1. INTRODUCTION

1.1 Report background

The Great Barrier Reef (GBR) stretches about 1900 kilometres along the coast of Queensland from Torres Strait in the north to its southern most point, some 90 kilometres offshore from Gladstone.

Because of this extent, the GBR poses many problems for a management body like the Great Barrier Reef Marine Park Authority (GBRMPA) when data for inventory, monitoring or impact modelling need to be available or collected. The most obvious problem is one of scale. The GBR region covers an area of about 348,700 square kilometres. The map base problem is almost as great, since a satisfactory cartographic base for the GBR does not yet exist.

The CSIRO Division of Water and Land Resources has co-operated in a developmental study of remote sensing of the GBR with the GBRMPA and the Australian Survey Office (ASO). Methods developed during a CSIRO research project funded by the Australian Marine Sciences and Technologies Advisory Council (AMSTAC) were used. This project investigated the use of remotely sensed data from the Landsat satellite series as an aid to management of the GBR.

The scope of the study (see section 2.2) included an evaluation of Landsat imagery for the inventory, survey design and monitoring needs of the Authority in its planning and management roles. It also included an evaluation of the accuracy of Landsat data as a cartographic base for the GBR and as a means for shallow water depth assessment.

On the basis of these studies, a set of specifications for the products of Landsat analysis has been drawn up which balance the planning needs of the GBRMPA with the consistent ability of Landsat data to meet those needs. The ASO has taken over the computer software and methods developed in these studies and is currently extending the mapping program to the rest of the GBR.

The Landsat based information system is summarized briefly in section 2.2 and fully described in a series of reports listed at the end of this report. This report proceeds from that basis to investigate areas where the information base is currently poor, but where a wide variety of remote sensing data opportunities exist to be utilized to overcome the problems of scale and information base faced by researchers, planners and managers in the GBR region.

1.2 Remotely sensed data

Remote sensing has played and will continue to play an essential role in providing information for management of the GBR Marine Park.

As reviewed in this report, remote sensing is taken to mean earth observation by recording data from the electromagnetic spectrum - which includes light, radiated heat, radar and radio waves. The recording is done by a sensor, which may be a camera for light and the sensor is carried on a platform, which may be an aircraft or satellite. The narrowness of the band of wavelengths included in a sensor's measurement defines the spectral resolution and the range of wavelengths of the spectrum covered defines the spectral extent of the sensor.

Since no combination of platform and sensor(s) can cover all of the space, time and spectral scales needed for a complete information package, remote sensing of the GBR must encompass a wide range of methods, from satellite coverage through aircraft and ships to floating and moored buoys.

An information base which may be developed from remotely sensed data includes,

(i) A fixed reference spatial data base - or inventory,

(ii) opportunistic, but nevertheless useful, historical records of dynamic events - such as sediment plumes or plankton blooms, and

(iii) designed detection, monitoring and assessment schemes for natural and man induced dynamic flows within the GBR system.

Established remote sensing methods have already been used for inventory and both established and archived data exist for opportunistic monitoring as described later in this report.

The information potential of (iii) is the most difficult to obtain and to accomodate within existing data base structures. It is, however, the most important type of remote sensing input to models of the dynamic components in the GBR system. These include current speed and direction, circulation dynamics and their interactions with coastal sediment transport, pollution dispersal, phytoplankton dynamics and the highly significant and mobile boundaries between water masses - the oceanic fronts (cf Middleton, 1983).

1.3 Sampling strategy

Given the wide range of space and time scales involved in such processes the sampling strategy proposed for the MAREX (MArine Resources EXperiment) program (OCS Working Group, 1982) and supported by the Ocean Sciences Board (1982) is applicable to the GBR data base. This strategy proposes a multiplatform (satellite, aircraft, ship and buoy) approach to the measurement of ocean primary productivity (Smith et al., 1981, 1982). The mathematical methods and remote sensing techniques which have proven effective in measuring chlorophyll in the open ocean and provide the basis for the MAREX Report are yet to be assessed and developed in the shelf and coastal environment of the GBR. The basic design, however, is still sound as a basis for this assessment and development.

The appropriate combination of methods to be employed is a function of the space and time resolution and extent of the relevent phenomena as well as the spectral resolution and extent of the instruments deployed on the platforms.

'Resolution' will be taken to mean the minimal dimension which contains the variation of a feature, or event, and 'extent' to mean the distance or time over which it persists. These dimensions may be illustrated graphically on a space and time plot like Figure 1. This Figure has been adapted from Esaias (1981) and derives biological resolutions and extents from Walsh et al (1977).

Biologically, resolution is related to the basic social scale (including competition for example) and extent to the general environmental scale of the phenomena (cf Platt, 1972). The limits shown in Figure 1 are consequently only illustrative since the general interaction between biological and physical processes (as well as the scales at which one or the other dominates, cf Denman et al., 1977) is as yet poorly known and is a topic which the remote sensing techniques described in this report may well address.

Specifically, this report describes a number of the remote sensing opportunities which have been and could be used to provide information for the kind of phenomena plotted in Figure 1. It provides the background and detail for the paper presented at the Great Barrier Reef Conference in Townsville in September 1983 (Jupp, 1983), develops in the context of the GBR some of the issues discussed by Carpenter (1982), and complements the discussion papers on physical oceanography of the GBR lagoon contained in Middleton (1983).

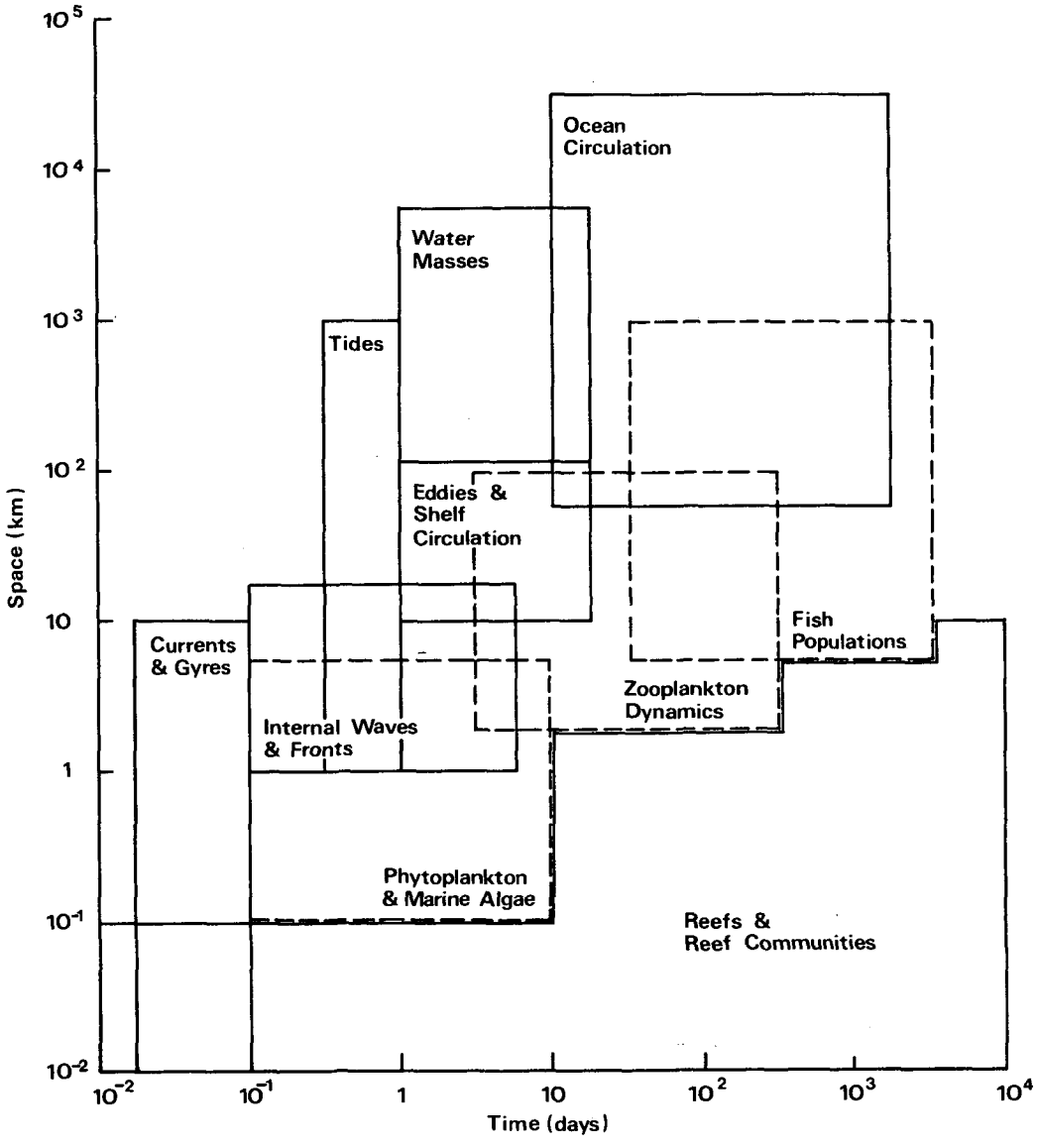

Figure 1. Resolution and extent of GBR phenomena in time and space dimensions.