.............................	---	---	---	---
41.	Fish..................................	---	---	---	---
42.	Birds and Mammals.....................	---	---	---	---
43.	Water Level...........................	---	---	---	---
44.	Waves.................................	---	---	---	---
45.	Tides.................................	---	---	---	---
46.	Currents..............................	---	---	---	---
47.	Coastal Erosion.......................	---	---	---	---
48.	Ice...................................	---	---	---	---
49.	Ice Bergs.............................	---	---	---	---
50.	Ship Location.........................	---	---	---	---
51.	Other (specify).......................	---	---	---	---

[SU] **WHICH OF THE FOLLOWING IS/ARE OF INTEREST TO YOUR ORGANIZATION?** Please refer to questions 1 through 9 on separate sheet and answer with correct code number in appropriate column Q1 through Q9. If only a general answer is given for a set of data, use only the capitalized heading (i.e. MARINE WEATHER) and its corresponding columns.

	DATA/INFORMATION	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
29.	MARINE WEATHER									
30.	Wind									
31.	Atmospheric pressure									
32.	Air temperature									
33.	Visibility									
34.	Precipitation									
35.	Humidity									
36.	Freezing spray									
37.	Cloud cover									
38.	Other									
39.	HYDROGRAPHY									
40.	Water depth									
41.	Bottom type									
42.	Other									
43.	NAVIGATIONAL HAZARDS									
44.	SEA TEMPERATURE									
45.	Surface									
46.	Sub-surface									
47.	Bottom									
48.	Thermocline depth									
49.	Thermal fronts									
50.	Heat content/flux									
51.	Other									
52.	SALINITY									
53.	Surface									
54.	Sub-surface									
55.	Bottom									
56.	Other									

	DATA/INFORMATION	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
57.	SUSPENDED SEDIMENTS									
58.	WATER COLOUR									
59.	WATER CHEMISTRY									
60.	Oxygen									
61.	Carbon dioxide (flux)									
62.	Nutrients									
63.	Hydrocarbons									
64.	Trace metals									
65.	Other									
66.	WATER QUALITY									
67.	Biological oxygen demand									
68.	Pollutants									
69.	Other									
70.	PLANKTON									
71.	Phytoplankton									
72.	Zooplankton									
73.	Red tides/paralytic shellfish poisoning									
74.	Bioluminescence									
75.	Other									
76.	SEAWEEDS									
77.	Stocks									
78.	Population dynamics									
79.	Diseases									
80.	Harvest									
81.	Other									
82.	SHELLFISH									
83.	Stocks									
84.	Population dynamics									
85.	Diseases									
86.	Harvest									
87.	Other									

	DATA/INFORMATION	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
88.	FISH									
89.	Stocks									
90.	Population dynamics									
91.	Movements									
92.	Diseases									
93.	Harvest									
94.	Other									
95.	BIRDS AND MAMMALS									
96.	Stocks									
97.	Population dynamics									
98.	Movements									
99.	Diseases									
100.	Harvest									
101.	Other									
102.	WATER LEVEL									
103.	Mean water level									
104.	Storm surges/tsunamis									
105.	Other									
106.	WAVES									
107.	Height									
108.	Period									
109.	Direction									
110.	Spectra									
111.	Extreme events									
112.	Internal									
113.	Other									
114.	TIDES									
115.	Observed tides									
116.	Predicted tides									
117.	Other									
118.	CURRENTS									
119.	Speed and direction									
120.	Variability									
121.	Spectra									
122.	Other									

	DATA/INFORMATION	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
123.	COASTAL EROSION									
124.	ICE									
125.	Area covered/edge location/concentration									
126.	Physical properties									
127.	Morphology									
128.	Movement									
129.	Freeze-up/break-up									
130.	Erosion and scouring									
131.	Other									
132.	ICE BERGS									
133.	Location/concentration									
134.	Morphology (size/type)									
135.	Movement									
136.	Scouring									
137.	Other									
138.	SHIP LOCATION									
139.	Movements									
140.	Identification									
141.	Other									
142.	ADDITIONAL DATA (Not listed above, specify)									
143.	Plumes									
144.	Upwelling									
145.	Eddies									
146.	Fronts									
147.	Spills									
148.	Other									

OCEAN DATA QUESTIONNAIRE

[DBM-1] This study will be recommending a list of ocean information products and services for an expanded Ocean Information Centre. New data products might include the integration of satellite and in-situ data; environmental anomaly reports; and combinations of data not previously available. Forms could include charts; plots; images; individual values; or continuous records; and be available in a variety of formats via several forms of electronic data transfer. **WHAT PRODUCTS WOULD YOU LIKE US TO RECOMMEND?** (Please list below.)

[DBM-2] We would appreciate any **COMMENTS AND SUGGESTIONS** on the use and provision of ocean related information in Canada. (Please write below.)

THANK YOU.

APPENDIX B.2

CATEGORY OF ORGANIZATION

FREQ	% RESPONSE	CATEGORY
71	42.51	INDUSTRY
71	42.51	GOVERNMENT
22	13.17	EDUCATION
0	0.00	NON-PROFIT
3	1.80	OTHER
167 NUMBER OF RESPONDENTS		

INDUSTRY: BUSINESS ACTIVITY

FREQ	% RESPONSE	CATEGORY
8	11.27	MARINE TRANSPORTATION
9	12.68	FISHERIES
2	2.82	AQUACULTURE
5	7.04	OFFSHORE OIL & GAS
5	7.04	ENGINEERING & CONSTRUCTION
0	0.00	RECREATION
31	43.66	CONSULTING
1	1.41	VALUE-ADDED RESELLER
10	14.08	OTHERS
71 NUMBER OF RESPONDENTS		

APPENDIX B.2

GOVERNMENT CATEGORY

FREQ	% RESPONSE	CATEGORY
4	5.63	INTERNATIONAL
51	71.83	NATIONAL
11	15.49	PROVINCIAL
4	5.63	REGIONAL
1	1.41	MUNICIPAL
0	0.00	OTHER

71 NUMBER OF RESPONDENTS

EDUCATIONAL ACTIVITY

FREQ	% RESPONSE	CATEGORY
8	36.36	OCEANOGRAPHY
2	9.09	HYDROGRAPHY/SURVEYING
1	4.55	GEOLOGY
0	0.00	GEOGRAPHY
1	4.55	OCEAN ENGINEERING
5	22.73	BIOLOGY
0	0.00	CHEMISTRY
0	0.00	METEOROLOGY/CLIMATE
0	0.00	ANIMAL RESEARCH
1	4.55	ZOOLOGY
0	0.00	REMOTE SENSING
0	0.00	PHYSICS
0	0.00	ECONOMICS
0	0.00	ENVIRONMENT
0	0.00	RESOURCE STUDIES
0	0.00	NAVAL ARCHITECTURE/MARINE STRUCTURES
4	18.18	OTHERS

22 NUMBER OF RESPONDENTS

APPENDIX B.2

ANNUAL SALES FOR INDUSTRY RESPONDENTS

FREQ	% RESPONSE	CATEGORY
21	29.58	$ 50,000–100,000
9	12.68	$ 101,000–200,000
3	4.23	$ 201,000–300,000
3	4.23	$ 301,000–400,000
3	4.23	$ 401,000–500,000
2	2.82	$ 501,000–600,000
3	4.23	$ 601,000–700,000
2	2.82	$ 701,000–800,000
4	5.63	$ 801,000–900,000
1	1.41	$ 901,000–1,000,000
4	5.63	$ 1,000,000– 5,000,000
1	1.41	$ 5,000,000–10,000,000
15	21.13	$10,000,000–15,000,000
0	0.00	$15,000,000–25,000,000
0	0.00	MORE THAN 25,000,000
0	0.00	DID NOT ANSWER
71 NUMBER OF RESPONDENTS		

NUMBER OF EMPLOYEES IN GROUP/ORGANIZATION

FREQ	% RESPONSE	CATEGORY
36	21.56	LESS THAN 10
18	10.78	11 – 20
22	13.17	21 – 30
9	5.39	31 – 40
9	5.39	41 – 50
15	8.98	51 – 100
53	31.74	MORE THAN 100
5	2.99	DID NOT ANSWER
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

INFORMATION NEED AND INTEREST

FREQ	% RESPONSE	CATEGORY
152	91.02	WITH PRESENT NEED FOR OCEAN DATA/INFORMATION
164	98.20	FORESEE A FUTURE NEED FOR OCEAN DATA/INFORMATION
164	98.20	INTERESTED IN BEING KEPT INFORMED
167 NUMBER OF RESPONDENTS		

PRIMARY USE OF OCEAN DATA/INFORMATION

FREQ	% RESPONSE	CATEGORY
40	23.95	OPERATIONS
67	40.12	RESEARCH
30	17.96	ENGINEERING
4	2.40	RESALE
4	2.40	EDUCATION
7	4.19	REGULATORY REQUIREMENT
0	8.98	OTHER
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

PRIMARY AREA OF INTEREST

FREQ	% RESPONSE	CATEGORY
36	21.56	PACIFIC
18	10.78	ARCTIC
49	29.34	ATLANTIC
33	19.76	INLAND WATERS
2	1.20	OCEANS–outside economic zone
29	17.37	OTHER
167 NUMBER OF RESPONDENTS		

WHAT ARE YOUR AREAS OF INTEREST?

FREQ	% RESPONSE	CATEGORY
85	50.90	PACIFIC
90	53.89	ARCTIC
95	56.89	ATLANTIC
84	50.30	INLAND WATERS
60	35.93	OCEANS–outside economic zone
19	11.38	OTHERS
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

HOW MUCH DO YOU SPEND ANNUALLY ON OCEAN DATA?

FREQ	% RESPONSE	CATEGORY
51	30.54	LESS THAN $1,000
18	10.78	$ 1,001 – 2,500
6	3.59	$ 2,501 – 5,000
7	4.19	$ 5,001 – 7,500
5	2.99	$ 7,501 – 10,000
3	1.80	$ 10.001 – 15,000
4	2.40	$ 15,001 – 25,000
4	2.40	$ 25,001 – 50,000
13	7.78	$ 50,001 –100,000
2	1.20	$ 100,001–250,000
12	7.19	MORE THAN 250,000
8	4.79	NOTHING
34	20.36	UNSURE
167 NUMBER OF RESPONDENTS		

HOW MANY OF YOUR STAFF WORK WITH OCEAN DATA/INFORMATION?

FREQ	% RESPONSE	CATEGORY
36	21.56	0
18	10.78	1–5
49	29.34	6–10
33	19.76	11–20
2	1.20	MORE THAN 20
29	17.37	DON'T KNOW/UNSURE
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

HOW DO YOU PRESENTLY OBTAIN DATA?

FREQ	% RESPONSE	CATEGORY
118	70.66	COLLECT IT OURSELVES
59	35.33	BY CONTRACTING OUT
106	63.47	PURCHASE FROM THE GOVERNMENT
75	44.91	PERSONAL BRIEFING
120	71.86	PAPER CHARTS, PLOTS AND LISTINGS
65	38.92	ELECTRONIC DATA TRANSMISSION
76	45.51	COMPUTER MEDIA
31	18.56	PUBLIC MEDIA(RADIO, TV, NEWSPAPER)
28	16.77	OTHERS
167 NUMBER OF RESPONDENTS		

HOW SOON AFTER COLLECTION DO YOU NEED YOUR DATA/INFORMATION?

FREQ	% RESPONSE	CATEGORY
54	32.34	IMMEDIATELY
40	23.95	WITHIN 6 HOURS
34	20.36	WITHIN 12 HOURS
58	34.73	DAILY (WITHIN 24 HOURS)
72	43.11	WEEKLY
90	53.89	MONTHLY
85	50.90	ANNUALLY
15	8.98	DON'T KNOW/UNSURE
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

HOW WOULD YOU PREFER TO OBTAIN OCEANS DATA?

FREQ	% RESPONSE	CATEGORY
105	62.87	COLLECT IT OURSELVES
54	32.34	BY CONTRACTING OUT
95	56.89	PURCHASE FROM THE GOVERNMENT
59	35.33	PERSONAL BRIEFING
92	55.09	PAPER CHARTS, PLOTS AND LISTINGS
90	53.89	ELECTRONIC DATA TRANSMISSION
95	56.89	COMPUTER MEDIA
20	11.98	PUBLIC MEDIA(RADIO, TV, NEWSPAPER)
13	7.78	OTHERS
167 NUMBER OF RESPONDENTS		

HOW IMPORTANT IS OCEAN INFORMATION TO YOUR ORGANIZATION?

FREQ	% RESPONSE	ANSWERS
79	47.31	IT IS HELPFUL TO OUR ORGANIZATION
125	74.85	IT IS ESSENTIAL TO OUR ORGANIZATION
27	16.17	IT SAVES MONEY
32	19.16	NEEDED FOR EQUIPMENT SAFETY
34	20.36	NEEDED FOR PERSONNEL SAFETY
32	19.16	REQUIRED BY REGULATION
19	11.38	OTHER
167 NUMBER OF RESPONDENTS		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

PREFERRED DATA/INFORMATION FORMAT VS ORGANIZATION TYPE

	COLLECT IT OURSELVES	BY CONTRACTING OUT	PURCHASE FROM GOVERNMENT	PERSONAL BRIEFING	PAPER CHARTS, PLOTS OR LISTINGS	ELECTRONIC DATA TRANSMISSION	COMPUTER MEDIA	PUBLIC MEDIA (RADIO,TV,NEWSPAPERS	OTHER	TOTAL	INDUSTRY TYPE
FREQ	4	2	7	3	7	5	3	2	0	8	
ROW%	50.0	25.0	87.5	37.5	87.5	62.5	37.5	25.0	0.0		MARINE
COL%	10.3	8.7	14.9	13.0	17.1	11.9	7.9	16.7	0.0	11.3	TRANSPORTATION
TOT%	5.6	2.8	9.9	4.2	9.9	7.0	4.2	2.8	0.0		
FREQ	6	1	6	6	6	8	5	7	0	9	
ROW%	66.7	11.1	66.7	66.7	66.7	88.9	55.6	77.8	0.0		FISHERIES
COL%	15.4	4.3	12.8	26.1	14.6	19.0	13.2	58.3	0.0	12.7	
TOT%	8.5	1.4	8.5	8.5	8.5	11.3	7.0	9.9	0.0		
FREQ	2	0	0	2	1	1	0	0	0	2	
ROW%	100	0.0	0.0	100	50.0	50.0	0.0	0.0	0.0		AQUACULTURE
COL%	5.1	0.0	0.0	8.7	2.4	2.4	0.0	0.0	0.0	2.8	
TOT%	2.8	0.0	0.0	2.8	1.4	1.4	0.0	0.0	0.0		
FREQ	3	5	4	3	4	4	5	1	0	5	
ROW%	60.0	100	80.0	60.0	80.0	80.0	100	20.0	0.0		OFFSHORE OIL & GAS
COL%	7.7	21.7	8.5	13.0	9.8	9.5	13.2	8.3	0.0	7.0	
TOT%	4.2	7.0	5.6	4.2	5.6	5.6	7.0	1.4	0.0		
FREQ	2	3	5	2	2	1	2	0	0	5	
ROW%	40.0	60.0	100	40.0	40.0	20.0	40.0	0.0	0.0		ENGINEERING
COL%	5.1	13.0	10.6	8.7	4.9	2.4	5.3	0.0	0.0	7.0	& CONSTRUCTION
TOT%	2.8	4.2	7.0	2.8	2.8	1.4	2.8	0.0	0.0		
FREQ	0	0	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		RECREATION
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	21	10	21	5	15	17	18	2	1	31	
ROW%	67.7	32.3	67.7	16.1	48.4	54.8	58.1	6.5	3.2		CONSULTING
COL%	53.8	43.5	44.7	21.7	36.6	40.5	47.4	16.7	50.0	43.7	
TOT%	29.6	14.1	29.6	7.0	21.1	23.9	25.4	2.8	1.4		
FREQ	0	0	1	0	1	1	1	0	0	1	
ROW%	0.0	0.0	100	0.0	100	100	100	0.0	0.0		VALUE-ADDED RESELLER
COL%	0.0	0.0	2.1	0.0	2.4	2.4	2.6	0.0	0.0	1.4	
TOT%	0.0	0.0	1.4	0.0	1.4	1.4	1.4	0.0	0.0		
FREQ	1	2	3	2	5	5	4	0	1	10	
ROW%	10.0	20.0	30.0	20.0	50.0	50.0	40.0	0.0	70.0		OTHER
COL%	2.6	8.7	6.4	8.7	12.2	11.9	10.5	0.0	350	14.1	
TOT%	1.4	2.8	4.2	2.8	7.0	7.0	5.6	0.0	9.9		
FREQ	39	23	47	23	41	42	38	12	2	71	TOTAL
ROW%	54.9	32.4	66.2	32.4	57.7	59.2	53.5	16.9	2.8		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

ORGANIZATION TYPE BY PROVINCE OF RESPONDENT

	NFLD	NS	NB	PEI	QUE	ONT	MAN	SASK	ALTA	BC	YUK	NWT	TOTAL	ORGANIZATION TYPE
FREQ	4	12	0	0	4	20	1	0	11	19	0	0	71	
ROW%	5.6	16.9	0.0	0.0	5.6	28.2	1.4	0.0	15.5	26.8	0.0	0.0		INDUSTRY
COL%	44.4	41.4	0.0	0.0	23.5	43.5	20.0	0.0	91.7	42.2	0.0	0.0	42.5	
TOT%	2.4	7.2	0.0	0.0	2.4	12.0	0.6	0.0	6.6	11.4	0.0	0.0		
FREQ	2	15	1	0	7	24	4	1	0	17	0	2	73	
ROW%	2.7	20.5	1.4	0.0	9.6	32.9	5.5	1.4	0.0	23.3	0.0	2.7		GOVERNMENT
COL%	22.2	51.7	100	0.0	41.2	52.2	80.0	100	0.0	37.8	0.0	100	43.7	
TOT%	1.2	9.0	0.6	0.0	4.2	14.4	2.4	0.6	0.0	10.2	0.0	1.2		
FREQ	3	2	0	0	6	2	0	0	1	8	0	0	22	
ROW%	13.6	9.1	0.0	0.0	27.3	9.1	0.0	0.0	4.5	36.4	0.0	0.0		EDUCATION
COL%	33.3	6.9	0.0	0.0	35.3	4.3	0.0	0.0	8.3	17.8	0.0	0.0	13.2	
TOT%	1.8	1.2	0.0	0.0	3.6	1.2	0.0	0.0	0.6	4.8	0.0	0.0		
FREQ	0	0	0	0	0	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		NON-PROFIT
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	0	0	0	0	0	0	0	0	0	1	0	0	1	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0		OTHERS
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.6	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0		
FREQ	9	29	1	0	17	46	5	1	12	45	0	2	167	TOTAL
ROW%	5.4	17.4	0.6	0.0	10.2	27.5	3.0	0.6	7.2	26.9	0.0	1.2		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

AREA OF INTEREST BY ORGANIZATION TYPE-

	PACIFIC	ARCTIC	ATLANTIC	INLAND WATERS	OPEN OCEANS	OTHER	TOTAL	ORGANIZATION TYPE
FREQ	13	11	25	11	0	11	71	
ROW%	18.3	15.5	35.2	15.5	0.0	15.5		INDUSTRY
COL%	36.1	61.1	51.0	33.3	0.0	37.9	42.5	
TOT%	7.8	6.6	15.0	6.6	0.0	6.6		
FREQ	16	7	20	17	1	12	73	
ROW%	21.9	9.6	27.4	23.3	1.4	16.4		GOVERNMENT
COL%	44.4	38.9	40.8	51.5	50.0	41.4	43.7	
TOT%	9.6	4.2	12.0	10.2	0.6	7.2		
FREQ	6	0	4	5	1	6	22	
ROW%	27.3	0.0	18.2	22.7	4.5	27.3		EDUCATION
COL%	16.7	0.0	8.2	15.2	50.0	20.7	13.2	
TOT%	3.6	0.0	2.4	3.0	0.6	3.6		
FREQ	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0		NON-PROFIT
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	1	0	0	0	0	0	1	
ROW%	100	0.0	0.0	0.0	0.0	0.0		OTHERS
COL%	2.8	0.0	0.0	0.0	0.0	0.0	0.6	
TOT%	0.6	0.0	0.0	0.0	0.0	0.0		
FREQ	36	18	49	33	2	29	167	TOTAL
ROW%	21.6	10.8	29.3	19.8	1.2	17.4		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

AREAS OF INTEREST BY PROVINCE OF RESPONDENT

	NFLD	NS	NB	PEI	QUE	ONT	MAN	SASK	ALTA	BC	YUK	NWT	TOTAL	AREA OF INTEREST
FREQ	4	9	0	0	2	20	1	0	6	43	0	0	85	
ROW%	4.7	10.6	0.0	0.0	2.4	23.5	1.2	0.0	7.1	50.6	0.0	0.0		PACIFIC
COL%	44.4	31.0	0.0	0.0	11.8	43.5	20.0	0.0	50.0	95.6	0.0	0.0	50.9	
TOT%	2.4	5.4	0.0	0.0	1.2	12.0	0.6	0.0	3.6	25.7	0.0	0.0		
FREQ	7	19	0	0	5	29	3	0	10	15	0	0	90	
ROW%	7.8	21.1	0.0	0.0	5.6	32.2	3.3	0.0	11.1	16.7	0.0	0.0		ARCTIC
COL%	77.8	65.5	0.0	0.0	29.4	63.0	60.0	0.0	83.3	33.3	0.0	0.0	53.9	
TOT%	4.2	11.4	0.0	0.0	3.0	17.4	1.8	0.0	6.0	9.0	0.0	0.0		
FREQ	8	29	1	0	9	29	1	0	10	8	0	0	95	
ROW%	8.4	30.5	1.1	0.0	9.5	30.5	1.1	0.0	10.5	8.4	0.0	0.0		ATLANTIC
COL%	88.9	100	100	0.0	52.9	63.0	20.0	0.0	83.3	17.8	0.0	0.0	56.9	
TOT%	4.8	17.4	0.6	0.0	5.4	17.4	0.6	0.0	6.0	4.8	0.0	0.0		
FREQ	4	10	0	0	7	41	4	1	3	13	0	0	84	
ROW%	4.8	11.9	0.0	0.0	8.3	48.8	4.8	1.2	3.6	15.5	0.0	0.0		INLAND WATERS
COL%	44.4	34.5	0.0	0.0	41.2	89.1	80.0	100	25.0	28.9	0.0	0.0	50.3	
TOT%	2.4	6.0	0.0	0.0	4.2	24.6	2.4	0.6	1.8	7.8	0.0	0.0		
FREQ	6	14	0	0	2	20	1	0	2	15	0	0	60	
ROW%	10.0	23.3	0.0	0.0	3.3	33.3	1.7	0.0	3.3	25.0	0.0	0.0		OCEANS-Outside
COL%	66.7	48.3	0.0	0.0	11.8	43.5	20.0	0.0	16.7	33.3	0.0	0.0	35.9	Economic Zone
TOT%	3.6	8.4	0.0	0.0	1.2	12.0	0.6	0.0	1.2	9.0	0.0	0.0		
FREQ	0	0	1	0	8	7	1	0	1	0	0	0	19	
ROW%	0.0	0.0	5.3	0.0	42.1	36.8	5.3	0.0	5.3	0.0	0.0	0.0		OTHER
COL%	0.0	0.0	100	0.0	47.1	15.2	20.0	0.0	8.3	0.0	0.0	0.0	11.4	
TOT%	0.0	0.0	0.6	0.0	4.8	4.2	0.6	0.0	0.6	0.0	0.0	0.0		
FREQ	9	29	1	0	17	46	5	1	12	45	0	0	167	TOTAL
ROW%	5.4	17.4	0.6	0.0	10.2	27.5	3.0	0.6	7.2	26.9	0.0	0.0		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

PRIMARY USE BY ORGANIZATION TYPE

	OPERATIONS	RESEARCH	ENGINEERING	RESALE	EDUCATION	REGULATORY REQT.	OTHER	TOTAL	ORGANIZATION TYPE
FREQ	22	15	21	3	0	0	0	71	
ROW%	31.0	21.1	29.6	4.2	0.0	0.0	0.0		INDUSTRY
COL%	55.0	22.4	70.0	75.0	0.0	0.0	0.0	42.5	
TOT%	13.2	9.0	12.6	1.8	0.0	0.0	0.0		
FREQ	17	33	9	1	1	7	0	73	
ROW%	23.3	45.2	12.3	1.4	1.4	9.6	0.0		GOVERNMENT
COL%	42.5	49.3	30.0	25.0	25.0	100	0.0	43.7	
TOT%	10.2	19.8	5.4	0.6	0.6	4.2	0.0		
FREQ	0	19	0	0	3	0	0	22	
ROW%	0.0	86.4	0.0	0.0	13.6	0.0	0.0		EDUCATION
COL%	0.0	28.4	0.0	0.0	75.0	0.0	0.0	13.2	
TOT%	0.0	11.4	0.0	0.0	1.8	0.0	0.0		
FREQ	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0		NON-PROFIT
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	1	0	0	0	0	0	0	1	
ROW%	100	0.0	0.0	0.0	0.0	0.0	0.0		OTHERS
COL%	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
TOT%	0.6	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	40	67	30	4	4	7	15	167	TOTAL
ROW%	24.0	40.1	18.0	2.4	2.4	4.2	9.0		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

PRIMARY USE BY INDUSTRY TYPE

	OPERATIONS	RESEARCH	ENGINEERING	RESALE	EDUCATION	REGULATORY REQT.	OTHER	TOTAL	INDUSTRY TYPE
FREQ	7	0	0	0	0	0	1	8	
ROW%	87.5	0.0	0.0	0.0	0.0	0.0	12.5		MARINE TRANSPORTATION
COL%	31.8	0.0	0.0	0.0	0.0	0.0	10.0	11.3	
TOT%	9.9	0.0	0.0	0.0	0.0	0.0	1.4		
FREQ	8	0	0	0	0	0	1	9	
ROW%	88.9	0.0	0.0	0.0	0.0	0.0	11.1		FISHERIES
COL%	36.4	0.0	0.0	0.0	0.0	0.0	10.0	12.7	
TOT%	11.3	0.0	0.0	0.0	0.0	0.0	1.4		
FREQ	2	0	0	0	0	0	0	2	
ROW%	100	0.0	0.0	0.0	0.0	0.0	0.0		AQUACULTURE
COL%	9.1	0.0	0.0	0.0	0.0	0.0	0.0	2.8	
TOT%	2.8	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	1	0	4	0	0	0	0	5	
ROW%	20.0	0.0	80.0	0.0	0.0	0.0	0.0		OFFSHORE OIL & GAS
COL%	4.5	0.0	19.0	0.0	0.0	0.0	0.0	7.0	
TOT%	1.4	0.0	5.6	0.0	0.0	0.0	0.0		
FREQ	1	0	4	0	0	0	0	5	
ROW%	20.0	0.0	80.0	0.0	0.0	0.0	0.0		ENGINEERING
COL%	4.5	0.0	19.0	0.0	0.0	0.0	0.0	7.0	& CONSTRUCTION
TOT%	1.4	0.0	5.6	0.0	0.0	0.0	0.0		
FREQ	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0		RECREATION
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	1	14	11	0	0	0	5	31	
ROW%	3.2	45.2	35.5	0.0	0.0	0.0	16.1		CONSULTING
COL%	4.5	93.3	52.4	0.0	0.0	0.0	50.0	43.7	
TOT%	1.4	19.7	15.5	0.0	0.0	0.0	7.0		
FREQ	0	0	0	1	0	0	0	1	
ROW%	0.0	0.0	0.0	100	0.0	0.0	0.0		VALUE-ADDED RESELLER
COL%	0.0	0.0	0.0	33.3	0.0	0.0	0.0	1.4	
TOT%	0.0	0.0	0.0	1.4	0.0	0.0	0.0		
FREQ	2	1	2	2	0	0	8	10	
ROW%	20.0	10.0	20.0	20.0	0.0	0.0	80.0		OTHER
COL%	9.1	6.7	9.5	66.7	0.0	0.0	80.0	14.1	
TOT%	2.8	1.4	2.8	2.8	0.0	0.0	11.3		
FREQ	22	15	21	3	0	0	10	71	TOTAL
ROW%	31.0	21.1	29.6	4.2	0.0	0.0	14.1		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

EXPENDITURE ON OCEAN DATA/SERVICES PURCHASE BY ORGANIZATION TYPE– ANNUAL EXPENDITURE ($000)

	<1	1-2.5	2.5-5	5-7.5	7.5-10	10-15	15-25	25-50	50-100	100-250	>250	NONE	NOT SURE	TOTAL	CATEGORY
FREQ	42	9	3	3	3	2	3	2	4	1	4	1	15	71	
ROW%	59.2	12.7	4.2	4.2	4.2	2.8	4.2	2.8	5.6	1.4	5.6	1.4	21.1		INDUSTRY
COL%	39.3	50.0	50.0	42.9	60.0	66.7	75.0	50.0	30.8	50.0	33.3	12.5	44.1	42.5	
TOT%	25.1	5.4	1.8	1.8	1.8	1.2	1.8	1.2	2.4	0.6	2.4	0.6	9.0		
FREQ	0	0	0	0	0	0	0	0	0	1	6	7	16	73	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	8.2	9.6	21.9		GOVERNMENT
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	50.0	87.5	47.1	43.7	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	3.6	4.2	9.6		
FREQ	13	5	1	1	0	0	0	0	2	0	2	0	3	22	
ROW%	59.1	22.7	4.5	4.5	0.0	0.0	0.0	0.0	9.1	0.0	9.1	0.0	13.6		EDUCATION
COL%	12.1	27.8	16.7	14.3	0.0	0.0	0.0	0.0	15.4	0.0	16.7	0.0	8.8	13.2	
TOT%	7.8	3.0	0.6	0.6	0.0	0.0	0.0	0.0	1.2	0.0	1.2	0.0	1.8		
FREQ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		NON-PROFIT
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	1	0	0	0	0	0	0	0	0	0	0	0	0	1	
ROW%	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		OTHER
COL%	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	
TOT%	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	107	18	6	7	5	3	4	4	13	2	12	8	34	167	TOTAL
ROW%	64.1	10.8	3.6	4.2	3.0	1.8	2.4	2.4	7.8	1.2	7.2	4.8	20.4		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

RESPONSE TIME REQUIRED VS ORGANIZATION TYPE

ORGANIZATION TYPE		IMMEDIATELY	WITHIN 6 HOURS	WITHIN 12 HOURS	WITHIN 24 HOURS	WEEKLY	MONTHLY	ANNUALLY	UNDETERMINED	
INDUSTRY	FREQ	26	20	19	29	33	31	29	7	71
	ROW%	36.6	28.2	26.8	40.8	46.5	43.7	40.8	9.9	
	COL%	48.1	50.0	55.9	50.0	45.8	34.4	34.1	46.7	42.5
	TOT%	15.6	12.0	11.4	17.4	19.8	18.6	17.4	4.2	
GOVERNMENT	FREQ	24	16	13	24	29	42	44	5	73
	ROW%	32.9	21.9	17.8	32.9	39.7	57.5	60.3	6.8	
	COL%	44.4	40.0	38.2	41.4	40.3	46.7	51.8	33.3	43.7
	TOT%	14.4	9.6	7.8	14.4	17.4	25.1	26.3	3.0	
EDUCATION	FREQ	4	4	2	4	9	17	12	3	22
	ROW%	18.2	18.2	9.1	18.2	40.9	77.3	54.5	13.6	
	COL%	7.4	10.0	5.9	6.9	12.5	18.9	14.1	20.0	13.2
	TOT%	2.4	2.4	1.2	2.4	5.4	10.2	7.2	1.8	
NON-PROFIT	FREQ	0	0	0	0	0	0	0	0	0
	ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
OTHERS	FREQ	0	0	0	1	1	0	0	0	1
	ROW%	0.0	0.0	0.0	100	100	0.0	0.0	0.0	
	COL%	0.0	0.0	0.0	1.7	1.4	0.0	0.0	0.0	0.6
	TOT%	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	
TOTAL	FREQ	54	40	34	58	72	90	85	15	167
	ROW%	32.3	24.0	20.4	34.7	43.1	53.9	50.9	9.0	

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

RESPONSE TIME REQUIRED VS INDUSTRY TYPE–

	IMMEDIATELY	WITHIN 6 HOURS	WITHIN 12 HOURS	WITHIN 24 HOURS	WEEKLY	MONTHLY	ANNUALLY	UNDETERMINED	TOTAL	INDUSTRY TYPE
FREQ	3	3	3	6	4	3	3	0	8	
ROW%	37.5	37.5	37.5	75.0	50.0	37.5	37.5	0.0		MARINE TRANSPORTATION
COL%	11.5	15.0	15.8	20.7	12.1	9.7	10.3	0.0	11.3	
TOT%	4.2	4.2	4.2	8.5	5.6	4.2	4.2	0.0		
FREQ	4	4	4	7	5	2	3	0	9	
ROW%	44.4	44.4	44.4	77.8	55.6	22.2	33.3	0.0		FISHERIES
COL%	15.4	20.0	21.1	24.1	15.2	6.5	10.3	0.0	12.7	
TOT%	5.6	5.6	5.6	9.9	7.0	2.8	4.2	0.0		
FREQ	2	1	1	1	0	0	0	0	2	
ROW%	100	50.0	50.0	50.0	0.0	0.0	0.0	0.0		AQUACULTURE
COL%	7.7	5.0	5.3	3.4	0.0	0.0	0.0	0.0	2.8	
TOT%	2.8	1.4	1.4	1.4	0.0	0.0	0.0	0.0		
FREQ	2	2	1	2	2	3	3	0	5	
ROW%	40.0	40.0	20.0	40.0	40.0	60.0	60.0	0.0		OFFSHORE OIL & GAS
COL%	7.7	10.0	5.3	6.9	6.1	9.7	10.3	0.0	7.0	
TOT%	2.8	2.8	1.4	2.8	2.8	4.2	4.2	0.0		
FREQ	1	1	1	2	3	1	2	0	5	
ROW%	20.0	20.0	20.0	40.0	60.0	20.0	40.0	0.0		ENGINEERING
COL%	3.8	5.0	5.3	6.9	9.1	3.2	6.9	0.0	7.0	& CONSTRUCTION
TOT%	1.4	1.4	1.4	2.8	4.2	1.4	2.8	0.0		
FREQ	0	0	0	0	0	0	0	0	0	
ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		RECREATION
COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
FREQ	11	7	7	9	16	19	15	4	31	
ROW%	35.5	22.6	22.6	29.0	51.6	61.3	48.4	12.9		CONSULTING
COL%	42.3	35.0	36.8	31.0	48.5	61.3	51.7	57.1	43.7	
TOT%	15.5	9.9	9.9	12.7	22.5	26.8	21.1	5.6		
FREQ	0	0	1	0	0	0	0	0	1	
ROW%	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0		VALUE-ADDED RESELLER
COL%	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	1.4	
TOT%	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0		
FREQ	3	2	1	2	3	3	3	3	10	
ROW%	30.0	20.0	10.0	20.0	30.0	30.0	30.0	100		OTHER
COL%	11.5	10.0	5.3	6.9	9.1	9.7	10.3	143	14.1	
TOT%	4.2	2.8	1.4	2.8	4.2	4.2	4.2	14.1		
FREQ	26	20	19	29	33	31	29	7	71	TOTAL
ROW%	36.6	28.2	26.8	40.8	46.5	43.7	40.8	9.9		

APPENDIX B.2

OCEAN INFORMATION CENTRE SURVEY RESULTS

PRESENT DATA/INFORMATION FORMAT VS ORGANIZATION TYPE–

ORGANIZATION TYPE		COLLECT IT OURSELVES	BY CONTRACTING OUT	PURCHASE FROM GOVERNMENT	PERSONAL BRIEFING	PAPER CHARTS, PLOTS OR LISTINGS	ELECTRONIC DATA TRANSMISSION	COMPUTER MEDIA	PUBLIC MEDIA (RADIO,TV,NEWSPAPERS	OTHER	
INDUSTRY	FREQ	26	22	19	29	35	32	30	8	0	75
	ROW%	34.7	29.3	25.3	38.7	46.7	42.7	40.0	10.7	0.0	
	COL%	47.3	52.4	55.9	50.0	47.3	34.4	34.5	50.0	0.0	43.1
	TOT%	14.9	12.6	10.9	16.7	20.1	18.4	17.2	4.6	0.0	
GOVERNMENT	FREQ	25	16	13	24	29	44	45	5	0	76
	ROW%	32.9	21.1	17.1	31.6	38.2	57.9	59.2	6.6	0.0	
	COL%	45.5	38.1	38.2	41.4	39.2	47.3	51.7	31.2	0.0	43.7
	TOT%	14.4	9.2	7.5	13.8	16.7	25.3	25.9	2.9	0.0	
EDUCATION	FREQ	4	4	2	4	9	17	12	3	0	22
	ROW%	18.2	18.2	9.1	18.2	40.9	77.3	54.5	13.6	0.0	
	COL%	7.3	9.5	5.9	6.9	12.2	18.3	13.8	18.8	0.0	12.6
	TOT%	2.3	2.3	1.1	2.3	5.2	9.8	6.9	1.7	0.0	
NON-PROFIT	FREQ	0	0	0	0	0	0	0	0	0	0
	ROW%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	COL%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOT%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
OTHERS	FREQ	0	0	0	1	1	0	0	0	0	1
	ROW%	0.0	0.0	0.0	100	100	0.0	0.0	0.0	0.0	
	COL%	0.0	0.0	0.0	1.7	1.4	0.0	0.0	0.0	0.0	0.6
	TOT%	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	
TOTAL	FREQ	55	42	34	58	74	93	87	16	0	174
	ROW%	31.6	24.1	19.5	33.3	42.5	53.4	50.0	9.2	0.0	

APPENDIX C

TABULATION OF QUESTIONAIRE RESPONSES DESCRIBING

DELIVERY TIME,

SPATIAL AND TEMPORAL RESOLUTIONS,

AREA OF INTEREST,

MEANS OF DATA ACQUISITION,

ANNUAL EXPENDITURES AND

WILLINGNESS TO MAKE DATA AVAILABLE TO OTHERS.

APPENDIX C

Table C.1. Required delivery time for ocean information, parameters ordered by total response

Number of respondents in each category

Immediately

	E	G	I	T
WAVES	1	4	8	13
WETHR	1	3	9	13
CURRNT	0	1	7	8
HAZRD	0	3	5	8
TIDES	0	4	3	7
HYDRG	0	3	3	6
TEMP	1	2	3	6
PLKTN	0	3	3	6
SHIPS	0	2	3	5
SEDMT	0	1	4	5
SAL	1	2	2	5
OTHER	1	2	1	4
CHEM	0	2	2	4
BERGS	0	2	2	4
LEVEL	0	2	2	4
QUAL	0	1	2	3
ICE	0	2	1	3
WEEDS	0	1	1	2
COLOR	0	1	1	2
EROSN	0	1	1	2
FISH	0	1	0	1
SHELL	0	1	0	1
BIRDS	0	1	0	1

Within 6H

	E	G	I	T
WETHR	0	4	4	8
WAVES	0	3	3	6
TEMP	0	0	4	4
TIDES	0	1	2	3
OTHER	0	2	1	3
ICE	1	0	1	2
HYDRG	1	1	0	2
COLOR	0	0	2	2
SHIPS	0	0	2	2
SEDMT	0	0	2	2
CURRNT	0	1	1	2
FISH	0	0	1	1
BERGS	1	0	0	1
QUAL	1	0	0	1
PLKTN	0	0	1	1
SAL	0	0	1	1
EROSN				
LEVEL				
CHEM				
HAZRD				
SHELL				
WEEDS				
BIRDS				

Within 12H

	E	G	I	T
CURRNT	0	1	2	3
FISH	0	0	2	2
WETHR	0	2	0	2
TIDES	0	0	1	1
PLKTN	0	0	1	1
QUAL	0	1	0	1
ICE	0	0	1	1
WAVES	0	0	1	1
COLOR	0	1	0	1
LEVEL	0	0	1	1
CHEM	0	0	1	1
HYDRG				
TEMP				
SEDMT				
BIRDS				
SHIPS				
OTHER				
WEEDS				
HAZRD				
EROSN				
SHELL				
SAL				
BERGS				

Within 24H

	E	G	I	T
TEMP	1	5	3	9
ICE	2	2	4	8
SHIPS	3	1	4	8
COLOR	3	1	3	7
FISH	2	4	1	7
BIRDS	3	2	1	6
BERGS	3	1	1	5
LEVEL	2	0	3	5
SHELL	2	3	0	5
PLKTN	0	2	2	4
WETHR	1	1	2	4
HAZRD	2	0	2	4
QUAL	1	3	0	4
CHEM	0	3	1	4
WAVES	1	1	2	4
TIDES	1	0	3	4
SAL	0	3	1	4
CURRNT	0	2	1	3
EROSN	3	0	0	3
WEEDS	1	2	0	3
SEDMT	1	1	0	2
OTHER	0	1	1	2
HYDRG	0	0	1	1

Within 7d

	E	G	I	T
FISH	0	1	5	6
SAL	0	4	1	5
TEMP	0	4	0	4
CURRNT	0	2	2	4
SHELL	0	0	3	3
PLKTN	1	0	2	3
WETHR	1	1	1	3
BIRDS	0	0	2	2
HAZRD	0	2	0	2
TIDES	0	1	1	2
ICE	0	1	1	2
HYDRG	0	1	1	2
COLOR	0	1	1	2
SEDMT	0	1	1	2
WAVES	0	0	1	1
WEEDS	0	0	1	1
EROSN				
OTHER				
QUAL				
CHEM				
LEVEL				
SHIPS				
BERGS				

Within 1m

	E	G	I	T
LEVEL	2	4	5	11
CURRNT	4	3	4	11
WAVES	3	3	4	10
SEDMT	4	3	2	9
SAL	3	1	4	8
TEMP	2	2	4	8
PLKTN	2	2	3	7
TIDES	3	0	3	6
CHEM	3	3	0	6
HYDRG	0	0	5	5
COLOR	2	2	1	5
SHELL	2	2	1	5
FISH	2	1	2	5
BIRDS	1	1	3	5
QUAL	1	2	1	4
WEEDS	1	1	2	4
WETHR	1	0	3	4
ICE	0	1	2	3
EROSN	0	1	2	3
HAZRD	1	0	1	2
BERGS	0	1	1	2
SHIPS	0	1	0	1
OTHER	0	0	1	1

Within 1a

	E	G	I	T
HYDRG	4	4	7	15
TIDES	2	3	4	9
EROSN	3	2	1	6
LEVEL	1	2	2	5
CURRNT	2	1	2	5
BIRDS	0	1	3	4
SEDMT	1	2	1	4
ICE	1	2	1	4
SAL	1	1	2	4
CHEM	1	1	1	3
PLKTN	1	2	0	3
WAVES	1	0	2	3
FISH	0	2	1	3
WETHR	1	1	0	2
QUAL	1	1	0	2
SHELL	0	0	2	2
TEMP	1	1	0	2
HAZRD	0	2	0	2
COLOR	0	1	0	1
WEEDS	1	0	0	1
BERGS				
OTHER				
SHIPS				

APPENDIX C

Table C.2. Required temporal resolution for ocean information, parameters ordered by total response

Number of respondents in each category

Hourly					3 hours				
	E	G	I	T		E	G	I	T
CURRNT	5	3	8	16	WAVES	4	5	7	16
TIDES	6	0	5	11	WETHR	2	2	8	12
WETHR	2	0	7	9	CURRNT	2	3	2	7
WAVES	1	0	4	5	TIDES	0	1	2	3
LEVEL	0	3	2	5	BERGS	1	0	2	3
SEDMT	0	1	3	4	TEMP.	1	0	1	2
SAL.	0	1	1	2	LEVEL	1	0	0	1
OTHER	1	1	0	2	HAZRD	0	0	1	1
SHIP	0	0	2	2	PLKTN	1	0	0	1
TEMP.	0	1	1	2	QUAL.	1	0	0	1
CHEM.	0	1	0	1	CHEM.	1	0	0	1
ICE	0	0	1	1	ICE	1	0	0	1
BERGS	0	1	0	1	SAL.	1	0	0	1
HAZRD	0	1	0	1	COLOR				
PLKTN	0	1	0	1	BIRDS				
QUAL.	0	1	0	1	EROSN.				
HYDRG	0	1	0	1	SEDMT				
SHELL					HYDRG				
EROSN.					OTHER				
FISH					SHIP				
WEEDS					FISH				
COLOR					SHELL				
BIRDS					WEEDS				

6 hours					12 hours				
	E	G	I	T		E	G	I	T
TIDES	0	3	8	11	WETHR	2	4	1	7
WAVES	0	2	5	7	SHIP	3	1	1	5
WETHR	0	3	3	6	ICE	1	1	2	4
CURRNT	0	1	5	6	FISH	2	1	1	4
TEMP.	1	0	3	4	TIDES	0	3	0	3
CHEM.	0	1	1	2	SEDMT	1	1	1	3
QUAL.	1	0	1	2	WAVES	1	2	0	3
PLKTN	0	0	1	1	COLOR	2	0	1	3
SHIP	0	0	1	1	BERGS	3	0	0	3
SAL.	0	0	1	1	BIRDS	3	0	0	3
ICE	0	1	0	1	EROSN.	3	0	0	3
LEVEL	0	0	1	1	LEVEL	2	1	0	3
HAZRD	0	1	0	1	QUAL.	1	2	0	3
BERGS	0	0	1	1	SHELL	2	0	0	2
HYDRG					HAZRD	2	0	0	2
SEDMT					OTHER	0	0	1	1
SHELL					WEEDS	1	0	0	1
BIRDS					CHEM.	0	1	0	1
COLOR					PLKTN				
WEEDS					TEMP.				
OTHER					SAL.				
EROSN.					HYDRG				
FISH					CURRNT				

Daily					Weekly				
	E	G	I	T		E	G	I	T
TEMP.	3	4	4	11	SAL.	0	6	2	8
ICE	2	3	6	11	TEMP.	0	5	2	7
PLKTN	1	4	4	9	FISH	0	1	5	6
SEDMT	5	2	1	8	SHELL	1	2	2	5
LEVEL	2	3	3	8	COLOR	0	1	4	5
OTHER	0	6	2	8	PLKTN	1	2	2	5
FISH	1	4	2	7	SEDMT	0	1	3	4
SAL.	3	0	3	6	ICE	1	1	2	4
SHIP	0	2	4	6	QUAL.	0	2	2	4
COLOR	2	1	2	5	CURRNT	0	2	2	4
HAZRD	0	1	4	5	CHEM.	0	2	2	4
WETHR	1	2	2	5	WEEDS	0	2	1	3
CHEM.	2	1	2	5	WAVES	0	1	2	3
CURRNT	0	2	1	3	BIRDS	0	1	2	3
SHELL	0	1	1	2	TIDES	0	1	1	2
HYDRG	0	0	2	2	HYDRG	0	0	1	1
WAVES	0	0	2	2	WETHR	0	0	1	1
QUAL.	0	2	0	2	EROSN.	0	1	0	1
BERGS	0	0	2	2	BERGS	0	1	0	1
TIDES	0	1	1	2	LEVEL				
BIRDS	0	1	1	2	OTHER				
WEEDS	0	1	0	1	SHIP				
EROSN.					HAZRD				

Monthly					Yearly				
	E	G	I	T		E	G	I	T
LEVEL	0	3	4	7	HYDRG	5	6	6	17
SEDMT	1	3	2	6	EROSN.	2	1	4	7
FISH	2	2	2	6	HAZRD	0	3	1	4
PLKTN	2	2	2	6	LEVEL	1	0	2	3
SAL.	1	2	3	6	BIRDS	0	1	1	2
BIRDS	1	2	2	5	CHEM.	0	0	1	1
WEEDS	2	1	2	5	WEEDS	0	1	0	1
TEMP.	0	1	3	4	SHELL	0	0	1	1
COLOR	1	3	0	4	FISH	0	1	0	1
EROSN.	1	2	1	4	TIDES	0	0	1	1
SHELL	1	2	1	4	WAVES				
QUAL.	1	2	0	3	ICE				
CHEM.	1	2	0	3	SAL.				
WAVES	0	2	0	2	SHIP				
HYDRG	0	1	1	2	WETHR				
CURRNT	0	2	0	2	PLKTN				
ICE	0	1	0	1	SEDMT				
HAZRD	1	0	0	1	BERGS				
TIDES	0	1	0	1	CURRNT				
OTHER	0	0	1	1	QUAL.				
WETHR	0	1	0	1	COLOR				
SHIP					TEMP.				
BERGS					OTHER				

APPENDIX C

Table C.3. Required spatial resolution for ocean information, parameters ordered by total response

Number of respondents in each category

<10m

	E	G	I	T
SEDMT	1	4	4	9
HYDRG	2	1	5	8
TEMP.	2	4	1	7
CHEM.	1	3	2	6
SAL.	2	3	1	6
QUAL.	0	3	2	5
WAVES	1	1	2	4
COLOR	0	2	2	4
PLKTN	0	2	1	3
CURRNT	0	2	1	3
ICE	0	0	2	2
HAZRD	1	0	1	2
TIDES	0	1	1	2
SHELL	0	1	1	2
WEEDS	0	1	1	2
BIRDS	0	0	1	1
EROSN	0	0	1	1
FISH	0	0	1	1
OTHER	1	0	0	1
LEVEL				
WETHR				
BERGS				
SHIPS				

<100m

	E	G	I	T
HYDRG	2	4	3	9
HAZRD	0	3	3	6
SEDMT	2	2	1	5
QUAL.	1	1	1	3
CURRNT	1	1	1	3
EROSN	0	1	1	2
SHIPS	0	1	1	2
COLOR	1	1	0	2
WEEDS	1	1	0	2
OTHER	0	2	0	2
SHELL	1	1	0	2
WAVES	0	0	1	1
ICE	0	1	0	1
LEVEL	0	1	0	1
CHEM.	0	1	0	1
PLKTN	0	1	0	1
FISH	0	1	0	1
SAL.				
BIRDS				
WETHR				
TEMP.				
TIDES				
BERGS				

<1Km

	E	G	I	T
CURRNT	3	3	7	13
TEMP.	3	5	5	13
HYDRG	1	3	7	11
PLKTN	1	3	5	9
SAL.	2	3	4	9
ICE	1	4	3	8
WAVES	0	1	6	7
SEDMT	1	2	3	6
COLOR	1	2	3	6
FISH	0	1	4	5
OTHER	0	2	3	5
SHIPS	0	2	3	5
SHELL	1	1	3	5
CHEM.	0	4	1	5
WETHR	1	3	1	5
QUAL.	0	4	1	5
TIDES	1	0	3	4
WEEDS	0	3	1	4
BIRDS	0	3	1	4
EROSN	2	1	1	4
BERGS	1	2	1	4
LEVEL	1	0	2	3
HAZRD	0	2	1	3

<10Km

	E	G	I	T
WETHR	1	4	13	18
WAVES	4	5	8	17
TIDES	3	4	8	15
FISH	5	5	5	15
PLKTN	5	5	3	13
CURRNT	1	3	8	12
LEVEL	2	4	5	11
TEMP.	1	3	6	10
BIRDS	4	2	4	10
SAL.	2	4	4	10
ICE	2	1	5	8
COLOR	3	1	4	8
SHIPS	3	0	4	7
EROSN	3	1	3	7
SEDMT	3	1	3	7
CHEM.	4	1	2	7
WEEDS	3	1	2	6
QUAL.	4	2	0	6
BERGS	3	0	2	5
OTHER	0	3	2	5
SHELL	3	2	0	5
HAZRD	2	0	2	4
HYDRG	0	0	1	1

<100Km

	E	G	I	T
WETHR	4	7	7	18
LEVEL	3	3	5	11
TIDES	2	6	3	11
WAVES	1	4	3	8
CURRNT	2	2	2	6
FISH	1	3	1	5
ICE	2	1	1	4
SAL.	0	1	2	3
TEMP.	0	1	2	3
PLKTN	0	0	2	2
CHEM.	0	1	1	2
HYDRG	0	1	1	2
EROSN	1	1	0	2
SHELL	0	0	1	1
WEEDS	0	0	1	1
BIRDS	0	0	1	1
HAZRD				
QUAL.				
BERGS				
OTHER				
SHIPS				
COLOR				
SEDMT				

>100Km

	E	G	I	T
WETHR	1	1	1	3
BIRDS	0	1	1	2
TEMP.	0	1	1	2
BERGS	0	1	1	2
HYDRG	1	1	0	2
CURRNT	0	2	0	2
LEVEL	0	2	0	2
SHIPS	0	1	0	1
SEDMT	0	1	0	1
COLOR	0	1	0	1
WAVES	0	1	0	1
SAL.	0	1	0	1
EROSN	0	1	0	1
ICE	0	1	0	1
SHELL	0	1	0	1
FISH	0	1	0	1
CHEM.	0	1	0	1
TIDES	0	1	0	1
PLKTN	0	1	0	1
WEEDS	0	1	0	1
QUAL.	0	1	0	1
OTHER	0	1	0	1
HAZRD				

Unsure

	E	G	I	T
SAL.	0	1	5	6
TIDES	0	1	4	5
HYDRG	0	2	3	5
LEVEL	0	2	2	4
WAVES	0	2	2	4
FISH	0	2	2	4
TEMP.	0	1	3	4
CURRNT	0	2	2	4
CHEM.	0	1	2	3
SEDMT	0	1	2	3
BIRDS	0	1	2	3
ICE	0	1	2	3
PLKTN	1	1	1	3
EROSN	0	0	3	3
HAZRD	0	2	1	3
BERGS	0	1	2	3
WETHR	0	1	1	2
QUAL.	0	1	1	2
SHELL	0	1	1	2
SHIPS	0	1	0	1
COLOR	0	0	1	1
OTHER				
WEEDS				

APPENDIX C

Table C.4. Area of interest, parameters ordered by total response

Numbers of respondents in each category

LOCAL	E	G	I	T	REGIONAL	E	G	I	T	COAST-WIDE	E	G	I	T	BASIN-WIDE	E	G	I	T	GLOBAL	E	G	I	T
SEDMT	2	5	5	12	WETHR	2	3	10	15	WETHR	2	8	7	17	WETHR	2	4	5	11	CURRNT	2	1	0	3
WAVES	2	3	5	10	PLKTN	1	7	6	14	TIDES	3	7	6	16	HYDRG	1	2	4	7	SAL.	2	1	0	3
HYDRG	2	2	6	10	CURRNT	3	2	7	12	TEMP.	3	6	5	14	ICE	3	3	0	6	LEVEL	2	0	0	2
LEVEL	2	3	4	9	WAVES	1	2	8	11	FISH	2	6	5	13	BERGS	4	1	1	6	TEMP.	2	0	0	2
CURRNT	1	3	5	9	TIDES	0	2	7	9	CURRNT	1	7	5	13	FISH	3	2	1	6	PLKTN	2	0	0	2
TIDES	2	3	4	9	FISH	1	3	5	9	WAVES	1	7	5	13	COLOR	3	2	1	6	TIDES	1	0	1	2
SAL.	1	1	5	7	TEMP.	0	3	6	9	SAL.	3	6	3	12	WAVES	1	2	2	5	HYDRG	2	0	0	2
QUAL.	1	4	2	7	WEEDS	1	4	4	9	PLKTN	2	4	4	10	BIRDS	3	1	1	5	WAVES	1	0	0	1
TEMP.	1	2	4	7	HYDRG	1	2	5	8	HYDRG	0	6	4	10	TEMP.	0	4	1	5	COLOR	1	0	0	1
EROSN.	1	2	4	7	LEVEL	0	3	5	8	ICE	2	5	2	9	HAZRD	2	2	0	4	WETHR	1	0	0	1
CHEM.	1	4	1	6	BIRDS	0	2	6	8	LEVEL	1	5	3	9	SEDMT	2	0	1	3	CHEM.	1	0	0	1
ICE	0	1	4	5	CHEM.	1	4	3	8	HAZRD	1	3	4	8	SHIP	3	0	0	3	FISH				
SHELL	1	3	1	5	QUAL.	1	6	1	8	OTHER	0	6	2	8	CURRNT	0	1	2	3	QUAL.				
PLKTN	1	2	1	4	SHELL	2	1	3	6	COLOR	1	1	5	7	SAL.	0	2	1	3	SEDMT				
BIRDS	0	2	1	3	SAL.	0	3	3	6	SEDMT	2	3	2	7	SHELL	2	0	1	3	BIRDS				
COLOR	0	2	1	3	SEDMT	1	3	2	6	CHEM.	2	4	1	7	EROSN.	3	0	0	3	OTHER				
OTHER	1	1	1	3	SHIP	0	2	4	6	SHIP	0	3	2	5	PLKTN	1	0	1	2	SHELL				
FISH	0	2	0	2	EROSN.	2	0	3	5	WEEDS	2	1	1	4	LEVEL	1	1	0	2	EROSN.				
SHIP	0	0	2	2	HAZRD	0	2	3	5	QUAL.	2	2	0	4	QUAL.	1	0	1	2	WEEDS				
WEEDS	0	2	0	2	ICE	0	0	5	5	SHELL	0	3	0	3	WEEDS	1	0	0	1	BERGS				
WETHR	0	1	0	1	BERGS	0	0	4	4	BIRDS	1	2	0	3	CHEM.	0	0	1	1	ICE				
HAZRD					COLOR	0	2	1	3	EROSN.	0	3	0	3	TIDES	0	1	0	1	HAZRD				
BERGS					OTHER	0	1	2	3	BERGS	0	3	0	3	OTHER					SHIP				

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Table C.5. Present means of ocean data acquisition, parameters ordered by total response

Number of respondents in each category

Ourselves	E	G	I	T	Contract	E	G	I	T
PLKTN	5	7	7	19	HYDRG	0	1	3	4
SEDMT	6	4	5	15	EROSN	0	1	2	3
CURRNT	3	4	8	15	OTHER	0	3	0	3
TEMP	1	6	6	13	COLOR	0	2	0	2
CHEM	3	7	2	12	ICE	0	1	1	2
SAL	1	6	5	12	QUAL	0	1	1	2
WAVES	2	3	6	11	WETHR	0	0	1	1
QUAL	3	6	2	11	CHEM	0	1	0	1
FISH	1	5	5	11	TEMP	0	0	1	1
WEEDS	2	4	2	8	WAVES	0	1	0	1
COLOR	2	2	4	8	CURRNT	0	1	0	1
TIDES	0	2	6	8	SHIPS				
SHELL	3	2	2	7	SAL				
ICE	1	2	3	6	FISH				
BIRDS	0	2	4	6	HAZRD				
SHIPS	0	3	2	5	BERGS				
BERGS	0	2	2	4	WEEDS				
LEVEL	0	2	2	4	PLKTN				
EROSN	0	1	2	3	SHELL				
WETHR	0	1	2	3	TIDES				
OTHER	1	1	0	2	BIRDS				
HYDRG	0	2	0	2	LEVEL				
HAZRD	0	1	0	1	SEDMT				

From gov't	E	G	I	T	Personal	E	G	I	T
TIDES	2	6	9	17	FISH	2	1	3	6
HYDRG	3	3	8	14	BIRDS	3	1	1	5
LEVEL	2	4	4	10	CURRNT	1	1	2	4
WETHR	3	4	2	9	EROSN	4	0	0	4
WAVES	2	4	3	9	SHIPS	3	0	1	4
EROSN	0	1	3	4	LEVEL	1	2	0	3
TEMP	0	2	2	4	BERGS	3	0	0	3
ICE	0	2	2	4	SHELL	2	0	1	3
HAZRD	0	1	2	3	WAVES	1	1	1	3
CURRNT	0	1	2	3	ICE	1	0	1	2
SAL	0	1	1	2	WETHR	1	1	0	2
FISH	0	1	0	1	COLOR	2	0	0	2
SHELL	0	0	1	1	HAZRD	2	0	0	2
BIRDS	0	1	0	1	WEEDS	1	0	0	1
SHIPS					TIDES	0	1	0	1
WEEDS					QUAL	1	0	0	1
SEDMT					SEDMT	1	0	0	1
QUAL					SAL				
PLKTN					TEMP				
OTHER					OTHER				
BERGS					CHEM				
CHEM					HYDRG				
COLOR					PLKTN				

Public	E	G	I	T	Unsure	E	G	I	T
WETHR	0	0	3	3	WETHR	0	2	2	4
WAVES	0	1	1	2	LEVEL	0	1	2	3
WEEDS	0	1	0	1	SAL	0	1	2	3
QUAL	0	1	0	1	FISH	1	1	1	3
HAZRD	0	1	0	1	BIRDS	0	1	2	3
SHELL	0	1	0	1	OTHER	0	1	1	2
OTHER	0	1	0	1	COLOR	0	1	1	2
EROSN	0	1	0	1	PLKTN	0	1	1	2
LEVEL	0	0	1	1	CHEM	0	1	1	2
TIDES	0	1	0	1	TEMP	0	0	2	2
TEMP					SEDMT	0	1	1	2
HYDRG					CURRNT	0	1	1	2
BIRDS					WAVES	0	0	1	1
SAL					SHIPS	0	0	1	1
CHEM					HAZRD	0	0	1	1
SHIPS					TIDES	0	0	1	1
PLKTN					WEEDS	0	0	1	1
SEDMT					WETHR	0	0	1	1
BERGS					EROSN	0	1	0	1
COLOR					QUAL	0	0	1	1
FISH					BERGS				
CURRNT					SHELL				
ICE					ICE				

APPENDIX C

Table C.5. Present means of ocean data acquisition, parameters ordered by total response

Paper

	E	G	I	T
HYDRG	2	5	6	13
HAZRD	1	3	3	7
ICE	2	3	1	6
WETHR	1	1	3	5
TEMP	0	2	1	3
EROSN	2	0	1	3
BERGS	1	0	2	3
SEDMT	0	0	3	3
SAL	0	1	2	3
CURRNT	0	2	0	2
BIRDS	0	0	2	2
LEVEL	1	0	1	2
OTHER	0	0	1	1
SHIPS	0	0	1	1
PLKTN	1	0	0	1
TIDES	0	0	1	1
FISH	0	0	1	1
COLOR	0	0	1	1
WEEDS				
QUAL				
CHEM				
WAVES				
SHELL				

Telephone

	E	G	I	T
WAVES	0	0	1	1
ICE	0	0	1	1
SHIPS	0	0	1	1
WETHR	0	0	1	1
WEEDS				
SHELL				
SAL				
HAZRD				
BERGS				
BIRDS				
QUAL				
LEVEL				
TIDES				
FISH				
HYDRG				
TEMP				
CURRNT				
EROSN				
PLKTN				
SEDMT				
COLOR				
CHEM				
OTHER				

Radio

	E	G	I	T
WETHR	0	3	2	5
WAVES	0	1	1	2
CURRNT	0	1	0	1
CHEM				
PLKTN				
BIRDS				
SEDMT				
SAL				
ICE				
TIDES				
QUAL				
HAZRD				
LEVEL				
COLOR				
OTHER				
WEEDS				
SHELL				
BERGS				
EROSN				
FISH				
TEMP				
HYDRG				
SHIPS				

Satellite

	E	G	I	T
WETHR	1	0	0	1
ICE	1	0	0	1
WEEDS				
BERGS				
OTHER				
BIRDS				
COLOR				
TEMP				
EROSN				
FISH				
SHIPS				
PLKTN				
SEDMT				
CURRNT				
QUAL				
SAL				
LEVEL				
HYDRG				
CHEM				
WAVES				
HAZRD				
SHELL				
TIDES				

Computer

	E	G	I	T
TEMP	3	1	2	6
WETHR	1	2	3	6
SAL	3	0	2	5
SEDMT	0	2	1	3
TIDES	3	0	0	3
LEVEL	2	0	1	3
CURRNT	1	0	2	3
COLOR	1	1	1	3
WAVES	1	0	1	2
HYDRG	1	0	1	2
ICE	0	0	1	1
OTHER	0	0	1	1
BIRDS	1	0	0	1
FISH	1	0	0	1
CHEM	1	0	0	1
BERGS	0	1	0	1
EROSN	0	0	1	1
SHELL				
WEEDS				
PLKTN				
HAZRD				
SHIPS				
QUAL				

Other

	E	G	I	T
CURRNT	2	3	6	11
TEMP	2	3	4	9
SAL	2	3	3	8
WAVES	0	1	7	8
PLKTN	1	4	2	7
CHEM	1	2	3	6
TIDES	1	2	2	5
FISH	0	3	2	5
WETHR	0	1	4	5
SEDMT	0	3	2	5
QUAL	1	3	0	4
WEEDS	1	2	1	4
LEVEL	0	1	3	4
SHELL	0	3	1	4
OTHER	0	1	2	3
SHIPS	0	1	2	3
ICE	0	0	3	3
BIRDS	0	1	1	2
HAZRD	0	0	2	2
COLOR	0	0	2	2
BERGS	0	0	2	2
HYDRG	0	0	1	1
EROSN				

APPENDIX C

Table C.6. Preferred means of ocean data collection, parameters ordered by total response

Number of respondents in each category

Ourselves	E	G	I	T
PLKTN	4	4	3	11
QUAL	3	5	2	10
FISH	1	5	4	10
SEDMT	2	2	5	9
CHEM	2	5	2	9
CURRNT	1	3	4	8
SAL	2	5	1	8
TEMP	2	4	1	7
WEEDS	2	3	2	7
SHELL	2	2	2	6
WAVES	1	1	4	6
TIDES	0	2	3	5
BIRDS	0	2	3	5
ICE	0	2	2	4
LEVEL	0	2	1	3
BERGS	0	2	1	3
COLOR	1	2	0	3
HYDRG	0	2	1	3
WETHR	0	1	2	3
EROSN	0	1	1	2
SHIPS	0	1	1	2
OTHER	1	1	0	2
HAZRD	0	1	0	1

Contract	E	G	I	T
HYDRG	0	0	3	3
EROSN	0	0	2	2
TEMP	0	0	1	1
WETHR	0	0	1	1
ICE	0	0	1	1
OTHER	0	1	0	1
QUAL				
FISH				
SHELL				
SEDMT				
LEVEL				
SHIPS				
SAL				
BIRDS				
CURRNT				
BERGS				
HAZRD				
WEEDS				
TIDES				
CHEM				
WAVES				
PLKTN				
COLOR				

From Gov't	E	G	I	T
TIDES	1	4	8	13
HYDRG	2	3	7	12
WAVES	0	2	3	5
LEVEL	0	1	4	5
ICE	0	0	3	3
HAZRD	0	1	2	3
WETHR	0	0	2	2
CURRNT	0	0	2	2
BERGS	0	0	1	1
COLOR	0	1	0	1
SHELL	0	0	1	1
TEMP	0	0	1	1
EROSN	0	0	1	1
BIRDS				
WEEDS				
OTHER				
PLKTN				
SEDMT				
QUAL				
SHIPS				
SAL				
FISH				
CHEM				

Personal	E	G	I	T
BIRDS	3	1	0	4
FISH	2	1	0	3
SHIPS	3	0	0	3
EROSN	3	0	0	3
BERGS	3	0	0	3
LEVEL	1	2	0	3
SHELL	3	0	0	3
COLOR	2	0	0	2
WAVES	1	1	0	2
TIDES	0	2	0	2
WETHR	1	1	0	2
HAZRD	2	0	0	2
ICE	1	0	1	2
CURRNT	0	1	0	1
QUAL	1	0	0	1
SEDMT	1	0	0	1
WEEDS	1	0	0	1
CHEM				
OTHER				
TEMP				
HYDRG				
PLKTN				
SAL				

Public	E	G	I	T
WETHR	0	0	3	3
CURRNT	0	0	2	2
WAVES	0	0	2	2
OTHER	0	1	0	1
CHEM	0	0	1	1
SAL	0	0	1	1
FISH	0	0	1	1
PLKTN	0	0	1	1
SHIPS	0	0	1	1
TEMP	0	0	1	1
COLOR	0	0	1	1
BERGS				
HYDRG				
EROSN				
ICE				
WEEDS				
QUAL				
BIRDS				
TIDES				
HAZRD				
SEDMT				
SHELL				
LEVEL				

Unsure	E	G	I	T
LEVEL	1	1	2	4
BIRDS	0	1	3	4
EROSN	0	1	1	2
SEDMT	0	0	2	2
FISH	0	1	1	2
SHIPS	0	0	2	2
OTHER	0	1	1	2
WEEDS	0	0	2	2
SAL	0	0	2	2
TEMP	0	0	2	2
CURRNT	0	0	2	2
WAVES	0	0	2	2
PLKTN	0	0	2	2
QUAL	0	0	1	1
WETHR	0	0	1	1
HYDRG	0	0	1	1
CHEM	0	0	1	1
HAZRD	0	0	1	1
SHELL	0	0	1	1
COLOR	0	0	1	1
TIDES	0	0	1	1
ICE				
BERGS				

APPENDIX C

Table C.6. Preferred means of ocean data collection, parameters ordered by total response

Paper	E	G	I	T
HYDRG	2	5	6	13
EROSN	2	2	2	6
SEDMT	1	3	1	5
SAL	0	3	2	5
ICE	2	2	0	4
HAZRD	1	2	1	4
OTHER	0	3	1	4
BIRDS	0	1	2	3
LEVEL	0	1	2	3
CURRNT	0	2	0	2
PLKTN	1	1	0	2
TEMP	0	2	0	2
QUAL	0	2	0	2
FISH	0	1	1	2
WETHR	0	2	0	2
TIDES	0	1	1	2
CHEM	0	2	0	2
COLOR	0	1	1	2
SHELL	0	1	0	1
BERGS	0	0	1	1
SHIPS	0	0	1	1
WAVES	0	1	0	1
WEEDS	0	1	0	1

Telephone	E	G	I	T
WETHR	0	1	5	6
ICE	0	2	3	5
TEMP	0	0	4	4
WAVES	0	1	3	4
HAZRD	0	1	2	3
LEVEL	0	2	1	3
COLOR	0	0	3	3
CURRNT	0	1	2	3
CHEM	0	1	2	3
FISH	0	0	3	3
PLKTN	0	1	1	2
EROSN	0	1	1	2
TIDES	0	1	1	2
SHIPS	0	0	2	2
WEEDS	0	1	0	1
SAL	0	0	1	1
BERGS	0	0	1	1
SHELL	0	1	0	1
SEDMT	0	0	1	1
QUAL	0	1	0	1
BIRDS	0	0	1	1
OTHER	0	0	1	1
HYDRG	0	1	0	1

Radio	E	G	I	T
WETHR	0	4	1	5
TEMP	0	1	3	4
WAVES	0	2	1	3
FISH	0	0	2	2
COLOR	0	1	1	2
CURRNT	0	1	1	2
OTHER	0	0	1	1
PLKTN	0	0	1	1
ICE	0	1	0	1
SEDMT	0	1	0	1
TIDES	0	0	1	1
SAL				
BERGS				
WEEDS				
SHELL				
SHIPS				
LEVEL				
HYDRG				
CHEM				
QUAL				
EROSN				
BIRDS				
HAZRD				

Satellite	E	G	I	T
COLOR	1	1	1	3
WETHR	1	0	1	2
SEDMT	0	1	1	2
PLKTN	0	1	1	2
SHIPS	0	2	0	2
TEMP	1	0	0	1
BERGS	1	0	0	1
ICE	1	0	0	1
FISH	0	1	0	1
TIDES	0	0	1	1
LEVEL	1	0	0	1
HAZRD				
CURRNT				
BIRDS				
CHEM				
WAVES				
EROSN				
SHELL				
SAL				
OTHER				
QUAL				
HYDRG				
WEEDS				

Computer	E	G	I	T
WETHR	5	5	4	14
CURRNT	5	3	2	10
WAVES	4	4	1	9
TEMP	3	4	2	9
SAL	4	1	4	9
TIDES	5	0	0	5
LEVEL	3	1	1	5
CHEM	3	2	0	5
SEDMT	2	2	0	4
PLKTN	2	1	0	3
HYDRG	2	0	1	3
QUAL	1	1	1	3
FISH	3	0	0	3
COLOR	1	1	0	2
ICE	1	1	0	2
BERGS	0	1	0	1
HAZRD	0	1	0	1
WEEDS	1	0	0	1
BIRDS	1	0	0	1
EROSN	1	0	0	1
SHIPS	0	1	0	1
SHELL				
OTHER				

Other	E	G	I	T
CURRNT	1	2	5	8
SAL	0	3	4	7
WAVES	0	1	6	7
PLKTN	0	4	2	6
TEMP	0	3	3	6
TIDES	0	2	3	5
WETHR	0	1	3	4
LEVEL	0	1	3	4
FISH	0	2	1	3
WEEDS	0	2	1	3
SHELL	0	2	1	3
ICE	0	0	3	3
BIRDS	0	1	1	2
OTHER	0	1	1	2
QUAL	0	2	0	2
HAZRD	0	0	2	2
CHEM	0	1	1	2
BERGS	0	0	2	2
SEDMT	0	1	1	2
SHIPS	0	0	2	2
HYDRG	0	0	1	1
EROSN	0	0	1	1
COLOR				

APPENDIX C

Table C.7. Annual expenditures for ocean information, parameters ordered by total response

Number of respondents in each category

Nothing

	E	G	I	T
WETHR	0	4	8	12
WAVES	0	2	5	7
CURRNT	0	2	5	7
FISH	0	2	4	6
PLKTN	0	2	3	5
TEMP.	0	2	3	5
COLOR	0	0	5	5
SHIPS	0	1	3	4
LEVEL	0	3	1	4
TIDES	0	2	2	4
ICE	0	1	2	3
SAL.	0	2	1	3
CHEM.	0	1	2	3
BIRDS	0	1	2	3
SEDMT	0	1	2	3
OTHER	0	1	1	2
HAZRD	0	1	1	2
WETHR	0	2	0	2
QUAL.	0	1	0	1
BERGS	0	1	0	1
WEEDS	0	0	1	1
SHELL	0	0	1	1
EROSN	0	1	0	1

<$1K

	E	G	I	T
WETHR	6	3	11	20
TIDES	5	4	10	19
WETHR	5	7	4	16
TEMP.	4	3	5	12
WAVES	3	3	6	12
SAL.	4	3	4	11
LEVEL	4	2	4	10
CURRNT	3	1	5	9
ICE	2	3	3	8
HAZRD	1	3	4	8
CHEM.	4	2	2	8
PLKTN	4	2	2	8
SEDMT	3	2	3	8
BIRDS	1	2	4	7
FISH	2	2	3	7
SHELL	2	2	2	6
EROSN	2	0	4	6
QUAL.	2	2	1	5
BERGS	1	2	2	5
WEEDS	2	1	1	4
COLOR	1	1	1	3
OTHER	1	1	1	3
SHIPS	0	0	1	1

$1K - 2.5K

	E	G	I	T
WETHR	0	0	2	2
SAL.	0	0	1	1
WAVES	0	0	1	1
FISH	0	0	1	1
WETHR	0	0	1	1
CURRNT	1	0	0	1
TIDES	0	0	1	1
EROSN	0	1	0	1
SEDMT				
TEMP.				
SHELL				
OTHER				
QUAL.				
LEVEL				
CHEM.				
PLKTN				
BERGS				
SHIPS				
COLOR				
WEEDS				
BIRDS				
ICE				
HAZRD				

$2.5 - 5K

	E	G	I	T
WETHR	0	0	2	2
TIDES	0	1	1	2
CHEM.	0	1	1	2
COLOR	0	1	0	1
QUAL.	0	0	1	1
TEMP.	0	1	0	1
WAVES	0	0	1	1
CURRNT	0	0	1	1
LEVEL	0	0	1	1
SEDMT	0	1	0	1
PLKTN	0	0	1	1
WETHR				
EROSN				
SAL.				
HAZRD				
SHIPS				
WEEDS				
SHELL				
BERGS				
OTHER				
ICE				
FISH				
BIRDS				

$5K - 7.5K

	E	G	I	T
SHIPS	3	0	0	3
COLOR	2	0	1	3
BIRDS	3	0	0	3
EROSN	3	0	0	3
BERGS	3	0	0	3
HAZRD	2	0	0	2
OTHER	0	1	1	2
ICE	1	0	1	2
FISH	2	0	0	2
SHELL	2	0	0	2
SEDMT	1	0	1	2
TEMP.	0	0	1	1
LEVEL	1	0	0	1
QUAL.	1	0	0	1
PLKTN	0	1	0	1
WEEDS	1	0	0	1
WAVES	1	0	0	1
WETHR	1	0	0	1
SAL.				
WETHR				
TIDES				
CURRNT				
CHEM.				

$7.5K - 10K

	E	G	I	T
TEMP.	0	1	0	1
QUAL.	0	1	0	1
FISH	0	1	0	1
CURRNT	0	1	0	1
SEDMT	0	1	0	1
COLOR				
EROSN				
SAL.				
CHEM.				
ICE				
PLKTN				
OTHER				
TIDES				
WETHR				
HAZRD				
WETHR				
BIRDS				
WAVES				
LEVEL				
WEEDS				
SHELL				
SHIPS				
BERGS				

$25K - 50K

	E	G	I	T
COLOR	1	1	0	2
WETHR	0	0	1	1
SHIPS	0	1	0	1
CURRNT				
EROSN				
WAVES				
LEVEL				
HAZRD				
OTHER				
SEDMT				
CHEM.				
BERGS				
TIDES				
QUAL.				
SAL.				
WETHR				
ICE				
WEEDS				
FISH				
BIRDS				
SHELL				
TEMP.				
PLKTN				

$50K - 100K

	E	G	I	T
CURRNT	1	0	0	1
WAVES	0	0	1	1
WETHR	0	0	1	1
CHEM.				
QUAL.				
SEDMT				
BERGS				
COLOR				
OTHER				
SHIPS				
TEMP.				
LEVEL				
WEEDS				
BIRDS				
TIDES				
SAL.				
WETHR				
EROSN				
FISH				
PLKTN				
ICE				
SHELL				
HAZRD				

>$250K

	E	G	I	T
SHIPS	0	1	0	2
FISH	0	1	0	2
WETHR	0	0	1	2
SAL.				
SEDMT				
CHEM.				
QUAL.				
WETHR				
PLKTN				
WETHR				
EROSN				
SHIPS				
BERGS				
BIRDS				
OTHER				
TEMP.				
TIDES				
SHELL				
WEEDS				
ICE				
HAZRD				
LEVEL				
COLOR				

Unsure

	E	G	I	T
CURRNT	1	7	9	17
WAVES	1	7	8	16
SAL.	1	6	8	15
TEMP.	1	6	7	14
PLKTN	2	6	5	13
WETHR	0	6	7	13
LEVEL	0	5	8	13
ICE	1	4	7	12
SEDMT	1	6	5	12
CHEM.	0	7	3	10
FISH	1	5	4	10
TIDES	0	4	5	9
QUAL.	0	6	3	9
WETHR	0	4	4	8
EROSN	0	3	4	7
SHELL	0	5	2	7
OTHER	0	4	2	6
BIRDS	0	3	3	6
WEEDS	0	4	2	6
SHIPS	0	1	5	6
HAZRD	0	2	3	5
COLOR	1	1	2	4
BERGS	0	1	3	4

APPENDIX C

Table C.8. Willingness to make data available to other users

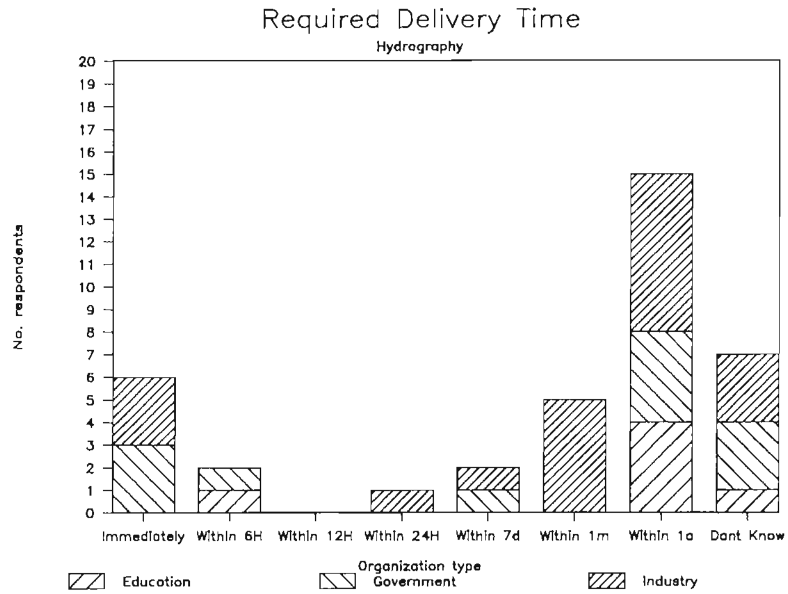
Number of respondents in each category

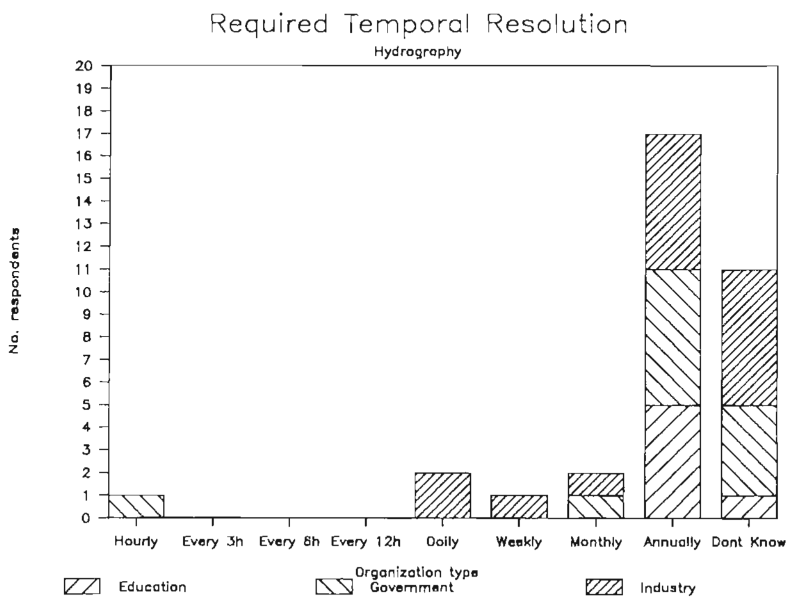
Yes	E	G	I	T	No	E	G	I	T	Unsure	E	G	I	T
WAVES	5	11	17	33	TIDES	0	1	2	3	EROSN	3	0	2	5
CURRNT	5	11	16	32	SHIP	0	0	2	2	HYDRG	0	1	3	4
TEMP.	6	13	11	30	FISH	0	0	2	2	WETHR	0	2	2	4
WETHR	4	9	16	29	HAZRD	2	0	0	2	BERGS	3	0	1	4
SAL.	6	11	11	28	HYDRG	0	0	1	1	FISH	2	1	1	4
TIDES	6	8	13	27	COLOR	0	0	1	1	SHIP	3	0	1	4
PLKTN	6	10	10	26	SEDMT	0	0	1	1	LEVEL	1	0	2	3
FISH	3	8	11	22	CURRNT	0	0	1	1	CURRNT	0	1	2	3
HYDRG	4	8	10	22	LEVEL	0	0	1	1	TEMP.	0	1	2	3
SEDMT	5	8	9	22	TEMP.	0	0	1	1	PLKTN	1	1	1	3
ICE	2	7	10	19	WAVES	0	0	1	1	BIRDS	3	0	0	3
LEVEL	4	7	8	19	WETHR	1	0	0	1	TIDES	0	0	2	2
CHEM	5	9	5	19	BERGS					CHEM	0	0	2	2
QUAL	3	8	4	15	EROSN					SAL.	0	0	2	2
BIRDS	1	4	9	14	SHELL					QUAL	1	0	1	2
HAZRD	1	6	7	14	WEEDS					WAVES	1	0	1	2
SHELL	3	6	5	14	OTHER					ICE	1	0	1	2
COLOR	3	4	6	13	QUAL					COLOR	2	0	0	2
WEEDS	3	5	4	12	BIRDS					SHELL	2	0	0	2
BERGS	1	4	5	10	ICE					WEEDS	1	0	0	1
EROSN	2	3	4	9	CHEM					OTHER	0	1	0	1
SHIP	0	5	4	9	PLKTN					SEDMT	1	0	0	1
OTHER	1	4	2	7	SAL.					HAZRD				

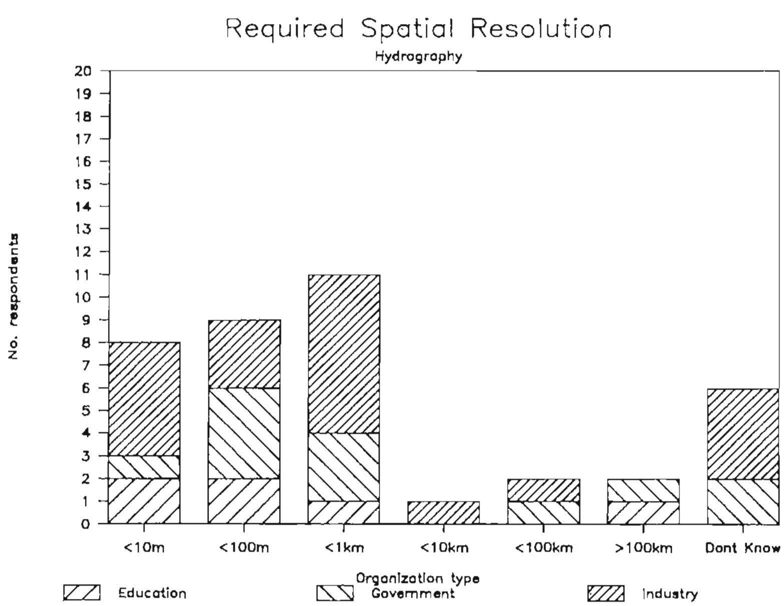
APPENDIX D

GRAPHICAL REPRESENTATIONS OF

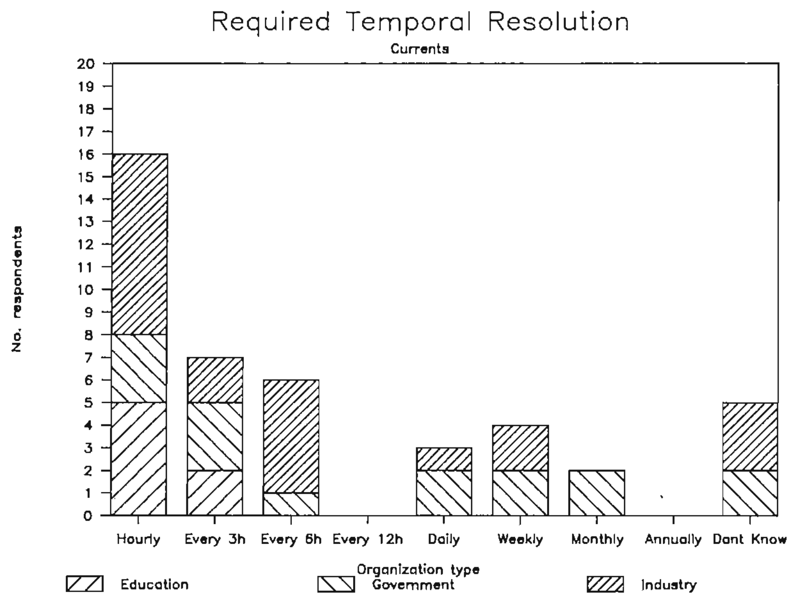
REQUIRED DELIVERY TIME,
SPATIAL AND TEMPORAL RESOLUTION

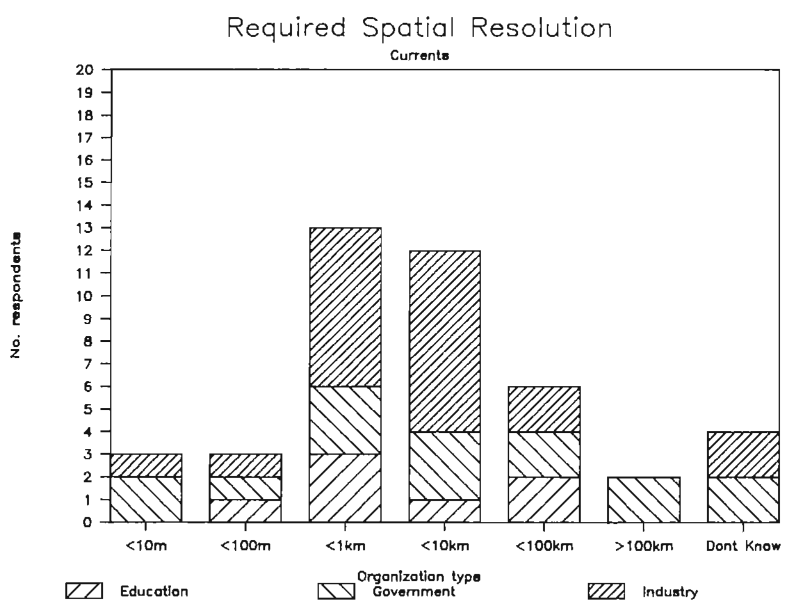

Required Delivery Time
Hydrography
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

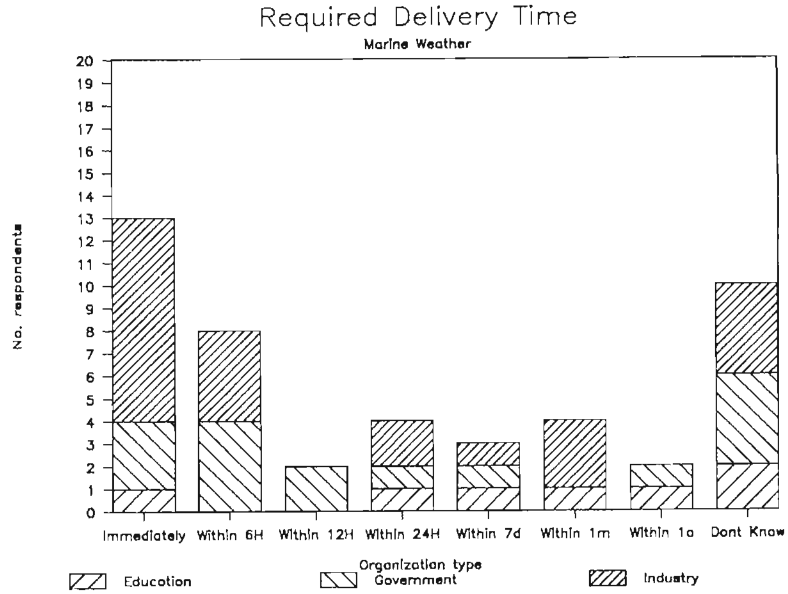

Required Temporal Resolution
Hydrography
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

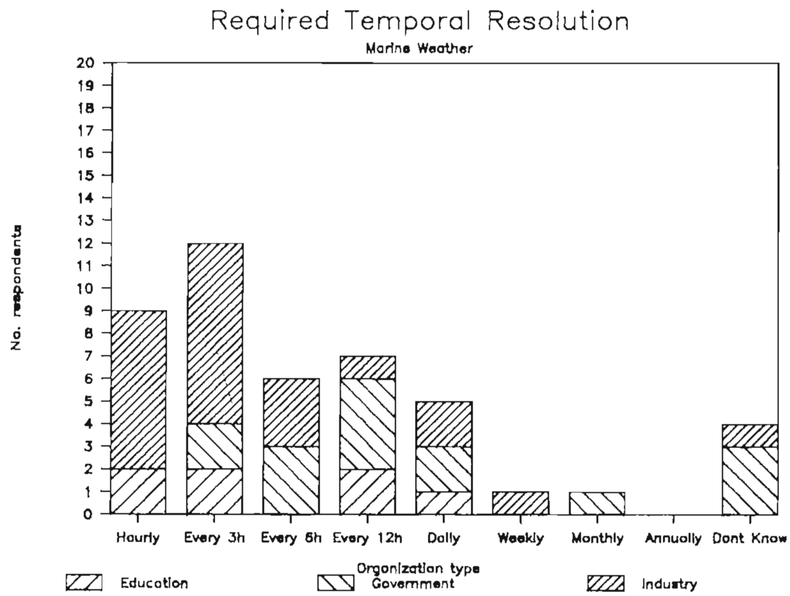

Required Spatial Resolution
Hydrography
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

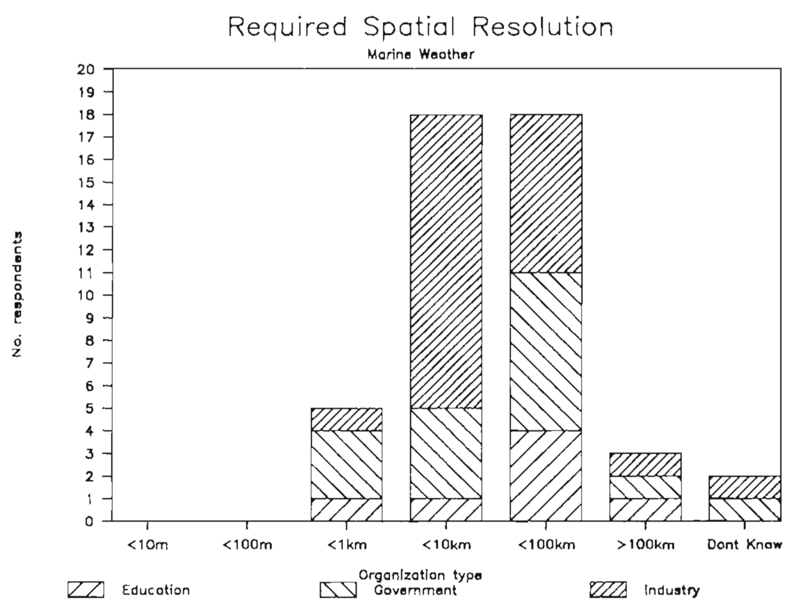

Required Delivery Time
Currents
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Currents
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

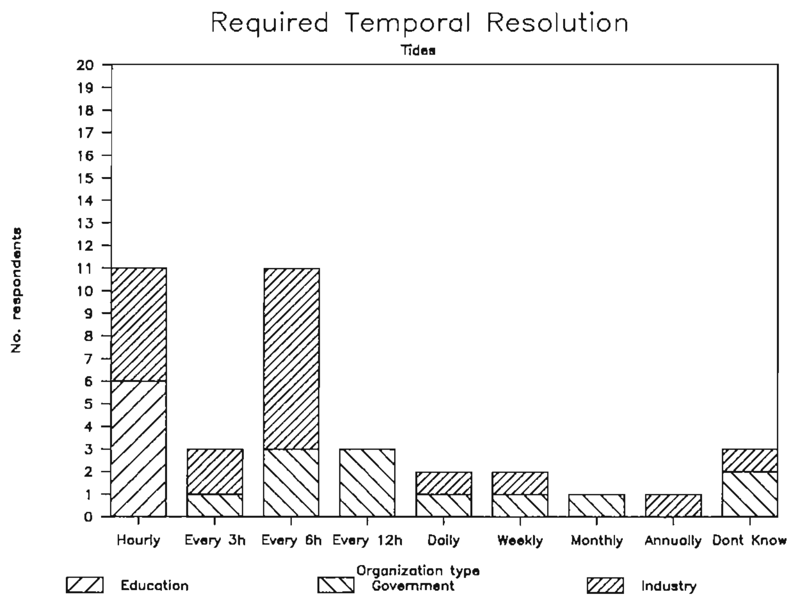

Required Spatial Resolution
Currents
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

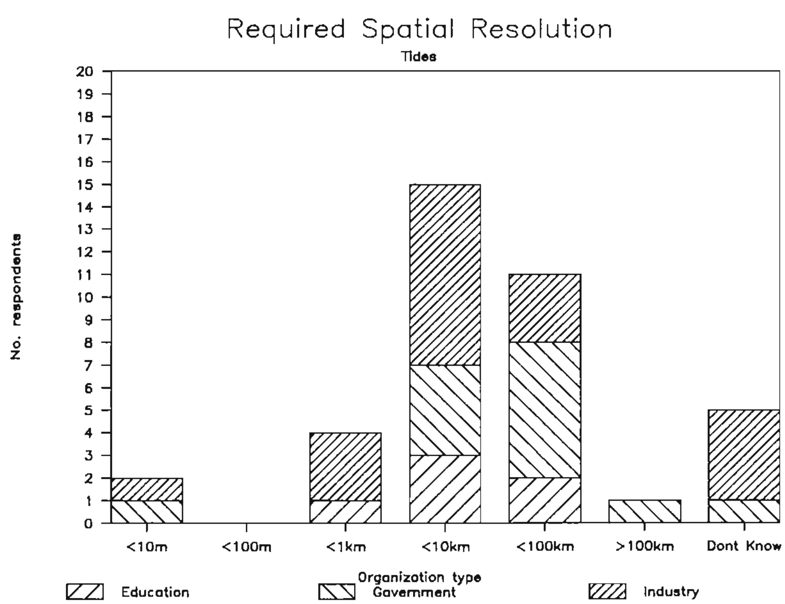

Required Delivery Time
Marine Weather
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

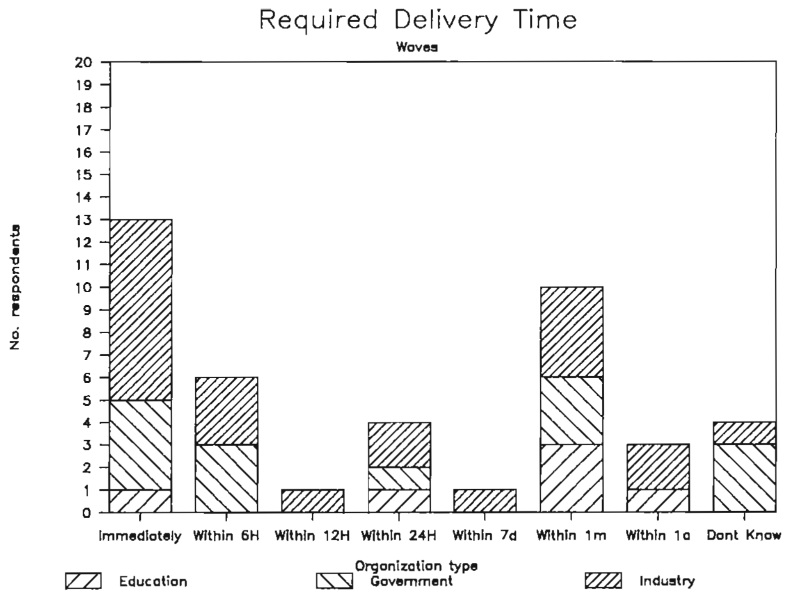

Required Temporal Resolution
Marine Weather
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

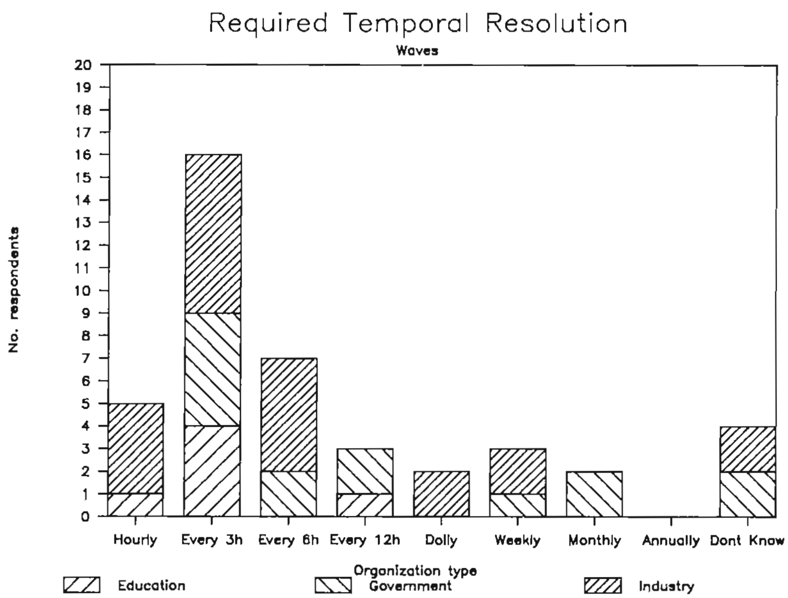

Required Spatial Resolution
Marine Weather
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

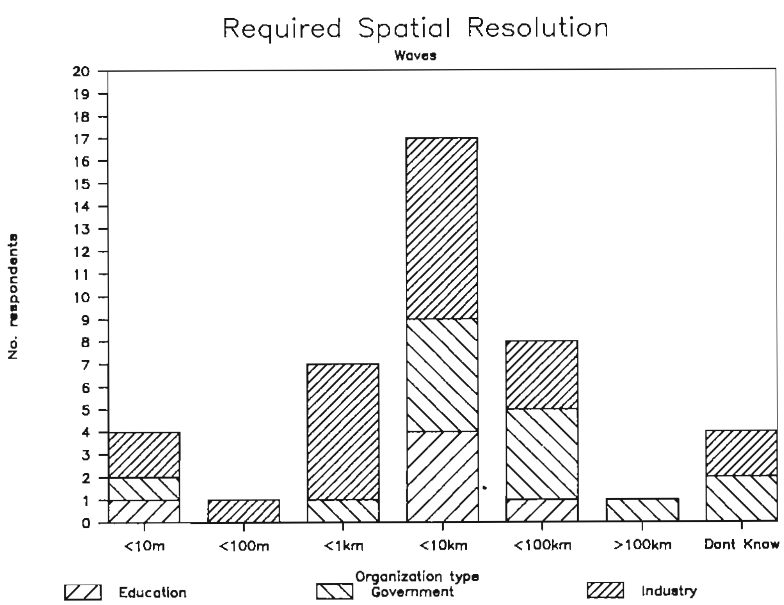

Required Delivery Time
Tides
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

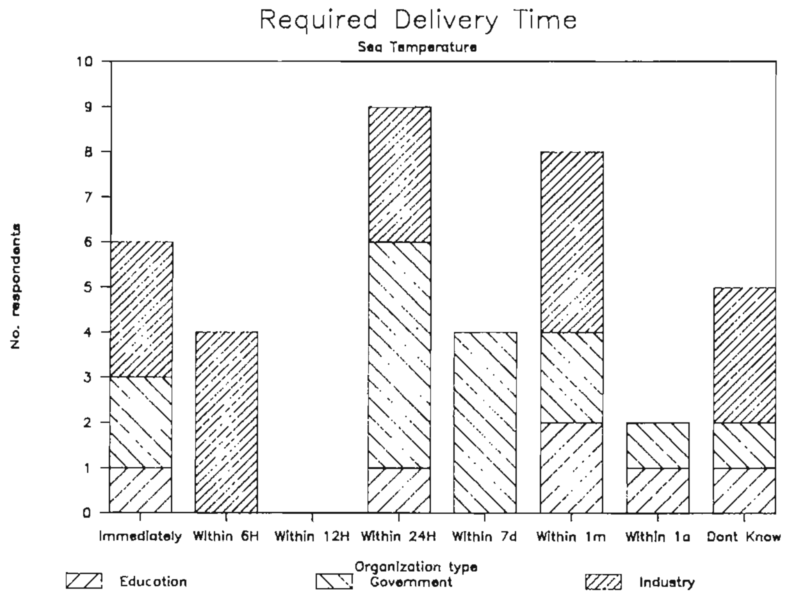

Required Temporal Resolution
Tides
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

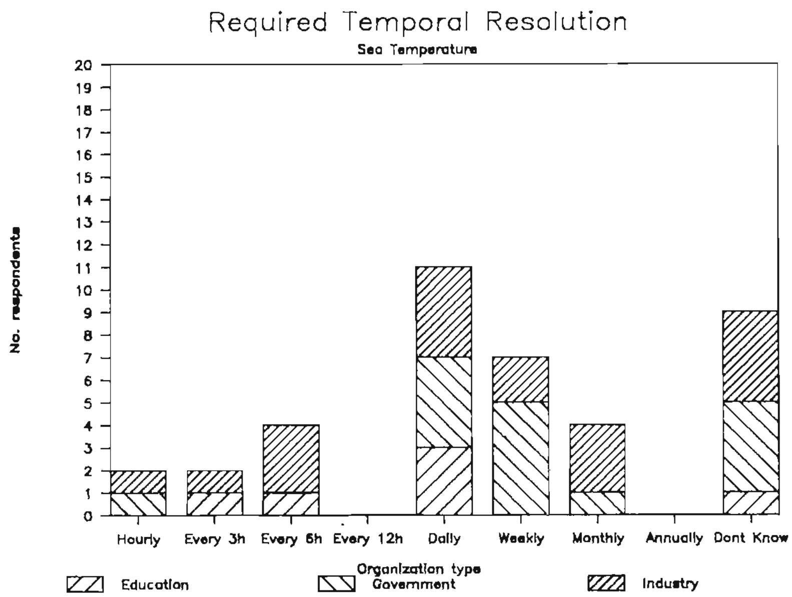

Required Spatial Resolution
Tides
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

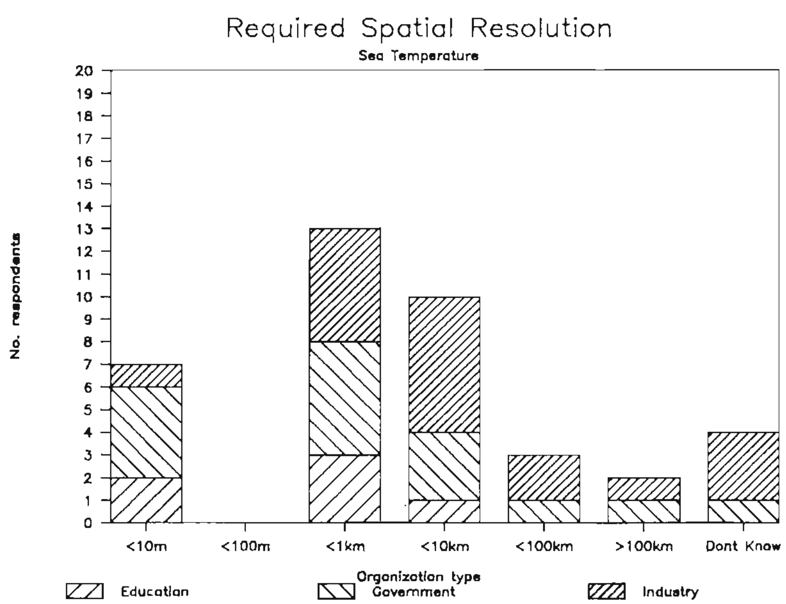

Required Delivery Time
Waves
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

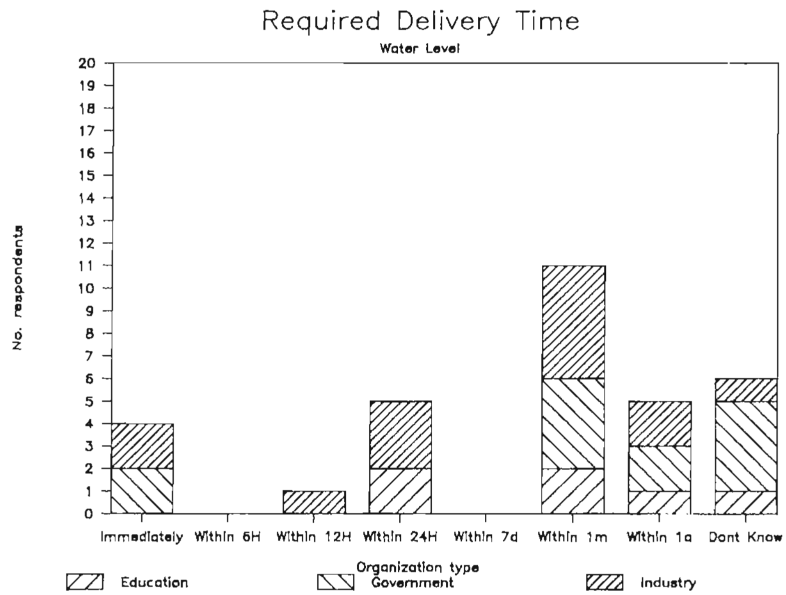

Required Temporal Resolution
Waves
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

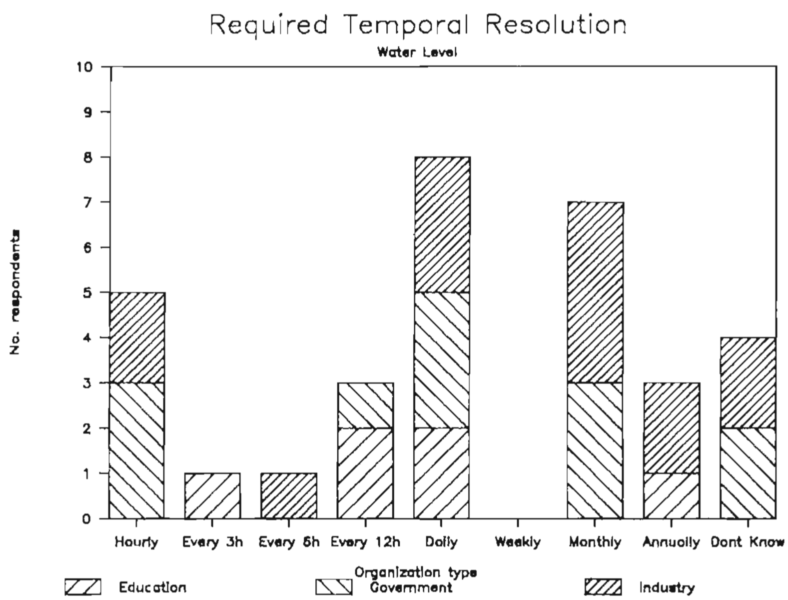

Required Spatial Resolution
Waves
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

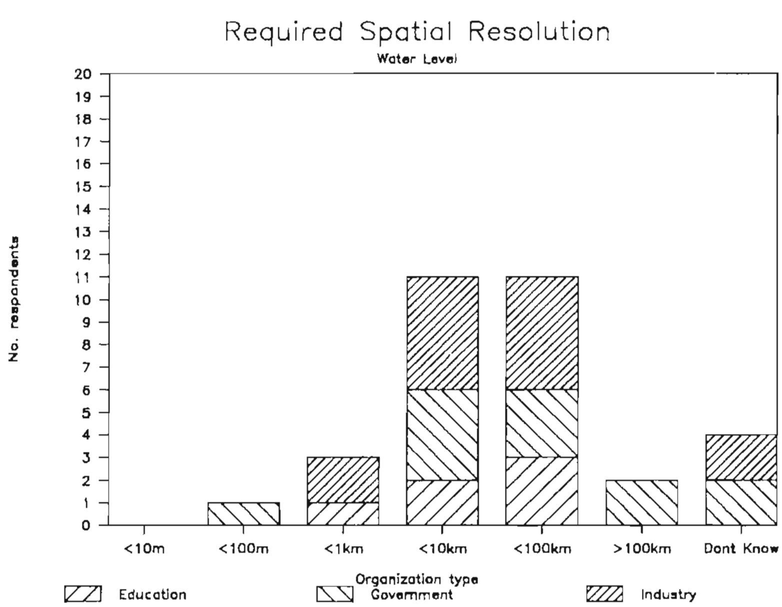

Required Delivery Time
Sea Temperature
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Sea Temperature
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

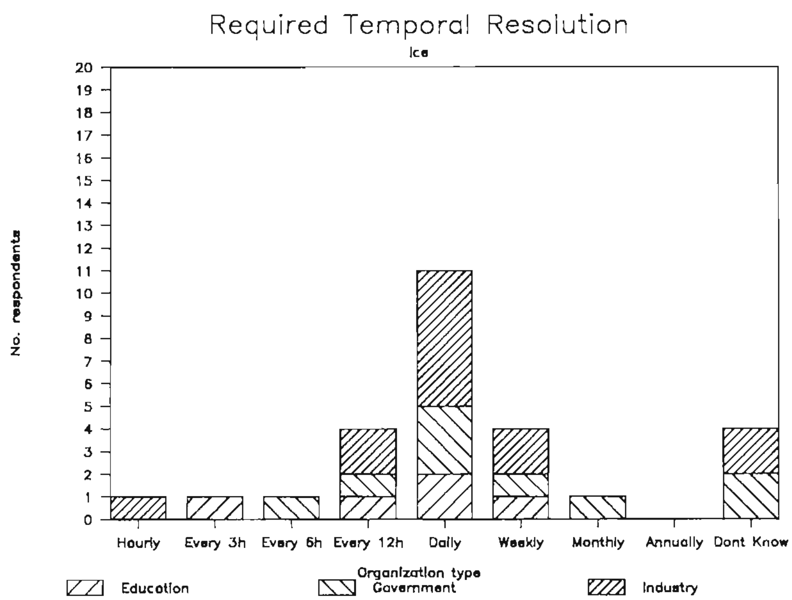

Required Spatial Resolution
Sea Temperature
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry


Required Delivery Time
Water Level
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

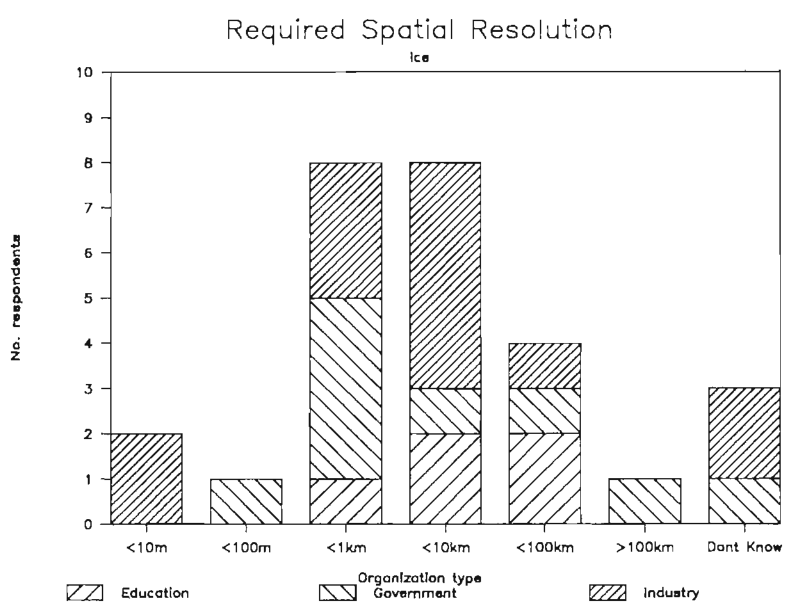

Required Temporal Resolution
Water Level
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Water Level
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

Required Delivery Time
Ice
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

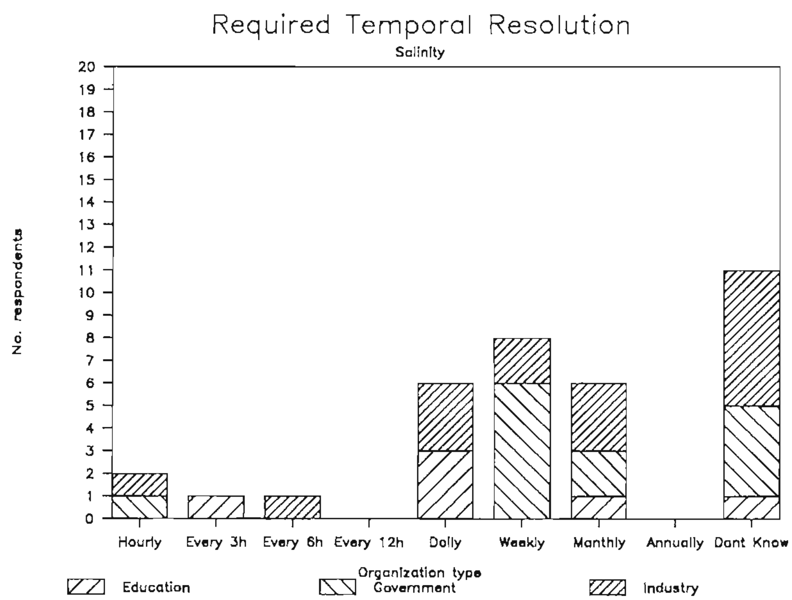


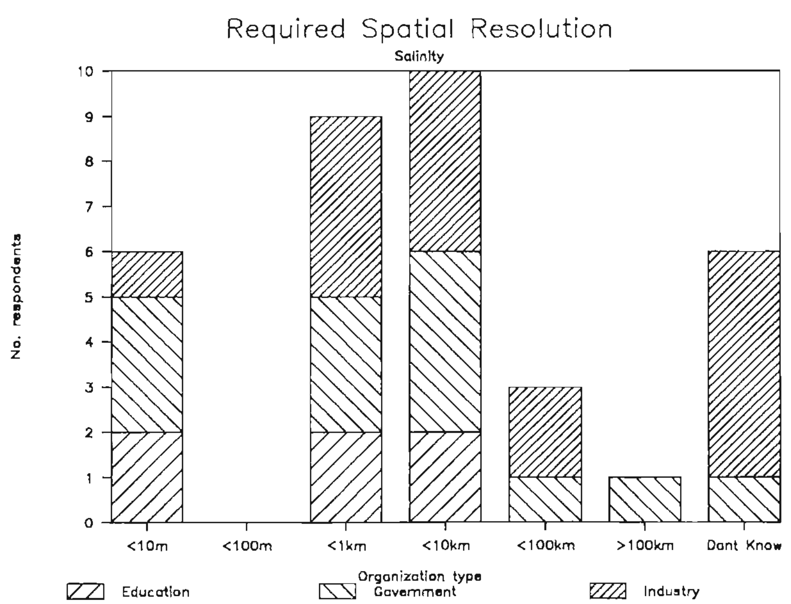
Required Temporal Resolution
Ice
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

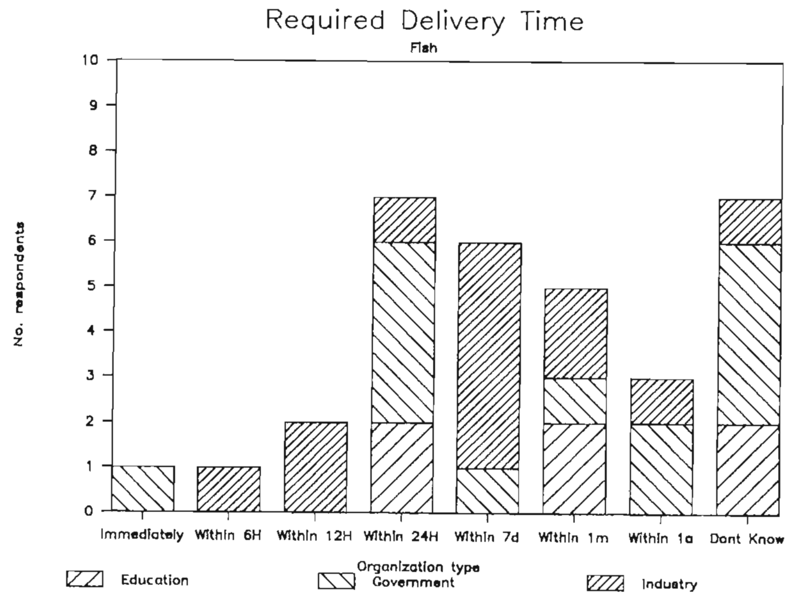


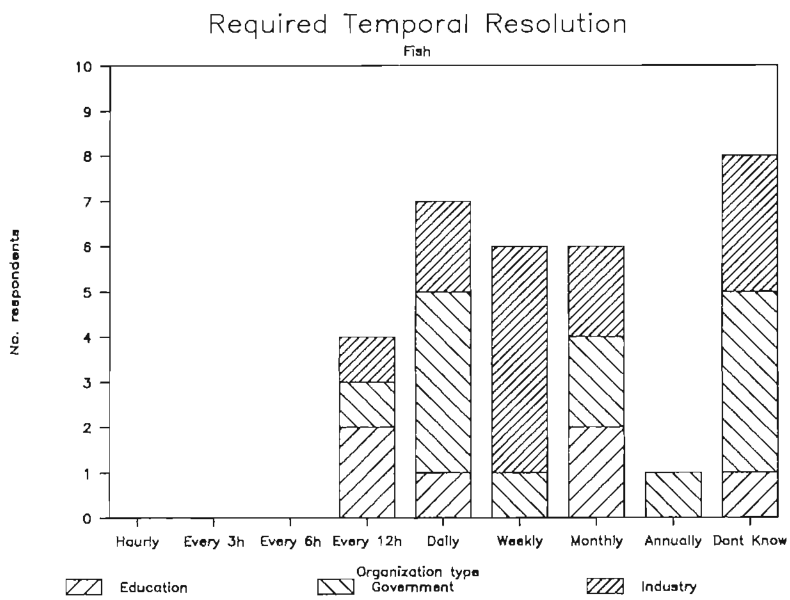
Required Spatial Resolution
Ice
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

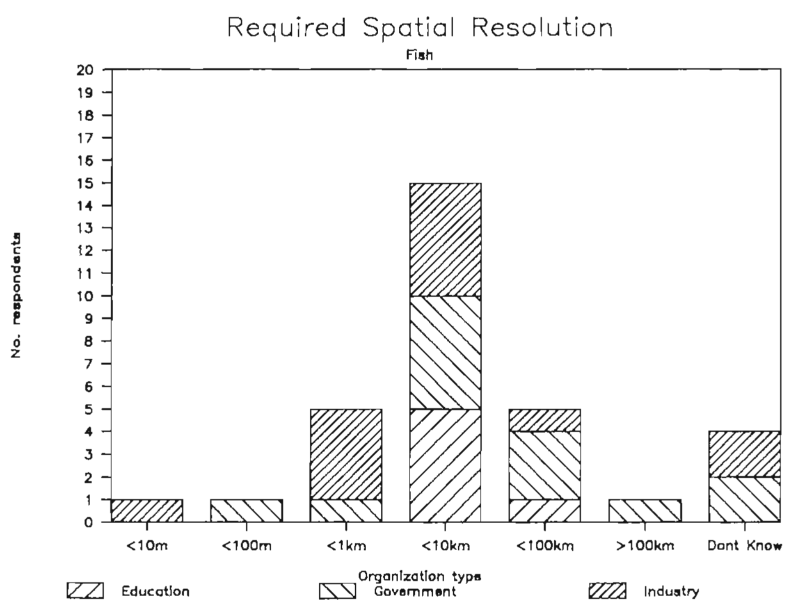

Required Delivery Time
Salinity
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Salinity
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

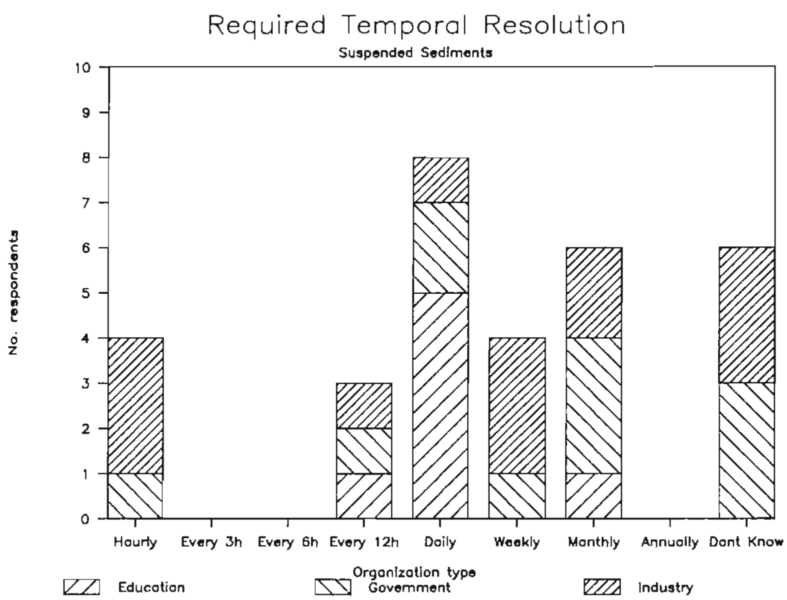

Required Spatial Resolution
Salinity
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry


Required Delivery Time
Fish
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

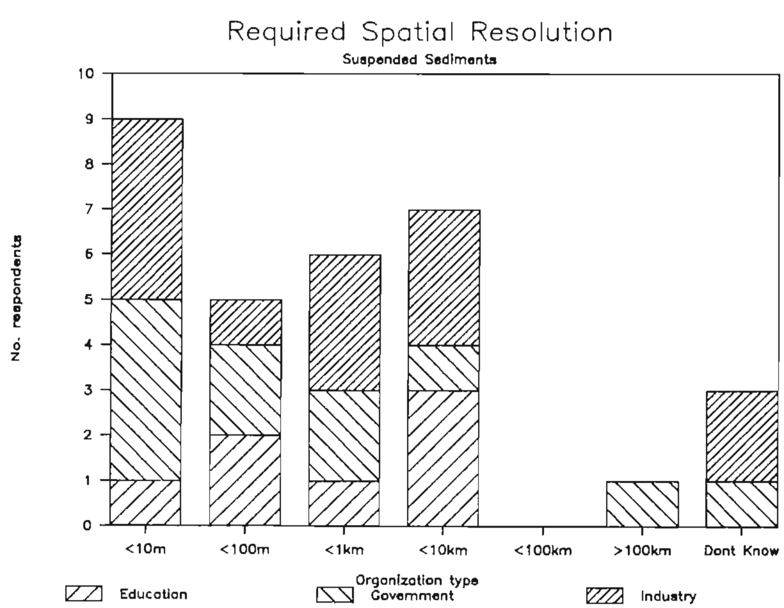

Required Temporal Resolution
Fish
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Fish
No. respondents
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

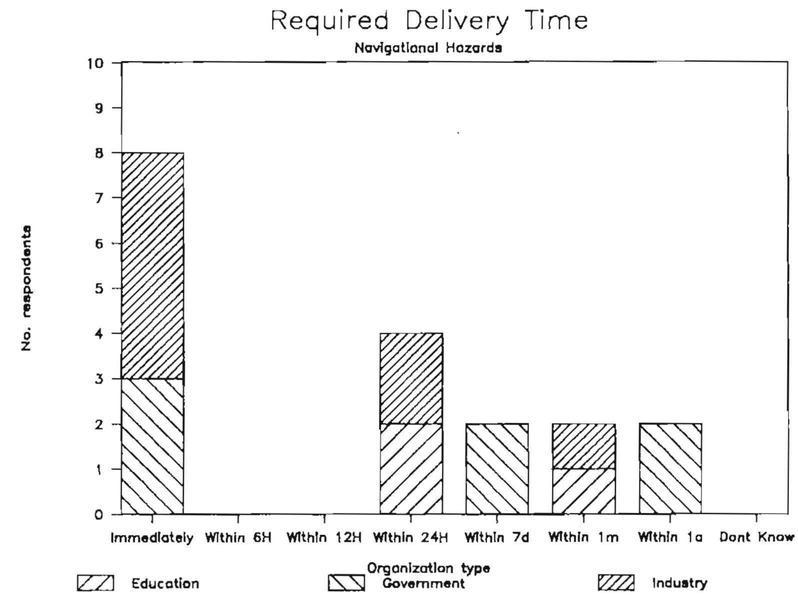
Required Delivery Time
Suspended Sediments
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry



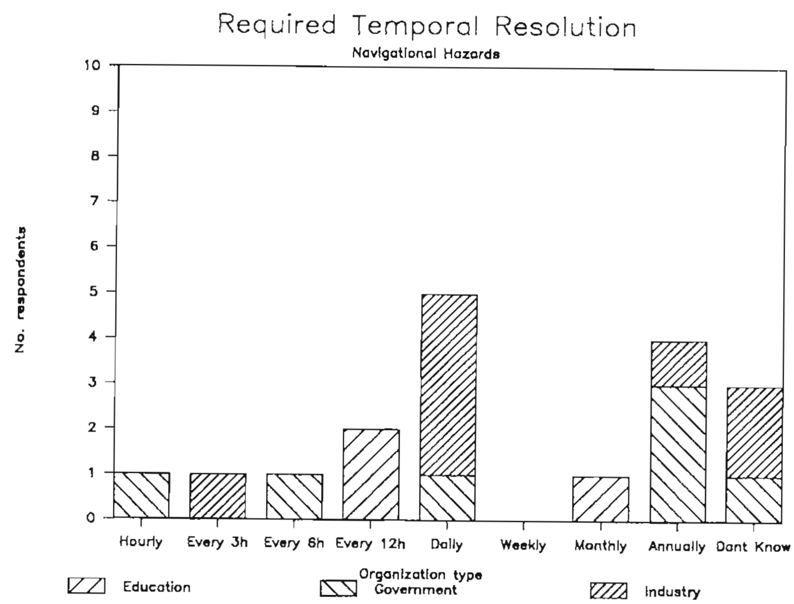
Required Temporal Resolution
Suspended Sediments
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry



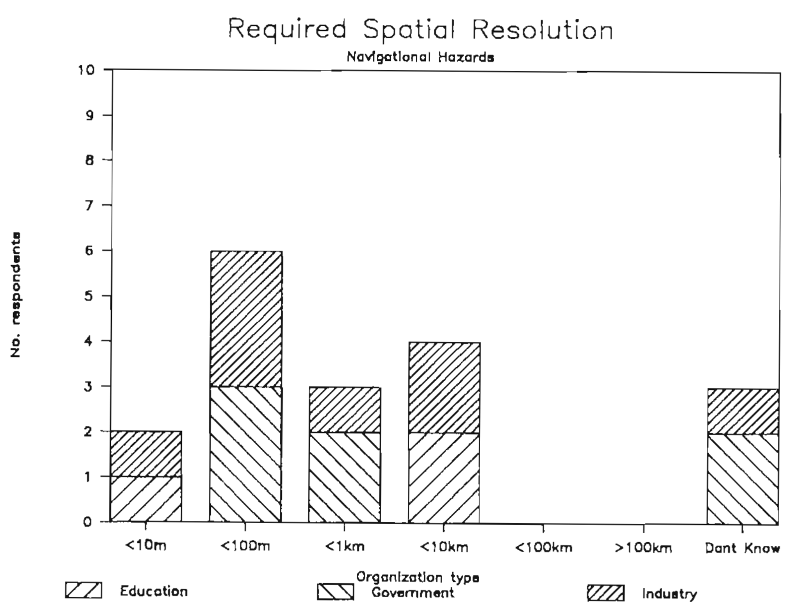
Required Spatial Resolution
Suspended Sediments
No. respondents
0
1
2
3
4
5
6
7
8
9
10
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry



Required Delivery Time
Navigational Hazards
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

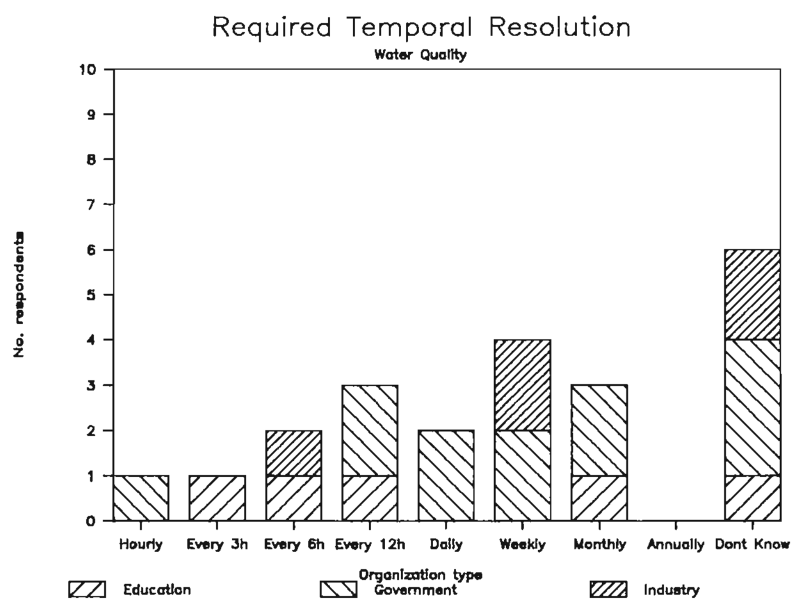


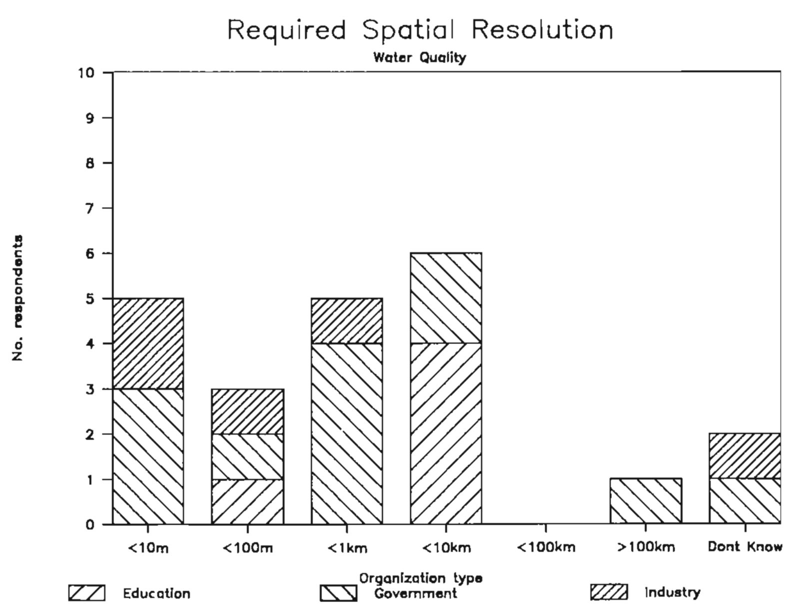
Required Temporal Resolution
Navigational Hazards
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry



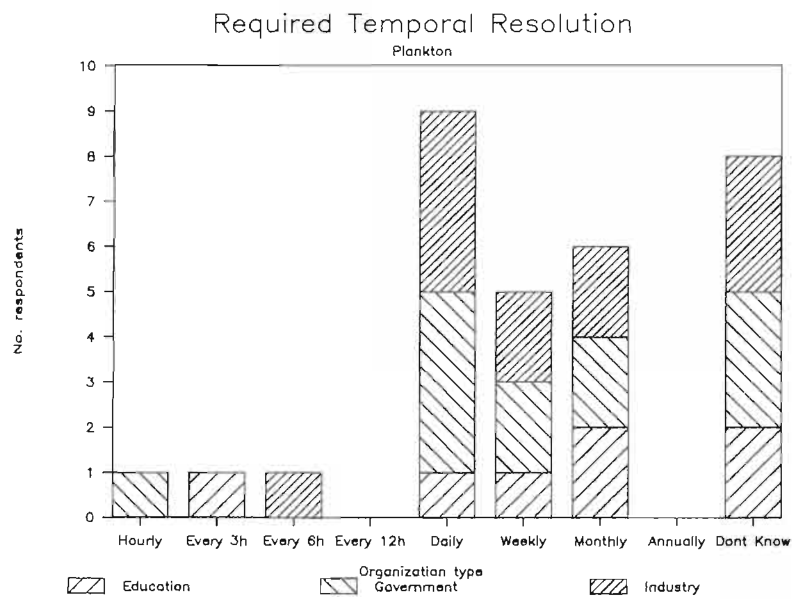
Required Spatial Resolution
Navigational Hazards
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry


Required Delivery Time
Water Quality
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

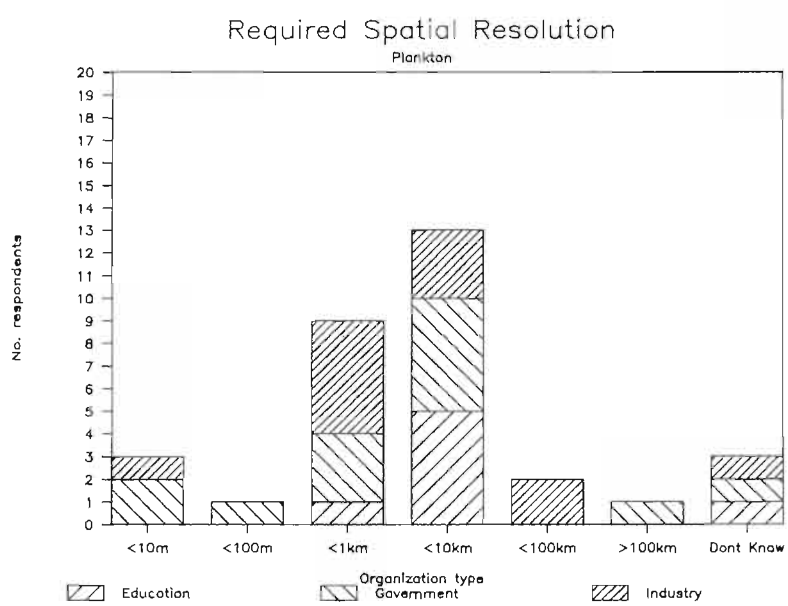

Required Temporal Resolution
Water Quality
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Water Quality
No. respondents
0
1
2
3
4
5
6
7
8
9
10
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

Required Delivery Time
Plankton
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

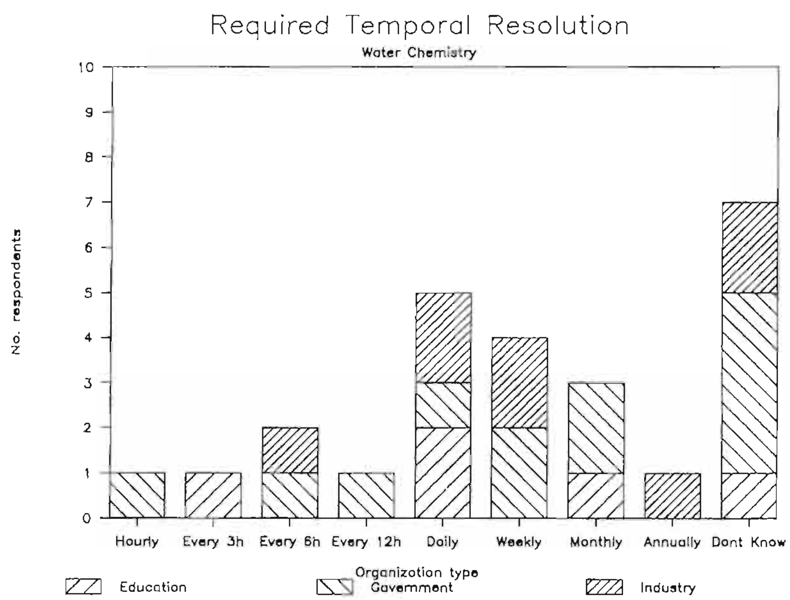


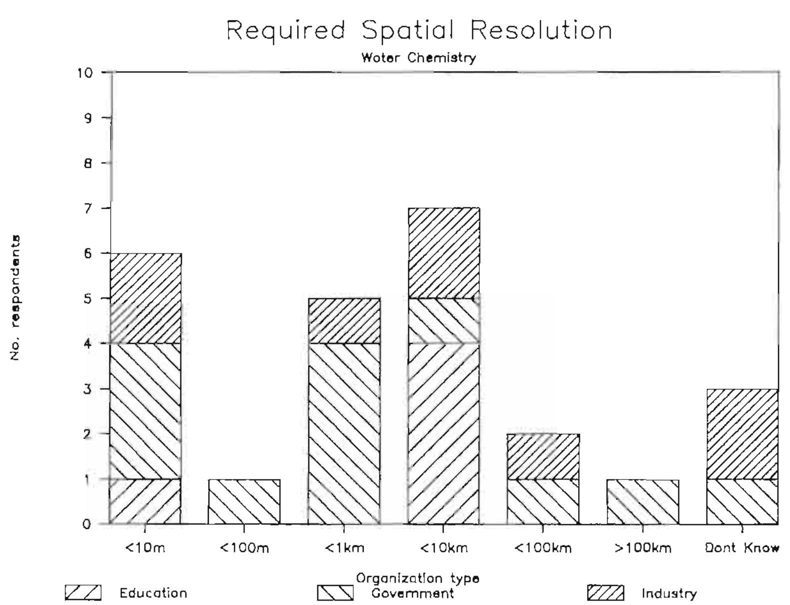
Required Temporal Resolution
Plankton
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry



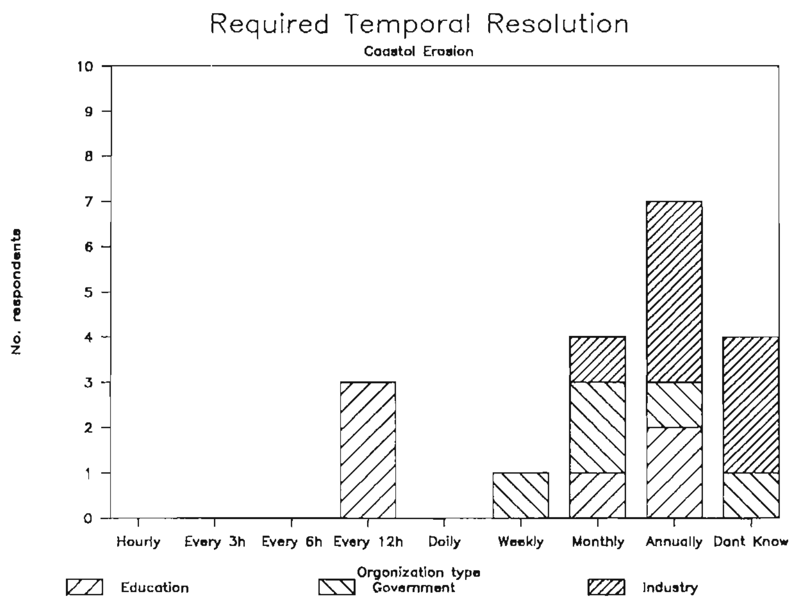
Required Spatial Resolution
Plankton
No. respondents
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

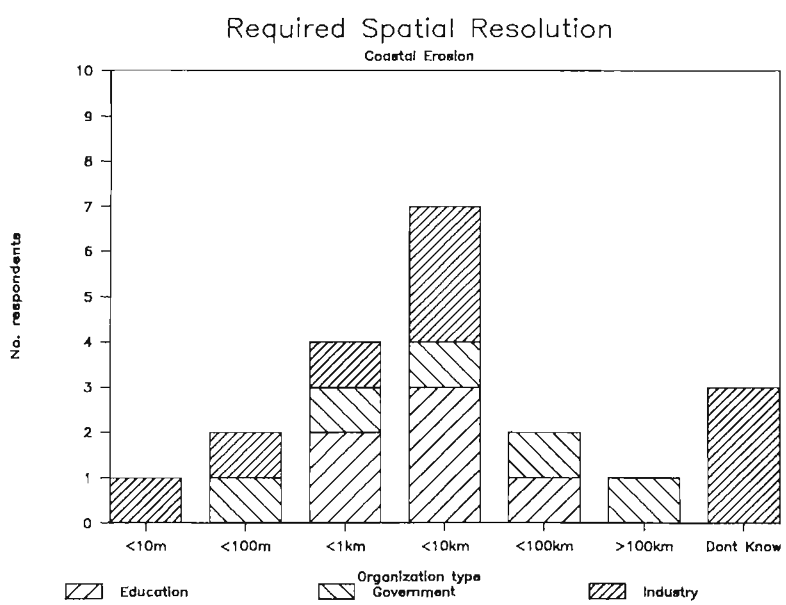

Required Delivery Time
Water Chemistry
No. respondents
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Water Chemistry
No. respondents
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

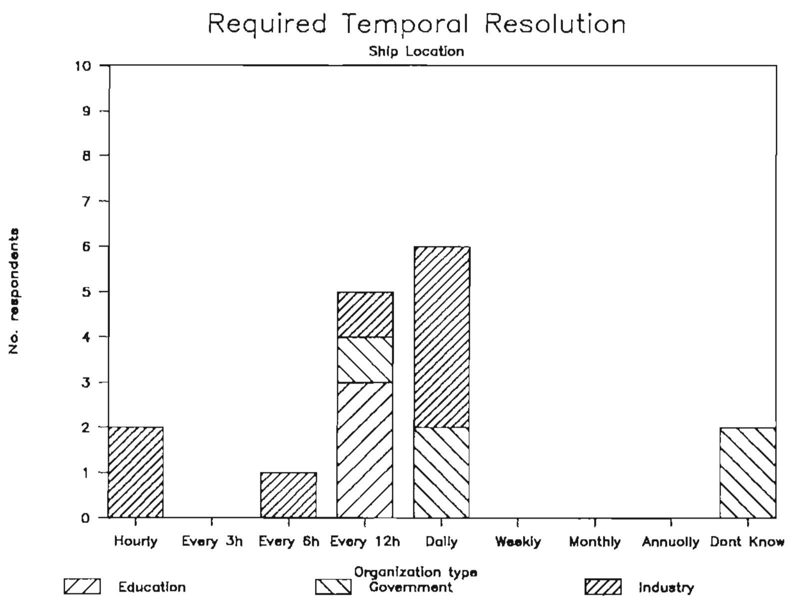

Required Spatial Resolution
Water Chemistry
No. respondents
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

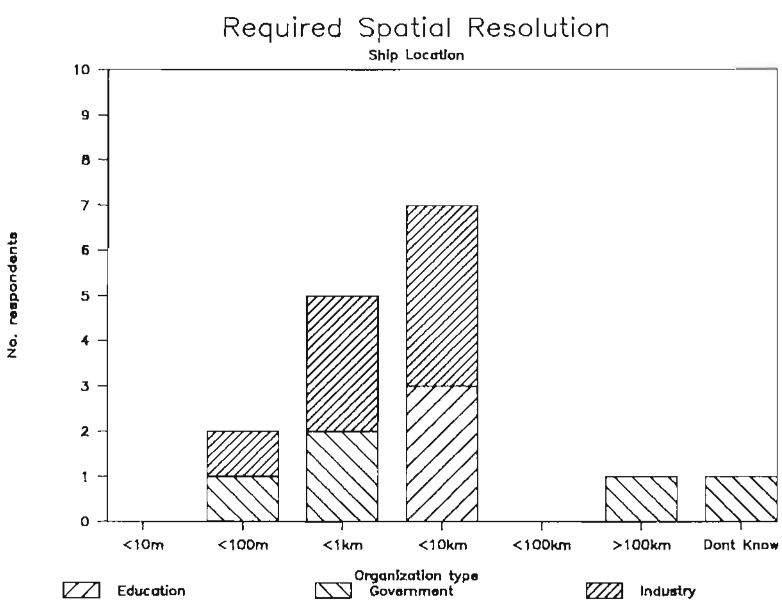

Required Delivery Time
Coastal Erosion
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Coastal Erosion
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

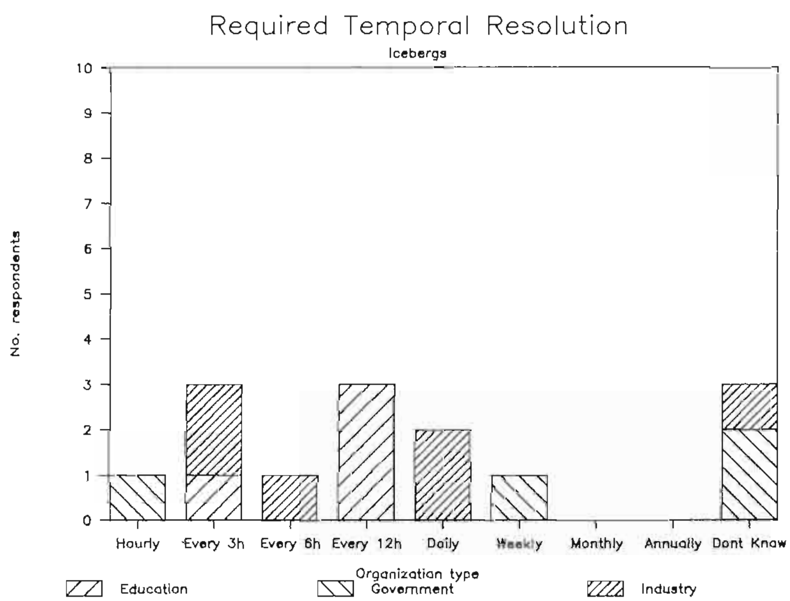

Required Spatial Resolution
Coastal Erosion
No. respondents
0
1
2
3
4
5
6
7
8
9
10
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

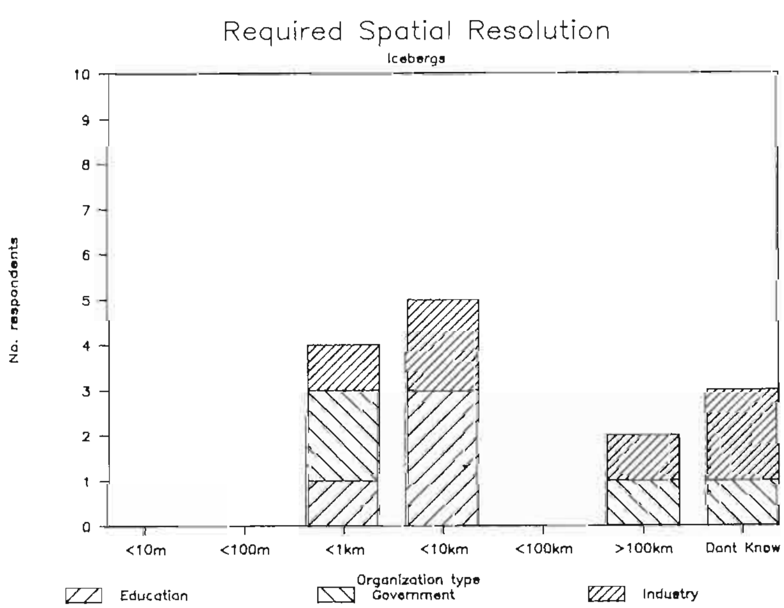

Required Delivery Time
Ship Location
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Ship Location
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

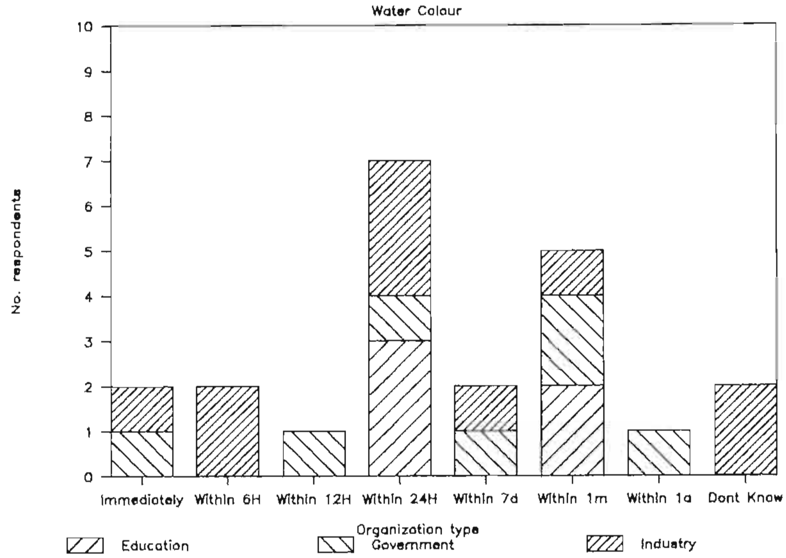

Required Spatial Resolution
Ship Location
No. respondents
0
1
2
3
4
5
6
7
8
9
10
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry


Required Delivery Time
Icebergs
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

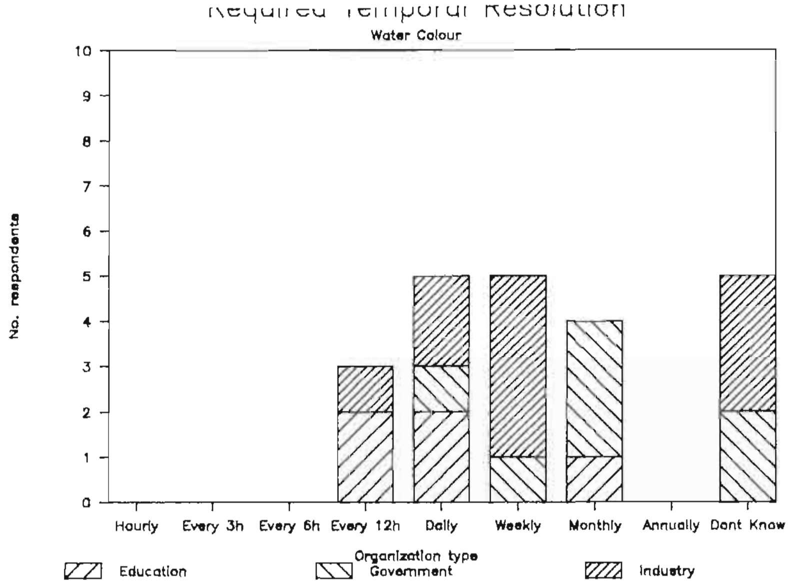

Required Temporal Resolution
Icebergs
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Icebergs
No. respondents
10
9
8
7
6
5
4
3
2
1
0
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

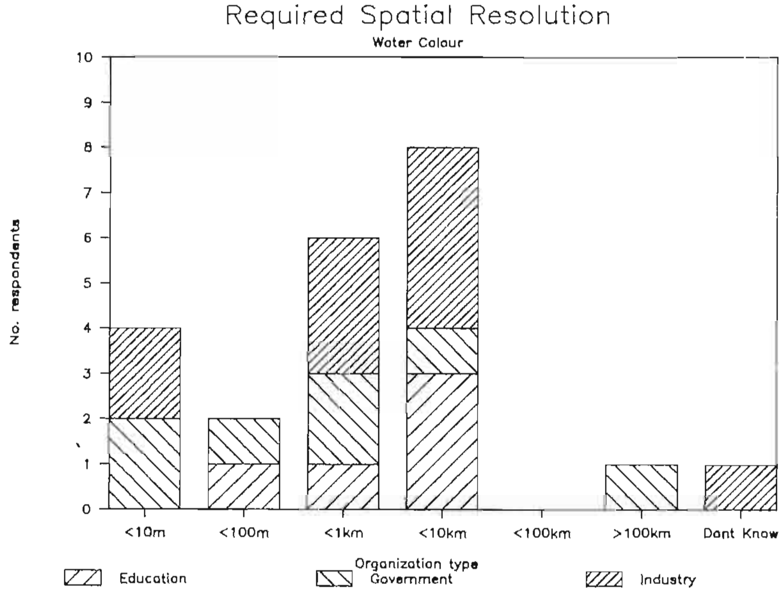
Required Delivery Time



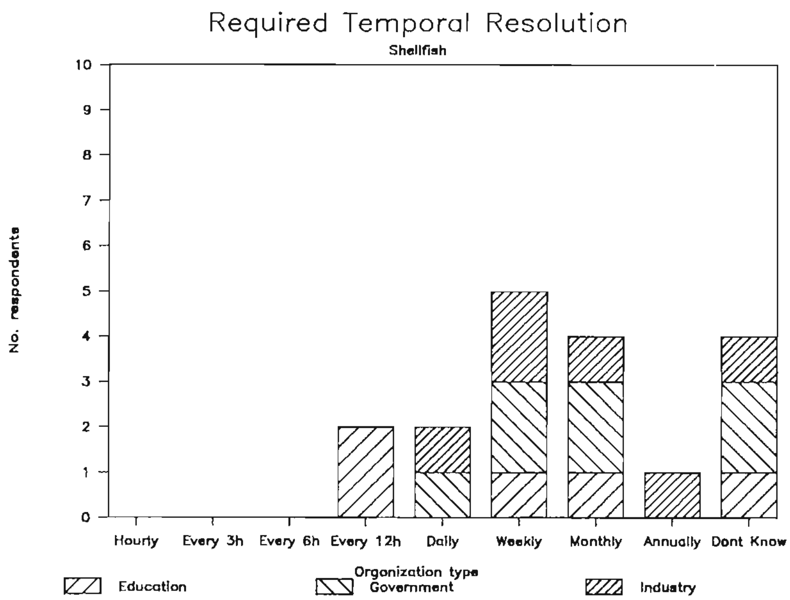
Required Temporal Resolution

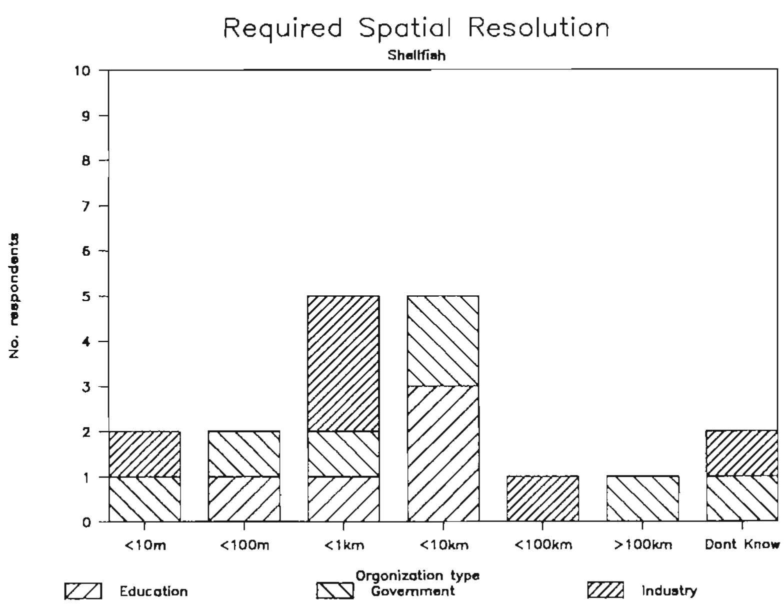


Required Spatial Resolution

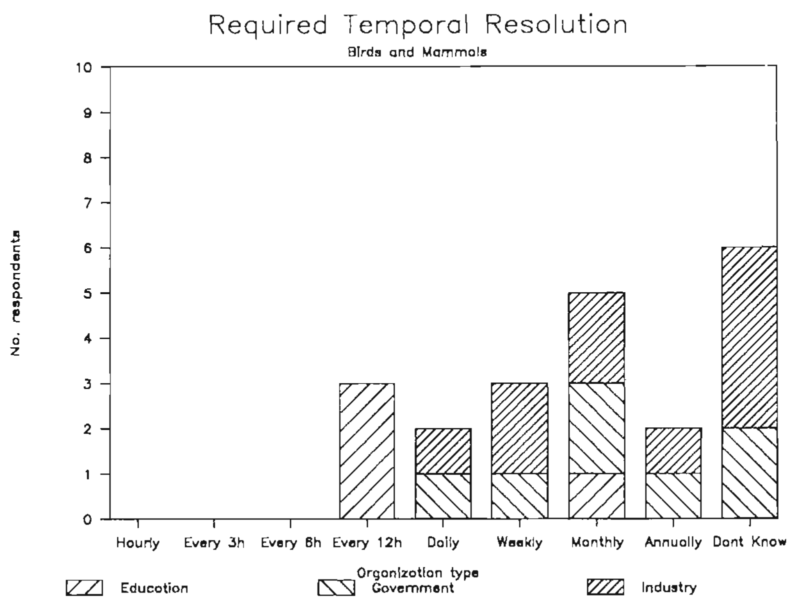


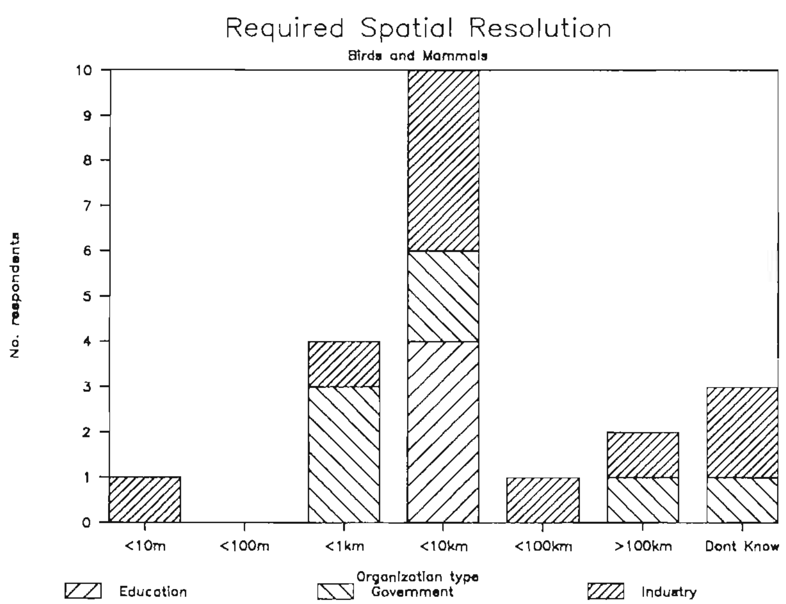

Required Delivery Time
Shellfish
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry

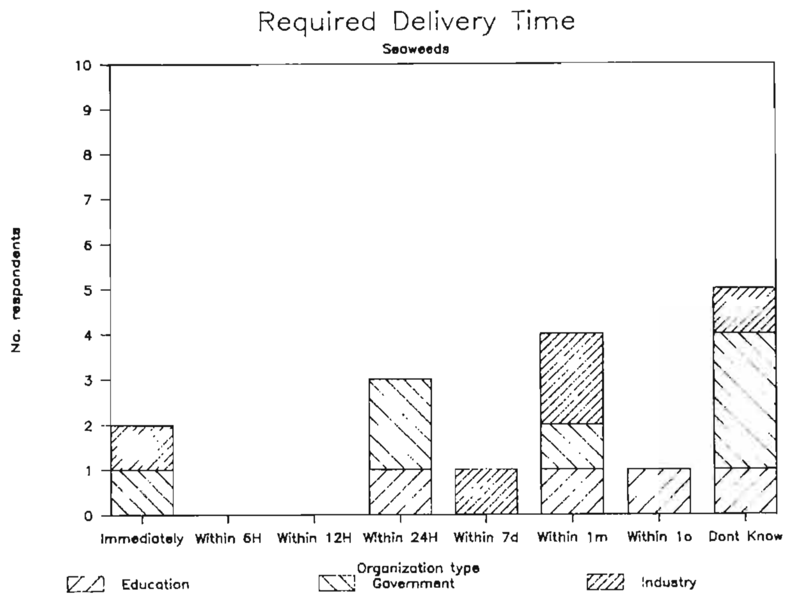

Required Temporal Resolution
Shellfish
No. respondents
10
9
8
7
6
5
4
3
2
1
0
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry

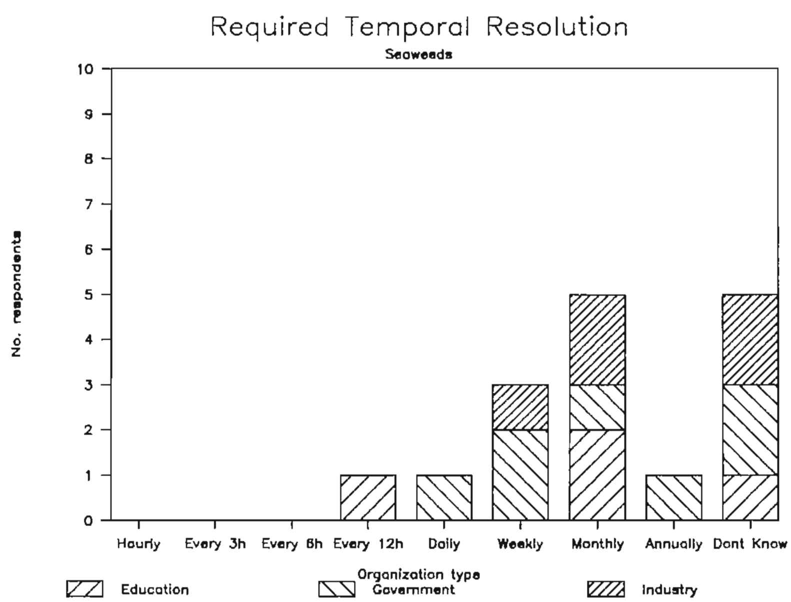

Required Spatial Resolution
Shellfish
No. respondents
10
9
8
7
6
5
4
3
2
1
0
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry

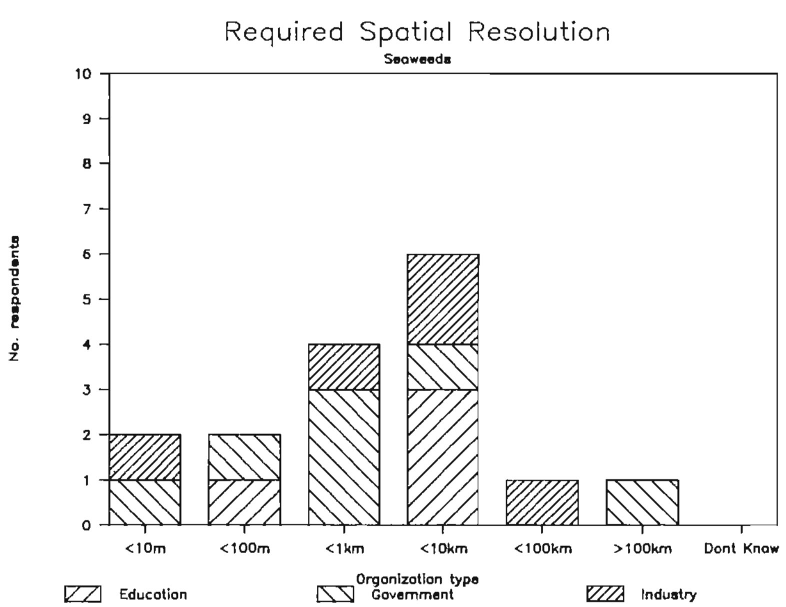

Required Delivery Time
Birds and Mammals
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Immediately
Within 6H
Within 12H
Within 24H
Within 7d
Within 1m
Within 1a
Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Birds and Mammals
No. respondents
0
1
2
3
4
5
6
7
8
9
10
Hourly
Every 3h
Every 6h
Every 12h
Daily
Weekly
Monthly
Annually
Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Birds and Mammals
No. respondents
0
1
2
3
4
5
6
7
8
9
10
<10m
<100m
<1km
<10km
<100km
>100km
Dont Know
Organization type
Education
Government
Industry


Required Delivery Time
Seaweeds
No. respondents
0 1 2 3 4 5 6 7 8 9 10
Immediately Within 6H Within 12H Within 24H Within 7d Within 1m Within 1o Dont Know
Organization type
Education
Government
Industry


Required Temporal Resolution
Seaweeds
No. respondents
0 1 2 3 4 5 6 7 8 9 10
Hourly Every 3h Every 6h Every 12h Daily Weekly Monthly Annually Dont Know
Organization type
Education
Government
Industry


Required Spatial Resolution
Seaweeds
No. respondents
0 1 2 3 4 5 6 7 8 9 10
<10m <100m <1km <10km <100km >100km Dont Know
Organization type
Education
Government
Industry

APPENDIX E

LISTING OF AN ON–LINE SESSION ON NECSYS

APPENDIX E

LOG NECSYS

XXXXXXXXXWWWWWWWWWMMMMMMMMECSYSThank you ...

Job 280 on TTY333 3-Feb-88 12:03:09, Last Login 3-Feb-88 08:36:44

****

* INGRES Release 5 for VM/CMS is *
* available on the NOAA VM machine *
* for testing from 2/1/88 - 3/31/88 *

****

[Connected to MAIN:<NECSYS>]

[CONNECTED TO B2:<NNNNN.000>]

PRESS RETURN ==>

THE ELECTRONIC CATALOG SERVICE (ECS)

SATELLITE DATA SERVICES DIVISION - NATIONAL CLIMATIC DATA CENTER

USER SERVICES - CALL FOR INFORMATION - 301-763-8111
- FTS 763-8111
TELEX - RCA 248376 OBSWUR
TELEMAIL - AHORVITZ/NESDIS

IF YOU ARE A FIRST TIME USER CHOOSE OPTION 1 FROM THE ECS MAIN MENU. THIS WILL GIVE YOU MORE INFORMATION ABOUT THE SYSTEM.

ECS MAIN MENU

1) HELP - HOW ECS WORKS
3) NOAA POLAR ORBITER (NPO) LEVEL 1B INVENTORY
6) DMSP SSM/I INVENTORY (UNDER DEVELOPMENT)
8) CREATE A DIRECT WORK ORDER (AVAILABLE FOR NPO DATA ONLY)
9) DISPLAY PENDING WORK ORDERS FOR THIS SESSION
10) SUBMIT WORK ORDERS TO SDSD
99) TERMINATE THE SESSION

PLEASE ENTER OPTION ==> 1

THE ELECTRONIC CATALOG SERVICES SYSTEM IS AN ON-LINE INVENTORY OF AND ORDER PLACEMENT SERVICE FOR DIGITAL SATELLITE DATA HELD BY THE SATELLITE DATA SERVICES DIVISION. IN ORDER TO PERUSE THE INVENTORIES AND PLACE ORDERS FOR DATA, YOU MUST FIRST ESTABLISH AN ACCOUNT WITH SDSD.

WHEN YOU ESTABLISH AN ACCOUNT YOU WILL RECEIVE A "CUSTOMER IDENTIFICATION NUMBER". ENTRY OF THIS "ID" IS REQUIRED TO PERUSE THE INVENTORIES. THE ANNUAL COST TO MAINTAIN AN ACCOUNT

WILL BE $100, WHICH IS NON-REFUNDABLE BUT WILL BE CREDITED TOWARD YOUR FIRST PURCHASE OF DATA.

SINCE PREPAYMENT IS REQUIRED, NO ORDER WILL BE FILLED UNTIL IT IS DETERMINED THAT SUFFICIENT FUNDS EXIST IN THE USER'S ACCOUNT OR UNTIL PAYMENT IS RECEIVED. TO ESTABLISH AN ACCOUNT CALL

(301) 763-8111 FTS 763-8111

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
FEATURES AVAILABLE:

HELP FILES

YOU ARE IN THEM NOW. THEY WILL CHANGE AS THE SYSTEM CHANGES.

INVENTORY SEARCH

NOAA POLAR ORBITER LEVEL 1B DATA SET INVENTORY:

AVHRR 4 KM GAC DATA - OCT 1978 TO PRESENT
AVHRR 1 KM HRPT DATA - APRIL 1985 TO PRESENT
AVHRR 1 KM LAC DATA - APRIL 1985 TO PRESENT
TOVS DATA (HIRS/MSU/SSU) - APRIL 1985 TO PRESENT

DMSP SSM/T AND SSM/I LEVEL 1B AND LEVEL 2 DATA:

AVAILABLE BY SUMMER 1988

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
CREATE A DIRECT WORK ORDER

ALLOWS A USER TO PLACE AN ORDER FOR DATA WITHOUT SEARCHING AN INVENTORY. THIS FEATURE SHOULD BE USED ONLY BY EXPERIENCED USERS WHO KNOW THE EXACT DATA SET NAME NEEDED. A "CUSTOMER IDENTIFICATION NUMBER" IS REQUIRED TO USE THIS FEATURE.

DISPLAY PENDING WORK ORDER FOR THIS SESSION

ALLOWS A USER TO VIEW A DIRECT WORK ORDER AFTER IT IS

MADE BUT BEFORE IT IS SUBMITTED FOR PROCESSING.

SUBMIT WORK ORDERS TO SDSD

ALLOWS A USER TO SUBMIT ONE OR MORE WORK ORDERS TO SDSD FOR PROCESSING.

PRESS RETURN TO CONTINUE

APPENDIX E

ECS MAIN MENU

1) HELP - HOW ECS WORKS
3) NOAA POLAR ORBITER (NPO) LEVEL 1B INVENTORY
6) DMSP SSM/I INVENTORY (UNDER DEVELOPMENT)
8) CREATE A DIRECT WORK ORDER (AVAILABLE FOR NPO DATA ONLY)
9) DISPLAY PENDING WORK ORDERS FOR THIS SESSION
10) SUBMIT WORK ORDERS TO SDSD
99) TERMINATE THE SESSION

PLEASE ENTER OPTION ==> 3

PLEASE ENTER YOUR CUSTOMER IDENTIFICATION NUMBER ==> XXXXXXXXX

SUCCESSFULLY CHECKED ID

NOAA POLAR ORBITER LEVEL 1B DATA SET INVENTORY

YOU ARE NOW IN THE NOAA POLAR ORBITER (NPO) INVENTORY MODULE OF THE ELECTRONIC CATALOG SERVICES (ECS) SYSTEM.

HERE YOU CAN INTERROGATE INVENTORIES OF AVHRR GAC, HRPT, AND LAC DATA, AND OF TOVS DATA. THE SEARCH CRITERIA INCLUDE DATA TYPE, DATA DATE RANGE, SATELLITE, AREA (SPECIFIED BY LATITUDE AND LONGITUDE BOX OR POINT), AND THE DIRECTION OF THE SATELLITE

YOU CAN ALSO CREATE A WORK ORDER FOR THESE DATA. THE SYSTEM WILL GIVE THE USER AN ESTIMATE OF THE NUMBER OF INPUT AND OUTPUT TAPES NEEDED TO FILL THE ORDER. WITH THIS INFORMATION AND A CURRENT SDSD PRICE LIST YOU WILL BE ABLE TO DETERMINE THE COST OF YOUR ORDER.

FINALLY, YOU CAN PLACE THE ORDER FOR PROCESSING.

AN ENTRY OF "Q" WILL RETURN YOU TO THE ECS MAIN MENU

CHOOSE OPTION 1 TO GET MORE DETAILED INFORMATION FOR NPO MODULE.

PRESS RETURN TO CONTINUE

NPO LEVEL 1B INVENTORY SUB-MENU

1) HELP - HOW TO USE NPO INVENTORY
2) SEARCH NPO LEVEL 1B INVENTORY - BUILD WORK ORDER
3) DISPLAY PENDING WORK ORDERS FOR THIS SESSION
4) SUBMIT WORK ORDER(S) TO SDSD
Q) EXIT - RETURN TO ECS MAIN MENU

PLEASE ENTER OPTION ==> 1

NOAA POLAR ORBITER INVENTORY MODULE

APPENDIX E

THE NOAA POLAR ORBITER (NPO) INVENTORY MODULE PROVIDES ACCESS TO INVENTORIES OF AVHRR (GAC, HRPT, AND LAC) AND TOVS (HIRS, MSU,AND SSU) DATA SETS. THE SYSTEM LEADS THE USER THROUGH A SERIES OF QUESTIONS DEALING WITH SEARCH CRITERIA INCLUDING DATA TYPE, TIME OF INTEREST, GEOGRAPHICAL LOCATION, ETC. A TELESCOPING SEARCH IS PERFORMED AFTER CERTAIN CRITERIA ARE PROVIDED BY THE USER. AFTER THE AUTOMATED SEARCH IS COMPLETED THE USER HAS THE OPPORTUNITY TO FURTHER REDUCE THE SUBSET OF THE RETRIEVED DATA BY REVIEWING AND MANUALLY REJECTING CERTAIN DATA SETS. ONCE THE USER IS SATISFIED WITH HIS SEARCH HE/SHE CAN PLACE AN ORDER FOR THE DATA.

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
SYNTAX OF NPO MENU:

NPO LEVEL 1B INVENTORY SUB-MENU

1) HELP - HOW TO USE THE NPO INVENTORY
2) SEARCH NPO LEVEL 1B INVENTORY - BUILD WORK ORDER
3) DISPLAY PENDING WORK ORDERS
4) SUBMIT WORK ORDER(S) TO SDSD
Q) EXIT - RETURN TO ECS MAIN MENU

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
SEARCH CRITERIA QUERIES AND RESPONSES

DATA TYPE

AS MANY AS FOUR DATA TYPES CAN BE REQUESTED PER SEARCH. THESE INCLUDE GAC, HRPT, LAC AND TOVS. YOU ENTER YOUR CHOICES ONE AT A TIME FOLLOWED BY A CARRIAGE RETURN. WHEN YOU ARE THROUGH WITH YOUR CHOICES ENTER CARRIAGE RETURN. IF YOU ARE INTERESTED IN SPECIFIC TOVS DATA SETS SUCH AS HIRS ENTER TOVS AT THIS POINT. YOU WILL BE GIVEN A CHANCE TO SELECT THE SPECIFIC TYPE OF TOVS DATA LATER.

SYNTAX:

THE FOLLOWING DATA TYPES ARE AVAILABLE:
GAC, LAC, HRPT, TOVS

ENTER 1 TO 4 DATA TYPES. FOLLOW EACH DATA TYPE BY A CARRIAGE RETURN.
DATA TYPE ==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
DATE RANGE

YOU MAY CHOOSE A DATE OF INTEREST OR A DATE RANGE. A DATE RANGE CANNOT EXCEED 185 DAYS AND NO DATE PRIOR TO OCTOBER 30, 1978 WILL BE ACCEPTED. A SINGLE DATE SHOULD BE ENTERED AS MONTH, DAY, YEAR IN THE FORMAT MM/DD/YYYY.

APPENDIX E

DATE RANGES SHOULD BE ENTERED IN THE FORMAT MM/DD/YYYY,MM/DD/YYYY.

SYNTAX:

ENTER DATE ==> MM/DD/YYYY OR DATE RANGE ==>
MM/DD/YYYY,MM/DD/YYYY
EX. FOR JANUARY 7, 1986 : 01/07/1986 ==>

AT THIS POINT THE SYSTEM WILL PERFORM A SEARCH BASED ON DATA TYPE AND DATE (DATE RANGE). A SUMMARY TABLE BASED ON THE SATELLITE ID AND DATA TYPE, FOR THE GIVEN DATE(S) WILL BE DISPLAYED.

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
SATELLITE

BASED ON THE SUMMARY TABLE YOU WILL BE ASKED TO CHOOSE DATA SETS FROM ONE OR MORE SATELLITES BY ENTERING THEIR TWO-LETTER DESIGNATOR DISPLAYED UNDER THE COLUMN LABELED "ID". SEPARATE ID'S WITH A COMMA.

SYNTAX:

ENTER THE ID(S) FOR THE SATELLITE(S) YOU WANT.
SEPARATE ID'S BY A COMMA ==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
GEOGRAPHIC AREA OF INTEREST

YOU MUST CHOOSE AN AREA OR POINT OF INTEREST. AREAS CANNOT EXCEED 90 DEGRESS IN LATITUDE OR LONGITUDE. LATITUDE AND

LONGITUDE VALUES MUST BE ENTERED IN WHOLE DEGREES WITH THE DIRECTION INDICATED AS N,S OR E,W. VALID LATITUDE VALUES RANGE BETWEEN 0 AND 78; VALID LONGITUDE VALUES ARE BETWEEN 0 AND 180.

AREAS WHICH ARE SMALLER THAN 10 DEGREES IN LATITUDE AND/OR LONGITUDE ARE BETTER DEFINED (FOR SEARCH PURPOSES) BY THE CENTER POINT OF THE AREA.

SYNTAX:

PLEASE ENTER THE SOUTHERNMOST LATITUDE IN DEGREES (0 - 78)
AND DIRECTION (N OR S) ==>

PLEASE ENTER THE NORTHERNMOST LATITUDE IN DEGREES (0 - 78) AND DIRECTION (N OR S) OR ENTER A CARRIAGE RETURN FOR A SINGLE POINT
==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
GEOGRAPHIC AREA OF INTEREST

SYNTAX (CONTINUED):

PLEASE ENTER THE WESTERNMOST LONGITUDE IN DEGREES (0 - 180)
AND DIRECTION (E OR W) ==>

PLEASE ENTER THE EASTERNMOST LONGITUDE IN DEGRESS (0 - 180) AND
DIRECTION (E OR W) OR ENTER A CARRIAGE RETURN FOR A SINGLE POINT
==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
DIRECTION OF SATELLITE

FOR EACH SATELLITE CHOSEN THE SYSTEM WILL DISPLAY THE LOCAL

SOLAR TIME OF ITS ASCENDING NODE AND REQUEST THAT YOU PICK
THE
DIRECTION OF THE SATELLITE. YOUR CHOICES ARE NORTHBOUND
SOUTHBOUND OR BOTH. DEPENDING ON THE TIME OF THE ASCENDING
NODE,
YOUR CHOICE WILL LIMIT THE SEARCH TO DATA SETS WHICH PROVIDE
DAYTIME COVERAGE, NIGHTTIME COVERAGE, OR BOTH.

SYNTAX:

LOCAL SOLAR TIME OF THE ASCENDING NODE FOR ____-__ IS ABOUT ____

LST

DO YOU WANT DATA FROM:
(1) NORTHBOUND PASSES OVER THE SELECTED AREA?
(2) SOUTHBOUND PASSES OVER THE SELECTED AREA?
(3) BOTH PASSES OVER THE SELECTED AREA?

PLEASE ENTER 1,2 OR 3 ==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
AT THIS POINT THE SYSTEM WILL DISPLAY THE RANGE OF EQUATOR
CROSSINGS
AND TIMES INTO AN ORBIT THAT WILL COVER YOUR AREA/POINT OF
INTEREST.
PRESS "RETURN" AND EACH DATA SET CHOSEN THUS FAR WILL BE CHECKED
AND
RETAINED IF IT MEETS THESE CRITERIA. THIS CHECKING TAKES SOME
TIME
SO PLEASE BE PATIENT. WHEN THE SYSTEM IS THROUGH, IT WILL
DISPLAY
ANOTHER SUMMARY TABLE BASED ON THE CRITERIA ENTERED TO THIS
POINT.

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
BUILDING A WORK ORDER

APPENDIX E

YOU CAN BUILD A WORK ORDER OR FURTHER TAILOR YOUR REQUEST
USING
THE MENU SHOWN BELOW. YOU CAN 1) LIST THE DATA SETS ON YOUR
TERMINAL (THEY SCROLL BY RATHER FAST, SO TURN ON YOUR
PRINTER,
OR USE CONTROL S AND CONTROL Q TO STOP AND START THE
SCROLLING);
2) KEEP/DELETE CERTAIN DATA SETS BY FLAGGING THEM (NOT
RECOMMENDED IF YOU HAVE MORE THAN A FEW DOZEN DATA SETS);
3) DELETE DATA SETS THAT DO NOT COVER YOUR AREA WITH A
MINIMUM AMOUNT OF FLIGHT TIME; 4) RETURN TO THE NPO MENU
WITHOUT
CREATING A WORK ORDER; 5) CREATE A WORK ORDER (WRITE DOWN THE
WORK ORDER NUMBER ASSIGNED TO EACH SEARCH, YOU'LL NEED IT
LATER).

AFTER YOU CREATE A WORK ORDER CONTROL WILL BE RETURNED TO THE
NPO
MENU WHERE YOU CAN PERFORM ANOTHER SEARCH, LOOK AT YOUR WORK
ORDERS AND/OR SUBMIT THEM FOR PROCESSING.

PRESS RETURN TO CONTINUE, 'Q' TO QUIT
SYNTAX:

NPO WORK ORDER BUILD MENU

DO YOU WISH TO
1) LIST ALL THESE DATA SETS
2) SPECIFY KEEP/DELETE OPTIONS ON INDIVIDUAL DATA SETS
3) DELETE DATA SETS WITH UNDER A MINIMUM SCENE DURATION
4) RETURN TO NPO MENU WITHOUT GENERATING A WORK ORDER
5) GENERATE A WORK ORDER FOR THESE DATA SETS
PLEASE ENTER OPTION ==>

PRESS RETURN TO CONTINUE, 'Q' TO QUIT Q

NPO LEVEL 1B INVENTORY SUB-MENU

1) HELP - HOW TO USE NPO INVENTORY
2) SEARCH NPO LEVEL 1B INVENTORY - BUILD WORK ORDER
3) DISPLAY PENDING WORK ORDERS FOR THIS SESSION
4) SUBMIT WORK ORDER(S) TO SDSD
Q) EXIT - RETURN TO ECS MAIN MENU

PLEASE ENTER OPTION ==> Q

ECS MAIN MENU

APPENDIX E

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 1) HELP - HOW ECS WORKS
 3) NOAA POLAR ORBITER (NPO) LEVEL 1B INVENTORY
 6) DMSP SSM/I INVENTORY (UNDER DEVELOPMENT)
 8) CREATE A DIRECT WORK ORDER   (AVAILABLE FOR NPO DATA ONLY)
 9) DISPLAY PENDING WORK ORDERS FOR THIS SESSION
10) SUBMIT WORK ORDERS TO SDSD
99) TERMINATE THE SESSION

PLEASE ENTER OPTION ==> 99
CPU TIME 4.56   ELAPSED TIME 7:17.93

USAGE FOR JOB 280 AT 12:10
   CONNECT TIME            0.1252 HOURS    $   0.75
   CPU PRIME USAGE         8.8130 SECONDS  $   0.53
   CPU NON-PRIME USAGE     0.0000 SECONDS  $   0.00
                                          ---------
   TOTAL COST                              $   1.28

KILLED JOB 280, USER NECSYS, ACCOUNT NNNNN.000, TTY 333,
  AT  3-FEB-88 12:10:42,  USED 0229 187A DISCONNECTED 00 40
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APPENDIX F

SELECTED ACRONYMS USED IN TEXT

APPENDIX F

ACR	Active Cavity Radiometer
ADEOS	Advanced Earth Observation Satellite
ARISTOTELES	Applications Research Involving Space Techniques Observing the Earth's Fields from Low–Orbit Earth Satellite
AMSU	Advanced Microwave Sounding Unit
ATMOS	Atmospheric Trace Molecular Spectroscopy Sensor
COLUMBUS	European component of the US/International Space Station
COM	Carbon Dioxide Monitor
COPE	Co–orbiting Platform Elements component of the US/International Space Station
COSMOS	USSR Cosmos series satellite
DMSP	US Defense Meteorological Satellite Program
EGS	Experimental Geogetic Satellite
EOS	Earth Observation System (US component of the US/International Space Station)
ERBI	Earth Radiation Budget Instrument
ERS	European Earth Resources Satellite
ESA	European Space Agency
FILE	Feature Identification and Location Experiment
GEOS	Geodynamics Experimental Ocean Satellite
GEOSAT	Geodetic Satellite
GGM	Gravity Gradiometer Mission
GLRS	Geodynamics Laser Ranging Experiment
GMS	Japan's Geostationary Meteorological Satellite
GOES	US Geostationary Meteorological Satellite
GOES	Next Advanced US Geostationary Meteorological Satellite
GPS	Global Positioning System
GRADIO	Satellite Gradiometer
GREM	Geopotential Research Explorer Mission
HIRIS	High–Resolution Imaging Spectrometer
IRS	Indian Remote Sensing Satellite
J–EOS	Japan's Earth Observation Satellite (Japan's component of the US/International Space Station)
J–ERS	Japan's Earth Resource Satellite
LAGEOS	Laser Dynamics Satellite
LANDSAT	Land Observing Satellite
LASER RANGER	Laser Ranger Satellite
LIDAR	Shuttle Light Intensity Detection and Ranging Instrument
LOCSTAR	European communication systems
MAPS	Measurement of Air Pollution from Space
METEOR	European Geostationary Meteorological Satellite
METEOSAT	Meteorological Satellite
METEOSAT P2	Meteorological Satellite Prototype 2

APPENDIX F

MFE	Magnet Field Explorer
MOP	Meteosat Operational Program
MOS	Japan's Marine Observation Satellite
MTE	Mesospheric–Tropospheric Explorer
N–ROSS	US Navy Remote Ocean Sensing Satellite
NSCAT	NASA Scatterometer
OCI	Ocean Colour Instrument
POES	Polar Orbiting Environmental Satellite (NOAA)
RADARSAT	Canada's Radar Satellite System
SIR–C	Shuttle Imaging Radar–C
Sea–WiFS	Sea–viewing Wide Field of view Sensor
SEM	Solid Earth Mission
SISEX	Shuttle Imaging Spectrometer Experiment
SPOT	France's Earth Observation Satellite
SRA	Scanning Radar Altimeter
SSM/I	Special Sensor Microwave Imager
TOM	Total Ozone Monitor
TOPEX/POSEIDON	Ocean Topography Experiment
TREM	Tropical Rainfall Experiment Mission
UARS	Upper Atmosphere Research Satellite
X–SAR	West German/Italian X–band Synthetic Aperture Radar