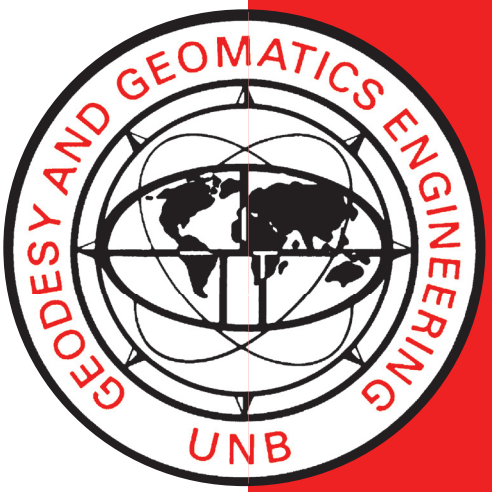
MARINE INFORMATION MANAGEMENT SYSTEMS: A STRATEGY FOR THE MANAGEMENT OF MARINE RELATED DATA

H. A. NANTON

January 1993



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PREFACE

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MARINE INFORMATION MANAGEMENT SYSTEMS: A STRATEGY FOR THE MANAGEMENT OF MARINE RELATED DATA

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PREFACE

This technical report is a reproduction of a report submitted in partial fulfillment of the requirements for the degree of Master of Engineering in the Department of Surveying Engineering, January 1993. The research was supervised by Dr. David E. Wells, and funding was provided by the University of the West Indies.

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ABSTRACT

This report identifies a strategy for the management of marine related data through a system of policies for data and information exchange between users of information concerning the marine environment. These users include departments and agencies involved directly and indirectly with the marine environment at all levels from the data collectors to the politicians capable of making policies which can have some impact on the marine environment. This strategy is proposed through the establishment of a Marine Information Management System or MIMS.

In establishing these policies, this report identifies the fact that traditional management of our marine resources has been done on a user and task specific basis which does not allow users to see interactions outside their specific area of interest. Based on addressing the issues and policies identified in this report, more comprehensive management of marine related information and resources is possible. This is achieved through improved communication, and an increased level of awareness of the interactions between users of the marine environment.

The report identifies the MIMS as a means of achieving more comprehensive information and resource management. It identifies a number of the issues involved in information management such as standardization, data exchange and cost recovery. The proposed MIMS incorporates policies at the resource management level and at the information management level.

The work done here shows that while some minimum hardware configuration may be necessary to achieve its objectives, the MIMS will place more emphasis on the policies required for information exchange. A policy approach to the problem has

therefore been taken since these must be addressed before any decisions can be made on the actual format and design of the proposed system.

While the work done here has been based on research done in Canada, some issues which may apply to other regions such as developing countries are also identified.

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ACKNOWLEDGEMENTS

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* The University of the West Indies for the financial support enabling me to carry out this study;
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CHAPTER ONE

INTRODUCTION AND OVERVIEW

Our existence on earth revolves around the presence of the earth's natural resources and on our interaction with these resources. These resources, largely the result of natural processes, provide people with food, energy, the air that they breathe and forms of recreation. Though many of the resources utilized are extracted or processed in some manner to be of use, some exist in a state which are already of value. One such resource is the environment of which we are a part.

The value of any natural resource extends beyond the mere economic worth of the resource. While it may be difficult to place an *economic* value to these resources, there are other values which can be identified. There is little questioning the value of a resource such as the air that we breathe and the benefits of sustaining it. Likewise, scenic resources provide a psychological relief which though valuable, cannot be easily quantified in economics terms.

One of the problems readily seen in our treatment of available resources, is the focus on our own welfare. Young [1982] stated that resources must be considered against and in addition to their perceived roles for the sole benefit of people. This thinking supports the fact that we are but one form of life on earth and we must therefore take a holistic approach to managing the resources around us. The environment must therefore be viewed not only as an extension of individual resources and their role in our society, but as a larger ecosystem. The consequences of

neglecting this fact have been studied by many environmentalists, e.g. Carson [1962]. These studies have indicated that an intimate interaction exists between the life forms on earth and the environments which sustain them. Any action which affects the environment will inevitably affect species native to it as well as other species along that particular food chain. It is therefore important to consider our environment as having a right to its own welfare.

Even if we are to consider only ourselves in the use of resources, care must still be practised since in many cases these resources are nonrenewable. Kemp and Long [1980] described the earth's resources as a "cake of unknown size" in stressing the need for social and environmental planning, in spite of the sheer competition in exploiting these resources. We simply cannot assume that the environment will continue to replenish itself and be around for our future generations.

It is this which dictates that management of the available resources is of utmost importance for the continued existence of life as we know it. Rather than simply using our environment and its resources, we must understand it and try to organize our activities in such a manner that the benefits we achieve are not at the expense of other activities, other life forms and indeed the environment itself.

This report will examine how these activities may be organized within the marine environment. In doing so, some considerations of establishment of a system for managing marine related information will be discussed as well as how it may be used and by whom. In this approach, only the policies involved in the actual establishment will be treated in detail. This approach is taken since these policies should be addressed before any decisions on the design and required technology for such a system can be made. In addition to this, it is believed that the technology to be used is dependent on the individual case and in any event, already exists.

This report is structured into three parts. The first part which includes Chapters One to Three defines the problem and need for information management and presents the concepts of an MIMS as a strategy for managing marine related data. In the second part of the report, Chapters Four and Five examine issues related to information management while Chapter Six evaluates an information management system proposed by ICOIN Industries Inc. for the Passamaquoddy Bay area in New Brunswick, Canada. The third part of the report proposes strategies for the implementation of an MIMS.

The work done in this report is based on literature research and a study of users of the marine environment. It is geared at providing a better understanding of the need for consolidating marine information from the many data sources, the need for management of this information as well as some of the special considerations involved in fulfilling these needs.

1.1 Defining the Marine Environment and its Resources

The extent of the marine environment may be defined in a horizontal sense by identifying the Coastal Zone, the Inner Marine Zone and the Outer Marine Zone areas [Ford, 1990]. The Coastal Zone may be defined as that area from the ordinary high water mark extending seaward to three (3) nautical miles. The Inner Marine Zone extends from the outer limit of the Coastal Zone to the limit of the territorial sea or twelve (12) nautical miles from State's baseline. The Outer Marine Zone extends from the outer limit of the Inner Marine Zone to the limit of the Exclusive Economic Zone, or two hundred (200) nautical miles from the baselines used for determining the breadth

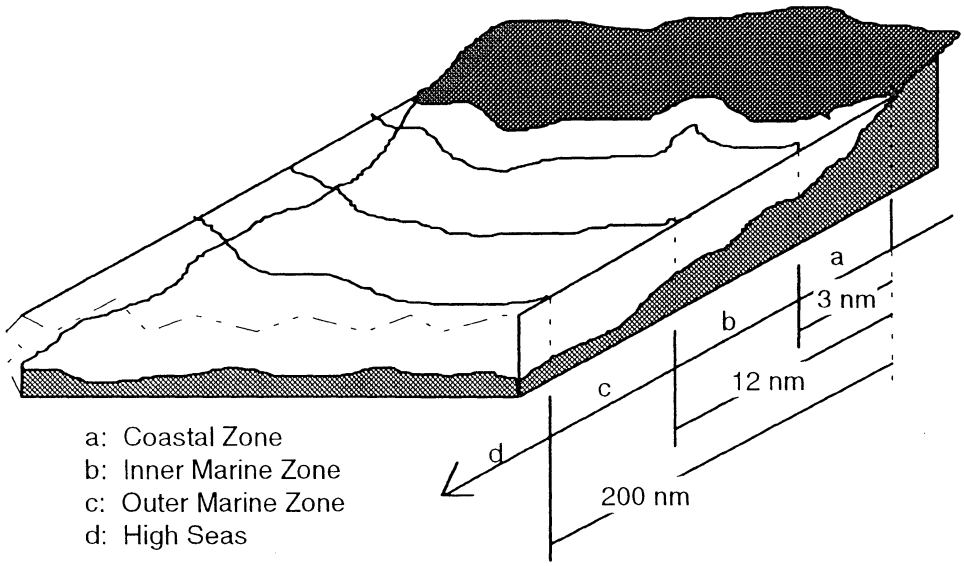

Figure 1.1 Horizontal zones of the marine environment (after Ford [1990, p. 99])

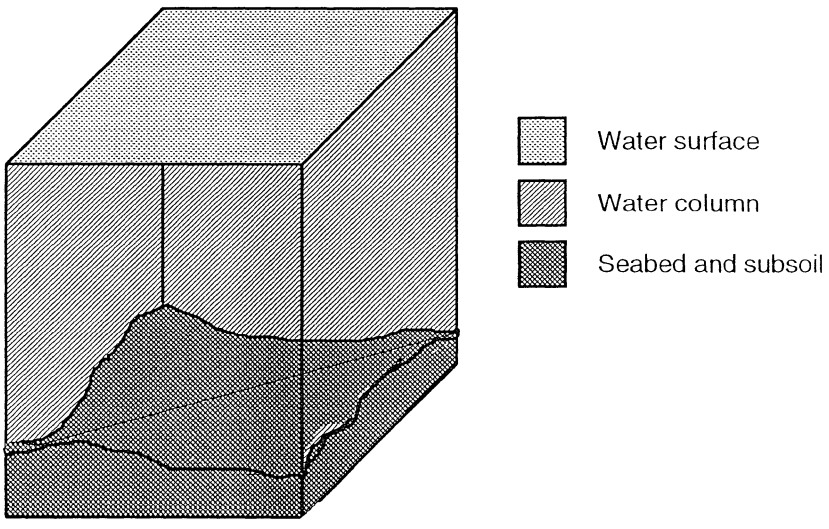

Figure 1.2 Vertical zones of the marine environment

of the territorial sea. A fourth zone, the High Seas, may be identified as that area extending seaward of the outer limit of the exclusive economic zone. See Figure 1.1.

The marine environment may also be defined in a vertical sense as having three areas of activity. These areas include the surface of the water, the actual water column and the seabed and subsoil. See Figure 1.2.

The term natural resources is defined by Howe [1989] in the Encyclopedia Americana as:

> ...naturally occurring materials that are useful to man or could be useful under certain conceivable technological, economic, or social circumstances.

Close interpretation of this definition shows that the term resources here applies not only to the actual materials, but also to the use of facilities afforded by their existence. Any use of the environment may therefore be considered as a resource of that environment. The resources of the marine environment therefore do not only include the living and non living materials such as fish, fossil fuels or mineral ores, but also extends to **activities** within the environment. Activities such as recreation, transportation and research are therefore resources which are also to be managed.

The nature of the resources vary between the various zones of the marine environment. As a result, the activities and information requirements also vary [Ford, 1990].

Activities within the Coastal Zone include:

- Port and harbour management works;
- Nearshore dumping and effluent discharge;
- Inshore navigation;
- Aquacultural farming;
- Inshore fishing;

- Hydrographic works;
- Oceanographic research; and
- Recreation.

Due to the proximity to the shoreline and higher concentrations of traffic within this zone, accuracies required for the related information is generally higher than that required for the other zones.

The Inner Marine Zone does not support as heavy a traffic flow as the Coastal Zone. Most of the activity in the fishing industry however, takes place within this zone and the demand for management of this living resource is of utmost importance. This zone also contains many offshore dumping grounds and together with the Coastal Zone, serves as the area for the discharge of industrial effluents.

Activities within the Inner Marine Zone include:

- Near shore fishing;
- Mineral extraction;
- Transportation;
- Oceanographic research; and
- Discharge of land based waste material.

The major activities within the Outer Marine Zone are:

- Deep sea fishing;
- Mineral exploration and exploitation;
- Shipping; and
- Oceanographic research.

Due to the larger area covered by this zone, fewer conflicts of interest are seen to occur here. This is not to say however, that the management of the resources in this region of the environment should be taken for granted. An oil spill at the inner edge of

this zone for example, could prove costly if the relevant mitigative information is not available for speedy decision making.

The outermost horizontal marine zone is that of the High Seas. This is defined in UNCLOS III[1] as being all marine areas which are not included in the definition of the EEZ, the territorial waters, the internal waters, or the archipelagic waters of coastal states.

The High Seas is open to all states for activities which include the following:

- Shipping;
- Ocean fishing;
- Mineral extraction; and
- Scientific research.

Though this zone is not governed by any particular State, it is recognized in UNCLOS III[2] as an area for cooperation and management of the marine resources.

Figure 1.3 gives a graphical illustration of the distribution of marine resources and activities as they relate to the horizontal and vertical zones identified above.

1.2 Factors Leading to the Awareness of the Need for Management

We can be said to be living in an era of environmental awareness spawned by the efforts of the environmentalists such as Carson [1962]. These efforts served to

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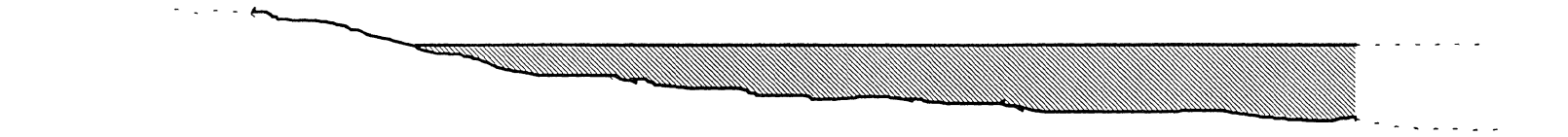
[1]Third United Nations Convention on the Law of the Sea, (1983). Part VII , Section 1, Article 86. page 30.

[2]United Nations Convention on the Law of the Sea (1983). Part VII, "High Seas", Section 2. pp. 37-38



	Coastal Zone	Inner Marine Zone	Outer Marine Zone	High Seas
Water Surface	Water sport and other recreation Pleasure boating Inshore transportation Harbour and port works	Shipping Pleasure boating	Shipping	Shipping
Water Column	Water sports Aquaculture Inshore fishing Effluent discharge	Near shore fishing Offshore dumping	Deep sea fishing Marine scientific research	Marine scientific research Deep sea fishing Submarine utility lines As laid down in UNCLOS III, Article 87, all States have the freedom to participate in the above activities within the High Seas. This must however be done in accordance with the rights of freedom of other States.
Seabed and Subsoil	Tourism (coral reef conservation) Crustacean mining Offshore excavation Dredge spoil dumping Submarine utility lines	Mineral extraction Submarine utility lines	Mineral extraction Oil and natural gas exploration and extraction Submarine utility lines	

Figure 1.3 Distribution of activities within the horizontal and vertical zones of the marine environment

increase public awareness of the fact that our resources are finite and should therefore be managed to ensure that these are preserved. For many years the trend of thought saw a somewhat open and nonchalant attitude towards our resources in general. Of all resources however, our oceans have been one of the most abused [Becht and Belzung, 1975]. The size of this resource relative to our landmass led to the belief that the raw materials derived were unlimited and our waste could be indefinitely absorbed. An example of this attitude was summarized by Young [1982] in reference to marine fisheries management. Here he states that prior to the second World War, though no one person or State had a legitimate claim to the fish within their habitat, anyone was free to engage in the act of fishing anywhere outside the then three mile territorial sea limit. This freedom was not restricted to time, place or volume of catch. A similar attitude towards waste disposal resulted in the uncontrolled flow of land based pollutants into the 'vast self-cleansing' body of our oceans.

Because of the vast body of water making up our oceans, such disregard continued for quite some time before the consequences became apparent. Within recent times there has been a dramatic increase in activities carried out in the marine environment. Some of the main reasons for this increased activity are discussed below.

The increase in world population has been the main reason for increased marine activity over the last forty years. Between 1950 to 1990, world population has risen from approximately two and one-half to over five billion people, [World Resources 1990-91]. This increase has placed increased demands on the available resources. More food must now be produced to sustain the increasing population and biological depletion has begun to occur. This problem has been made worse by fishermen, who becoming aware of the decreased numbers in stock, attempted to stake as large a claim as possible on the depleting stock. During the same period identified above, the

global catch increased from 19.8 million metric tons to 97.4 million metric tons, [World Resources 1990-91]. It should be noted that the United Nations' Food and Agriculture Organization considers the maximum sustainable yield of all conventional fish to be of the order of 100 million metric tons. The need for food was not the only effect of the increased population. Increased travel and communication and need for mineral resources spurred on by the population growth saw the number of marine activities also increase.

Perhaps the largest single factor of population growth affecting the marine environment is the urbanization associated with it. By 1983, 41.6 % of the world's population lived or worked in urban centres, [World Resources 1986]. Most of these major industrial and metropolitan sites are situated along waterfronts for ease of access to shipping or other communication links [Heikoff, 1977]. This situation resulted in an increase in the demand for development along coastal areas, an increase in industrial and residential waste and an increase in traffic within the nearshore regions of the environment.

Not only has the population increased, but so has the general standard of living. this places an even higher demand on the environment. Not only must the environment support an increased number of people, but it must also now cater to their increased need for processed goods and services.

One other main reason for the increase in marine activity has been the discovery of offshore mineral resources. In 1958, the International Geophysical Year, scientists noted that the future use of the sea will be as important for mineral resources as it was at the time, for food [Becht and Belzung, 1975]. Over the last couple decades, world production of energy and mineral ores has increased by over one hundred percent. This increase represents activities such as oil and natural gas exploitation,

non-fuel minerals exploitation, and sand bar and bottom excavation for construction. Though not all of these resources are marine based, the activities associated with them do impact on the marine environment. Over 3.2 million tons of oil enter our oceans annually from the air, surface runoff, industrial waste and transportation which, in itself, accounts for 45 % of this total [World Resources 1990-91].

Another reason for the increased activity in the marine environment is the increase in the number of coastal sovereign states over the last three decades. With the fall of colonial rule in the developing world, many more states now have a say in the exploitation of their resources. This has effectively increased the number of actors as well as competition for the existing marine resources.

For a very long time users were willing to ignore the effects of this increased activity in the marine environment. It has now however become apparent that as with any resource, management is necessary to sustain this in a manner suitable for use. Within recent times we have therefore seen a change in attitude where indifference has given way to concern and a more positive role has been adopted in planning and development. A number of factors may be attributed to this attitudinal change.

With the increase in the number of resources, some form of management had to be established. Initially this took the form of individual state bodies regulating the use of the resources under their jurisdiction. This management looked only therefore at the specific activities of a particular interest group.

The increase in the number of coastal sovereign states brought with it not only an increase in marine activity but also a greater awareness of the marine environment. The new leaders of these coastal or island territories were now forced to be more competitive on the world markets, and with this, resources had to be better managed.

In addition to this, these states now had a greater say in managing their own resources which under colonial rule was not always done in the interest of the former colonies.

One of the major reasons for the change in attitude towards the marine environment , has been summarized in the following view:

> Current concern about the environment stems from the evidence that exploitation of environment resources — as sources of raw materials and as sinks for waste products — has resulted in serious depletion of nonrenewable resources and in hazards to human health and to the biosphere. [Heikoff, 1977].

In effect, the recent concern over the marine environment stems from the environmental risk placed on human welfare by these increased and uncoordinated activities. The oceans are no longer able to absorb the overfishing, pollutants and destruction of the ecosystems it sustains, without the effects of these problems impacting on our own quality of life. Heikoff [1977] also noted that "... environment values have been destroyed out of proportion to the economic advantages... ."

Yet another reason for the recent change in attitude stems from the fact that the activities within the environment have resulted in decreasing economic gains from the industries it supports. This is mainly true of the fishing industry where overfishing has brought about a decrease in stocks.

This changing attitude towards the marine environment is reflected in the efforts of the Third United Nations Convention on the Law of the Sea (UNCLOS III). This new order does not only strive to achieve a comprehensive agreement on all matters relating to the law of the sea but also as a charter for international cooperation on all matters relating to our oceans.

This process leading to man's awareness of the need to manage marine resources is illustrated in Figure 1.4.

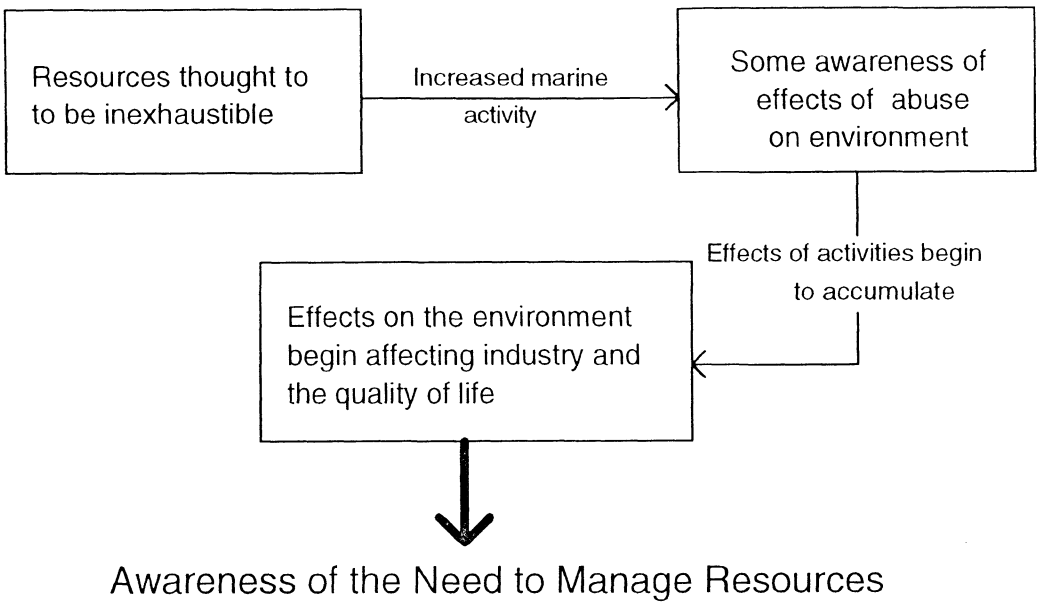


Figure 1.4 Stages in awareness of the need for resource management

1.3 Traditional Management of Marine Information

Management of any resource, as was shown above, results from concern on the part of individuals who exploit that resource. This concept was demonstrated clearly by Barker [1990] who represented coastal management concerns as three orthogonal axes. A parallel may be drawn here for concerns over the wider marine environment based on traditional resource management. See Figure 1.5.

The surface XYZ represents the capability of a given state to exploit the various marine resources, and also serves to illustrate that maximizing any one concern will be done at the expense of the others. Points on the surface XYZ represent the actual concern within smaller communities of the state. Point A may therefore represent a

fishing community, whereas point B may represent the concerns of an area engaged in offshore oil and gas exploration.

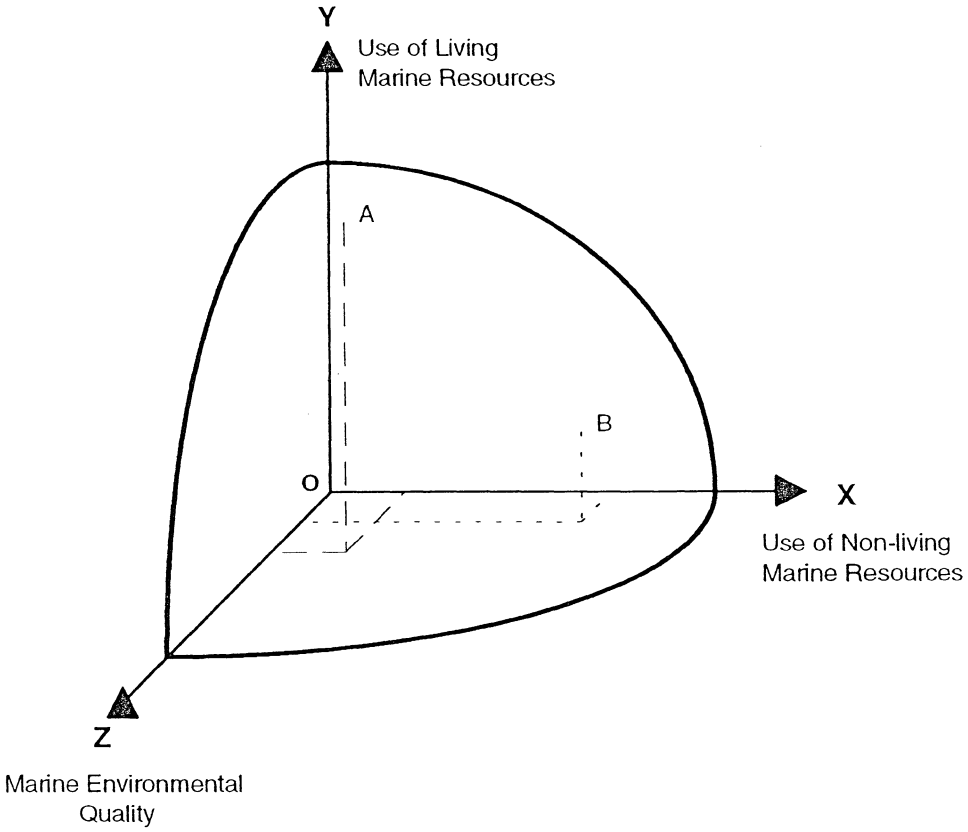


Figure 1.5 Axes of marine resource management concerns (after Barker [1990, p. 4]).

As was mentioned in Section 1.2 and stressed by Barker, traditional management of marine resources has closely approximated the surface OYX, with exploitation of both living and non-living resources being done at the expense of environmental quality.

1.3.1 Fisheries Management

Fishing is possibly the oldest of human activity in the marine environment. It is therefore not surprising that fish were the first marine resources for which any management attempt was made. In many developing countries, fisheries management represents the only form of marine resource management [Duncan, 1991].

Rounsefell [1975] stated that the greatest problem surrounding fisheries management is that it is a common property resource. There exists therefore, no incentive for restraint to harvesting, since the open competition does not guarantee that what is not fished today will be available tomorrow.

It is not possible within the fishing industry to manage the actual resource, rather what has been managed is the harvesting. What complicates this issue even further is the fact that traditionally, management of this harvesting depended on the assessment of catches. Statistics compiled for fisheries databases are generally derived from fishermen's reports on volumes of catch, species caught and location of harvest. Management of fisheries resources has therefore been an effort based on moderating the volume of catches. This is generally achieved through quotas which reflect the number of registered fishermen and the sustainable yield for the species under concern. This system of management is illustrated in Figure 1.6.

Though the issue of fisheries management is not the goal of this report, it is useful to note here that the above system of management focuses mainly around overfishing. Overfishing is however but one problem in the management of fisheries resources[3].

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[3]See Section 3.2

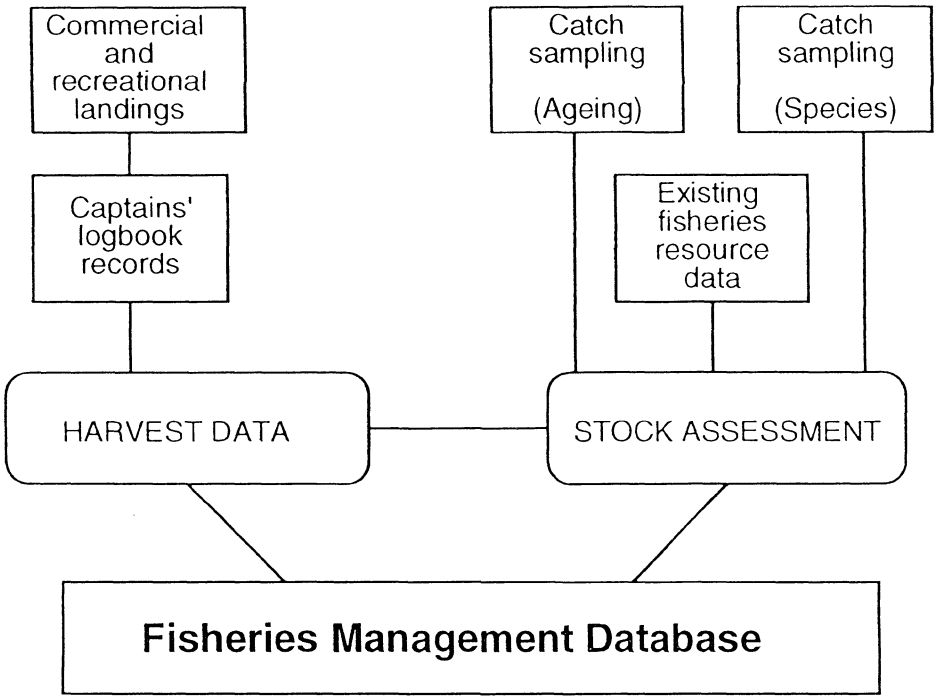

Figure 1.6 Traditional fisheries management structure

1.3.2 Marine Mineral Resource Management

The term marine mineral resource is taken here to collectively refer to mineral fuels, and mineral ores. The responsibility for managing these resources in most cases lies within the federal or national departments. Unlike land based resources, marine mineral resources are considered more within a national context rather than a regional one. This therefore makes for more coordination in management.

The nature of this resource also enables it to be better controlled than fisheries resources. This arises from the fact that mineral resources do not have the dynamics associated with that of fish. As such, management of offshore mineral resources more

closely resembles that of land based land information management. Parcels of the seabed are leased out and geographically referenced on some base map as is information on the operators and nature of work carried out. The leased parcels are indexed allowing them to be referenced against the nature of the nature of work being carried out. All companies wishing to engage in exploration are first required to obtain a license for exploratory work followed by a permit for the actual extraction.

Though this system of licensing and approval allows for upkeep of records within this area of activity, it only seeks to manage mineral resource activity. As such, the wider scope of the marine environment is not considered. One document regarding offshore exploration released by Energy, Mines and Resources Canada, [1977b] stated that with respect to exploratory works, other offshore related government departments, "... are notified far enough ahead to allow time for appropriate action." Though this does identify a recognition of the roles of other departments in the marine environment, the document does not identify the level of cooperation between these departments nor what action may be taken if some conflict were to arise.

1.3.3 Coastal Development Works Management

Coastal development works include activities such as port and harbour development, harbour channel maintenance, land reclamation and the development of beach facilities. The coastal zone was possibly the first of the marine zones where the need for resource management was recognized. To date this zone has also received the most attention on matters of resource management. This is likely due to the higher activity within this zone, and the fact that conflicting activities can be more easily identified. Moreover, these conflicts have a more direct effect on us since the coastal zone represents one of our habitats as well.

This awareness however, has not necessarily resulted in effective coastal zone management. What has occurred is management segregated between various objectives and resources through various coastal management programs. The individual goals of these programs as mentioned earlier do not recognize the zone as an ecosystem to be managed as a whole. Barker [1990], referred to this as "coastal sectoral management," due to the narrow environmental scope of the programs. He also went on to state that:

> [The problems of the coastal zone] ...were not being addressed by the independent piecemeal action being undertaken by 'coastal management programs'... [and furthermore] the uncoordinated allocation process led to abuses of coastal resources that were not in the nation's interest.

1.3.4 Marine Transportation Management

Marine transportation management focuses on two issues. The first of these involves the siting and establishment of shipping lanes, while the other is concerned with the management of traffic within these lanes.

Traffic management is of importance in ensuring accident free movement within regulated zones. Again this form of management is a narrow one and does not address the wider range of marine related activities. In order to examine this, one has to look at the way in which shipping lanes are established and whether they were optimally placed.

Traditionally lanes have been established based on general headings to destinations, bathymetry and surface currents [Gibbs, 1982; Roach, 1991]. Though this does not generally create a problem in open seas, other factors important to nearshore

areas are generally not considered. These include proximity to fishing or spawning grounds and surface flow along lanes, of significance in the event of a spillage, but also includes the effect of ship noise on marine habitats.

CHAPTER TWO

MARINE INFORMATION INFRASTRUCTURE

2.1 Existing Provisions for Information Exchange

There exists today many marine related databases. In the Canadian Atlantic Zone alone more than five hundred of these are documented with many more likely to be present. Indices of these may be found in any of these directories produced for example, by the Champlain Institute [1991] or the Atlantic Coastal Zone Information Steering Committee ACZISC[1].

To date no known attempts have been made at physically integrating any of these data sets with others outside the office of origin, nor have there been any formal attempts to establish any policies with regard to communication between marine related organizations [Butler, 1992]. Marine related data is, however, available to outside users and information is shared among the various owners of the data. Users of marine related data have therefore had to manually construct the required information from the various sources of data [Roberts, 1992]. In such a situation, not only is the information

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[1]ACZISC Directory of coastal information holdings, ACZISC Secretariat, c/o LRIS/CMP, P.O. Box 310, 16 Station Street, Amherst, Nova Scotia, Canada, B4H 3Z5. This is an ongoing project geared at indexing all marine related data sets for the Atlantic Zone of Canada.

gathering process a slower one, but it restricts itself to data sources of which the collector is already aware.

Present efforts at providing some degree of integration of marine related data sets are being carried out by ICOIN Industries Inc. for the Passamaquoddy area, (see Chapter 6), and the Gulf of Maine Council on the Marine Environment. Both organizations have projects at the proposal stages. One finished product which is an aid to marine information management is the Bay of Fundy, Gulf of Maine and Georges Bank (FMG) Resource and Environmental Database, (see Appendix II). The FMG Database comprises of digitized map manuscripts of the area with geographically referenced marine data sets overlaid as thematic layers, and as such is not geared toward information exchange between users.

In an attempt to assess what infrastructure exists for the exchange of marine information, a questionnaire survey was developed and issued to marine related agencies involved at the provincial and federal levels, as well as to commercial and research organizations, (see Appendix I for a full discussion on the design and analysis of the survey). A discussion of the responses to this survey serves to identify the need for a better infrastructure while also assessing users' reaction to issues on data sharing.

2.2 Assessment of Marine Information Infrastructure

Most users of marine data and information are presently aware of available sources of data and are capable of extracting data from these sources. As such some infrastructure for marine information does exist. What this infrastructure lacks, however, is the connectivity over the wider marine environment. Users may get data from an

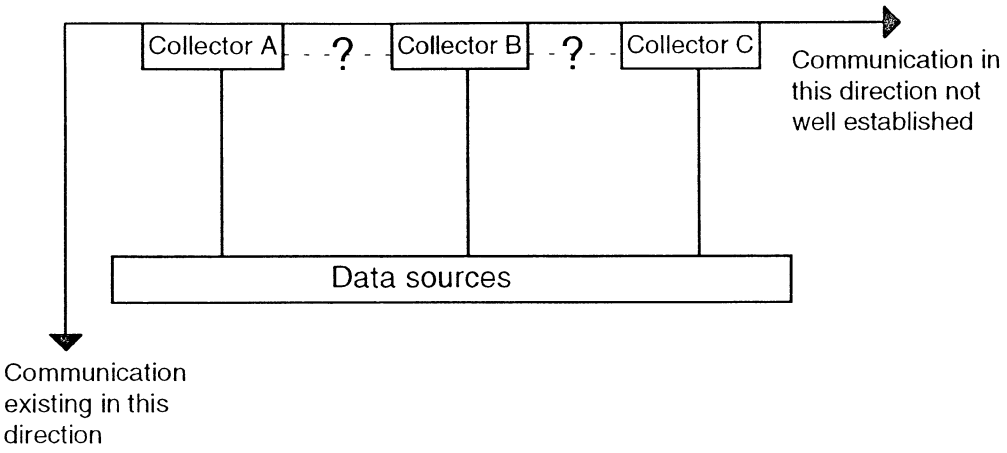

Figure 2.1 Uni-dimensional nature of information infrastructure

established source showing a connection with that source, but not with other users who may be contacting that same source for the same data. This was illustrated by a few responses which indicated an outside agency as a source of data while also indicating that no other outside agency would be routinely contacted before carrying out some other task. While such users may be aware of opportunities for data sharing between themselves and the usual source, such opportunities between other agencies collecting the same data from the same source may be lost. In most cases the only agencies contacted before specific tasks were conducted, appeared to be the sources of data for these tasks. This suggests that the infrastructure is uni-dimensional in nature, existing between collectors and sources but not between the various collectors, see Figure 2.1.

In addition to this, a number of respondents indicated that communications of some data collection and information processing tasks occurred only by way of informal talks with the related agency. If we are to assume that no directory of holdings is consulted before such communications, then again users will not generally be aware of all sources of information outside those of which they are already aware.

While some duplication may be unavoidable or even necessary, its occurrence due to lack of communication should be avoided since it increases the cost of information to users. It is difficult in a survey of this manner to tell exactly where duplication might exist amongst data collection/information processing efforts. The one dimensional nature of the infrastructure does however lend itself to this occurring. This was verified by a number of responses which indicated an awareness of such duplication due to a lack of communication between agencies. The lack of communication also lends itself to an increased likelihood of conflicting activities which could be detrimental to an industry or the environment. An awareness of this occurring was also indicated in a number of responses.

Most of the respondents indicated a strong support for a more comprehensive infrastructure for information exchange between marine related agencies, though there was some skepticism expressed on its feasibility. One respondent, while in support, expressed concern that depending on design, this could result in a layer of bureaucracy which could lead to slower decision making and increased information costs.

All respondents indicated a willingness to share data either freely or at some costs to accessing organizations though in some cases this would only apply to some agencies. Some respondents indicated that the issue of privacy has to be considered where the data is obtained from private companies. In addition to this it is believed that researchers should retain the rights of data until this has been published.

These issues as well as others relating to establishing a system for the management of marine related data will be discussed in the following chapters.

CHAPTER THREE

MARINE INFORMATION MANAGEMENT SYSTEMS

We have, within the last couple decades, entered an information age which has brought with it increasingly large volumes of data. Data by itself is, however, of little use until processed to provide information, and thus there has been increasing demands on the data processing stage of the information process. These demands are due to both the complexity of effectively handling the larger volumes, as well as to the increased need for more information from the traditional data sources.

The importance of increased information potential of acquired data is seen for example in the marine environment, where there are multiple users of varying interests. In such a situation, there exists the possibility of duplicated resources and conflicting usage which could have negative effects on both the industries involved and the environment.

The marine environment represents a scenario where fishing, energy, transportation and recreational concerns all exist alongside each other. From the previous chapter, it is clear that there are marine related databases already in existence. There are no doubts that the data collected is processed and information derived. As such they are in fact marine related information management systems. Traditionally however these management systems have been established on a user specific basis and are generally task specific. Each agency therefore acquires and processes the data as is needed for their specific application or interest. As will be

discussed in the following section, this is not necessarily undesirable. The problem arises however, from the fact that other users are generally unaware of the existence of these databases once they are not directly related to the specific activity. The management of these databases and information derived therefore exists in isolation from other applications and their users.

With such a disjointed system of management, it is difficult for individual users to fully understand the full range of cause and effect between their activities and those of other users. A holistic approach to resource management is therefore not possible. Moreover, the question of whether or not the data required for a given application already exists and its format cannot be addressed if there exists no communication between users.

A survey of the existing data sources may well indicate that in many cases these sources are capable of supplying the necessary data or information for another application. What is needed therefore is the awareness among users of these sources and how they may be better utilized. A Marine Information Management System (MIMS) can be a step in achieving this awareness.

3.1 What is an MIMS

A Marine Information Management System or MIMS can be seen as a strategy or means to achieving marine resource management, where user needs and environmental data are used in designing some model of the marine environment and our interaction with it. The use of this model in turn gives some feedback to the users of the environment which can in turn be used to enhance the initial model. This cycle is illustrated in Figure 3.1.

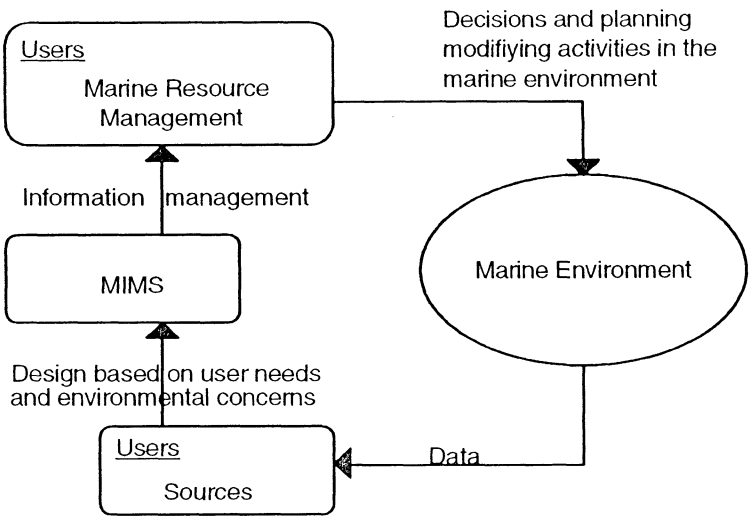

Figure 3.1 Role of an MIMS in marine resource management (After Nichols [1992])

The MIMS is also proposed to better coordinate activities in the marine environment. This coordination is possible through the establishment of an infrastructure for data and information exchange between marine related agencies thereby enabling better feedback on the environment.

The object here is not to propose a new system of data collection/processing, but rather to look at the existing databases and see how they may be better utilized as well to provide a framework for establishing databases. In many cases too much of an investment has already been made in the data that already exists, and it is neither likely nor feasible that this approach will be abandoned in favour of an entirely new system. Furthermore, agreement on one such system is not likely to be easily achieved where one is dealing with many users of varying interests. Instead what is being proposed is a system which allows for the collaboration of various agencies to assess what data is already available and the quality of this data, current data formats, and a means whereby information may be shared between them.

This collaboration is required on three 'planes' in both a horizontal and vertical sense and is represented as axes of control over marine resource management, (see Figure 3.2).

The vertical user classification in this diagram represents the various levels of users from the querying staff, general users and data gatherers for the various databases, to their respective political leaders who are invariably the ones with the final say in infrastructural matters of this nature. The politicians are also the ones with the power to negotiate amongst the horizontal user classes as well as the outer zones of management. Included in the category of data collectors are the individuals who though not actively participating in the MIMS infrastructure, are affected by any use of the environment, (e.g. fishermen), and are therefore also important in the design process.

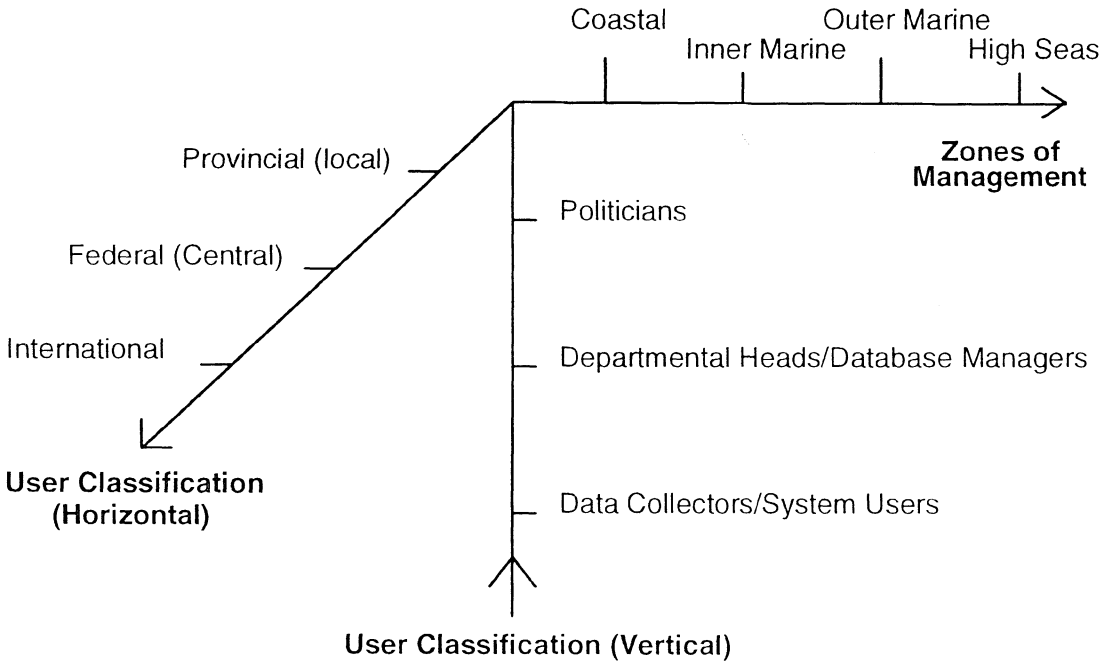

Figure 3.2 Axes of marine resource management

The horizontal user classes represent the need for cooperation amongst the various regions of control from a local to international level of cooperation. International cooperation is of importance not only in the High Seas, but even more importantly, where maritime jurisdictions between two coastal states meet.

The zones of management axis represents the various zones as they were described in Chapter One, (see Figures 1.1 and 1.2). In Figure 3.2, the various zones also extend to encompass all three vertical zones as illustrated in Figure 1.2.

In this illustration, comprehensive marine information and resource management will be achieved when cooperation exists and encompasses all levels on each of the three axes. This would be represented by a closed surface which intersects each axis at the Data collector..., International and High Seas 'coordinates'.

This ideally, is the main objective of an MIMS. In practice, the surface would fall short on one if not all of the three axes indicating that one user group or zone is not sufficiently represented. In many cases also, the order of the user classes may be reversed. It is for example, possible to find cooperation over the wider national issues amongst federal departments, while cooperation on a more local level is lacking.

Again in some cases, we may find management represented by two or more sets of axes. Thus there may be cooperation between all vertical user classes within both localized provincial and federal departments while no cooperation exists between the two bodies.

3.1.1 Objectives of an MIMS

The object of this coordination is to optimize the data collection, data processing and dissemination efforts of marine agencies thereby avoiding unnecessary duplication of resources. It should be stressed here that some duplication is desirable and even

necessary as it may serve to corroborate and increase credibility of the data. Also data collected by one agency may not meet accuracy or frequency requirements of another agency wishing to obtain this same data. See Section 4.4 and Figure 4.3.

Many times the data captured by one user is not fully used, or can be used differently to yield additional information by another user. If the cost of collecting this data oneself is prohibitive for other users, then this additional information may never be obtained and the full potential of the data captured by the first user may not be realized.

Though data is currently collected through many different agencies, it may be argued that much of this is undertaken on budgets from the government. Coordination in data capture will allow the user to identify the availability of necessary data from other users. This could lead to a reduction in the cost of data capture to the government, and with this, a reduced cost of the information derived. This reduced cost will in turn be passed on to all users.

Coordination will also enable processing and distribution of the information derived to be more streamlined, comprehensive and faster over the larger community of marine related agencies. This in turn spells faster access to more up to date information.

Another objective of an MIMS is to facilitate more comprehensive decision making on matters relating to the marine environment. This is facilitated through an infrastructure for data and information exchange, allowing decision makers easy access to data and information ranging outside their specific areas of interest. While this does not guarantee a more comprehensive approach to management, it does facilitate it by allowing users to become more aware of the effects of their actions on other users and on the environment as a whole.

The manner in which these links can and will be established depends on a number of factors. These include the way data is presently being stored and used, and the available technological and personnel resources. The success of such a system is based on the cooperation of agencies and departments that interact with the marine environment. This cooperation is in turn dependent on convincing the various users of the marine environment that there is a need for such an effort.

3.2 The Need for an MIMS

The Annual Report of the Canadian Department of Fisheries and Oceans [1990], states that ocean related activities were worth more than $8 billion dollars (see Figure 3.3) while providing more than 165,000 full-time jobs to Canadian nationals. The commerce associated with this industry benefits many more individuals not directly involved in an ocean related activity as well as individuals in other countries. With the increasing number of users in the marine environment and the increased potential for exploiting the resources, there comes an increased possibility of conflicting uses, and therefore an increased need for management.

What is also often neglected is the fact that many land based activities indirectly affect the marine environment. This makes the role of management a more formidable one but further stresses the importance of cooperation and communication through an infrastructure for information exchange.

These points are emphasized in Table 3.1 and Table 3.2 which show a number of activities and their possible effects on the marine environment. Both these tables serve to indicate the wide range of activities that can affect marine life even though many of these activities are not directly related to the marine environment. The concern

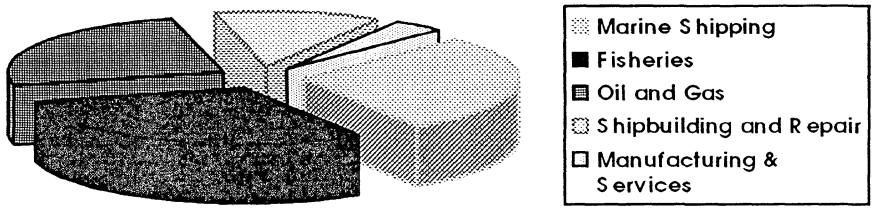

Fig. 3.3 Canada's oceans sectors industries (estimated output for 1985). (After Anderson [1989, p. 7])

here lies with how many of the agencies or departments involved in these activities are aware of **all** the possible effects of their activities.

Figure 1.5 (see page 14), indicated that there must be a compromise between environmental quality and exploitation since each of the concerns identified are inversely proportional to the others. As indicated by Barker [1990], while point Z maximizes environmental quality, this is achieved at the expense of no economic development. Conversely, maximizing any of the economic developmental concerns is done at the expense of the environment.

The goal of resource management therefore is not to prohibit all possible negative activities, but rather to ensure that their effects are minimized or removed wherever possible. Further to this, areas of possible negative impacts due to conflicting activities will be more easily identified allowing the appropriate steps to be taken. This objective is in keeping with the concept of sustainable development. This is defined in the Brundtland Report as, " development that meets the needs of the present without compromising the ability of future generations to meet their own needs.", [World Commission on Environment and Development, 1987].

Table 3.1 Possible effects of marine based activities on the marine environment

ACTIVITY	POSSIBLE EFFECT ON MARINE ENVIRONMENT
MARINE BASED	
Fishing	
Overfishing	:- diminishing stocks
	:- loss of species
Technique	
-- drift methods	:- killing of unintended species
-- bottom trawling	:- destruction of habitat
Shipping	
Spillage	:- pollution of environment by petroleum products and other cargo
Engine operation	:- acoustic stresses on habitat especially in narrow areas of heavy traffic
Mineral Resource Exploration	
Oil and gas exploration	:- intentional and accidental discharge of substances into waters (e.g. acids and drilling muds)
Deep sea mining	:- destruction of the ocean floor by scouring :- degradation of habitat due to large amounts of suspended sediments in the water column :- destruction of habitat due to settling of these sediments
Underwater blasting	:- destruction of habitat
Other Marine Activities	
Ocean dumping	:- destruction of habitat by chemical and solid waste disposal
Channel dredging	:- destruction of habitat by scouring and dumped spoils
Offshore nuclear testing	:- habitat disturbance and destruction
Offshore excavation for sands	:- loss of habitat and changes in circulation patterns :- destruction of habitat due to blasting :- loss of spawning rubble
Construction (islands)	:- permanent loss of habitat :- destruction of habitat due to blasting
Offshore tourism (coral reef visitation)	:- destruction of reefs and habitat stress
Man's direct intervention in the environment for the sake of some particular species	:- disturbance in the complex ecological balance of the local environment. (May result in reduction of numbers for other species)

Table 3.2 Possible effects of land based activities on the marine environment

ACTIVITY	POSSIBLE EFFECT ON MARINE ENVIRONMENT
LAND BASED	
Coastal Development	
- Port and harbour development	
---Construction of hurricane barriers and tidal dams and other harbour facility works	:- permanent loss of habitat :- leads to changes in the water mass exchange :- alters existing currents further leading to: -effects on pollution dispersal and dilution -changes in sedimentation due to velocity changes :- shorter wind fetches further reducing water exchange :- loss of habitat due to shifts in areas of scouring and sedimentation
Changes to existing coastline	:- alters existing current patterns :- disruption of alongshore mineral transportation - undernourishment of organisms downsteam of the disruptive construction - filling in and concurrent erosion due to construction of peninsulas in areas of alongshore current
Removal of shoreline vegetation	:- destruction of habitat :- loss of hiding ground for smaller species
Removal of aquatic vegetation	:- loss of hiding ground for smaller species :- possible loss of food for some species
Beach facility development	
- sand filling	:- destruction of habitat
- construction of barriers to stem longshore drift	:- disruption of alongshore mineral transportation - undernourishment of organisms downsteam of the disruptive construction :- disruption of water circulation pattern
Other coastal activities	
Sewerage treatment	:- nutrient loading due to seepage
Use of coastal water for cooling in industrial plants	:- heat stress in the local environment :- mechanical and heat stress for coastal organisms
Inland Activities	
River pollution and waste water runoff	:- dumping of chemical and solid waste as well as surface eroded materials into coastal area
Inland damming	:- alters depth and nature of shallow water habitats
Channel water level control structures	:- hinders movement of migration species (e.g. salmon)
Air pollution	:- poisoning of fish stock due to acid rain
Pest control	poisoning of fish stock

It is accepted that in any development or use of a resource, some negative impact will result on the environment. A functional information system will allow however, for some assessment of the state of the environment, enabling better decisions with regards to the nature and rates of development that will allow maximum economic benefits, while also enabling the environment to sustain itself. Anderson [1989] stated that, "No *sustained* [my emphasis] organized management of environmental/economic developments can be achieved without a supporting information infrastructure."

The words of Scarratt [1989] again indicate the need for an MIMS in relating to the role of database managers. He stated that:

> ... there is both intellectual and academic credit to be obtained by adopting a broader view of the relevance and importance of the work of (their) staff, and by encouraging a greater degree of cooperation with the stream of consultants who seek *exactly the same information that was given to the fisheries managers the week before, and will be requested presently by another company in yet a different discipline* [my emphasis].

Presently users are not sufficiently aware of the links between them due to the close knitted interaction within the marine environment. In view of the many possible conflicts within the marine environment, the justification for an MIMS is in the environmental/economic cost benefit which will accrue with the opportunities for more informed decisions.

CHAPTER FOUR

ISSUES IN INFORMATION MANAGEMENT

4.1 Feasibility Considerations

Although the concept of an MIMS as outlined in previous chapters seems favourable, one has to establish whether it is in fact feasible to establish such a system and the format in which it will be established. This feasibility study also provides the arguments which can be used to promote the idea for financial assistance to relevant authorities. It therefore represents an important initial stage of developing an MIMS. Neumann [1982] stated, "The *feasibility study* is one of the most crucial stages in the information system life. Its conclusions determine whether the project is going to live or die."

Not only must we be able to show that the project will survive, but in order for it to get off the ground, we must show that it can and will be successfully implemented. Neumann [1982] went on to state, that this success should be determined based on a technologically reliable solution which is both economically and organizationally acceptable.

Even after convincing the necessary individuals that the project is worthwhile, the feasibility study is the last stage before commitments, both financial and physical, are made. It therefore requires the most collaboration on the part of the prospective developers. The major components of a feasibility study are identified and discussed in the following sections.

4.1.1 Market Feasibility

This aspect of the feasibility study examines whether there is a need for the proposed system and how many individuals/agencies are willing to support it. The question to be answered here is whether the proposed system holds any advantages over the current system or arrangement for managing marine related data. The advantages of data integration among owners and users of marine related data is well recognized, [Anderson, 1989; Baser, 1989; Davies, 1989; Scarratt, 1989; Wilson, 1989; Roberts,1992; Schmidt, 1992b]. Once the need for an MIMS has been established, what is now required is some discussion on how this may be achieved both technically and financially.

4.1.2 Technical Feasibility

This establishes whether the proposed system can be developed and implemented using currently available resources and how this may be done. Three main considerations are inherent in this stage:

(i) The format of the existing data and information infrastructure.

(ii) The requirements of the proposed system.

(iii) The format and organizational structure of the proposed system.

As the 'Directory of Marine Data Sets 1991' shows, many marine related databases already exist in Canada, [Champlain Institute, 1991]. All of those listed in the Directory are in some digital format though not all are capable of dissemination in this

format. As pointed out before, not many of the owners of these data sets communicate outside of their specific interest. To date the seeker of information has had to be the one to piece the various data sets together to obtain the information sought.

In proposing a new system, this concept of integrating existing databases should be explored. The procedure for establishing an MIMS however, involves more than just integrating data sets . Merely integrating data sets only facilitates a means for communication. It will not however indicate what issues should be communicated and with whom they should be communicated. If for example a user is not aware of the impact of another user's work on a proposed project, then that data set will not be queried. See Figure 4.1(a). This approach is often the one taken since it is relatively easy to accomplish. The technology to integrate these systems is generally available and the desire to automation is often irresistible.

Though benefits will accrue from such a system, it does not facilitate the wider goal of comprehensive marine resource management. What is needed is a forum for users of the marine environment to discuss their information needs, what activities affect their work and in what way this is affected. A query based on this appreciation will be a more informed one allowing for more information to be derived in turn. This is illustrated in Figure 4.1(b).

It is only at this stage that the decision on the format of the information exchange can be made. The actual format of the exchange may be a digital automated one, or may be an analog one with plans for future automation. In some cases it may even be decided that a system of telephone calls or memos made to the appropriate departments is sufficient. What should be stressed here however, is the need for appropriate communication of the relevant issues. It is this communication rather than

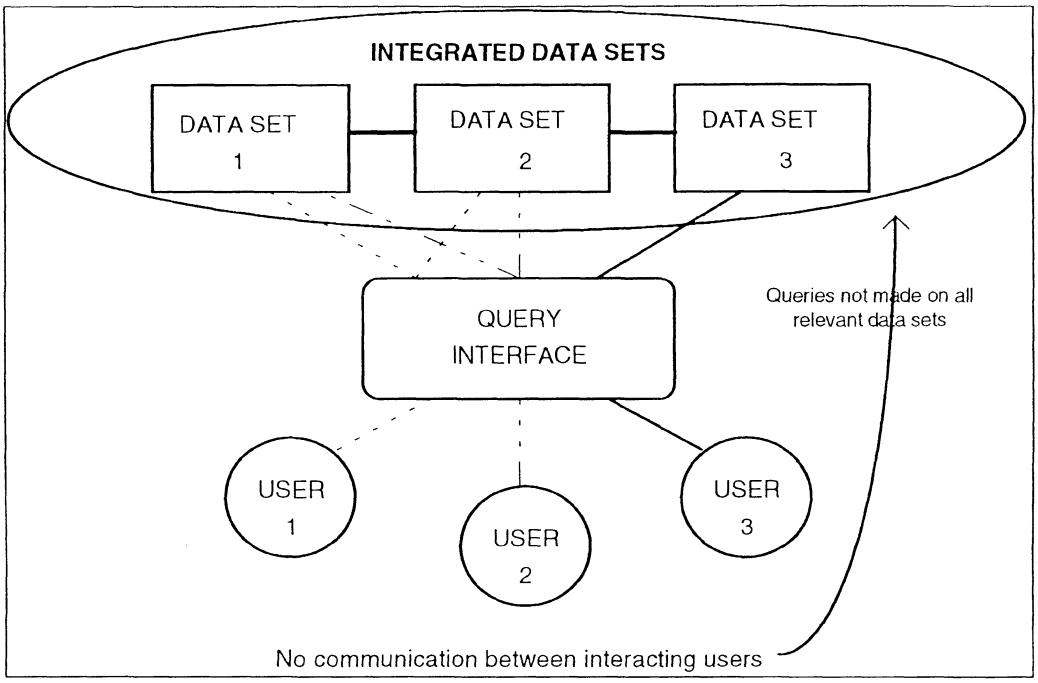

Figure 4.1(a) MIMS based on merely integrating existing data sets

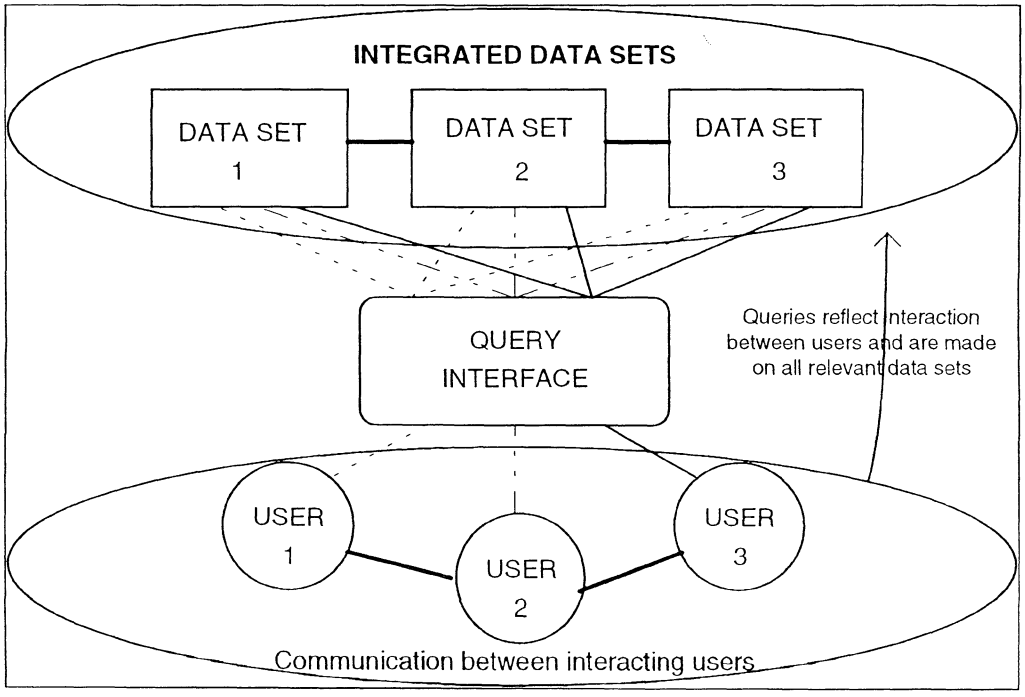

Figure 4.1(b) MIMS based on a comprehensive infrastructure

the format of the exchange that forms the basis for the success of the MIMS. In too many cases, users tend to believe that automation is by itself the solution to the problem. Automation will only allow greater ease of information exchange. As was illustrated in Figure 4.1, integration and automation in themselves does not necessarily ensure a broader perspective on the data and its use. Furthermore, automation if seen as necessary, is generally designed around the system presently in place, as well as to satisfy the perceived future needs. If the present system does not recognize the need for an interaction between the users, then neither will the system which is automated from it.

4.1.3 Economic Feasibility

As the term suggests, this aspect of the feasibility study establishes the economic viability and availability of funds for the proposed MIMS and may be considered in three stages:

(i) What funds will be required to implement the proposed design.

(ii) Whether or not the proposed MIMS will be economically viable.

(iii) What sources of funding will be available.

The extent of funding required will depend on the format of the existing data sets and the proposed format of the MIMS. The total cost of the system will also depend on the number as well as size of the data sets and their geographic distribution.

Though this may be considered as being a business venture, two profits are to be considered in determining its economic viability, these being financial and environmental.

Assuming a fully automated system, use can be made of the existing digital databases with modifications made to conform to some communication standard. The cost of such a system will therefore be the cost of automating the analog databases plus the cost of establishing and maintaining the network. It is arguable that analog databases would be automated in the future with or without a proposed MIMS. The issue is therefore one of doing so to ensure compatibility with other databases, this not necessarily being a more expensive undertaking. The operation of the system is capable of paying for itself to the benefit of all participants based on the ease of access to a wider range of data and information. This statement holds true even if the proposed system is to be analog based. The costs generated here will depend on the mode of communication decided upon, example telephone calls, faxes or mail. In either case, increased benefits will be realized for information requiring multiple database queries. An example of this is an Environmental Impact Assessment (EIA) study which draws on databases from many different disciplines. Scarratt [1989] stated:

> The lack of approved data or information bases has possibly led to excessively expensive environmental impact statements, since much of the cost has been incurred in assembling already existing information rather than on the acquisition of site specific data and general interpretation.

Even with marginal financial feasibility, the potential for supporting sustainable development cannot be overplayed and the environmental benefits of an MIMS go a long way in justifying the costs.

Most of the existing databases are either government based or have been established through government funds. The government is therefore a likely source of funds for the infrastructural development of an MIMS. The environmental objectives of resource management possible with an MIMS, also lends itself to political attractiveness

at a time when the general public is becoming increasingly environment conscious. Once established, operation and maintenance costs can be financed through the combined efforts of the participants as well as from service charges levied on usage by outside users.

4.2 Centralization versus Decentralization

Though an MIMS is concerned with integrating databases among users this does not imply that the organizational structure necessitates the physical integration of the data sets. Users may have access to data either through a centralized or distributed system, or some hybrid of these designs.

A centralized system is one where all data storage and processing is handled within a central database [Neumann, 1982]. Users access this site either through electronic or physical means. A decentralized or distributed system is designed around individual local databases networked together through some communication system [Burch and Grudnitski, 1986; Murdick 1980; Neumann, 1982]. The relative merits of each of these network designs have been well discussed by the above authors. Some of the advantages and disadvantages of each system are indicated in Tables 4.1 and 4.2.

At a time when computing and networking hardware is relatively inexpensive, the former advantages of economies of scale associated with a centralized system begin to lose their attraction and it is the disadvantages which make this network structure an unfeasible choice. In light of the present trends in data management, and the problems anticipated in agreeing on standards, the distributed system is seen as the preferred choice.

Table 4.1 Advantages and disadvantages of a centralized system

Advantages	Disadvantages
More economical since larger centralized system reduces the need for duplication of hardware and software at various sites.	Since system is designed around a centralized unit, failure of this shuts down the entire network.
Better control over use of information system by database managers.	System accomplishes a global functionality at the expense of not being tailored to any specific user or function.
More control over administrative tasks such as backup and recovery.	Standardization necessary for developing this system requires agreement and cooperation from all involved in order to be achieved.
Standardization of data sets assured over the database.	Original owners of the data sets do not have as much control over the data.
Easier operation for users outside the system since standardization ensures uniformity in querying procedures.	Centralized structure disregards any existing distributed databases.
Better facilitates global system planning by participants on issues of future developments.	Centralization over a large distribution of data sets lends for a very complex administrative task.

Table 4.2 Advantages and disadvantages of a decentralized system

Advantages	Disadvantages
Individual data set owners retain more control over data.	Though there is more control over the local data, administrative control over the entire network is made more difficult.
Individual databases could be better tailored to a specific use or function.	Greater degree of data duplication in data and hardware needed for the individual databases.
System failures are site specific and do not affect the entire network.	Less control over data format standards where data sets are distributed.
Simple organizational structure	More complex design required for information exchange where different data formats are being used.
No need for global support on data standard before system can be implemented	
Suited to instance where individual databases already exist.	
Facilitates easier expansion and upgrade of individual components.	
Reduced communication costs and faster data access to the owner of the database who will likely be the most frequent user.	

Listed below are some arguments supporting a distributed system as a preferred choice:

1. Where a system of this nature is likely to support such a large user base, the risk of a global system failure based on a single central system cannot be justified.
2. Though the administrative procedure is simplified and there is likely to be more uniformity inherent in the system, the task of agreement on that one standard and administration between participants is a mammoth one and will likely delay any implementation.
3. The greater degree of customization possible with individual databases allow them to better serve the need for which they were intended and developed, while still allowing access to other users.
4. In most cases as has been indicated before, some investment has already taken place in establishing individual databases. It is neither economical nor should it be expected that users will abandon this in favour of an entirely new system.
5. Departments responsible for these databases tend to feel a degree of possessiveness for the data they have collected and are more likely to support a distributed system where they retain more control of 'their' data and access to it.

4.3 Standardization

One of the main considerations of a distributed system comprising many data formats is the transfer of data between sites. This is likely to be a concern in Canada

for example, where the isolated development of the databases has taken place on a variety of platforms using various software packages.

Data transfer between users therefore requires transformations between the formats to ensure usability among all participants. Though this can be achieved, it does incur an overhead for system designers. In order to allow reciprocal communication amongst users of *n* different formats, it is necessary to have n^2 - n transformations. The Directory of Marine Data Sets produced by the Champlain Institute [1991], identifies some 57 data sets maintained in a digital format. If we consider these data sets only and assume different data structures are being used, then 3192 transformations will be required for each of these users to communicate with anyone else. In addition to this, for each new format incorporated into the system, 2n new transformations will be required.

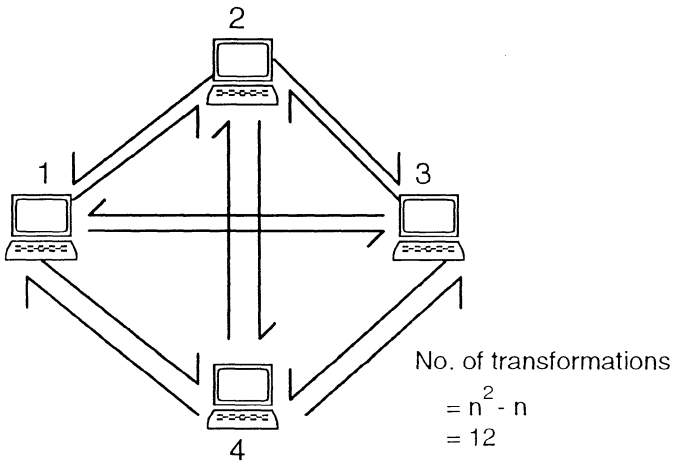

Figure 4.2 Data exchange with no standard format

In addition to standards in data structures, some form of standardization is also needed in classifying the data transferred between users. An example of where this

may be needed is in descriptions of the seabed. One user may describe as 'gravel' what another may have referred to as 'stone'. Since users of existing databases would already have based their work around some in-house classification scheme, this poses more of an issue than the actual data exchange format. Though one standard will be the ideal, it is realized that this may be a bit too ambitious where one is dealing with such a diverse range of users. Users should at least however be familiar with the differences in interpretations between their data sets and the ones being accessed. This point is especially important in the context of legal liabilities on use of data where this may have been incorrectly interpreted. See Section 4.6.

Another issue to be considered in data transfer is the differences in datum and coordinate framework used by the different users [Ogilvie, 1992]. Again it is not considered feasible or even necessary to enforce any standard on users. Though this approach may be seen as ideal, and standards should be promoted where possible, it may not be practical especially where users cover an extensive geographic area such as Canada. Persons accessing the database should however be aware of these parameters, or the transformations may be available as options to the user on accessing the data. This approach is seen as desirable for the following reasons:

(i) Allows individual databases to use datums better tailored to the specific needs of their owners, where in any event they will likely be the most frequent users of that data.

(ii) More likely to be found acceptable by all participants since it offers the least disruption of the already established way of processing.

(iii) Still allows other users to access databases and get usable data.

Standards in communication are also required for the proper transmission and reception of data between databases. Networks design should be designed around the Open Systems Interconnection (OSI) or other similiar concept, to allow for interfacing of the many hardware configurations likely to be encountered [Baser, 1989]. This also ensures that communications are not achieved at the expense of loss or corruption of data.

4.4 Data Quality

One of the concerns of agencies wishing to share data is the quality of the data available from other sources. This is a valid concern and a difficult one to address. Different users have differing accuracy as well as frequency requirements. Moreover, these requirements may vary from project to project within the same agency. This follows from the fact that data collection/information processing has traditionally been done on a project oriented basis rather than with a view to its wider usability.

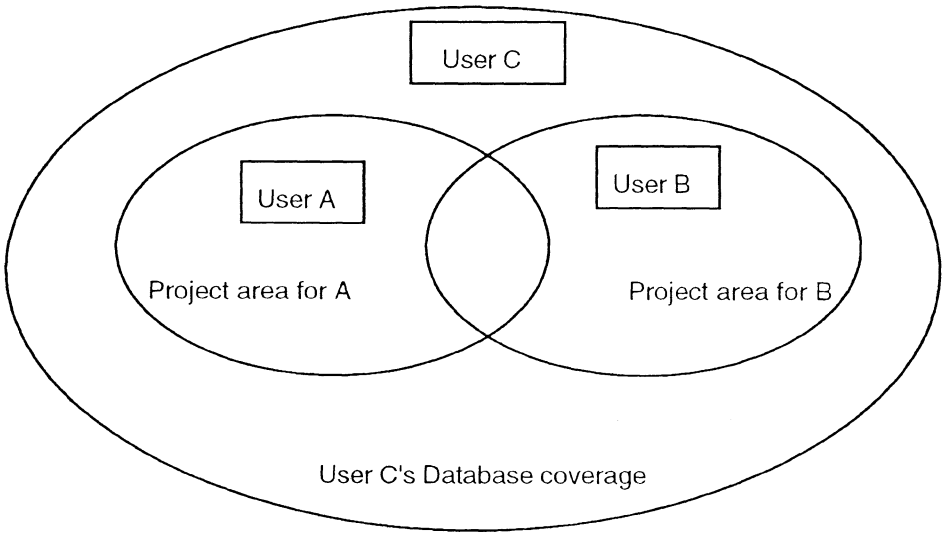

Figure 4.3 Data quality restrictions to data sharing

In Figure 4.3 for example, User C has a database covering a wide geographic area. Both users A and B require data for separate but overlapping areas within C's coverage area. The data in C's database may not be of sufficient accuracy for User A however while User B may require this to be more frequently updated. In spite of a willingness to share, the data of each of these users does not meet the requirements of the others. While cooperation between A and B will at least yield cheaper data than their individual efforts, User B will likely have to wait longer to obtain his data due to the higher accuracy requirements of A, while User A will be forced to undertake more data collection than is necessary due to the frequency of B's data collection efforts.

This difference in needs between users does place some restrictions on cooperation on data collection. On the other hand marine related agencies should not resign themselves to the fact that these differences will in all cases necessitate individual efforts. Proper indexing of the data collected will allow other agencies to assess the suitability of existing data for their needs before embarking on their own collection efforts.

4.5 Data Sharing Between Agencies

One of the major hurdles to be crossed in establishing an MIMS is the unwillingness of some users to share the data they have collected or the information processed. This is usually due to a number of reasons some of which are listed below.

4.5.1 Possessiveness of Data

Many users tend to feel that the data collected belongs to them solely and should not be made available to others. They view the data collected as a cost to them

which can be used as justification for further budgetary claims. Another reason for the possessive attitude is the authority which is associated with the data or information the department or agency is capable of producing. Another agency capable of using this information may be viewed as encroaching on this authority and may be denied access to an existing database. Associated with this outlook is the view that any collaboration which serves to identify and optimize duplication may likely result in a reduction in budgetary allocations together with reduced authority. Data is therefore not viewed as a common resource but as an earned commodity. Scarratt [1989] stated:

> ...the important point must be that data, particularly those obtained at public expense, be regarded as a common resource, regardless of origin, and only the interpretation, germane to a specific situation, be regarded as proprietary.

4.5.2 Data Security and Privacy

Within the context of information management, data security involves its protection against intentional or accidental destruction as well as disclosure by unauthorized personnel. Data privacy refers to the right to restrict access to certain data or information in the database.

Both these issues are of major concern where users have on-line access to databases. Presently, users outside the office responsible for the database have to specifically request access to any data required. This allows some degree of control over who obtains data and what data is being accessed. Also the requesting party in most cases does not achieve physical access to the database. Where databases are to be integrated however, the degree of control is somewhat shifted. Whilst the office responsible for the database can still control what data is accessed, the control over

who actually accesses that data now rests with any other office with on-line privileges. The security of the data in any database is therefore only as good as the *weakest* security link in the entire network. This is to say that if User A allows *anyone* to use his on-line facilities, then *anyone* has access to all the other databases to the extent of User A's access privileges.

Also of importance is the issue of privacy. Some data may at the time of collection, be declared as confidential for some period of time. This is true even where the data is owned by government departments and may be considered as public, as the data may have been collected through some private company [Ford, 1990]. Even where this is not the case, one department may fear that if the party accessing the data has an overlapping interest, this may jeopardize their own plans. This is complicated even further by the fact that the same data may not be considered confidential sometime in the future, in another situation, or with respect to other users.

Though the issue of confidentiality is a real one, the solution to the other issues here lies with local and network administration. All potential users of the MIMS must recognize the need for adequate personnel screening, user authorization, password management and limiting access to system facilities. Distributed systems can offer more localized control than centralized systems over all of the above which in turn may foster more support for data sharing. Other solutions may include the declaring of on-line data as read-only. Proposed changes to the local database and other relevant data from other users may also be stored separately for verification before the actual data is updated. Where data is deemed too sensitive for global access, it should be possible to assess which aspects of the data render it sensitive. These can be withheld while other aspects be made available where they may still be of some use to other users.

4.5.3 Cost Recovery

Costing of data services also becomes more complex where users have on-line access as compared to traditional dissemination methods. Cost recovery is therefore seen as a problem associated with data sharing. While systems can include automatic billing on chargeable services, the fact that this cost is not recovered on delivery of the data or service will be a matter of concern to some users. Perhaps more importantly is the issue of the value of digital over analog data. There is little doubt that a map delivered in digital format is, by virtue of its flexibility, more valuable than a printed chart of the same area. Pricing policies will therefore need to be reconsidered. See Section 5.5.

The politics of collaboration and sharing between any number of users is always a complicated issue. The unwilling parties have to be shown the benefits which will accrue to them and to all through the effort. In the case of the marine environment, most of the related agencies are governmental departments. Since this removes the market and financial competition that is present among private corporations, it may therefore be an easier task to convince each that the collaboration will not mean reduced financial power but increased efficiency.

4.6 Responsibility for Data

Though responsibility for data should not be affected by the manner in which it is accessed, the transparency of access afforded by a network does allow for the sources of data to be easily lost. This is especially true where a user is simultaneously

querying multiple databases to compile the desired information. Each department or agency participating in the MIMS should be responsible for the data within their database. This responsibility extends beyond the mere authenticity of the data. In order to assess whether the data can be used for a specific task, the user should be provided with the following:

(i) The accuracy of the data.

(ii) Techniques and equipment used in collection.

(iii) When the data was collected as well as frequency of collection.

(iv) What form of processing if any, has been carried out on the data displayed.

Users of the data on the other hand, are responsible for establishing the suitability of the data accessed for their specific needs. This responsibility also includes careful interpretation of data classifications and the checking of their meanings, (see Section 4.3). Someone providing access to data can only be responsible for the data in their database, they can not be responsible for misinterpretation of this by users who employ a different classification system.

4.7 Operation and Maintenance

Maintenance of the MIMS must take place on two levels. Firstly each data set owner must be responsible for the upkeep of their respective databases. This should not represent an additional cost as this would be necessary whether or not the database was integrated or not. Secondly, the actual network must be maintained, This maintenance involves:

(i) Maintenance of old communication links together with the establishment of new ones.

(ii) Establishment and testing of data transfer formats

(iii) Operation and maintenance of all equipment associated with the network.

(iv) Monitoring of networking technology and making decisions on upgrades.

In order to maintain uniformity, these duties should be carried out by some centralized body. This body may be some appropriate department, like the federal or national department responsible for communications, but should also include representatives from the various participating agencies. This not only better ensures that the needs of the individual agencies will be met, but also that upgrades done on these individual databases ensure compatibility with the existing network.

4.8 Data Distribution and Access to Outside Users

Some provisions must be made for data access to users outside of the network. This group may include for example, development companies whose interests are not specific to the marine environment and who will not have a need for owning or using a marine database. Data should therefore be available in a number of formats for transfer to these outside users. This could take the form of floppy diskettes formatted for the PC, Macintosh or other operating system, as well as on hardcopies.

4.9 Marketing

In addition to selling the idea for support by prospective participants, the system must also be sold to the general public. Marketing of the MIMS could be in the form of public forums, feature documentaries and brochures available at participating offices. This fosters greater public awareness of the marine environment while more importantly, advertising to marine planners and developers that resource management data already exists.

In addition to marketing of the system capabilities, the importance of issues such as standardization and quality control, and the likely variability in these must also be impressed on prospective participants and users. This ensures that users are not only aware of what is available, but of likely limitations as well. This in turn enables the user to make better use of the system through the more informed decisions capable and the increased confidence which can be placed on these.

4.10 Educating and Training

As with any new system, training and educating of prospective users constitutes a very important part of the MIMS. The objective of this is to introduce the concepts of data and information management while providing hands-on experience on the actual system software and hardware. While some of these are of concern only where the system is to be an automated one, this does not exclude the role of training for any proposed manual systems. In most cases where data is stored in an analog format, some restructuring of the system of filing or indexing may be deemed necessary whether the proposed system is to be automated or not.

In order to be effective, the training package should cover specific problem solving applications designed to enable users to appreciate how the system can satisfy their needs. In addition, the package should offer some global picture of the concepts of resource management, indicating what the components are and where they fit. This fosters an increased awareness of the importance of marine resource management while also increasing the morale of individual users who may otherwise never have a full appreciation of the importance of their role.

Where the proposed system is an automated one, some training on the hardware will also be necessary. The developer should bear in mind that some users may not have had any prior experience with computers or may be unfamiliar with the platform on which the software will be running. Appropriate training modules should therefore be incorporated. One problem likely to faced is the fear some individuals have towards computers based on their concerns of adaptability to the new technology and the perceived redundancy of their jobs. The training package will have to be capable of addressing such issues.

4.11 Summary

This chapter has addressed some of the issues that developers of any information system will encounter. These issues are concerned with the establishment and maintenance of the information system and facilitating the actual transfer of information between users. Where the information to be managed is marine related, as is the case with an MIMS, some further issues are seen to arise. These additional issues arise from the users perception of the environment and how its resources should be managed. These issues are introduced and discussed in Chapter Five of this report.

CHAPTER FIVE

SOME SPECIAL CONSIDERATIONS OF AN MIMS

A Marine Information Management System is in many ways similiar to a Land Information Management System. Many of the issues regarding the needs, the objectives and the approach are common to both. On the other hand there exists some differences based on the nature of the resources and the way these have been traditionally administered on the land as compared with the sea. These differences do not however remove the fact that much can be learned from reviewing similiar issues in land information management. This chapter is not an attempt to detail the policies of these proposed systems for managing land information as documentation on these may be easily accessed. Rather what is intended here is to draw attention to some of the additional issues and considerations when dealing with managing marine information.

5.1 Institutional Issues

Though a number of issues regarding the actual administration of marine resources through information management are similar to those on the land, there exists a number of different views held on each of these environments do exist.

While much of the interest in land and related matters is held privately, this is not generally the case in the marine environment. Apart from coastal and adjacent areas, much of the interest in the marine environment is vested in the coastal State.

This brings about two situations which affect the way we perceive the marine environment and our management of it.

Firstly though there may be the same diversity of interests in both environments, the diversity in nature of user groups is greater on the land than it is in the oceans. In the marine environment, these interests are held and administered mainly by public sector departments. The organizational structure of these user groups is generally not geared for profit and therefore there is generally not as high an incentive to manage information for resource management as there is on the land. Furthermore though there are many private sector interests, these are controlled and administered by the state. These corporations unlike their counterparts on the land, do not therefore have a vested interest in the marine environment other than the industries which their activities support.

The fact that there is less direct ownership results in some distancing of the activities of these user groups from possible effects these may have. As a result, the role of resource management may not be viewed as highly as is likely to be the case where there is more private interest. This also results in a slower reaction to signals of abuse from the marine environment. These are typical reactions of users to a common property resource, see Section 1.3.1, where anyone can be a user but no one individual is an owner.

Secondly, since the public generally views the marine environment as property vested in the State, there is more of a view that marine related facilities and information should be freely available. As such, users are less likely to be willing to pay for information or for the establishment of any infrastructure for managing this information. Cost recovery is therefore likely to be a more difficult task.

Another factor which brings about differences between the approaches to information management in the land and marine environments, is the fact that there is still the view that our marine resources are inexhaustible.

5.2 Social Issues

Another way in which the design of an MIMS requires special consideration is based on the social issues it attempts to address. Whenever one attempts to establish policies for management of resources, there is likely to be some conflict between users and how they perceive these policies will affect their interests. No one policy or group of policies will meet open acceptance from all concerned since there are conflicting interests in the marine environment. While, for example, it is to the advantage of the fisheries departments to promote aquacultural development, this is met with some opposition form the environmental departments based on the effect such developments have on the local ecosystem and water quality. The question of what rate of development is acceptable in terms of achieving sustainable development may likely yield different responses from the two departments. There is therefore a need for some priorities to establish the values of certain activities both in terms of their economic and environmental worth.

Becht and Belzung [1975] referred to this as the "need for universal values " in resource allocation. Another example given here highlights the potential conflict between interests of an industrial development and effluent discharge with the use of the area for recreation. The question which arises here is which user or activity should be given the higher priority for use of a common resource. In both of the above examples, society depends on the activities carried out and cannot therefore make a

decision to abandon one for the other. Furthermore, in relation to the issue of free enterprise, the issue of the rights of the affected group may be seen as violated if this is done for the benefit of another interest group. Becht and Belzung [1975] went on to state that:

> ... it is doubtful whether this nation (*The United States of America*) could maintain freedoms for its individuals if the control of basic resources were taken out of the market place entirely and placed in the hands of an overriding bureaucratic organization that would dictate all allocations.

Such issues will have to be considered when formulating resource management policies so that the MIMS designed to facilitate these policies will also reflect these concerns.

5.3 The Marine vs. the Land Context

One difference between a Land Information Management System and a Marine Information Management System is the larger data sets found in the marine environment. This is due to the increased importance placed on the third component, depth. In addition to this, there is a greater need for redundancy in the data where ground truthing of parameters describing the state of the water column and seabed, is difficult and costly. While this strengthens the argument for an efficient system of management, it also makes the task a more formidable one. Large data sets of diverse formats will be difficult to integrate and manage within a centralized system. This may well therefore, be another deciding factor on the issue of whether such a system will be of a centralized or distributed nature.

Due to the dynamic nature of the ocean medium and the marine living resources in which we are interested, marine information is more dynamic than information on the land. The higher temporal variations mean even larger data sets due to the greater need for time referencing. As such an information system for the marine environment should reflect this. With high temporal variations there is also the problem of obsolescence of data and with this the need for appropriate indexing and management of the data within the information system.

Yet another difference encountered in the marine environment is the inability to have physical boundaries to activities. While areas can be delimited on the surface or seabed, these have little or no effect on the activities within the water column. As indicated in earlier chapters, there is therefore a greater interaction between resources and activities, one user's actions therefore having an even greater effect on others and on the environment. The dynamics associated with the living marine resources also necessitates data sets which attempt to represent this through some model. When regarded in this light, the collaboration required for an MIMS is even more critical to it fulfilling its design objectives.

5.4 Funding Considerations

Since the task of establishing an MIMS is an infrastructural one, and based on the institutional issues identified in Section 5.1, there is likely to be a lower involvement of the private sector in establishment of such a system. Traditionally people have viewed the provision of infrastructure, outside of that required solely for private investment, as being the role of the government. While this implies that there is a need for aggressive marketing of the potential for businesses of an MIMS, it also suggests

that the idea may have to be initially sold to the public sector. Unlike the private sector however, the individuals and departments who are more closely involved in the marine environment are generally not the ones capable of making decisions, financial or otherwise, on as large a scale as an MIMS will require if it is to achieve its objectives. This is not very unlike the situation on the land where in this case the land records are held by some public department and any decision to develop an information system and the format of this therefore rests with the government. There will therefore exist the problems of mobilizing the right people as the decisions will likely more reflect political interests rather than purely environmental ones.

5.5 Pricing Policies

One of the main issues in developing an information management system is the pricing of the services provided. This issue is even more important in the context of anticipated cost recovery given the views discussed in Section 5.1. A number of reasons may be argued for or against the pricing of data or information offered through a system such as an MIMS [Australian Land Information Committee, 1990; FORUM Consulting Group, 1990].

One of the main arguments against the pricing of data is that the tax paying public has already paid for the acquisition of that data and will therefore be required to pay twice for this data. While this may be true, it may also be argued that the public is due some return on this investment where the service is not one constituting a basic necessity. The service offered by an MIMS is of greater value to a specific user group and as such, the entire public should not be asked to pay the cost of establishment, operation and maintenance without an attempt to recover some of these costs. The

information available through an MIMS has a value in addition to the actual costs associated with obtaining that information. When accessed, this information offers the potential for decision making and planning which in itself also has some value placed on it. Users of this information should therefore be required to pay some percentage of its value. Attaching a fee to the use of data or information also ensures that the quality of the data will be reasonably maintained since it is being done to satisfy a market. This market will in turn be more likely to have more confidence in the quality of the data it receives.

A number of options may be identified for recovery of costs [FORUM Consulting Group, 1990]. Four of these and their relative merits are discussed below:

1) Full cost recovery - Under this option, the user pays the full cost of supplying the data or information. This includes the cost of gathering and assembling the data as well as the cost of building the system, operating and maintenance costs, and the incremental costs incurred in providing the service to the general public. This option will generally lead to a high prices for the data thereby making it inaccessible to some potential users. It is also felt that it is unfair to charge non-government users for the full cost of data that was initially gathered for governmental uses.

2) Partial cost recovery - This involves some assessment of the full cost of the data and an attempt to recover some percentage of this. Thus in this case unlike with the full cost recovery option, there is some government subsidy, some costs therefore being absorbed by the government and the general tax paying public. The percentage to be recovered is generally arbitrarily decided and will usually be based on political rather than economic decisions.

3) Incremental cost recovery - Here only the cost of providing the information service to the general public is recovered, no attempt being made to recover actual data acquisition, system operation or maintenance costs. This represents the minimum cost recovery from the investment and is generally only justifiable where the service is not one of public interest but where an individual may from time to time request such a service.

4) Recovery based on market value - In this option the price is based on the demand and competition with private sector. While this is a useful means of pricing data and ensuring efficient operation, in many cases the government represents the sole source of this data or information. Where this the case, there is therefore no real 'market price' which makes this option an impractical one.

Based on a comparison of the above options, partial cost recovery is the most feasible model for cost recovery in an MIMS. The users of the system will therefore be required to pay some share of the total capital, operating and incremental costs of the data and information. This model is also seen as the most practical one for a privately developed prototype MIMS such as the Passamaquoddy ICOIN (see Chapter 6). This is based on the fact that since funding has been achieved for the undertaking, the full cost model is unfair, as well as on the fact that there are no market forces yet in place on which to base the more attractive market value model. The share charged to customers should fall somewhere between the direct cost of the data and the incremental costs of supplying the information to the customer.

Further considerations in the pricing of information services are based on the value of digital data over that of analog data. While many agencies already charge for

information services, this has generally been based on distribution in an analog format. The question therefore is whether users should be required to pay more for digital data and on-line access.

Of these two considerations, the issue of cost based on on-line access is less difficult to deal with. Though the user may argue that they already have to bear the cost of on-line facilities and charges, it should be noted that the provision of on-line access also represents an additional cost to the system's capital and operational costs. As such these costs should be recovered in the cost of the data.

The issue of differential pricing of data in digital or analog formats may be decided by considering what the user gets when each of these formats is obtained. Analog data represents a 'snapshot' of the system's database. This may be in the form of a map or some printout of the data. The user therefore gets only a view of the database which may be used to provide some further information. In this format no manipulation of the data is possible and the range of uses for this data is restricted by the initial query which produced the data. In the case of digital data however, what the user obtains is a subset of the database. This enables full manipulation of the data to the extent of the user's capabilities while usage is restricted only by the nature and extent of the subset obtained. Digital data is therefore more valuable to a user based on its inherent flexibility. As such its price may reflect this higher value.

5.6 Summary

This chapter has identified some of the issues which though not central to the actual establishment and operation of an MIMS, must be understood and addressed if it is to achieve its objectives. These issues affect the way in which information derived

from the MIMS may be put to use based on the views held on the marine environment, and the data which describes it. These issues serve to strengthen the argument that the actual system for information management system can not be isolated from the need for established policies on resource management, see Section 7.1.

CHAPTER SIX

AN EVALUATION OF A PROPOSED SMALL SCALE MIMS

To date a number of marine information management projects have been proposed in various parts of the world. These have mainly been concerned with specific tasks such as aquaculture and coral reef management, or else have been targeted towards integration of databases over relatively small geographic areas. The scale on which these have been proposed may be an indication that this is possibly the most practical way to achieve comprehensive integration of marine related data sets, through organization based on various jurisdictions and specific tasks, which can subsequently be integrated over the broader marine environment.

Though there are a few information management systems currently in place, these have been more geared towards the coastal zone than towards the wider marine environment. The format of any proposed MIMS may however may well be modeled after one of these more localized systems which are already in place. The inherently simpler organizational structure will provide for an easier transition to the goal of management over larger geographic areas involving a greater diversity of users. In addition to this, design cues can be obtained from observing systems which have already been implemented. As is the situation with land information management systems therefore, much can be learnt from an examination of these proposed systems. One such system is the Passamaquoddy Inland Waters Coastal and Ocean Information Network (ICOIN), proposed by ICOIN Industries Inc., which will be

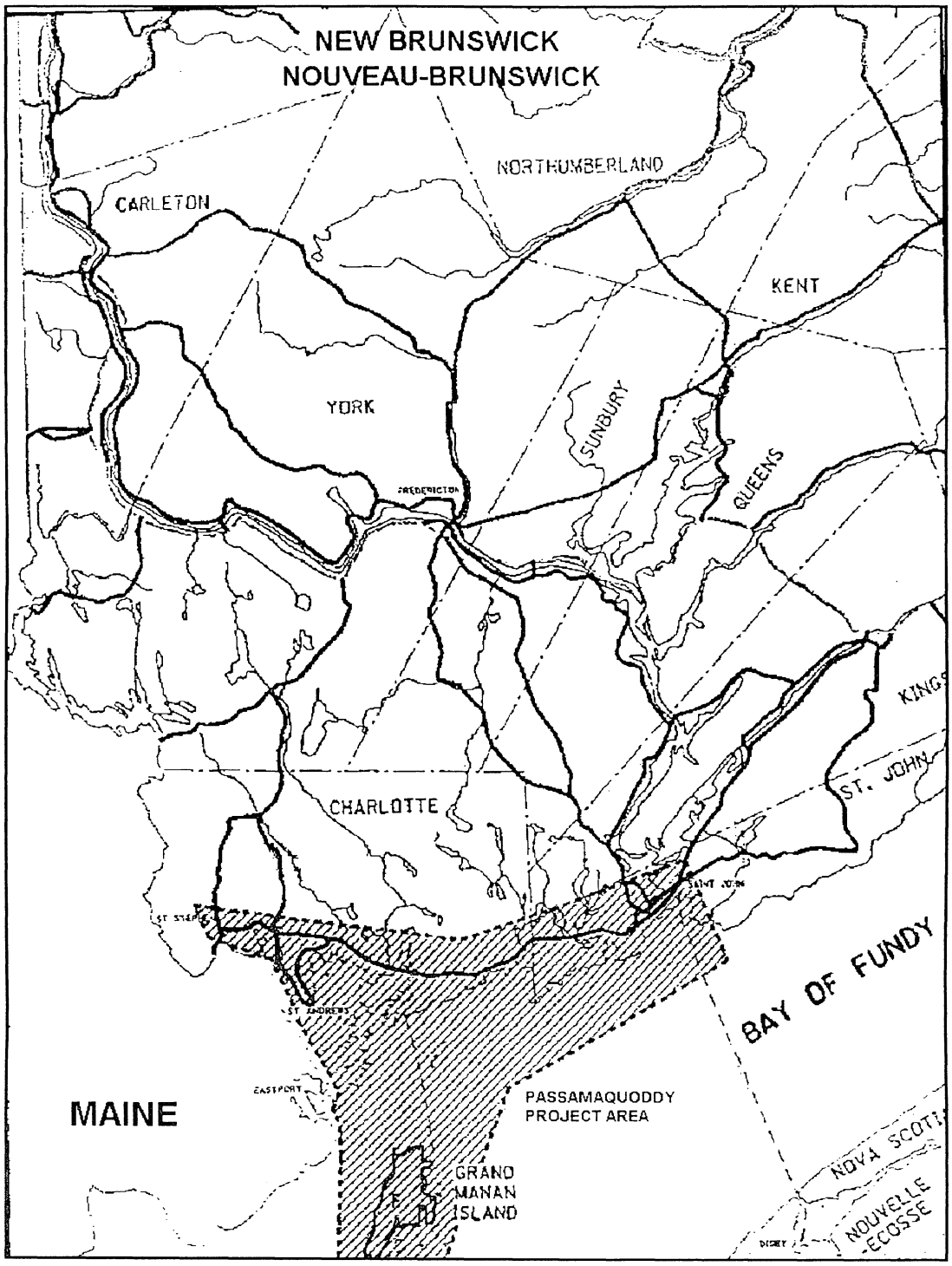

Figure 6.1 Proposed Passamaquoddy Project area

discussed in terms of its objectives and organizational structure with a view for identifying strategies which may be applied in an MIMS.

This chapter examines the concept and design of this proposed system through a summary of the proposal reports submitted by ICOIN Industries Inc. [ICOIN Industries Inc. 1992a; ICOIN Industries Inc. 1992b]. A discussion of some of the issues seen here as they relate to information management, is given at the end of the chapter.

6.1 Project Identification

The proposed project is being designed for the Passamaquoddy Bay/St. Croix area in New Brunswick, Canada, (see Figure 6.1). The proposed area of management is approximately 1600 hectares and serves as the drainage basin for the Magaguadavic, Digdequash and St. Croix Rivers and their watersheds. The St. Croix River serves as the border between the United States in Maine, and Canada in New Brunswick in the bay area and as such, this is an area of importance in terms of resource and environmental management on the provincial/state level as well on both a national and international level.

The Passamaquoddy area has been chosen due to its diversity of marine activities and the foreseen risks to the habitat due to pollution. The rich biota of the bay has resulted in a wealth of research data for the Bay from efforts of the Huntsman Marine Science Centre and the St. Andrew's Biological Centre, as well as other institutions.

Fishing and aquaculture are among the major industries of the towns around the Passamaquoddy Bay, while marine related tourism in the area accounts for some 40% of the Bay of Fundy's tourism revenue [Parks Canada and New Brunswick Department

of Tourism, Recreation and Heritage, 1985; ICOIN Industries Inc., 1992b]. These activities coexist with fairly heavy shipping traffic in and out of the Port of Saint John , with the risk of contamination from spilled petroleum and other industrial by-products.

Other potential sources of pollution include pulp mill effluent, other industrial and residential effluent, aquacultural waste, as well as pollution sources that occur over the entire watershed. The risks from these sources are amplified by the tides in the Bay of Fundy, whose circulation pattern may result in the trapping of these effluents within the Bay.

6.2 Project Objectives

The objectives of the Passamaquoddy project are based on the concept of an ICOIN as defined by ICOIN Industries Inc., that is, " ...to produce a mechanism for assisting managers and decision makers in information assembly, review, and analysis." [ICOIN Industries Inc., 1992b]. This is proposed through grouping of marine related geographically referenced databases. These databases are then queried through user defined applications developed with knowledge-based technology.

The project is to be implemented over a three year period (1992 to 1995) and will include the development of an ICOIN Information Management System (ICOIN-IMS) for which the Passamaquoddy Bay will serve as the initial node. This is further broken down into the following two phases:

Phase I	System Design
	Marketing
	Demonstration of the IMS technology

Phase II Acquisition of Hardware and Software

Data Structuring

Development of IMS Applications

Personnel Training and System Marketing

Phase I of the project, presently in progress, seeks to identify participants and data sets existing for the Passamaquoddy Bay area, promotion of the ICOIN concept and data acquisition. The deliverables from this phase include:

- System Design Report - this will outline what technology has been identified for use in the IMS, its capabilities and the organizational framework.
- Marketing Report - to identify the nature, size and growth potential of markets for the technology beyond the Passamaquoddy Bay area. This report will outline strategies for developing an infrastructure for marketing and promotion through contacts made with prospective clients. The competitive environment will also be assessed by looking at other systems and their functionality in terms of satisfying market requirements.
- Technology Demonstration - based on the assessment of the user requirements, existing configurations and identified technology, a visual/graphical overview of the potentials of the project will be developed. This demonstration will be a 'working model' of the final package and will therefore utilize 'shell' versions of the final application software running on a smaller platform.

6.3 Project Participants

The participants of the project may be categorized under two headings, the project team or developers and the potential user groups.

6.3.1 Project Team

This group is responsible for the planning and coordination of the project, administration of funds, system and application development, training and marketing. This team comprises a number of firms responsible for the various administrative components of the project and include the following:

Organization	Responsibility
ICOIN Industries Inc.	Development and commercialization of the ICOIN concept. Identification and outlining of project objectives.
ADI Limited	Project management and execution.
Washburn & Gillis Associates	Environmental planning and consulting, systems and applications development.
Geodat Information Services Limited	Geomatics, database and systems development.
Strategic Ventures Corporation	Marketing.
Ocean Systems Training	Training.

6.3.2 Potential User Groups

This group represents the users of the marine environment as well as research organizations that have volunteered expertise or agreed to allow access to their data sets for the Passamaquoddy area. The group to date includes the following agencies:

- New Brunswick Department of the Environment
- New Brunswick Department of Fisheries and Aquaculture
- New Brunswick Department of Economic Development & Tourism
- New Brunswick Department of Natural Resources and Energy
- New Brunswick Department of Advanced Education
- Transport Canada (Coast Guard)
- Environment Canada
- Canadian Parks Services
- Fisheries and Oceans Canada (CHS and MEDS)
- Huntsman Marine Science Centre
- University of New Brunswick and other Atlantic Canada Universities

Figure 6.2 illustrates the relationship between these developers and users within the proposed ICOIN-IMS.

6.4 Design Concepts

The organizational structure of the databases for the proposed ICOIN-IMS follows that of a star topology information system, within a nodal framework. The

individual databases are intended to be produced and data maintained by the respective participants, while the ICOIN-IMS itself integrates these databases into one centralized database for resource management. This arrangement represents a single node which covers a particular geographic area (e.g., the Passamaquoddy Bay). A number of similar nodes developed over different areas may be further integrated to facilitate marine resource management over a broader area and range of interests. See Figure 6.3.

Figure 6.4 illustrates the design structure of a single ICOIN-IMS node. This design is to be based on knowledge of environmental issues and user requirements. This knowledge will be gained through discussions between the database owners and application developers. The final product will be an expert system designed around the perceived needs of the users.

6.5 Technological Structure

The ICOIN-IMS takes a technological approach to the issue of resource management and the latest in database technology is being proposed to address the information requirements. The system will consist of three main components, the computer hardware, software and structured databases.

The proposed computer hardware for the IMS will be on the PC-based platform using present industry standards for networking, communication, input and output devices. This allows individual data set owners to be flexible in their choice of hardware while still ensuring flexibility for growth and international markets.

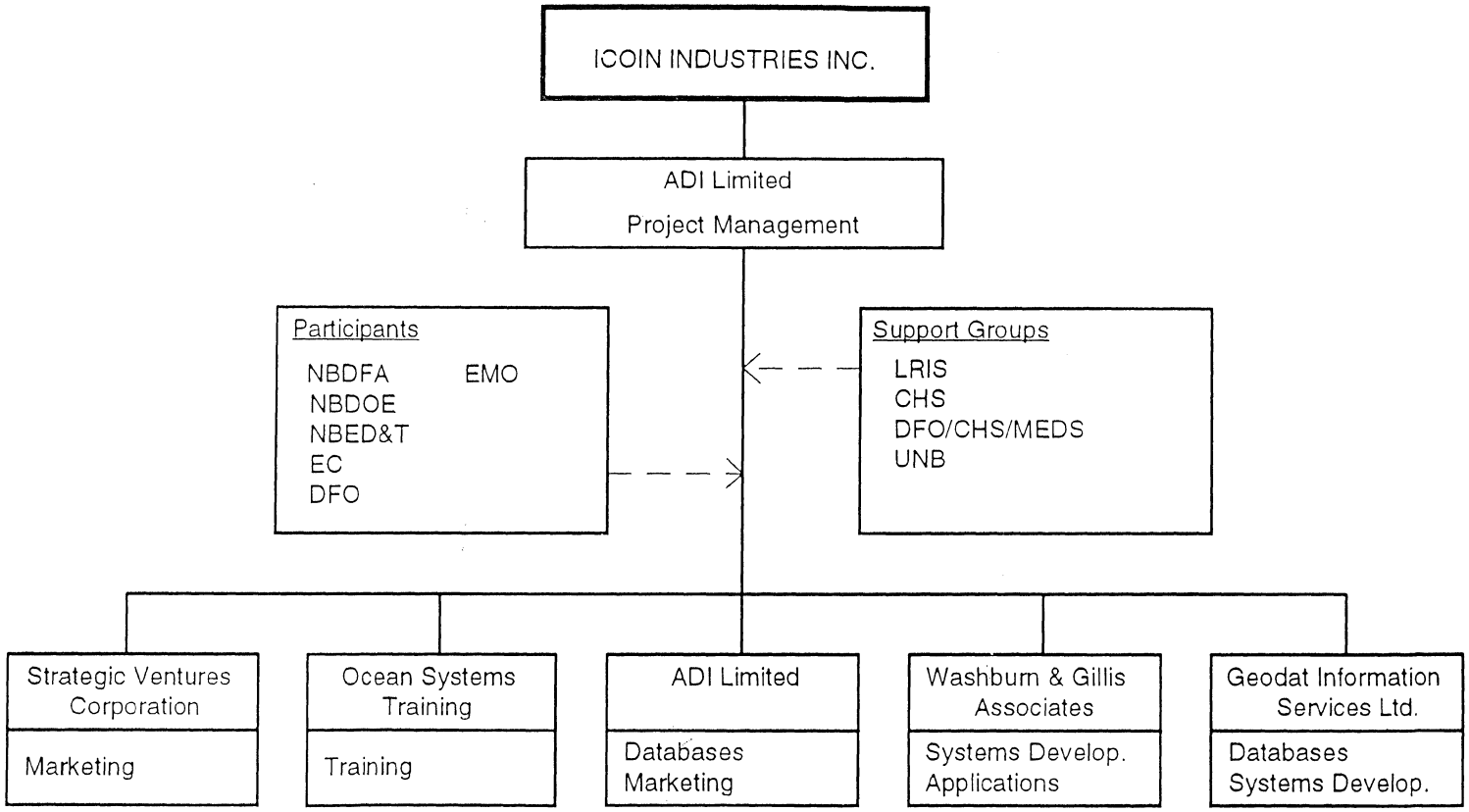

Figure 6.2 Relationship between developers/users of the proposed ICOIN-IMS

(from ICOIN Industries Inc. [1992b, p. 24])

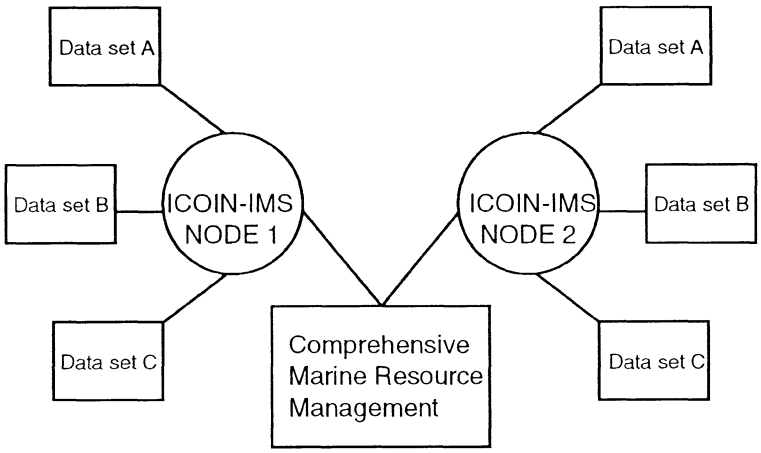

Figure 6.3 ICOIN-IMS design concept

Software for the IMS will be based on the existing data sets, their formats and structure. Queries will be handled through applications developed using Knowledge Based Systems (KBS). These applications are intended to be designed for specific ICOIN applications and will therefore be problem or theme specific as defined by the user. Geographic Information System (GIS) software will be utilized in managing the geographically referenced databases. In addition to the IMS, the system will employ software for report generation. This will involve the use of popular software packages for word processing and presentation software.

6.6 Financial Structure

ICOIN Industries has for this project identified Federal and Provincial funding bodies to support the development of the ICOIN-IMS. This is only intended however, for

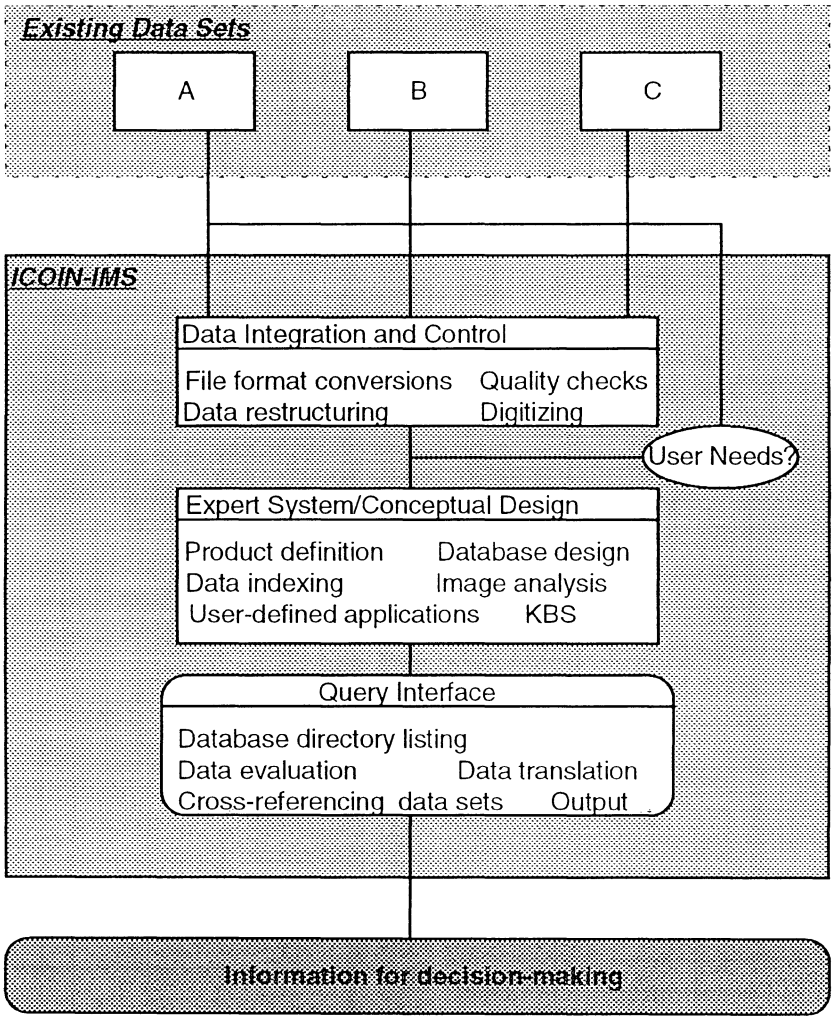

Figure 6.4 Design structure of the ICOIN-IMS node

the Passamaquoddy prototype. The ICOIN-IMS is a business venture to be sold to prospective clients as identified by the market study. It is therefore intended that future projects will be sold as a service to these clients whose subscription fee will pay for the development and maintenance of the system.

6.7 Discussion

In many ways, the Passamaquoddy project represents the ideal goal in marine information management, that is, to have knowledge based software operating on a GIS platform of fully integrated compatible databases. While this is indeed a goal for which to strive, there are many issues to be faced in achieving this goal.

The ICOIN-IMS solution is a technological one in that it merely facilitates resource management. As was discussed in Section 4.1.2, this only achieves the wider goal of comprehensive resource management if users of the technology are familiar with the issues surrounding their activities and those of others in the environment. While dialogue with users is proposed in designing the system, this is intended on an individual user/application developer level. The expert system is an attempt to model environmental issues, and as with any other model, this can only be as good as the data or information around which it has been designed. The design will therefore reflect environmental issues and requirements as seen by individual users, which depending on their level of awareness, may or may not address issues critical to other users. Moreover, the nature of expert systems and human reaction to them gives rise to two further concerns.

Firstly, due to the greater transparency of data manipulation afforded to the user by an expert system, the identification of any shortcomings in its design is made more

difficult. A user may therefore assume that all relevant data sets have been queried in the desired manner to yield the results displayed. Secondly, more reliance may be placed on information queried through such a system than would be placed on information gathered manually. The above are not shortcomings of expert systems, but rather the potential effect of an inadequately designed one when combined with the human fallibility. These can easily translate to misguided decision making.

Being a business venture, what is being sold by ICOIN Industries Inc. is a *system* rather than *policies.* As with any system, certain conditions must be met or are assumed to be present before it may be implemented.

One prerequisite for a successful ICOIN-IMS is the willingness of participants to allow outside access to their data sets. The refusal of one potential client to provide on-line access to data for an area may remove the attractiveness of the system to other users and restrict its viability in that area. Although this did not present a major problem for the Passamaquoddy project, it may be a factor in areas of more competing interests, or among jurisdictions where the concepts and advantages of information exchange have not been fully realized.

Being a *system* the affordability or lack thereof of the proposed technology and infrastructure can make it difficult to implement an ICOIN-IMS in areas such as developing countries, if no external funding can be identified. There is therefore a danger in marketing a system upon too intimate a link between the management and the technology. If it is perceived that they are interdependent, then the concept of management may be lost where the technological costs are prohibitive. Promotion of *policies* can, however, still allow for some form of improved information management in areas where the *system* technology can not be afforded.

The technical nature of this proposal also does not address the issues such as data standardization amongst users, data liabilities, costing and pricing considerations. These issues are potentially more difficult to deal with than the technical issues and in most cases these issues would not have been addressed since this may represent the first effort of this nature. Although these issues are not necessarily more important than the technical issues, it is important that they should be dealt with before the system is implemented, if it is to achieve its objectives.

The above are not arguments against the ICOIN-IMS concept but rather are additional points to be considered in achieving a comprehensive information and resource management tool. The ICOIN-IMS, as with any form of technology, should arise out of dialogue addressing the issues.

One argument for the ICOIN-IMS approach is that it does achieve some degree of management based on a product which can be readily modified. In doing so, it achieves the goal of information management in an ad-hoc site, specific manner. This may well be the most practical means of developing a resource management tool, that is, where users dictate management needs over smaller jurisdictions based on specific management goals [Baker 1992b]. This being the case, the points raised in the previous paragraphs should be borne in mind with a view for fostering dialogue among potential users even after the system has been implemented. This will at least ensure that modifications will reflect a trend towards further integrating the needs of the entire client base rather than merely satisfying their individual needs.

CHAPTER SEVEN

GUIDELINES FOR THE IMPLEMENTATION OF AN MIMS

As with any proposed system for managing information, the methods used and phases identified for implementation of an MIMS will vary from place to place. These will depend for example on the information needs and existing framework of the area together with established policies for information and marine resource management as well as available personnel, technological and financial resources.

While guidelines for implementation may vary, the fact that they should be considered is the one common aspect of any attempt to establish an information framework. This chapter identifies some of these issues with the aim of providing some general guidelines for implementation of an MIMS.

7.1 Institutional Guidelines

As indicated in Chapter Three, an MIMS is merely a strategy for the wider objective of marine resource management and will therefore only facilitate it. Resource management objectives must be clearly defined with policies established which the MIMS is then implemented to achieve. Without these policies, the MIMS can be reduced to an expensive toy. The lack of clear policies for development and management of marine resources places pressure on planners who struggle to interpret legislation. This makes it difficult for planners to achieve consistency in decisions on environmental use, which in turn can frustrate developers and create a

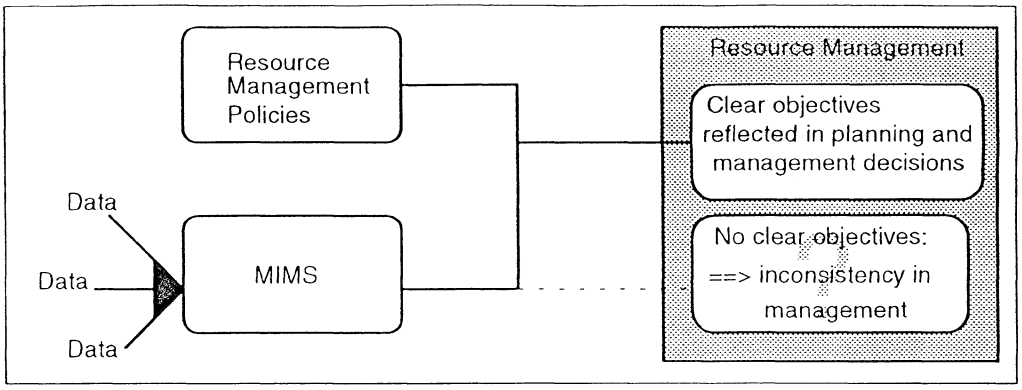

Figure 7.1 Role of policies in resource management

barrier to development and resource management. Additional pressures are placed on planners who, in the light of unclear policies, are forced to make decisions between conservation and financial investment from potential developers. These issues are not addressed by an MIMS which can only provide the information to make these decisions. What decisions are made depends on the resource management policies of the area under concern.

One of the shortcomings of many strategies for implementing a system is the lack of developers to assess what framework already exists and how any proposed system may be designed around it. It should be stressed here that in order to be successful, any proposed system must be designed around the users' needs as opposed to the users tailoring their needs to the system. Some research is therefore necessary and must precede formulation of policies and recommendations.

7.1.1 Assessment of Existing Management Techniques and User Needs

One of the first stages in the implementation of an information system is the identification of user groups and their needs. This may be accomplished through a

questionnaire on user needs, or by reviewing the results of similiar surveys. Although this will not provide information for designing the system it will give some indication of what issues the system should address. It can also be used to indicate what information already exists and the manner in which this has traditionally been managed.

In addition to assessing user needs, it is also useful to investigate what previous attempts have been made to establish similiar information systems, how these were executed and what measure of success was achieved. In too many cases what occurs is an attempt to implement a number of projects simultaneously Although these may have had slightly differing objectives, they cause some measure of confusion in the minds of participants. Also if any of these projects have been implemented, it is useful to examine these with an eye for identifying where any gaps may still exist.

7.1.2 Examination of Existing Policies for Land Information Management Systems

As was discussed in Chapter One and Five, our oceans' resources have generally been appreciated later than those on land. As a consequence, there generally is more experience in managing land based information. Many of the issues with regards to information management can therefore be identified, understood and resolved by examining land based information systems. Although as identified in Chapter Five, many issues are different between the two systems, there are a great many similarities such as administration and approaches to implementation.

7.1.3 Administrative Organization

Whether the system is to be centralized or decentralized, some department or group of individuals must be responsible for the administration of the proposed system. Options available in the identification of such a group are as follows:

(i) Identification of an existing department or agency seen as capable of handling the administrative aspects of the system.

(ii) Establishment of some special agency mandated to oversee these aspects.

(iii) Identification of individuals from prospective participating agencies to jointly oversee the administration.

These options each have their advantages and disadvantages. Though the second option may appear to be the most attractive, there is some degree of bureaucracy to be overcome in the formation of such a body. If a suitable department can be identified, then the first option seems advantageous since it makes use of available expertise and resources. This option is not likely however to be very favourable among other related departments who have competing interests, and who may therefore not wish to commit themselves or their data to the proposed system. In addition to this, there is the problem of allocation of additional staff and resources to handle the additional responsibilities. From an administrative point of view, the committee approach of the third option does not lend itself to a very efficient organizational structure for a system requiring daily services. This arrangement is more suited to the initial planning and assessment of the design criteria for the system but not for its long term administration.

A hybrid of the second and third options is seen as the most practical approach for administration of the proposed system. Initially, committees comprising of individuals from participating agencies may be identified for the assessment of potential users and their information needs, and the requirements of the system. Once these have been identified, the actual design and administration of the system should be taken over by some specially appointed group.

7.1.4 Achieving User and Political Cooperation

In order to be successful, there must be reasonable support at both the user and political levels. In achieving this cooperation however, one may either use political leverage to implement the proposed system or the efforts of the users may be used to the gain political support. This may be seen as a top-down as opposed to a bottom-up approach.

The Gulf of Maine Action Plan is an example of where the top-down approach was adopted [Kearney, 1992]. Here politicians from both the United States and Canada at both the local and federal levels agreed to the concept of the proposed system for marine information management. From this, a number of committees and working groups were identified to carry out the planning and design of the system based on user needs.

This example, based on the nature of the area it attempts to manage, may be more suited to a top-down approach. The Gulf of Maine has been a sensitive area of economic interest to both Canada and the United States and as such has very strong political interests. Where there are no such international issues at stake, or where the region is of a smaller areal extent, there may not be the initial political pressure to agree to management policies.

The danger in using a top-down approach lies in the fact that since this arises out of some sort of political approach, the motives may not be entirely based on environmental concerns. It is therefore left to the working groups and committees to establish what these concerns are and incorporate them into the proposed system. This in turn may be hindered to some extent by the apprehension of users if they see the system as being purely a political project. The advantage of this approach is seen in the fact that some degree of cooperation is achieved among users even if there is some disagreement with the concepts of information exchange. As such the implementation stage of the system can be more quickly reached.

In the bottom-up approach, the system is sold to the potential users who, based on extent of support and environmental concerns, can place pressure on the respective politicians to support the project. This approach will tend to take longer than the top-down approach since winning of political support presupposes user agreement in principle. Users will however likely place more confidence in a system designed in this manner. In gaining political support for the system, participants should be wary of paperwork done solely to please politicians at the expense the system's functionality.

7.2 Implementation Guidelines

In speaking about the need for coastal zone management, Chasis [1979] stated that this must be directed towards the accomplishment of specific goals and objectives if it is to be successful. This thinking suggests that a system encompassing the broader marine community is possibly too optimistic a goal for which to strive. This view is also echoed by Baker [1992b] who stated that such an approach may be impractical, and that marine resource management may have to be facilitated through information

systems designed in an ad hoc, user specific manner which may then be broadened over the wider marine environment by subsequent integration.

This approach however sounds not unlike the manner in which marine resources have been traditionally managed. The danger here lies in the many different and incompatible systems which could be proposed and implemented by different agencies, or even within a single agency for different purposes. Over as diverse a group as is present in the marine environment, it is however unlikely that users will :

(i) All share the same enthusiasm towards integration.

(ii) Have the same priorities with respect to financial commitment required for the system.

Under such circumstances, an umbrella system approach will be met with some measure of opposition and it is not likely to be successful. This approach is also not necessary in my opinion. As was discussed in Chapters Three and Four, the uniformity in systems types used by departments is not as critical as ensuring that these systems are for example using the same base data and standards of data exchange.

The difference between the traditional management and the MIMS approach therefore, will have to be through some coordinating body which will ensure some degree of standardization between the various efforts thereby enabling phased integration while also ensuring compatibility.

7.2.1 MIMS Design Components

From the last section, it can be seen that an MIMS encompasses more than the actual system for handling the user data. The components of the MIMS are illustrated in Figure 7.2.

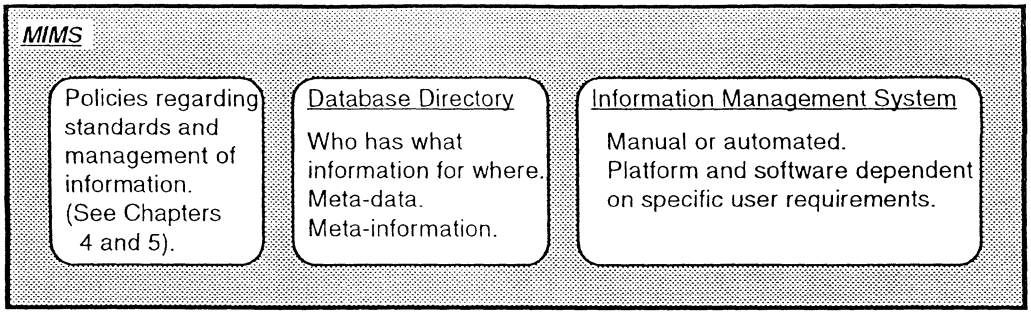

Figure 7.2 MIMS design components

In a proposed system, the coordinating body will be responsible for establishment of the policies and compilation of the database directory. These two components are independent of the management system to be implemented, and should form the base upon which this is developed and expanded over the community of users.

7.2.1.1 Database directory

Most attempts at producing marine database directories are geared at producing some listed index of current data holdings with their descriptions. While it may be relatively easy to produce a directory listing of marine related data sets, it is not believed that this provides the best format for increasing user awareness on what data is available and how they may be able to use it. This approach relies on the users' awareness of how these various data sets are correlated. While this may usually be the case, more information about the data and the inclusion of correlations between data sets will result in a more comprehensive directory.

This approach necessitates the move away from the traditional hardcopy directory products to an electronic format using database technology as has been

proposed by Baker [1992a]. This format will allow the user to browse the directory for the following information among others:

- profiles of source organizations;
- contact persons;
- descriptions of the databases;
- spatial and temporal coverage's;
- basic identification of available data sets;
- information on collection and processing methods used;
- quality assessments;
- searchable key-fields;
- linkages to entries from other data sets within the directory based on topic and area of search; and
- some global glossary on terms used to aid in interpretation of data attributes.

One such approach to date has been by the Gulf of Maine Council on the Environment [Gulf of Maine Council on the Marine Environment, 1992; Schmidt, 1992a]. This marine resource management initiative between the United States and Canada, still in its development stage, has for one of its objectives designed a directory of data sets identified in a user needs survey conducted for the area. This directory, developed using the dBase software package, allows the user to search the directory by specifying keywords or location/coverage parameters. While information related to individual data sets is updated by database administrators, the directory is managed and updated by the Gulf of Maine Data and Information Management Committee. Security is offered through the use of password protected data set files. Updating of information held within can therefore be restricted to authorized individuals.

Although the above approach does not incorporate all the information as listed at the beginning of this section, it does represent an increase in functionality over the traditional directory listings of marine related data sets found in other similar projects.

7.2.1.2 Information management system

Once policies with respect to the management of the resources and information have been established, and the directory of data sets developed, the system for actual management of the information can be designed. It is believed that this aspect of the MIMS should be left open to the designers based on factors such as the areal extent to be managed, available resources and perceived user needs. It is in my opinion that an MIMS should not be associated with one specific form of information management so as not to exclude its feasibility for any particular jurisdiction.

Whether the proposed system is manual or not, some reordering of the filing structure may be necessary. Traditionally filing systems have been developed on the basis of specific project or site information. Where this is generally adequate for managing these projects or areas, management over a broader perspective requires a different approach. It should be stressed here as in earlier sections, that this is also important where the proposed system requires the automation of some manual system (see Section 4.1.2).

In a manual system, information can be stored and retrieved using ordered catalog cards which describe the data and provide pointers to other cards pertinent to the specific query. The format of an automated system can be anywhere along a continuum from the use of the above mentioned catalog system in computerized form to the use of an expert system as proposed for the ICOIN-IMS (see Chapter 6). Whichever system is proposed, the design should be flexible enough to ensure

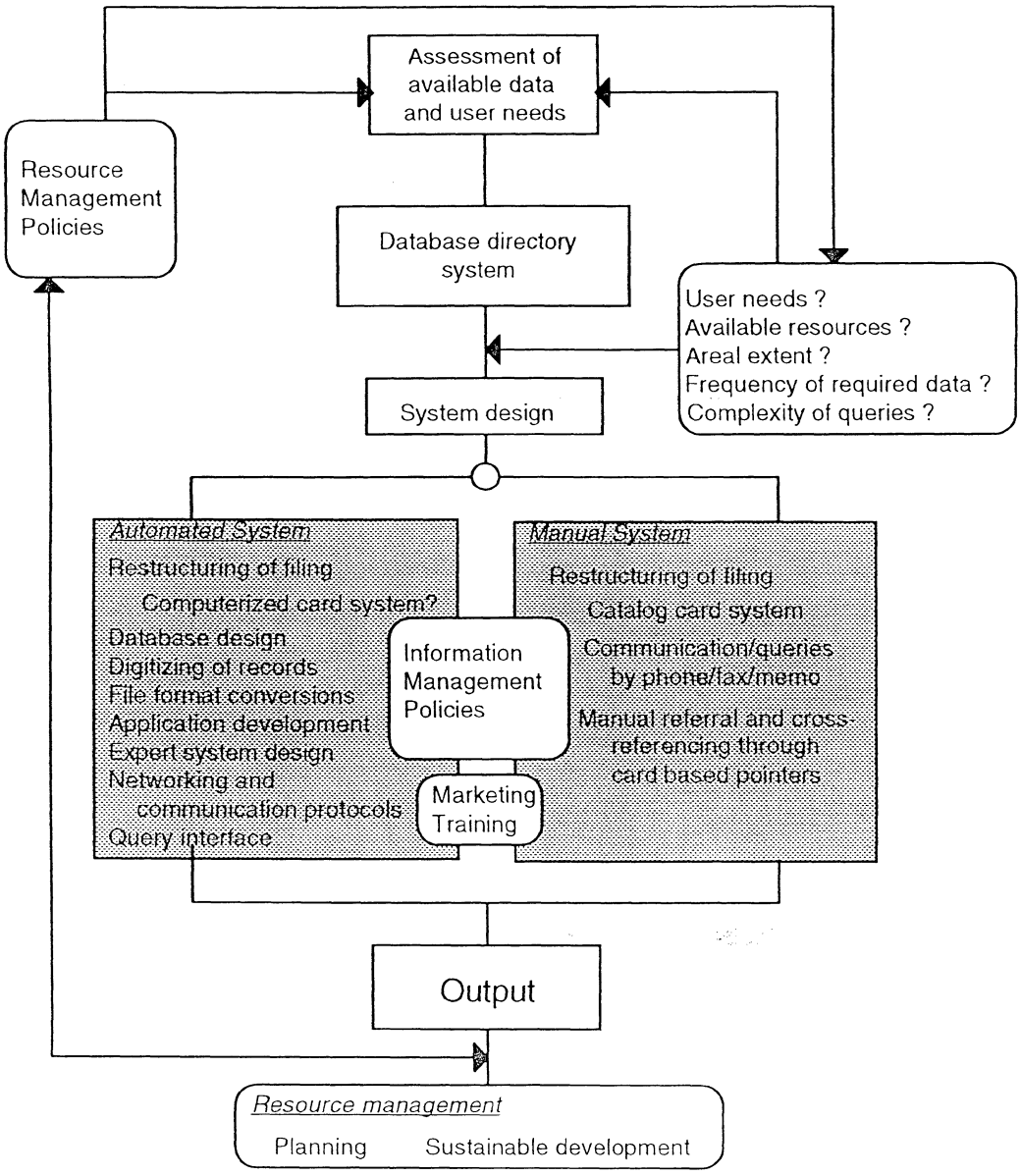

Figure 7.3 Processes involved in implementing an MIMS

functionality over the range of uses and anticipated changes in user requirements. Figure 7.3 illustrates the processes involved in implementing an MIMS.

7.3 Some Additional Issues for Implementation in Developing Countries

As the information needs of marine communities vary from place to place, so do the problems likely to be encountered in addressing these needs. In the case of developing countries, a number of issues relating to the management of information may be identified. These all have the potential to affect the manner in which any plans for a proposed MIMS may be implemented and an awareness of them is therefore important.

Traditionally, the role of the developing country has been one of data collection rather than information processing. In many cases, information needs have been and are being satisfied by contracts given to foreign consultants who may even collect the data themselves. One consequence of this is that these countries have not had a history of using locally generated information and may tend to place more trust in foreign expertise and information processed abroad than in a locally established system [Duncan, 1991]. Another consequence is that there will likely be a shortage of suitably trained personnel. Where there is the expertise and local processing, those associated with the information may tend to view this capability as bestowing to them some degree of power. The broadening of this base for information possible through an MIMS can be seen as a threat to this power and such individuals may therefore be less enthusiastic about sharing data or participating in the MIMS.

In many cases developing countries are not involved in front-end research on environmental issues. In addition to this, there is generally a weaker information base on which to assess these issues. The overall awareness of environmental impacts and the need for management may therefore not be fully appreciated in all cases. Under such circumstances, it is unlikely that there will be any clear policies for marine resource management.

The lack of economic resources is a problem facing many developing countries. As indicated earlier in this chapter, the actual system for information management within the MIMS should reflect available resources among other things. Moreover, since the information management system represents only a part of the MIMS (see Section 7.2.1 and Figure 7.2), there is a danger of losing the opportunity for establishing the MIMS if its marketing associates it with one particular system which may not be economically feasible for the region. (See also discussion on the ICOIN-IMS in Section 6.7).

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

Though the arguments in favour of an MIMS seem to warrant its existence, one question which may be asked is whether it will really be effectively used given a functional system. This point is a pertinent one given the fact that users of marine information in most cases already are aware of where the data exists and know how to obtain it [Baker, 1992b; Roberts, 1992]. A counter argument to this is that this awareness is based on prior experience of conflicts within the marine environment. An MIMS as proposed in this report can serve to broaden the range of marine activities over which such conflicts can be identified. This will however only be possible if all the components of the system have been considered in the implementation. The above point can therefore be reduced to an argument in favour of promoting the complete MIMS concept rather than simply establishing the information system component.

In addition to this, the MIMS offers an easier, more structured way of obtaining this information and enables a greater degree of standardization in the process. The advantages of this will continue to become increasingly important as further demands are placed on the marine environment, and the need for sustainable development becomes more critical.

This report has identified the need for information management as a means to achieving resource management in the marine environment, while also addressing how

this may be achieved and the issues likely to be encountered. Due to the diversity of interests found in the marine environment, it is unlikely that we could ever achieve the level of cooperation suggested for the wider international community or even on a national level. Still, even if the level of awareness of the need for information and resource management is raised, and we can achieve some agreement on data sharing for some aspects of marine activities for some areas of the marine environment, then this is believed to be a step in the right direction.

8.2 RECOMMENDATIONS

Two categories of recommendations can be made following the work done in this report. The first category deals with recommendations for implementing the MIMS and serves as a brief summary of some of the ideas presented in Chapter Seven, while the second category deals with recommendations for further research.

8.2.1 Recommendations for Implementing the MIMS

- Prior to implementation of any MIMS, policies regarding marine resource management should be established. This provides a framework for defining what the user needs are and how they can be incorporated into the MIMS.
- A special agency should be mandated to establish policies regarding information management issues as addressed in Chapter Four, and to design and oversee the administration of the proposed MIMS. The activities of this agency should be closely coordinated with the proposed users, to better ensure that user needs are being met.

- In addition to the policies identified in the above recommendations, a database directory as described in Section 7.2.1.1 should form the minimum configuration for the MIMS.
- In proposing the MIMS, it may be useful to consider targeting specific applications or geographic areas since these will be more manageable, and can serve as a framework on which to expand the area of management.
- Developers should avoid promoting the MIMS concept along the line of anyone specific form of technology as this may only serve to exclude its implementation in areas where this technology cannot be afforded.

8.2.2 Recommendations for Further Research

- More research is needed in the assessment and analysis of the user needs of marine related departments and agencies.
- Additional research is also required in the actual design and format of a system which may be implemented as a prototype of an MIMS. This will serve to identify further issues and problems and provide some insight on how these may be addressed.
- Further research is also required in the assessment of marine information needs of developing countries and how an MIMS may be designed to address these needs.

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APPENDIX I

QUESTIONNAIRE ON MARINE INFORMATION INFRASTRUCTURE

1. NAME OF RESPONDANT: _____

2. NAME OF ORGANIZATION:

_____

3. TYPE OF ORGANIZATION: Please circle one category.

FEDERAL COMMERCIAL RESEARCH EDUCATIONAL

OTHER (please specify) _____

4. MANDATING LEGISLATION (if applicable):

_____

_____

5. PLEASE INDICATE THE APPROPRIATE NUMBERS FROM THE FOLLOWING LIST (**LIST 1**) FOR THE FOLLOWING QUESTIONS.

DATA COLLECTED ON A FREQUENT BASIS	
DATA COLLECTED WITHIN THE LAST MONTH	
DATA COLLECTED WITHIN THE LAST SIX MONTHS	
ANY OTHER DATA USED BY ORGANISATION	

LIST 1 DATA CATEGORIES

HYDROGRAPHY
D1. Bathymetry
D2. Seabed topography
D3. Seabed quality
D4. Tidal data
D5 Current measurements
D6. Shorelining
D7. Mean water level

FISHERIES SCIENCE
D8. Stock assessment
D9. Catch analysis
D10. Population dynamics
D11. Ecosystem monitoring

OCEANOGRAPHY
D12. Pollution levels
D13. Water quality assessment
D14. Salinity/temperature profiling
D15. Water circulation
D16. Sea surface topography
D17. Chemical composition
D18. Sedimentology

MARINE METEOROLOGY
D19. Waves and swell
D20. Air temperature and circulation
D21. Atmospheric pressure
D22. Precipitation

MARINE TRANSPORTATION
D23. Route management
D24. Vessel movement
D25. Navigation aids

D30. MINERAL EXPLORATION

6. PLEASE INDICATE THE CATEGORIES CONSIDERED MOST IMPORTANT TO THE OPERATIONS OF YOUR DEPARTMENT.

FIRST		SECOND		THIRD	

7. HOW IS DATA PRESENTLY OBTAINED? Please indicate for each of the data categories identified in the last question.

MANNER IN WHICH DATA OBTAINED	FIRST	SECOND	THIRD
Collected by own department			
Bought from private organization Please specify			
Bought from government department Please specify			
By contract to other organization Please specify			

8. WHAT IS THE ESTIMATED ANNUAL COST OF THIS COLLECTED DATA?

Free/no cost	Less than $5,000	$5,000 - $10,000
$10,000 - $20,000	$20,000 - $50,000	$50,000 - $100,000
$100,000 - $250,000	More than $250,000	

9. WHAT INFORMATION IS PROCESSED FROM THE DATA COLLECTED? Please indicate the appropriate numbers from **LIST 2** below.

[ ] [ ] [ ] [ ]

Please specify any other_____

LIST 2 PROCESSED INFORMATION

I1. Coastal erosion
I2. Water level variations
I3. Navigational charts
I4. Updating and publishing of positions of Navigation aids
I5. Seabed profiling
I6. Aquaculture planning
I6. Harbour and engineering works planning
I7. Stock assessment
I8. Stock migratory patterns
I9. Water pollutant levels
I10. Water quality
I11. Ecosystem tolerances to marine activities
I14. Shiplane planning and charting

10. WHAT IS THE ESTIMATED ANNUAL COST OF PROCESSING THIS INFORMATION?

Free/no cost	Less than $5,000	$5,000 - $10,000
$10,000 - $20,000	$20,000 - $50,000	$50,000 - $100,000
$100,000 - $250,000	More than $250,000	

11. WHAT OTHER DEPARTMENTS/ORGANIZATIONS ARE CONSIDERED MOST IMPORTANT IN THE DATA COLLECTION/INFORMATION PROCESSING ROLES OF YOUR ORGANIZATION? Please indicate the appropriate numbers from **LIST 3** below.

Other _____

LIST 3 Other Marine Related Agencies

GOVERNMENT AGENCIES

A1. CANADIAN COAST GUARD

A2. DEPARTMENT OF FISHERIES AND OCEANS

A3. Aquaculture and Resource Development Branch

A4. Biological Sciences Directorate

A5. Canadian Hydrographic Service

A6. Fisheries and Research

A7. Marine Environmental Data Service

A8. ENERGY, MINES AND RESOURCES

A9. Canada Oil and Gas Lands Administration

A10. Geological Survey of Canada

A11. Geophysics and Marine Geoscience Branch

A12. Surveys, Mapping and Remote Sensing Sector

A13. ENVIRONMENT CANADA

A14. Canadian Parks Directorate

A15. Habitat Management

A16. Marine Environment Division

A17. PUBLIC WORKS CANADA

A18. Marine Works Division

PRIVATE ORGANIZATIONS

A19. Offshore engineering works

A20. Mineral exploration

A21. Fishing companies

A21. Shipping companies

A22 Research organizations

A23 Educational Institutions

12. WHAT SORT OF COMMUNICATION/COOPERATION EXISTS BETWEEN YOUR DEPARTMENT AND THESE OTHER AGENCIES IN THE AREA OF DATA COLLECTION AND DATA PROCESSING?

- There are established provisions for communication on such activities
- Informal communication; by way of telephone call or casual conversation
- Activities only communicated where permission for activity is required.
- No communication; aware of their activities after they have occurred.

13. WHAT AGENCIES WOULD YOU ROUTINELY CONTACT PRIOR TO OR DURING A SPECIFIC DATA COLLECTION OR PROCESSING TASK? Please indicate the appropriate numbers from **LISTS 1, 2 and 3** or specify any other.

Task to be performed(LIST 1 / LIST 2)	Agency contacted (LIST 3)
Other:-	
Other:-	
No agency is contacted for any task	

ASSESSMENT OF EXISTING MARINE INFORMATION INFRASTRUCTURE...

14. ARE YOU AWARE OF ANY CASES OF DUPLICATION IN DATA COLLECTION OR INFORMATION PROCESSING?	Yes	No
15. HAS LACK OF COMMUNICATION CONTRIBUTED TO ANY OF THESE CASES?	Yes	No
16. ARE YOU AWARE OF ANY CASES WHERE A LACK OF COMMUNICATION PROVED TO BE DETRIMENTAL TO AN INDUSTRY OR THE ENVIRONMENT?	Yes	No

17. ARE YOU IN SUPPORT OF A COMPREHENSIVE INFORMATION INFRASTRUCTURE BETWEEN RELATED AGENCIES FOR THE MANAGEMENT OF MARINE RESOURCES?

No ❑

Somewhat in favour ❑

Strongly in favour ❑

Undecided ❑

18. UNDER WHAT CONDITIONS WOULD YOU BE WILLING TO SHARE THE DATA THAT YOU HAVE COLLECTED OR INFORMATION YOU HAVE PROCESSED?

Not willing to share ❑

Access by approved agencies at some cost ❑

Free access by approved agencies ❑

Access to any agency at some cost ❑

Free access to any agency ❑

THANK YOU FOR TAKING THE TIME TO ANSWER THESE QUESTIONS

Would you be willing to participate in further discussions on this issue?	Yes	No

If so kindly leave an address and phone number as well as some indication of when it may be convenient to contact you.

_____

_____

_____

_____TEL:_( )_____

ASSESSMENT OF EXISTING MARINE INFORMATION INFRASTRUCTURE...

A1.1 Survey Objectives and Limitations

This questionnaire served to identify what infrastructure exists for the transfer of marine related data between marine related agencies. It also assessed how users of marine data in these agencies feel about the concept of a Marine Information management System (MIMS) and the sharing of data with users outside of their own organization. The questionnaire also served as a means of identifying specific users with whom more detailed discussions were held to provide additional information which may be difficult to obtain in a survey of this nature.

One of the limitations of a survey of this nature is based on the manner in which questions have to be designed to favour user responses [Fields, 1991]. While the most information may be derived from individual descriptive-type answers, responses to these take time, and the prospective respondent may not be able to afford this. In order to increase the percentage of user responses, the preferred approach is one where response options are provided in a list from which the user can select the most appropriate option. While this takes the least time to respond to and elicits the highest return rate, it does not provide the most information. Listed options are at best, close approximations to what the respondents answer would have been. In addition, where the survey is one of this nature, necessitating lists of data categories and related departments, these lists have to be kept short in order to restrict the length of the questionnaire to a length which will not deter prospective respondents. Some generalization is therefore necessary in these lists, and with this, interactions between the various users will be lost.

A1.2 Specific Objectives of Questions

In assessing what infrastructure exists for data and information exchange, the questions were designed to establish what provisions are made for such exchanges as well as to highlight where there may be overlaps in user interest and data collection efforts. The following paragraphs explain the objectives behind the design of the questions.

Questions one through four Purposes of identification of respondent as well allowing for cross-referencing the mandating authority of the agency/department. This will (a): allow an assessment of whether the agency is operating within its full potential, and (b) provide a first glance at any areas of possible duplication.

Questions five through six These will simply identify the data collected while also giving an indication of the present data collection efforts and their priorities to the **'p e r c e i v e d '** role of the agency.

Questions seven through ten Here a second glance of any duplication and its nature can be obtained. This may be easily achieved by cross-referencing the various responses. It will also indicate whether collected data is being fully utilized by the agency. By looking at the costs involved in obtaining and processing the data, we may be able to see where cooperation and communication can be improved. The cost figures provided here is not intended to allow 'costing' of any perceived duplication as questions 5 and 6 will not specify actual details on locality and required quality. Any perceived duplication may however be further explored if necessary through information provided at the end of the questionnaire.

Question eleven/twelve By checking responses here against an agency's mandate, a chance will be provided to spot where collected data is or is not being fully utilized. This question will likely to be the most important in showing where communication is lacking between related agencies.

Question thirteen This question in itself is capable of identifying the possibility of duplication whilst also providing proof of the uncoordinated activity present in the marine environment. Cross-referencing responses to this question against those from questions 7 through 10 will again indicate areas of possible duplication for further investigation.

Questions fourteen through seventeen Self explanatory.

A1.3 Survey Response and Analysis

The questionnaire was circulated to forty-two (42) individuals responsible for or involved in the maintenance of some marine related data set. These individuals represented federal, provincial, commercial and research organizations. While most of these were identified from the Directory of Marine Data Sets produced by the Champlain Institute [Champlain Institute, 1991], some were also obtained through referral from other users.

Prospective respondents were called in advance of distribution of questionnaires to establish their willingness to participate in the survey. Once the questionnaires were circulated, calls were again made to the prospective respondents to verify receipt and address any issues which these respondents may have had with

respect to the questions. Of the forty-two mailed questionnaires, nineteen of these were returned representing a return rate of forty-five percent.

Breakdown of respondents by type of organization

Federal	12
Provincial	3
Commercial	3
Research	1

Based on responses to the survey and telephone interviews held with some respondents and other users, the following was derived:

Users of marine data are presently aware of what sources of data exist for their information needs and how these may be accessed. This awareness appears, however to exist more between the user and their data sources rather than between other users of the same source.

Nine respondents indicated that there were no established provisions for communication with other related organizations with regards to data collection and information processing. Communication for these organizations involved only informal communication or communication where permission was required. Two of these respondents also indicated that for some of these tasks, no communication existed.

Of the nine respondents who indicated a lack of established provisions for communication, six of these indicated an awareness of duplication of data collection and information processing efforts which may be attributed to lack of communication between the respective organizations. Four of these six respondents were also aware

of this lack of communication resulting in some conflict of activity which had a negative impact on a marine related industry or the marine environment itself.

Eleven of the respondents were strongly in favour of the establishment of an infrastructure for information exchange between marine related agencies. Seven respondents were somewhat in favour of this with one respondent declining to answer.

All respondents were in favour of allowing outside access to data collected or information processed either free of charge or at some cost to approved organizations.

APPENDIX II

AN OVERVIEW OF THE FMG DATABASE

A2.1 Product Description

The FMG Resource and Environmental Database Version 1.0 is an integrated database and mapping system for the coastal and marine regions covering the Bay of Fundy, Gulf of Maine and Georges Bank areas. This was developed jointly by the Dalhousie and Saint Mary's Universities, Halifax, Nova Scotia, Canada and the Land Registration and Information Service (LRIS), Amherst, Nova Scotia, Canada as a product for Environment Canada.

The FMG database consists of over 70 geographically referenced digital map manuscripts serving as thematic layers on a 1:1,000,000 scale base map for the area[1]. Data for the these layers have been acquired by the respective Canadian and American organizations responsible for collecting the data. Many of the thematic layers, while referenced against a 1:1,000,000 basemap, have been geographically-referenced at larger scales thereby allowing the user to zoom in on smaller selected areas.

Thematic layers cover a range of data categories and include the following:

- Physiography and geology;
- Physical, chemical and biological oceanography;
- Ecological resources;
- Political and administrative boundaries;
- Human resource allocation; and
- Environmental and resource management issues.

---

[1]Title.txt file included in FMG database package.

The FMG database is available in two formats, for use with the CARIS Geographic Information System, or for use with the GeoAXES Spatial Analysis Software.

A2.2 Overview of the FMG Product

The CARIS format of the FMG database is distributed as a set of CARIS interchange or NTX files together with map referencing, symbol library and attribute table identification files for each thematic layer. Each thematic layer also has a text file associated with it that gives comments on the pertinence of the particular theme, the theme reference number and theme descriptions.

One comment on the FMG database is the lack of documentation both by way of product description and thematic layer information The package received by the Department of Surveying Engineering, University of New Brunswick included the storage medium and a product brochure. This brochure is more suited to advertisement purposes and does not give the purchaser any documentation on the thematic layers. Furthermore, no reference is made to the information files contained within the package, so the user is left to discover and explore these. With respect to the documentation on the specific thematic layers, the information files included in the package are more geared at giving an overview of the data in the layer as it relates to use in the FMG 'world'. Very little documentation is available on how the information was collected, dates of collection, or what limitations may be inherent in the data presented. This lack of documentation limits the scope of use of the FMG database since the user is unable to assess suitability for a particular application.

While many of the thematic layers are geographically referenced at larger scales, the base map to which they all referred is referenced was digitized at the scale of 1:1,000,000. Though zooming capabilities are supported, this will give a false impression of precision when working on smaller areas. Furthermore, various thematic layers may not be all referenced at the same scale. Assessment of limitations of generated output becomes more difficult therefore when this has involved several of these thematic layers.

A2.3 The FMG Database as Tool for Marine Information Management

The FMG database provides a ready format of geographically-referenced marine and coastal data for manipulation in any of its distribution formats. This can be used as a 'base' upon which specific users can incorporate their own data. Although there is a need for this type of data among users of the marine environment, users will generally have some concern about the quality of the 'base' that is being used. The lack of documentation can deter usage by potential users where precision is an issue. This may not be an issue for applications using mainly ecological themes such as species distributions where only general locations may be required.

The FMG database only facilitates information and resource management within a particular organization. Although information generated may be made available to outside users, it is not a tool for information exchange and management as proposed in the main text of this report. This is a specific system and as described in Chapters Six and Seven of this report, this forms only a part of the concept of an Marine Information Management System (MIMS).

A2.4 Conclusions

As a product ready for use, the FMG database does provide a means of ensuring that participating users will be referenced to some common basemap. Unfortunately, the lack of documentation does not allow an outside user to assess the suitability of this base for their own application. The FMG database is a tool which has a great potential for use in facilitating management of marine related information and resources. As with any system of this nature, however, it must be implemented alongside policies for management of this information and these resources. In the absence of these policies, the FMG database only allows users the facility of automation within the same uncoordinated framework described in Chapter Three of this report, since its use does not guarantee the communication needed between marine related organizations.

VITA

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