CRC REEF RESEARCH TECHNICAL REPORT

THE ESTIMATION OF VISITOR USE FROM GBRMPA DATA RETURNS

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FOREWORD

This report represents a very useful review of data available on visitor use of the Great Barrier Reef, with emphasis on information contained in databases of the Great Barrier Reef Marine Park Authority. Prior to the introduction of the Environmental Management Charge (EMC) in July 1993, data available on tourism use of the Reef were limited and patchy; the requirement for operators to provide logbook returns recording their use of the Marine Park has led to a great improvement in recording and understanding use of the area for commercial tourism.

This report provides an overview of the various databases containing information on visitor use of the Great Barrier Reef Marine Park, and has developed into a manual invaluable to researchers wishing to understand and gain access to these databases, particularly the Data Returns Database containing the EMC returns data. The examples and analyses included here provide an excellent illustration of the range of information available, and the limitations of the database in its current form.

The report also includes some very worthwhile recommendations regarding improved management and access to the databases, and verification of the data. Some of these suggestions are currently being addressed and it is hoped that all of them will be pursued. Although certain legal constraints must continue to apply to access and use of data where issues of privacy, freedom of information and commercial confidentiality are concerned, wider access to the data is to be encouraged, and will facilitate research and analysis of benefit to Marine Park management agencies and stakeholders.

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SUMMARY

Estimates of visitor use of the Great Barrier Reef have been very difficult in the past due to the absence of a formal database. Despite this some researchers have been able to compile partial estimates which were probably quite accurate. These have been partly based on assessments by GBRMPA staff drawn from a knowledge of permits issued to commercial tourism operators. The introduction of the Environmental Management Charge in the second half of 1993 and the associated Logbook returns now provides an opportunity to more closely monitor the levels of use of specific reefs and of sections of the GBR.

To the external researcher (and even to some staff of GBRMPA), there is a very complex array of data collected about use of the Great Barrier Reef. Some of this material is formally developed into a number of databases. At the start of the project it became apparent that there was a need to clarify the nature of the various databases which researchers might access and to evaluate the potential of the new opportunity represented by the EMC processes. To this end the project sought to:

a) Describe the existing databases on visitor use developed and maintained by GBRMPA;
b) Evaluate the accessibility and utility of data from these databases
c) Develop a useful "manual" to guide researchers who may wish to better understand availability and operation of GBRMPA'S databases.
d) Identify any improvements which might be made to the existing database and any new information needed.

With considerable assistance from many GBRMPA staff the project researchers were able to clarify the different databases and in particular to explore the potential of the Data Returns Database (the direct product of the new EMC charge). Initially the raw returns from operators were used to get a feel of available information. Subsequently, as the data were entered into the database we were able to directly access the database (remotely, from JCU) and start to build a picture of how useful it may be for specific queries. We completed a series of data extraction tasks on the 1994 returns and eventually developed a reasonable appreciation of the potential and limitations.

The report provides a very readable and clear set of guidelines to any researcher who wishes to make use of the data available from GBRMPA. It should help guide individuals to make

appropriate and specific requests to GBRMPA for access to data. Also included are many examples of the kinds of information which may be accessed using the systems described and the report includes reference to actual visitor numbers at various reefs and sections of reef. There is some discussion of the need to improve the data base, especially to increase the user-friendliness of the operating process, and to consider additional information to be gathered on a regular basis.

The new Data Returns Database provides an excellent tool for researchers to monitor and identify commercial tourism use at the widest possible range of scales for the GBR. Despite the relatively user-unfriendly software, a researcher can quickly gain competence in the direct access to the database and therefore select precise information to suit particular projects. The report identifies some critical issues for database users to be aware of so that they avoid producing erroneous data. It would be useful to review the EMC logbook to ensure simplified inclusion of additional data, notably activities. Alternatively, or additionally, the user interface with the Data Returns Database could be improved and the connections to other databases made more user friendly so that researchers could more readily access the fullest range of information.

INTRODUCTION

This project was originally established to review data which could help describe the pattern of tourist use in the Great Barrier Reef region. Much of the focus has been to determine the status of existing information on visitor use including historical changes. It is now clear that estimates of visitor use of the Great Barrier Reef have not been well founded on systematic and reliable sources. Reef wide estimates have relied on a great deal of interpretation of permits data but subject to a low level of data return compliance. It is not possible to undertake a review of historical patterns of use and change except by very broad inference. The recent introduction of an Environmental Management Charge and the associated reinvigorated Data Returns Database by GBRMPA has the potential to provide a much better understanding of Commercial Tourism use. No such prospects exist for information on private boat owner use.

With regard to use of the reef other than by commercial tourism it is clear that no figure of any reliability is available. One earlier publication of visitation levels (Driml, 1987) represents a singular effort to extract good information at that time. For specific points in time and space there are other estimates of use which may be reasonable for both commercial and private recreational use at the time but these also are surely outdated (eg Valentine & Landes, 1989 for the Whitsundays).

Data about non commercial visitor use (local recreation and private visits) are not available from GBRMPA and are unlikely to be available in the foreseeable future. Some specific information about use of this kind is available (eg Blamey & Hundloe 1993 for fishing in the GBR region, Valentine & Landes 1989 and Valentine 1992 for boat use in the Whitsundays area). There are a few other sources but it seems clear that an original data collection effort will be required to put together an accurate account of the patterns of use by private boat owners. This is an issue for further discussion and evaluation within the CRC.

During the course of this study the Great Barrier Reef Marine Park Authority introduced a formal data returns process based on logbook entries from commercial tourism operators, in association with the Environmental Management Charge. Following initial review of then existing data sources, mainly within GBRMPA, the project sought to examine and test the utility of this new source of data. This revised program was designed to produce a thorough

knowledge base for the use of researchers who wished to incorporate information about visitor use in their studies.

To this end the following report provides a number of specific outcomes:

(i) a description and review of the various forms of databases presently held by GBRMPA;

(ii) a detailed analysis of the Data Returns Database and the kinds of information which it may provide;

(iii) examples of present patterns of use drawn from the Data Returns Database including case studies at different scales and of different sites within the GBR;

(iv) a guide to the use of the Data Returns Database to assist researchers who may be considering seeking permission to access data, including discussion of some of the difficulties and shortcomings and the latest status of internet access;

(v) a discussion of the problems involved in identifying non-commercial (ie private) use of the GBR for recreation with reference to some specific prior studies.

The study was unable to embark on any original data collection and it will be critical for future CRC visitor use studies to address the question of private use data if such use is to be incorporated in management planning. To date only very limited work has been attempted in this field. Other sources of recreational use of the GBR include permit data bases held by the Queensland Department of Environment but in general these remain largely unanalysed at either local or regional levels. There is potential for a review of these sources as well as other techniques to assess private use, especially non-fishing use, of the GBR.

Researchers should find that this report provides a good understanding of the different kinds of data which may be available from existing sources and in relation to the Data Returns Database (the first reliable indication of commercial tourism visitor numbers), a comprehensive appreciation of its potential and the practical problems in using it. It is important to note that GBRMPA is developing guidelines for researcher access to these databases and each project coordinator will need to discuss these individually with GBRMPA staff. The general principle adopted by GBRMPA is to maximise access and use of databases amongst legitimate researchers but to ensure protection of commercially-in-confidence information. This effectively means that researchers can access detailed information about specific reefs and use but must be careful not to use this information in a way which would allow interpretation

of the published results to breech commercial confidentiality. GBRMPA is to be commended for taking steps to ensure the wider availability of these visitor use data.

1. INTRODUCTION TO GBRMPA DATABASES

Five databases of the Great Barrier Reef Marine Park Authority (GBRMPA) were reviewed in this project: the Permits Database, the Environmental Management Charge (EMC) Database, the Data Returns Database, the Human Use Database and the Aerial Surveillance Database. Emphasis is placed on the newly established Data Returns Database as this has the greatest potential for accurate and current information on actual use. The Planning and Management Section are using data from Permits and Aerial Surveillance Databases in conjunction with their GIS to plot patterns of human use within the Great Barrier Reef Marine Park (GBRMP). This has already been done with data from the Permits Database, and for some of the data from the Aerial Surveillance Database. A similar interaction between the GIS and the Data Returns Database was underway in 1996 by GBRMPA staff with excellent products.

1.1 Reef identification system

The GBRMP is subdivided into Sections, Sectors, and Plots. There are four sections: Far Northern; Cairns; Central; and Mackay/Capricorn (see Map 1). The exact numbers and locations of Sectors and Plots are confidential because of the aerial surveillance and enforcement program. Each reef and shoal within the GBRMP is allocated a unique identification number of the format **ab-xyz**, where ab is the degree of latitude at which the reef is found. The number xyz is obtained by numbering the reefs for each half degree of latitude from north to south, and left to right by half degrees. For example, Tongue Reef has the identification number 16-026, indicating that it is the 26th reef encountered when heading south from 16°S. Identification numbers of specific reefs are provided on maps and zoning plan documents produced by the GBRMPA. Some identification numbers apply to a cluster of reefs and/or bommies while in other cases a group of reefs with a single ID number may be given distinct sub-identification labels (usually letters a, b, c, etc). The details are shown on zoning plans and maps for each section. The remainder of this part of the report identifies the different databases which GBRMPA staff have developed and provides basic information about each.

Map 1: Great Barrier Reef Marine Park Showing Section Boundaries (GBRMPA, 1994)

2. THE DATABASES

2.1 Permits Database

This is an Oracle database with a Forms interface. Details from applications for permits are entered onto the database within 24 hours of receipt at GBRMPA. This database contains 6000 records, of which > 700 are currently valid permits. In 1994 some 576 were permits for chargeable activities, of which 513 were for tourist operations. Data from all permit applications submitted to GBRMPA are entered onto the database, which therefore contains details of failed and pending applications, as well as successful ones. It is possible that in the future some of the older records will be archived in order to speed access to more current ones.

Fields contained in this database include: name of applicant, company name, location of activity, nature of activity, frequency of activity (not for all records), maximum permitted number of people, permit type (broad category, see Appendix I), transport types used (vessel or aircraft), vessel name, maximum passenger capacity of vessel, vessel size (metres) and vessel registration number. Various administrative fields (including the current status of the application) are also included.

Location of activity is described in one of two ways. For fixed site operations, the specific Section(s), Sector(s), Plot(s), name(s) and GBRMPA ID number(s) of the reef(s) and/or island(s) covered by the permit are listed. Latitude and longitude of sites are not given, however, the GBRMPA ID numbers can be used as an approximation for latitude (within one degree, see above). For roving operations, a list of "inclusions" is given (e.g. Cairns Section, all zones and locations) followed by a list of "exclusions" such as Preservation Zones, some of which may be seasonal (e.g. bird nesting sites). The existence of roving permits makes it particularly difficult to quantify how many people are visiting any individual reef or island. Of 404 valid permits in 1994 for commercial tourist vessels 286 (71%) were roving permits. The standard schedule for roving permits allows the permit holder to visit any one site twice in each seven day period.

There are two fields for activity: Category and Code, and entries in these fields must come from a list of possibilities (Appendix II). Categories include broad descriptions of activity such as collecting, camping or motorised. Codes are more detailed such as (for motorised

activities), bareboat, jet skis, water skiing, para flying etc. Where a permit covers more than one activity and/or more than one location it is not possible to determine numbers of people involved in a specific activity at a specific location.

Reports on the permits in the database can be generated by activity (category and code), location (Section, Sector, Plot, ID number, location name) and vessel name or any combination of these. Reports can be restricted to currently valid permits if required.

In January 1993 data were transferred from an old version of the database program to the current version and it was discovered that some of the previous data entry had been incomplete and/or inaccurate. Consequently, pre-January 1993 data in this database are potentially unreliable, particularly those for activities and locations. Some corrections have been made to the database itself. However, only relatively major omissions or errors are likely to have been identified. The Permits Database has not yet been comprehensively revised and the same problems with missing data entries are still likely to exist. Researchers are advised to ascertain the reliability of this database at the time of use.

In principle, GBRMPA is willing to allow access to non-personal information (i.e. not personal or company names and addresses) in this database, but the situation has been reviewed recently although no written guidelines for access to information are available currently. This also applies to the Data Returns Database. As far as the CRC is concerned there is a formal process for access to GBRMPA data and this is first cleared through the Director. GBRMPA has developed a Deed of Agreement for access to all databases and a copy of the current agreement is given in Appendix III.

2.2 Environmental Management Charge (EMC) Database

This database contains financial information concerning permit holders liable to pay the EMC. It includes permit number, name and address of permit holder, dates of submission of log books, EMC due, and EMC already paid. It is an administrative database and contains little/no information on human use of the GBRMP.

2.3 Data Returns Database

This database was originally designed to hold data from return forms that permit holders were required to submit annually. Unfortunately, the database has had an unclear history of poor returns from permit holders, and poor accuracy of data entry. As an example, in November 1992, letters were sent out to permit holders reminding them of their obligation to submit data returns, but the response was less than 50%. After this, no further effort was made to collect data returns as the new EMC and log book system was due to be introduced.

Most of the major operators did comply with the original data return conditions, and from their returns GBRMPA were able to develop an understanding of where most of the visitation occurred. For example Driml (1994) relied on such estimates by GBRMPA staff to provide a commercial use figure. The new Data Returns Database, which uses the EMC log book data, is discussed in detail in the next section.

2.4 Human Use Database

The Human Use Database was designed in late 1992. The purpose of the database is to present an overview of research information on tourism and recreation relevant to the management of the GBRMP. The database analyses the content of written reports and the databases available within GBRMPA. A User's Guide is available which provides details on the information available from the Human Use Database, and how to obtain required data. The database is split into two tables: the Reports Table (currently containing 89 records) and the Database Table (currently containing six records). The six records in the Database Table are: Island and Reef Information System (IRIS), Key Sites Database, Strategic Plan Public Participation Database, Data Returns Database, Permits Database and Surveillance Database. The Human Use Database contains summary information about these other databases, but it does not access them directly.

One restriction of this database that should be noted is that it covers only data concerning tourism and recreational activities, not all human activities. Generally it can be a useful source to discover what previous studies have been conducted but it may not have very much original data.

2.5 Aerial Surveillance Database

This database contains data collected in two different ways: Transect and Sector/Plot flights. Transect flights are done by Coastwatch, while Sector/Plot flights are done by Coastwatch and QDEH. Plots to be flown in the Sector/Plot program are chosen in random order and when a plot is flown, the entire area is covered, allowing calculation of vessel density. However, order of flight and location of Transects is governed by interests of other Coastwatch participants (customs, defence etc.) and the only data received by GBRMPA are on positive sightings of vessels. Therefore, it is not possible to make any estimate of temporal or spatial density of vessels from transect data.

For both Transect and Sector/Plot flights the following data are collected: Flight details (date, take-off site and time, landing site and time) and weather details throughout the flight. For each positive sighting the following data are collected: time, nature of sighting (vessel, people, wildlife), location (usually place name). For positive sightings of vessels, the following data are collected if possible: name, registration number, class, size (m), description, a record of any radio conversation held with people on the vessel and a record of any photographs taken. Only about 30% of positive vessel sightings result in a positive identification of boat name or registration number. If possible, details of numbers of people visible on each vessel and their activities are also recorded. In addition, on Sector/Plot flights, the following data are also collected: Sector, Plot and reef ID number for locations of positive sightings and total time flying within each Plot.

The Aerial Surveillance Database is divided into four relational tables: Flight Details table, Sector/Plot table (used for Sector/Plot flights only), Weather table and Sighting table. Access to the Aerial Surveillance Database by CRC researchers would be possible, however vessel name and registration number will not be accessible.

2.6 Other Databases

Other databases operated by GBRMPA that include data on human use are: The Island and Reef Information System (IRIS), the Key Sites Database and the Great Barrier Reef Recreational Demersal Line Fisheries Log Book Database (REEF FISH). REEF FISH contains information from fishing clubs in the Cairns, Townsville, Mackay and Rockhampton Regions. However, only certain clubs submit data for the database and the proportion of total fishing effort represented by these clubs is unknown.

2.7 Human Use Data and GIS

Planning and Management personnel have used data from two GBRMPA databases in conjunction with GIS. Data on current permits for commercial tourist vessels have been extracted from the Permits Database, used to calculate Potential Visitors per Year (PVY) to the GBRMP and plotted using GIS. Data from the Aerial Surveillance Database on vessel numbers and estimated vessel capacity and activity (based on class of vessel) have been used to estimate visitation rates to the GBRMP. These estimates are being plotted onto GIS.

The work by GBRMPA to incorporate the Permit data into the reef wide GIS allows the rapid appraisal of Reef wide, Section wide, sub-section and even individual reef visitor potential and the preparation of detailed maps displaying the overall patterns. Taking the 1994 figures from the GIS for illustrative purposes, commercial tourist vessels in the GBRMP are permitted to carry some 10 million tourists per year. Half of these are site specific and are distributed as shown in Table I.

Table I Potential Visitors Per Year (PVY) on Commercial Tourist Vessels with Site Specific Permits [Source: GBRMPA]

SECTION	**# Reefs**	**#PVY**
Central	105	2484479
Cairns	45	2434662
Far Northern	8	47048
Mackay	25	142070

Those commercial tourist vessels with roving permits which contain an element of site specification account for another 3 million potential visitors per year as shown in Table II.

Table II: Potential Visitors Per Year (PVY) on Commercial Tourist Vessels with Roving Permits Plus an Element of Site Specific Permits (Site Specific Component only). [Source: GBRMPA]

SECTION	**# Reefs**	**#PVY**
Central	69	1945723
Cairns	50	986582
Far Northern	6	24592

Commercial tourist vessels which have roving permits have the potential to add a further 1.8 million visitors per annum at non-specific sites. Most of this is allocated by way of a section wide roving permit (1 million) with the remainder allocated to some lesser component of an entire section (almost all of this latter is split about evenly between the Central and the Cairns Sections). Such permits typically have a list of "inclusions" (reefs permitted to be used) and a list of "exclusions" (not permitted to be used). It is in this area of Section wide roving permits that the Far Northern Section has most of its potential commercial tourism: current permits of this kind allow for 242,376 PVY at 735 reefs as Table III shows.

Table III: Potential Visitors Per Year (PVY) on Commercial Tourist Vessels with Section-Wide Roving Permits. [Source: GBRMPA]

SECTION	**# Reefs**	**#PVY**
Central	510	300530
Cairns	291	354636
Far Northern	735	242376
Mackay	1052	166192

In the context of the CRC Special Interest Tourism project the distinct character of the Far Northern Region is evident from these figures.

It is planned that data from the Data Returns Database will be plotted on GIS. These data are expected to prove highly useful as the most accurate estimates of commercial activity in the GBRMP. Experimental work on this was continuing in 1996 and 1997.

There are a total of 2588 reefs identified within the four reef sections of which 32 preservation and scientific research reefs have not been permitted for use. Site specific permits include 183 reefs and site specific roving permits cover 129 reefs. In total 147 reefs are excluded from use by roving permits, some of which are included in site specific permits.

3. THE DATA RETURNS DATABASE

3.1 An introduction to basic database terms

The Oracle database management system which contains the Data Returns Database, uses Structured Query Language (SQL) as the data access language. This means that commands used to access the data must be written in SQL.

The data of the Data Returns Database are stored in two tables. These tables, like any other, consist of rows and columns. The rows are unordered, which means that the rows can not be specified by their position in the table. The columns, however, are named and ordered. A field refers to a specific datum value stored in a table for a specific row and column (See Figure 1).

return_id	*rdate*	*pax*
85234	1-aug-97	110
79364	19-sep-95	50
98746	2-dec-99	4

Figure 1: Representation of a database table, indicating the relationship between columns, rows, and fields

Columns may be designated to contain "not null" data, which means that every field in that column must contain an entry. For example, the *pax* column in the Data Returns Database contains "not null" data, as it would be useless for a database on visitor numbers to contain data entries (rows) which did not include the number of visitors.

Because databases often consist of two or more tables containing data which is continuous, it must be possible to link the two tables. For example, the Data Returns Database consists of two tables, one which contains general information such as visitor numbers and dates, while the other contains information on the location of visitation. Identification of visitor numbers to a particular location, can be achieved by associating the fields of the *pax* column with the given location in the *reef_id* column. This requires the two tables to be linked using what is called the "primary key". A primary key is a column which has a distinct value for each field, and occurs in both tables.

For the Data Returns Database, the primary key column in both tables is named *return_id*. The *permits.return_t* table contains the primary key *'regno'* which allows the Data Returns Database to be linked to the Permits Database.

3.2 Introduction to the Data Returns Database

In July 1993, the Environmental Management Charge (User Pays) came into effect. As part of that scheme, commercial tourist vessels are required to lodge a quarterly return (log book) with GBRMPA. This includes bare-boat operators. This log book contains dated daily information on crew numbers, passenger numbers, free of charge passenger numbers, transfer passenger numbers, vessel name, vessel registration number, and some form of activity location (See Appendix IV for a copy of a logbook form).

These data have been compiled into an Oracle Database, which is continuously updated and is now named the Data Returns Database. Because the logbooks are returned quarterly, and the operators have 30 days in which to lodge them, it can be up to four months from when a logbook comes into use until it arrives at GBRMPA for processing. Additional time is required for processing the data, and entering it into the Data Returns Database. The GBRMPA is attempting to maintain the data base as current as possible, typically with a lag of around six months between date of visit and access on the database.

Providing access rights have been granted by GBRMPA, the Data Returns Database can be accessed from a remote terminal. In late 1996 GBRMPA established access options through the internet via a secure non-public web page. Users require a login identity and a password to access the GBRMPA system. Once access is granted by GBRMPA, information on how to access the database through the internet is provided (see Section 3.3 below for further information).

The database consists of two tables, *permits.return_t* and *permits.rsite_t*. The primary key between the two is the column *return_id*. The *permits.return_t* table contains the column *regno*, which is the primary key with the Permits Database, interconnecting the two. The two tables have a one to many relationship, from *permits.return_t* to *permits.rsite_t*.

The *permits.return_t* table contains the following columns:

return_id; the primary key which consists simply of a number,

regno; primary key to the Permits Database,

rdate; the date of visitation,

pax; number of passengers (excludes crew, and includes foc passengers),

foc; number of free of charge passengers (see log book instructions for the definition of free of charge passengers),

vname; name of the vessel,

vregno; the vessel registration number, and

transfer; the number of transfer passengers (see log book instructions for the definition of transfer passengers).

Of these columns only the first four contain "not null" data. This means that those four are the only columns for that table which must contain data for each entry. For example, many operators are not involved with transfer passengers, and therefore, the column contains many blanks for given dates and operators. Transfer passenger data are now not recorded, but this situation is subject to review.

The *permits.rsite_t* table contains the following columns:

return_id; the primary key,
reef_id; the reef identification system employed by GBRMPA,
reef_sub_id; some reef systems are identified in greater detail using a sub-ID
lat_deg; degrees latitude of activity location,
lat_min; minutes latitude of activity location,
long_deg; degrees longitude of activity location,
long_min; minutes longitude of activity location, and
reef_name; reef name.

The only column containing "not null" data is *return_id*. However, it is expected that under only extreme situations will there be no form of activity location entered into the table. There is a potential problem, in that only one location may be entered by operators with roving permits which visit more than one location. This will limit the accuracy of the data, and in some instances may prove a significant hurdle to those doing studies which involve visitor numbers and locations. When an operator enters a longitude-latitude location into their logbook, GBRMPA uses the information to calculate the most appropriate reef ID number, which in most instances is also entered into the database.

The most effective form of reef location is reef ID numbers, which are included on the Zoning maps. A limitation of this reef location method, is that the part of the reef used is not indicated (eg. lagoon vs reef flat).

The main potential use for this database seems to be the ability to extract data on visitor numbers for given dates, the commonly visited reef areas, and the number of operators using a given area of the reef. When linked to the permits database, much more information may be available. This includes data such as comparisons between permitted user numbers and actual

visitor numbers, permitted activities at certain sites, and the numbers of visitors occurring continuously at site specific areas. However, although the Data Returns Database is reasonably user friendly, the Permits Database is considered extremely difficult to use, due in part to problems of incomplete data entries. There may also be more reluctance on the part of GBRMPA to grant access to the Permits Database due to confidentiality rights of the operators.

Several potential problems with the GBRMPA databases were identified during the original CRC study in 1994. The first was accessibility to reef specific data. At that time the data were not loaded into the database, and it was not possible to search by location. Now that the data have been installed into Oracle, it is possible to search by location, mainly by using reef ID. In some instances, the Data Returns Database also allows the operating vessel to be identified, without giving away any further commercial data. This would enable researchers to approach the appropriate operator and vessel(s) for permission to undertake any interview programs. If more data are required about the permits details, then the researcher can apply for access to the Permits Database.

Another problem was capacity to compare permitted use with actual use. It is possible to determine the EMC derived actual user numbers from the Data Returns Database, but the permitted user numbers must be retrieved from the Permits Database, which is more difficult to use and may involve more access problems. GBRMPA staff are attempting to develop better access interfaces.

There is currently no way to determine which activities were carried out at any given time, because the Returns logbooks do not include any activity information. Although the Permit Database provides the data on permitted activities there is no information available on what activities are actually undertaken. Clearly there is potential for considerable improvement by developing simple links between permit information and use.

3.3 Access to Data via a GBRMPA Web Page

In late 1996 GBRMPA established a secure web page designed to enable organisations with close links to the Authority to gain easy access to reef related data sets. Called *GBRMPA Info Exchange*, this web page is not accessible by the public. It was initially seen as a means of providing direct access for Queensland Department of Environment staff. Data accessed

through this page are sent securely and researchers must first be individually permitted access by GBRMPA.

The web page provides two main search options. Some excellent data have been made available without a password including the IRIS database (see above) and also summary data from the Data Returns Database. The latter includes quarterly summations of visitor numbers accessible for each discrete reef. In early 1997 there were some limitations in the design structure still being developed. For example there was no facility to select spatial aggregates above the specific reef scale and to retrieve data for a cluster of reefs required a tedious series of requests. It is likely that some of these summary statistics may be moved onto the GBRMPA external home page accessible to all web users. Data management staff have been producing regular updates of summary data including graphs of monthly visitation for the entire GBR and quarterly visitation by Section (Figure 2 shows a recent download).

Figure 2: Monthly Visitation to the Great Barrier Reef from the EMC Derived Database, [Source: Graphic Downloaded from *GBRMPA Info Exchange*. January 1997]

The second part of the *GBRMPA Info Exchange* home page requires password access and provides greatly increased detail on visitation. Testing the information available in early 1997 revealed two important elements. For a single reef site the data are extremely detailed but the interface is unable at this time to deal with spatial aggregates. The search parameters include

reefID (the official numerical designation for each individual reef - see Section 1 of this report), permit number and vessel name. Any one of these may be used to generate a search. For every search the date parameters must be specified and they may be for as little as a single day or for any other period up to the entire data collection period (begins 01 July, 1993).

If a search of a single reef is used for a three year period (for instance) the amount of data generated could be extremely large (your web browser may be unable to cope!). Data retrieved by these searches currently give daily visitor numbers for every vessel. This enables researchers to glean total visitor numbers, total commercial vessel numbers using the site, different passenger size classes of vessels, proportions of use associated with specific vessels and frequencies of use by vessels. For most reefs with significant visitation there are many commercial vessels involved in the course of each month.

Some of the technical limitations are currently being addressed by the GBRMPA data management staff. It has been recommended that search options be provided to select reefs by name (as well as reefID), to specify the time period for data aggregation (daily, weekly, monthly, quarterly and annually), and to specify multiple reefs. Such enhancements will provide increased efficiency for many researcher needs while retaining the valuable detail for those who need it.

GBRMPA staff are experimenting with designs of subsets of Section reefs as a useful means to aggregate data and if this work is successful that level of data summary may be suited to posting on the external homepage. Discussions are continuing about the extent to which data can be used without breeching perceived confidentiality needs. It is current and commendable policy of GBRMPA to maximise use of the data and minimise restrictions.

4. EXAMPLES AND CASE STUDIES FROM THE EMC DATA

Several case studies have been undertaken to provide examples of data which can be obtained from the databases. Particular emphasis is placed on the newly established returns database, and the new opportunities it provides.

4.1 Initial case studies

Some initial case studies were carried out before the data from the EMC logbooks had been processed and entered into the GBRMPA computer system. This was done to gain a general understanding of the strengths and weaknesses of the logbook data, and to answer questions about actual visitor numbers to the reef as compared to the permitted numbers.

4.1.1 Permitted and actual user numbers for fixed site permits

Initially an attempt was made to calculate the permitted visitor numbers to the GBRMP for all GBRMPA permits which were site specific. However, due to various technical problems, it was only possible at that time to compare permitted and actual visitor numbers for five sites. The permitted visitor numbers for each permit were obtained from the Permits Database for valid permits. The permit numbers were then used to identify the EMC logbooks for that permit. Logbook data had not then been entered into the computer which meant that the logbook figures had to be obtained by going through each entry from the appropriate logbook. Subsequently the data for permitted and actual use were extracted from the two databases for the 1994 results presented in Figure 3.

4.1.2 Permitted and actual visitor numbers to GBRMP pontoon sites

Permitted and actual visitor numbers were also compared for nine of the thirteen reefs which had pontoons associated with at least part of their area. This was done by examining figures from the Permits Database, and the new Data Returns Database. One problem experienced during this investigation was that in many cases permitted visitor numbers were not explicitly expressed, and had to be estimated from vessel carrying capacity.

Overall, both the studies found that actual visitor numbers were often well below permitted visitor numbers. However, there appears to be a general pattern whereby sites in the Cairns region have actual levels of use consistently close to the permitted levels. In some cases actual use levels exceed permitted levels on a month by month basis. By contrast, sites in the central section less frequently approach permitted levels of use.

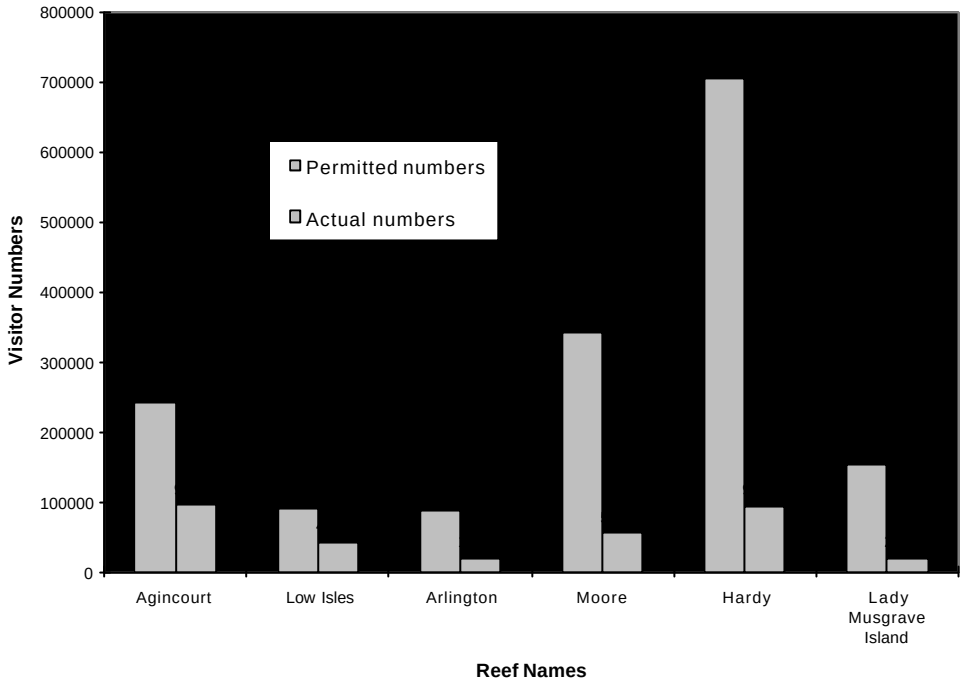

Figure 3: Graphs of Selected Sites with Permitted and Actual Use, 1994. Combines Permits database information with Data Returns Database (EMC) information.

4.2 More comprehensive investigations

After the initial investigations this project was suspended while the Data Returns Database was established on the GBRMPA computer system. Subsequently a number of analyses were carried out to review the utility of the system in providing data. These are described below, with information on the process of data access provided in the following section.

4.2.1 Visitor numbers to the Great Barrier Reef, carried by commercial operators, for the 1993-94 financial year

The number of visitors carried to the reef each day can be obtained from the *pax* and *foc* columns of the *permits.return_t* table. Again it is important to point out that the *foc* numbers are already included in the *pax* values. The transfer numbers for the same period are also provided, even though they are not using the reef directly (see the logbook instructions of Appendix IV for the definition of a transfer passenger).

Figure 4 presents the visitor and free of charge passenger numbers for the whole reef during the 1993-94 and 1994-95 financial years. The final numbers may be an underestimation, due to

the problems of data loss experienced by the database as described in Section 6. Estimated commercial passenger use for the 12 month period July 1993 - June 1994 is 2 165 436 and for the 12 month period July 1994 - June 1995 is 2 127 534. These annual visitation figures might be compared with the estimate given by Driml (1987) of 1 119 000 visitor days for 1984-85 based on a census of commercial operators. More recently (Driml, 1994) gives an estimate of commercial use for 1993 as 2 291 000 visitors, however this figure included some 947 272 transfers including those between Magnetic Island and Townsville (Driml, pers. comm.). The non-transfer total commercial visitor figure was 1 413 508. By comparison the 1993 - 95 database appears to have a very low number of transfers. It is unclear what the cause of this might be but very few, if any, Magnetic Island transfers are included.

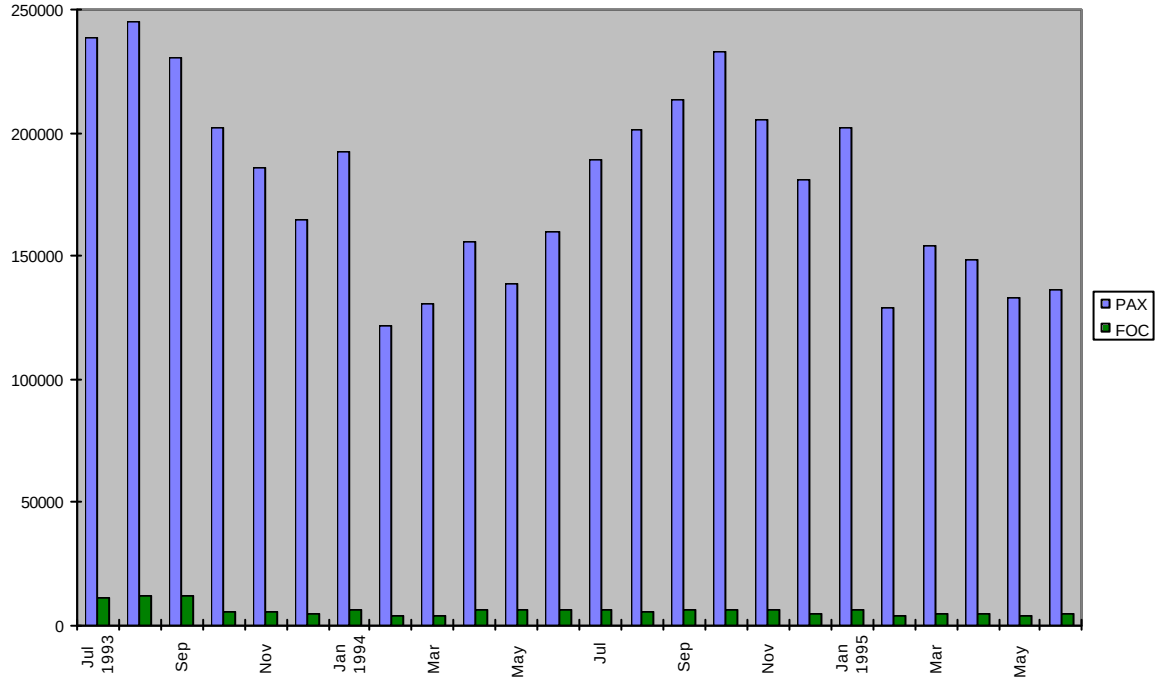

Figure 4: Monthly Visitation Data for the Great Barrier Reef July 1993 to June 1995, extracted from the Data Returns Database, PAX = paying passengers, FOC = others.

4.2.2 Visitor numbers for selected reefs of the Great Barrier Reef

The aim of this case study was to explore the data availability and extraction processes for a selected number of reefs. Reefs were selected for inclusion on the basis of anticipated visitation levels and that the site had numerous operators (to overcome any possible confidentiality issues). It is possible to isolate visitor numbers to the pontoons themselves using the data available from the Data Returns Database by linking up to the Permits Database and although we tested this process no results are presented here. By using visitor

numbers to the whole reef, rather than the specific pontoon sites, commercial confidentiality problems are also circumvented. The *pax* and *foc* numbers have been found for the following reefs: Agincourt, Low Isles, Norman, Arlington, Moore, Kelso, Hardy, Credlin, and Lady Musgrave Island.

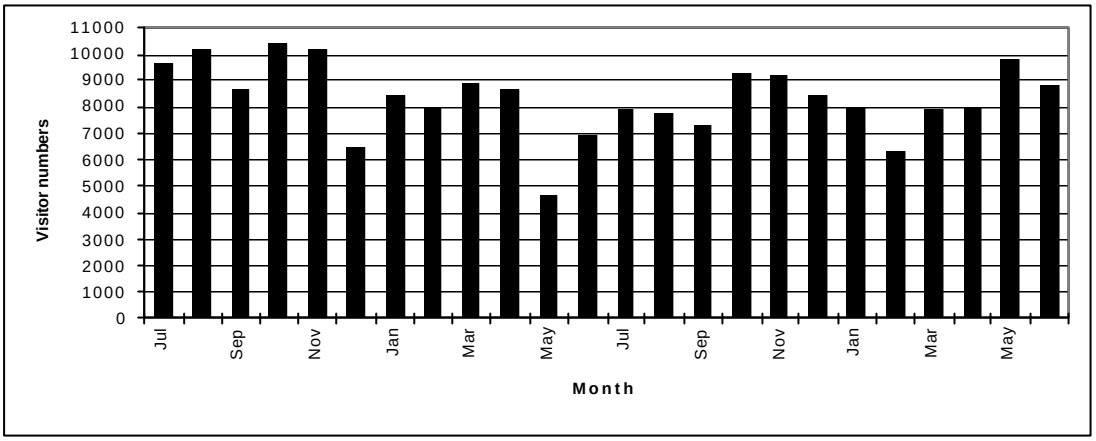

Figure 5: Total visitor numbers to Agincourt Reef, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 15 actual operators)

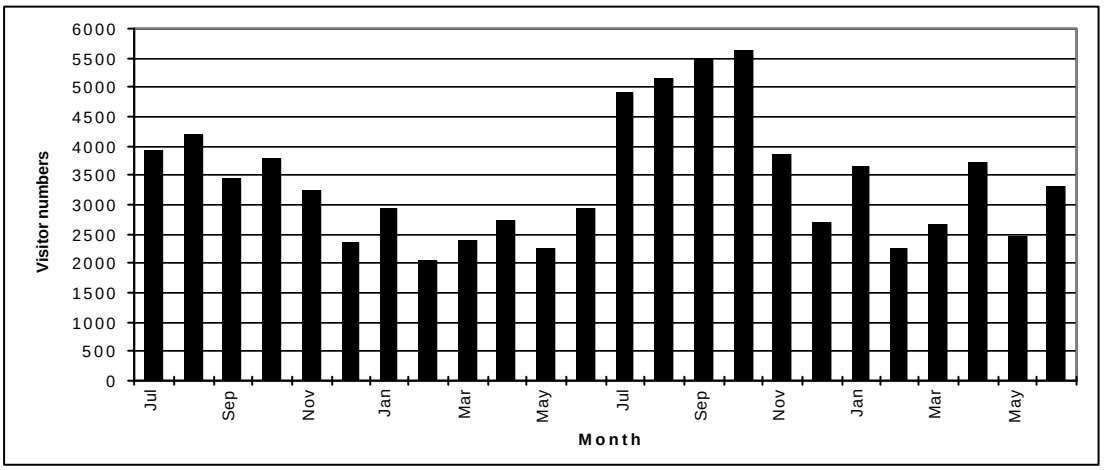

Figure 6: Total visitor numbers to the Low Isles Reef, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 14 actual operators)

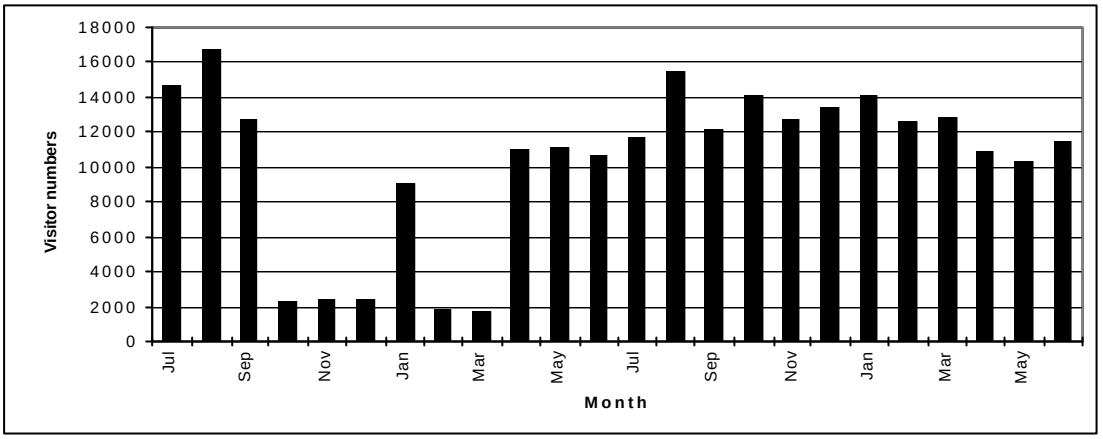

Figure 7: Total visitor numbers to Norman Reef, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 14 actual operators)

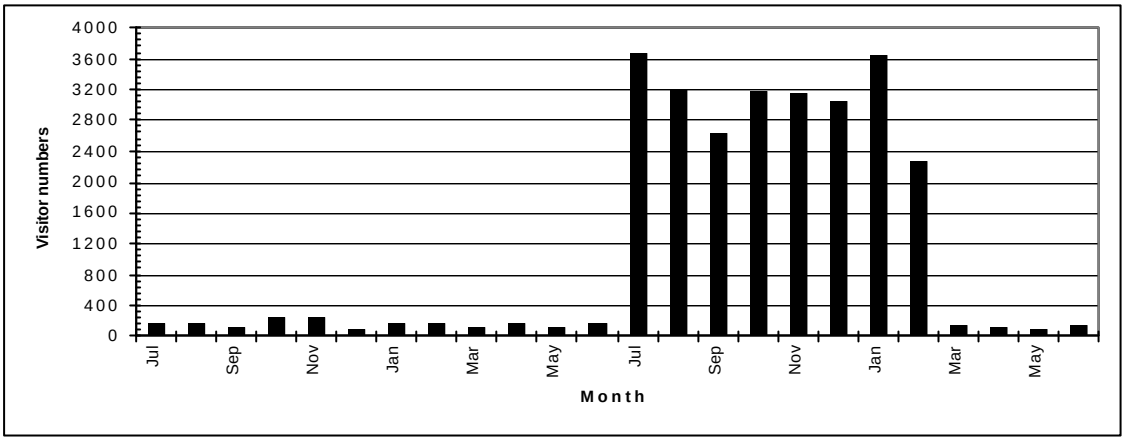

Figure 8: Total visitor numbers to Arlington Reef, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 14 actual operators)

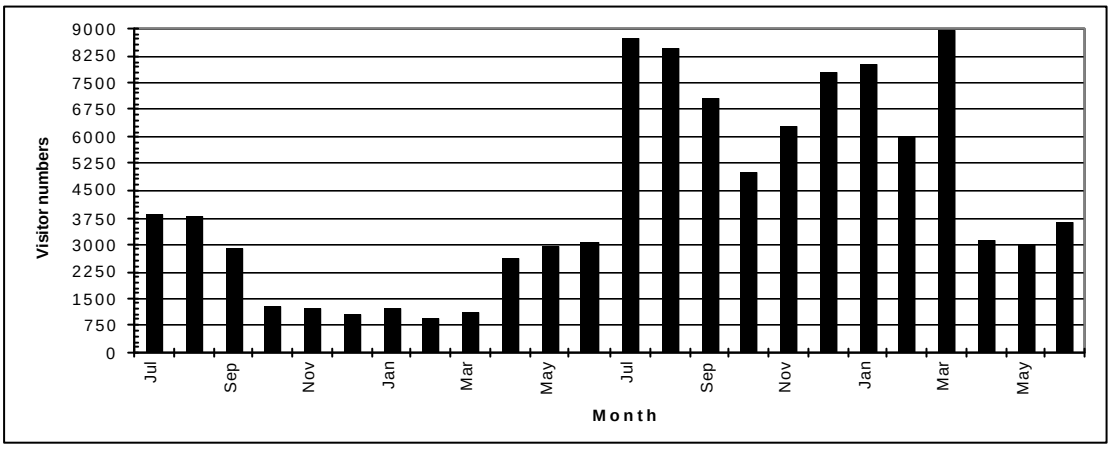

Figure 9: Total visitor numbers to Moore Reef, carried by commercial operators for each month of the 1993-4 and 1994-5 financial years (n ? 6 actual operators)

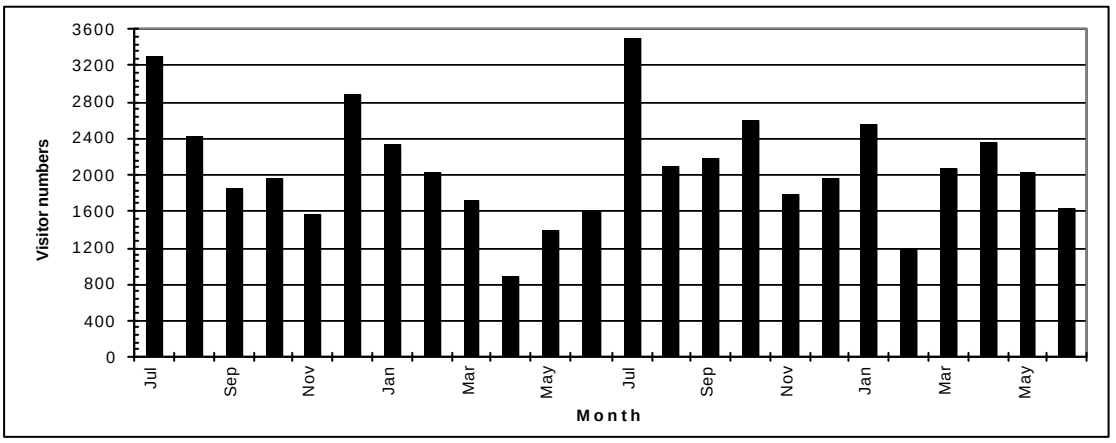

Figure 10: Total visitor numbers to Kelso Reef, carried by commercial operators for each month of the 1993-4 and 1994-5 financial years (n ? 6 actual operators)

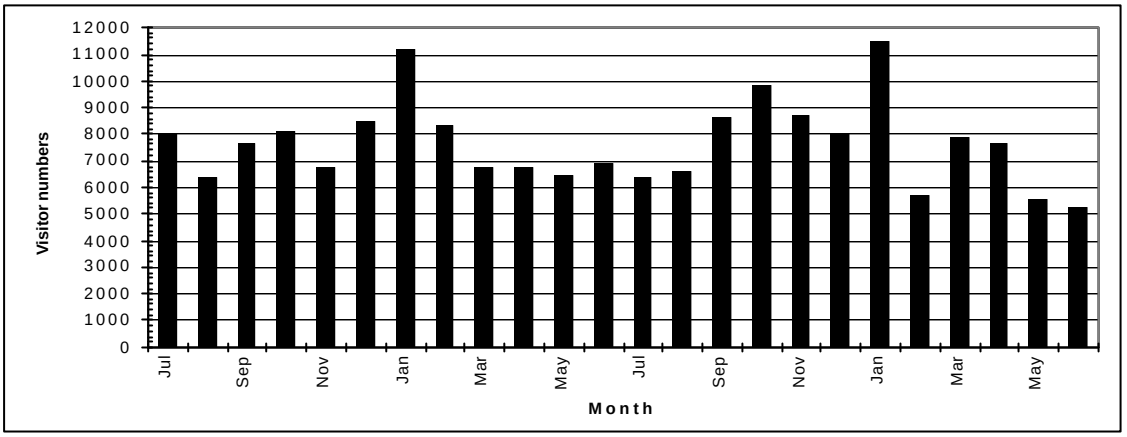

Figure 11: Total visitor numbers to Hardy Reef, carried by commercial operators for each month of the 1993-4 and 1994-5 financial years (n ? 10 actual operators)

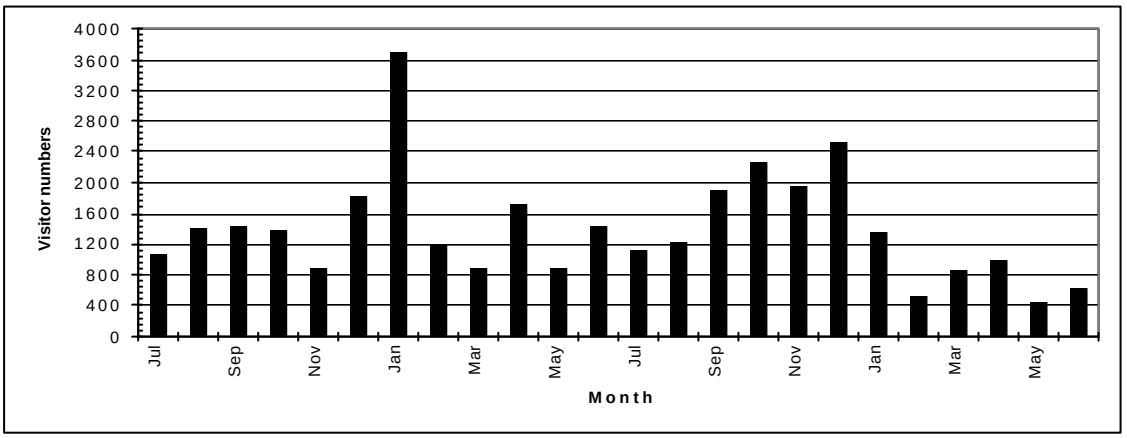

Figure 12: Total visitor numbers to Credlin Reef, carried by commercial operators for each month of the 1993-4 and 1994-5 financial years (n ? 4 actual operators)

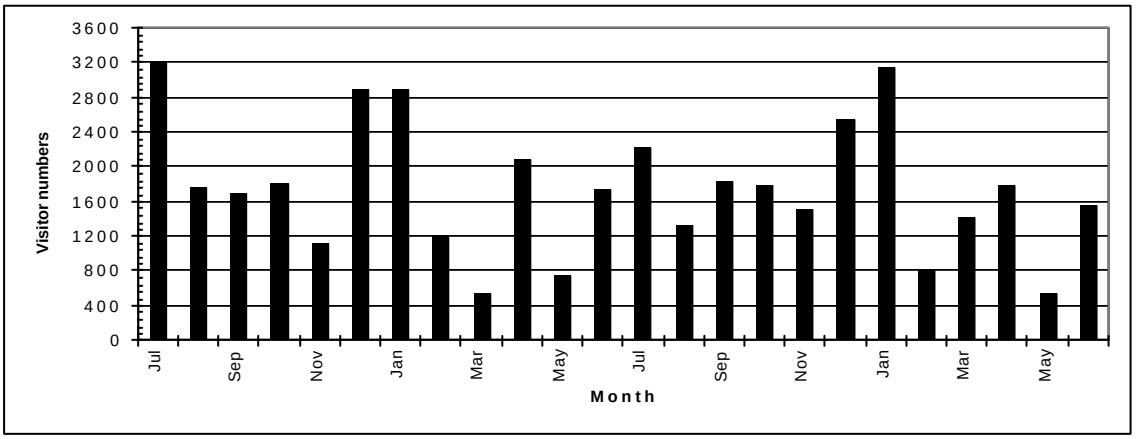

Figure 13: Total visitor numbers to Lady Musgrave Island Reef, carried by commercial operators for each month of the 1993-4 and 1994-5 financial years (n ? 12 actual operators)

4.2.3 Visitor numbers to the Yongala Wreck and alternative local sites

The Yongala Wreck represents a popular dive destination from Townsville for both tourists and locals. Dive suitability at the site is highly dependent upon the weather conditions. For this reason several local reefs are used as alternatives when the conditions are unfavourable, in particular Wheeler, Davies, and Keeper Reefs. Yongala is being used as a study site for another project within the CRC (Project 2.2.2, Special Interest Tourism). Visitor numbers for the Yongala Wreck and the alternative sites, for the period July 1993 to June 1995, were obtained from the Data Returns Database and are presented as Figure 14. It is clear that there is a marked inverse relationship between Wheeler Reef use and Yongala. In some months all sites are well down, the consequence of poor conditions. The extreme range of variation at Yongala for the period under study was from a minimum of 49 (February 1994) to a maximum of 487 (November 1994). The other sites had a much smaller variation of use numbers between months.

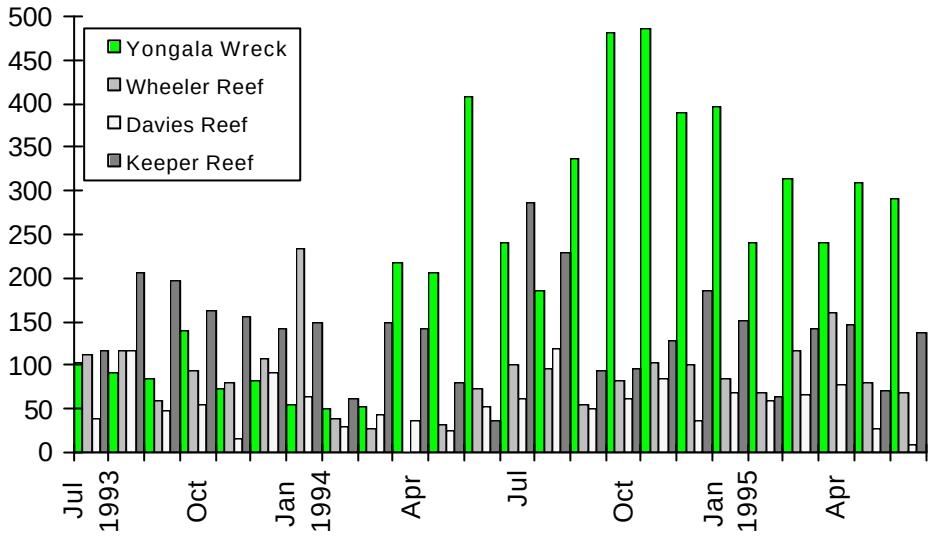

Figure 14: Total visitor numbers to the Yongala Wreck, and the alternative sites of Wheeler, Davies and Keeper Reefs, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years.

4.2.4 Visitor numbers to Ribbon Reef No.10 (including the Cod Hole) and Hastings Reef

Two other GBRMP sites popular with recreational divers are the Cod Hole and Hastings Reef. The Cod Hole site is included within the reef ID number for Ribbon Reef No.10, as a result the only way to identify visitor numbers to the Cod Hole is to use the visitor numbers for Ribbon Reef No.10. Visitor numbers for the first two years of EMC data have been extracted from the Data Returns Database and are presented as Figures 15 and 16. It is of interest to note that at the Cod Hole monthly use numbers by Commercial Operators is consistently high and in the 12 month period never fell below 600 passengers and averaged over 1000 each month. Some increase in use during July to November is evident from the data. Given the nature of the Cod Hole site, it is likely that almost all passengers recorded are divers. There is no information about length of stay but if each person made at least two dives at the site it would imply an average for the year of around 70 dives per day. It is not clear how many of these dives were actually at the Cod Hole but it is suspected that most are confined to that single site. The private use level is unknown.

Hastings Reef has a much greater level of use with over 60,000 passengers for the first twelve month period. However few passengers at this destination are likely to be divers and

the reef use profile will differ significantly from the Cod Hole. Such information is not available from the Data Returns Data base.

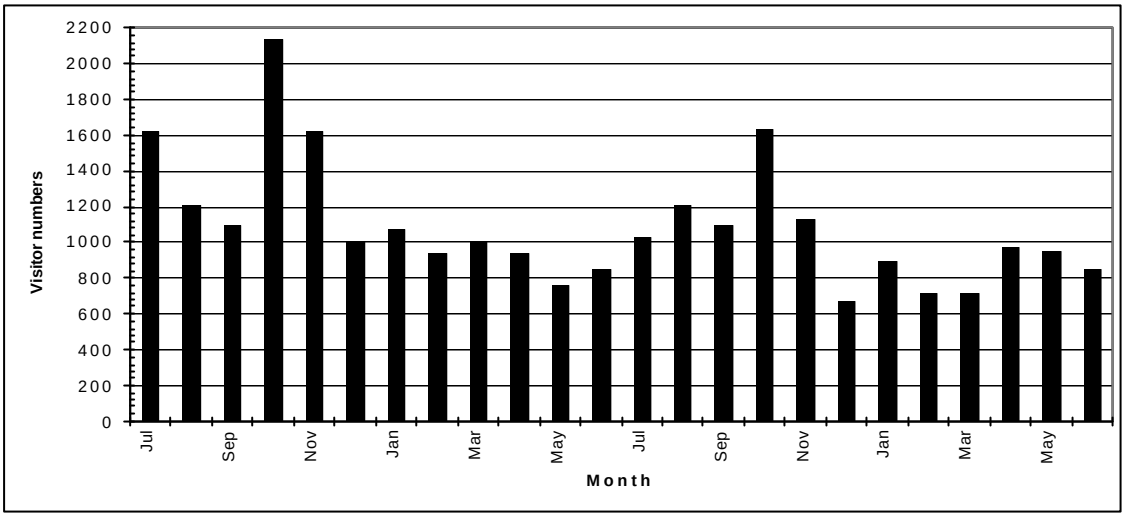

Figure 15: Visitor numbers to the Cod Hole/Ribbon Reef #10, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 20 actual operators)

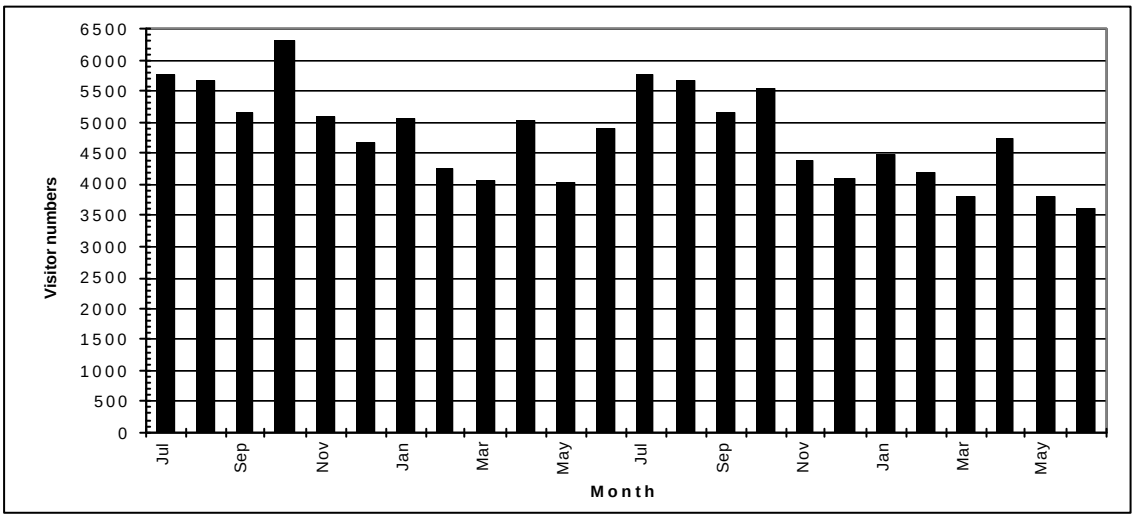

Figure 16: Visitor numbers to Hastings Reef, carried by commercial operators, for each month of the 1993-4 and 1994-5 financial years (n ? 20 actual operators)

4.2.5 Use intensity and frequency for the GBR

Although, as noted previously, a very high proportion of all reefs are permitted for commercial use (only 1% are excluded), the actual level of use at different sites can vary enormously. Using the Data Returns database the numbers of reefs having different levels of EMC based use for 1994 were examined and the following table was prepared:

Table IV: Annual Visitor Numbers by Number of Reefs, 1994

# of Visitors	# of Reefs	% of Visited Reefs
1 - 100	598	63.6
101 - 500	193	20.5
501 - 1 000	44	4.7
1 001 - 5 000	43	4.7
5 001 - 10 000	18	1.9
10 001 - 50 000	33	3.5
50 001 - 100 000	7	0.7
>100 000	4	0.4

The data in Table IV show that in 1994, despite the permit situation mentioned above, only 940 reefs (36%) actually received any commercial visitation. Most reefs received only a small number of commercial visitors (about 78% of visited reefs having less than 500 per annum). A relatively small number of reefs receive the bulk of the visitors. The majority of high volume reefs are those with Pontoons.

4.2.6 Using Site-based Quarterly Data from *GBRMPA Info Exchange*: Some Examples

Given the relative ease of extraction provided by the *GBRMPA Info Exchange* home page a few reef sites were searched and simple graphs produced to test utility and speed using this option. Instead of extracting the daily data, with the limitations of such large data sets, the summary statistics in the non-password area were accessed. These compile data from the database in quarterly chunks. Examples are given which can be compared with the more detailed monthly points for the same sites above. Although there is clearly a loss of information the difference in extraction ease and time is enormous. If the recommendations concerning time unit selection buttons are taken up then researchers will be able to get the finer quality data just as simply.

The examples presented below are for the first three years of the EMC data, from 1 July 1993 to 30 June 1996. Figure 17 shows the Lady Musgrave quarterly data.

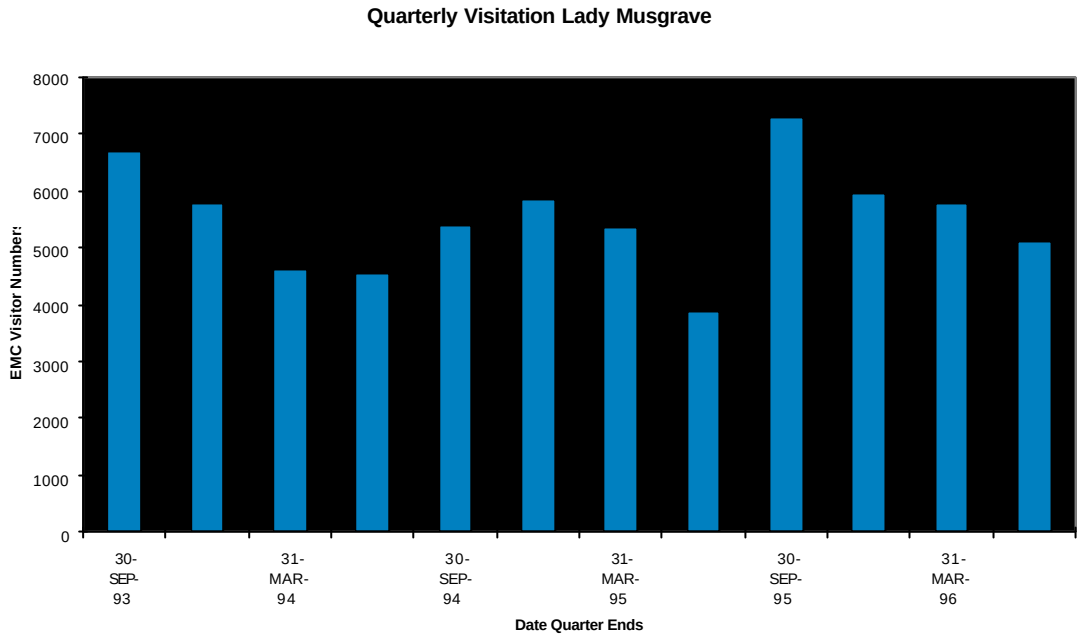

Figure 17: Quarterly EMC Visitor Data for Lady Musgrave Island and Reef (typically, n ? 12 actual operators per quarter)

The next three graphs show interesting contrasts in consistency over the three years. Agincourt Reefs (Figure 18), with many vessels using this site, retains a relatively high level of use but shows a steady decline over the three year period. Moore Reef (Figure 19), shows more seasonality than Agincourt but clearly went through significant growth of visitors in the three years. Figure 20 shows Norman Reef which experienced a dramatic decline in use in the second quarter but has since recovered to almost a consistently high quarterly use pattern.

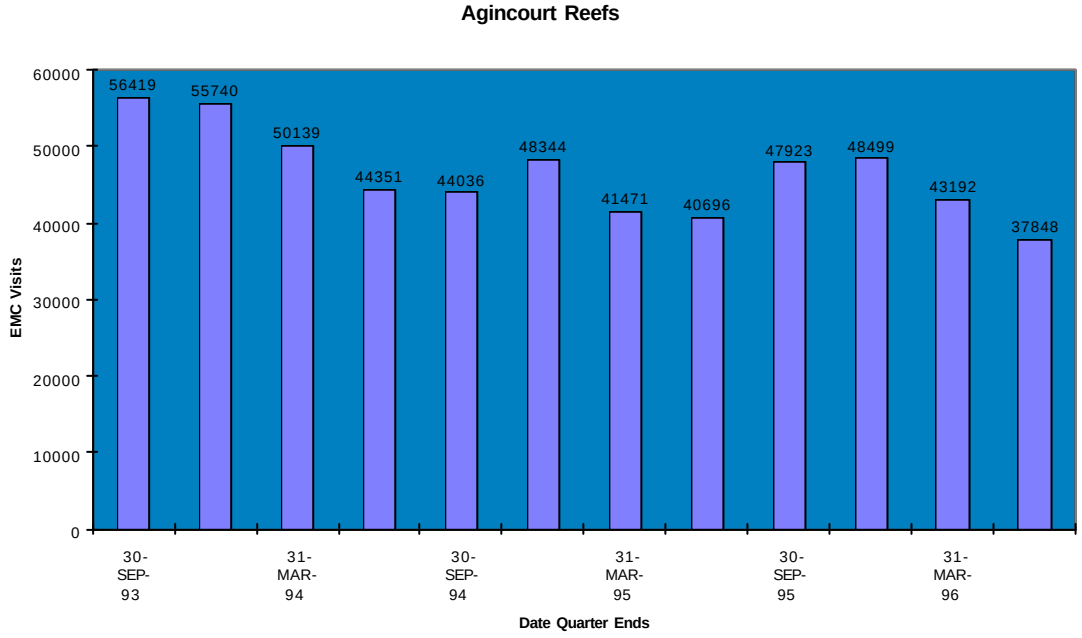

Figure 18: Three Years of Quarterly EMC Visitor Data for Agincourt Reef (typically, n ? 15 actual operators per quarter)

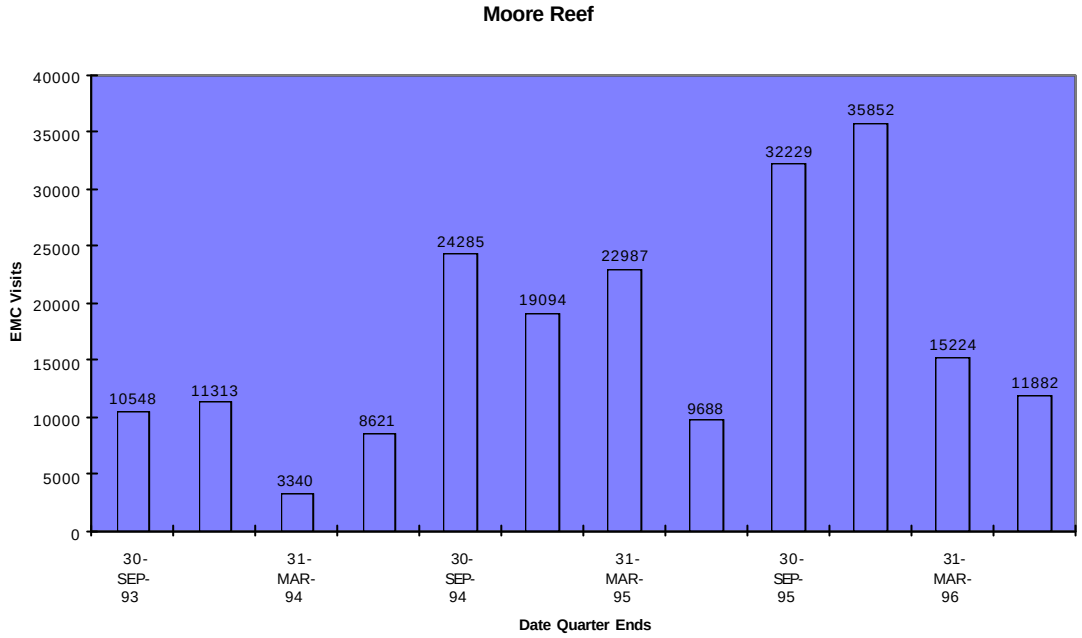

Figure 19: Three Years of Quarterly EMC Visitor Data for Moore Reef (typically, n ? 26 actual operators per quarter)

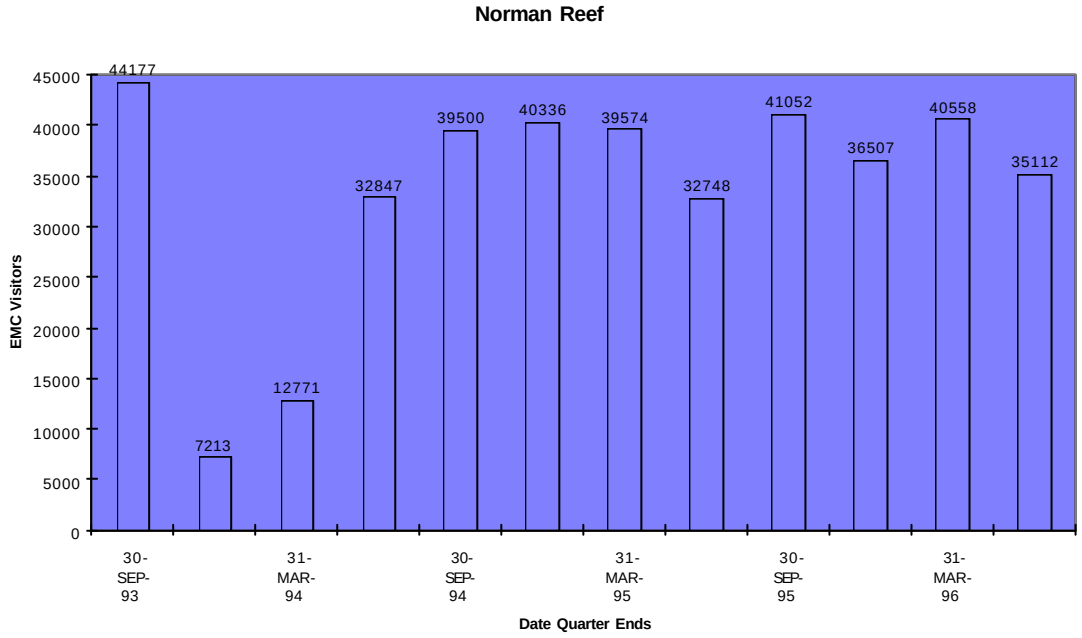

Figure 20: Three Years of Quarterly EMC Visitor Data for Norman Reef (typically, n ? 14 actual operators per quarter)

The final examples are two very different destinations. Figure 21 shows the quarterly data for Green Island, at one time the most heavily visited coral reef in Australia, if not the world. The period of the EMC data collection has seen a dramatic fall in use as the graph illustrates, although it still remains very high at an average over 400 persons per day. This fall coincides with development changes on Green Island itself and with the opening of additional

destinations in the region. These two factors are likely to be responsible for much of the variation. At the other end of the visitor intensity spectrum for commercial sites is the Yongala dive site, illustrated in Figure 22. This site shows a very significant increase in use (from a low starting point), and the quarterly aggregation tends to mask the weather related erratic monthly patterns seen in the earlier graph (Figure 14 above).

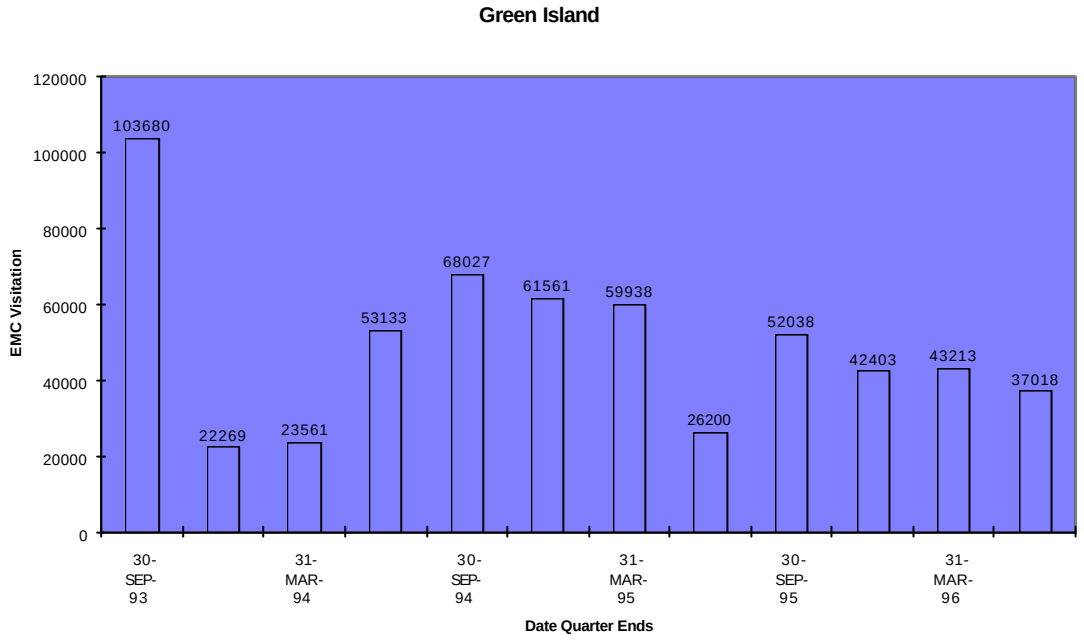

Figure 21: Three Years of Quarterly EMC Visitor Data for Green Island (typically, n ? 14 actual operators per quarter)

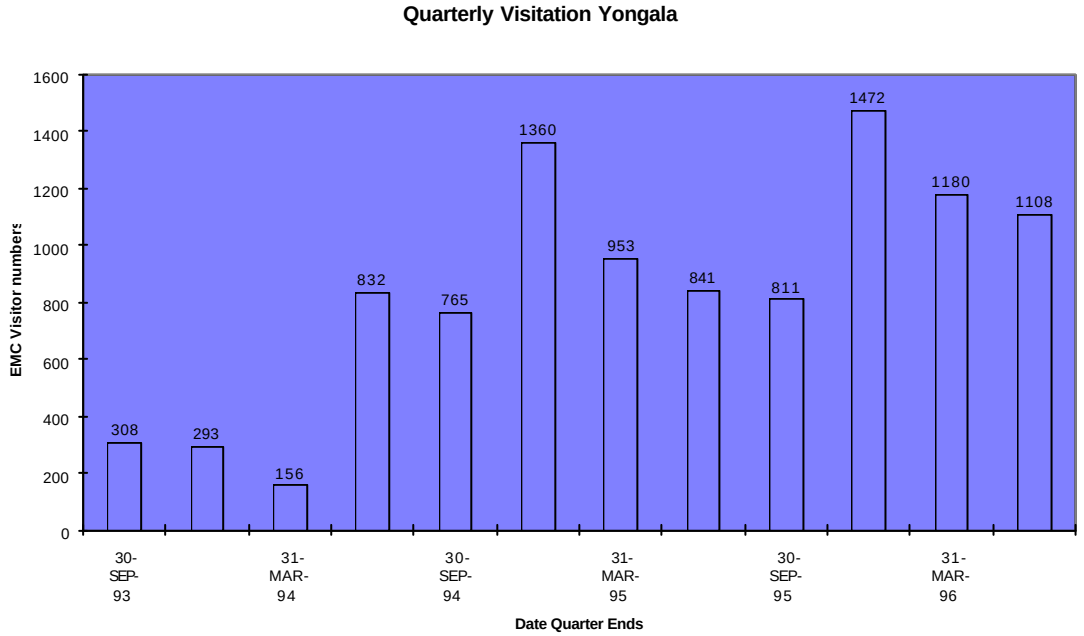

Figure 22: Three Years of Quarterly EMC Visitor Data for Yongala Dive Site (typically, n ? 16 actual operators per quarter)

4.3 The distribution of private boats along the coast adjacent to the GBRMP, and an estimate of yearly visitor numbers to the GBRMP by private boat owners

Although the Data Returns Database provides data on visitor numbers to the reef carried by commercial operators, there is also a large and important number of visitors to the reef attributable to private boaters. Because the number of visitors to the reef through private boat use is believed to be significant, an attempt has been made to estimate the number of visitor days to the reef due to private boat use.

To estimate the number of visitor days to the reef three pieces of information are required; the number of private boats which can visit the reef, the average number of visits made by those boats, and the average number of passengers for each visit to the reef.

Information on the number of boats registered in Queensland, the town where they are registered, and the number of boats in each of several size classes was obtained from the Queensland Department of Transport. Because boats smaller than 4m in length are unlikely to travel to the reef itself, they were excluded from the calculations. The rest of the boats were divided into two size classes: 4-6m and >6m in length. The numbers of registered boats in each of these two size classes for the coastal cities adjacent to the GBRMP are given in Figure 23. The data obtained from the Queensland Department of Transport were then combined with population numbers obtained from 1991 Census to calculate the number of registered boats per 1000 people at the city of registration. This was done independently for each of the two size classes, and for each of the coastal cities adjacent to the GBRMP which is used as a location of registration. The values obtained from this process are presented in Figure 24 which shows a very high concentration of boats in the 4-6m size class for Proserpine. This is most likely due to Proserpine's proximity to the Whitsunday Islands.

Valentine & Landes (1989) used a postal survey to estimate the average number of times boats from each of the two size classes visited the reef per year, and the average number of passengers aboard during each visit. Although the questionnaire sampled boat owners from several nearby coastal cities, it only asked about the number of times visits were made to the Whitsunday region. Because the nearest coastal town adjacent to the Whitsundays is Proserpine, the Proserpine values for the number of visits per year per boat is used to calculate the total number of boat visits per year for the reef.

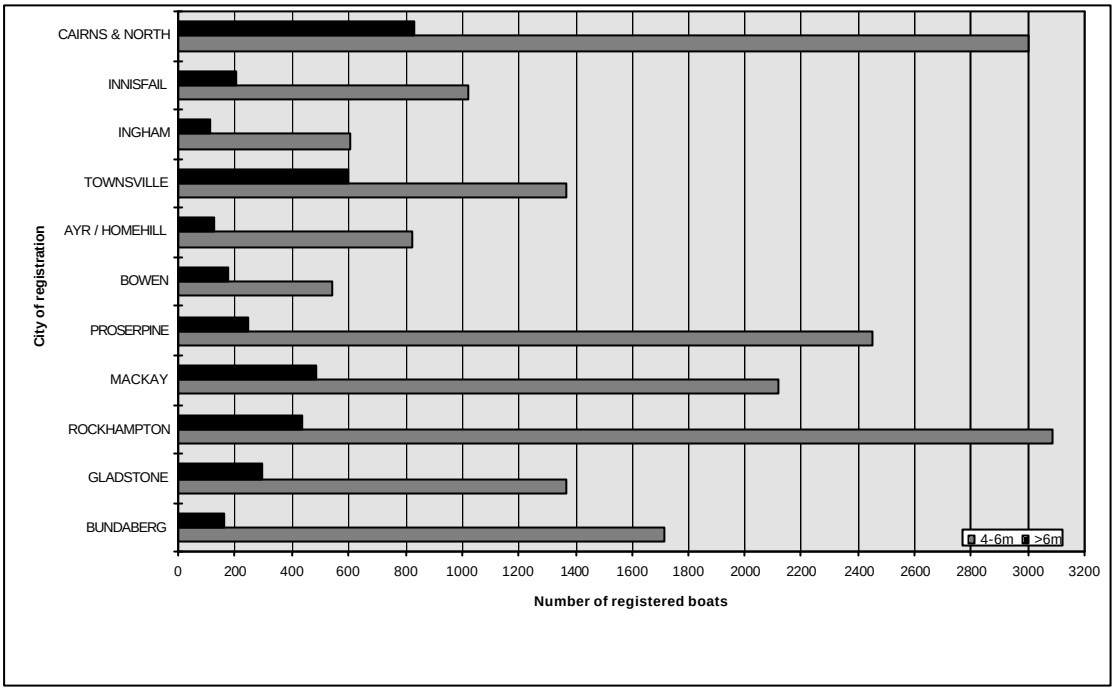

Figure 23: The distribution of boat registrations along the Queensland coast north of Bundaberg, for the boat size classes of 4-6m and >6m. (Data supplied by the Queensland Department of Transport).

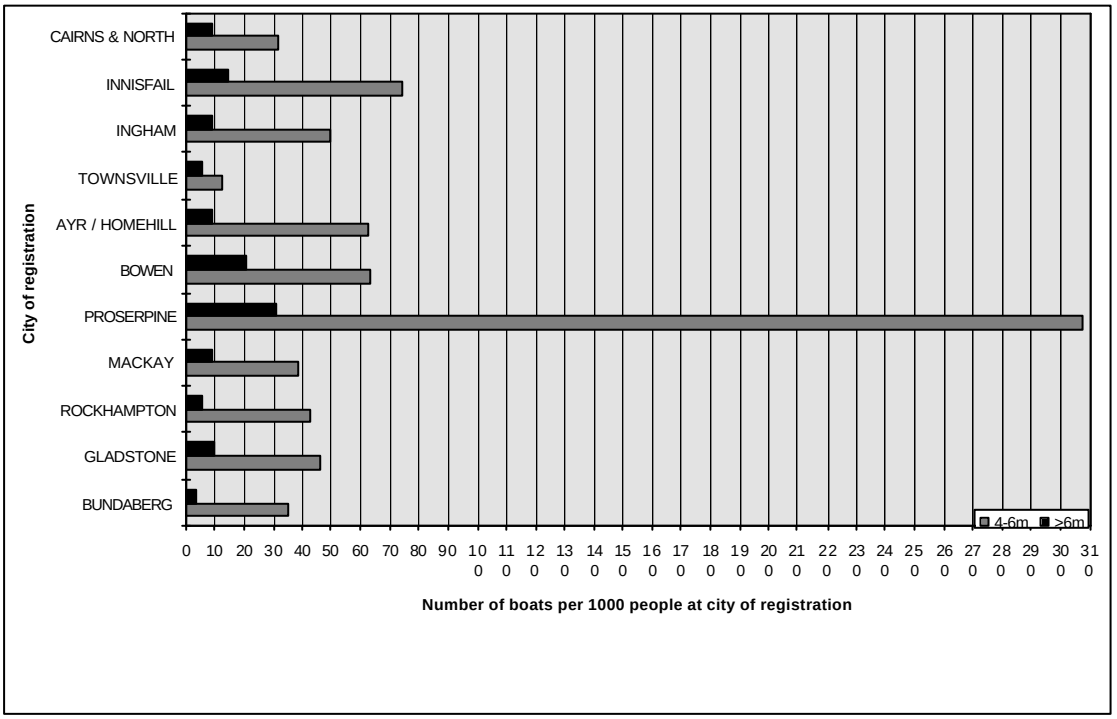

Figure 24: Number of registered boats per 1000 people at city of registration, for coastal towns of Queensland north of Bundaberg, grouped in the boat size classes of 4-6m and >6m. (Data supplied by the Queensland Department of Transport).

The average number of visits to the reef per year per boat given by Valentine & Landes (1989) is 24 for 4-6m boats and 40 for >6m boats. The average number of passengers per boat was estimated at 3. Because the Whitsunday area is favourable to boating due to its protected waters, it is likely that the level of boating occurring out of Proserpine is higher than the average for other areas adjacent to the reef. As a result, by using Proserpine boating rates as the average, the estimate of visitor days to the reef by private boat users may be high. The results of studies in Driml (1987) and Blamey & Hundloe (1993) suggest that these Proserpine rates of use may be too high although the latter study deals with recreational fishing use rather than the more comprehensive set of boating use for which the data were gathered in the Proserpine area.

For the 4-6m boat size class there are 19040 private boats registered in coastal cities adjacent to the GBRMP. Using the Proserpine figure of 24 visitor days to the reef per year per boat and an average of 3 passengers per trip we obtain a total of 1,370,880 visitor days. For the >6m boat size class there are 3726 private boats registered along the coast adjacent to the GBRMP. Using the Proserpine figure of 40 visit days to the reef per year and an average passenger number per trip of 3, a total of 447,120 visitor days is obtained. Overall this gives a combined figure of 1,818,000 visitor days to the reef per year due to private boats. Combined with the commercial estimate based on the Data Returns Database this gives a total estimate of 4 million visits for the 12 month period. This overall estimate is clearly subject to the qualifications expressed above. A formal project to more accurately estimate private boat use is overdue.

5. A GUIDE TO EXTRACTING DATA FROM THE DATA RETURNS DATABASE

This section gives basic SQL commands for some commonly asked database queries. An explanation of the queries, working examples, and some tips on using SQL are provided for two of the above case studies (Sections 4.2.1 and 4.2.2). The command strings used in the following examples may not be the only or simplest way to obtain the desired information, but they are straightforward, and they do work. Most of the data obtained for this project were done so using a remote terminal directly logged into the GBRMPA computer accessing the Data Returns Database and using SQL commands. This system is not recommended compared with the internet home page interface now developed.

A good introductory reference to using and creating SQL commands for an Oracle database is Sayles (1990).

5.1 Obtaining reef ID numbers

(i) Reef ID numbers can be obtained from the GBRMP zoning maps.

(ii) They can also be obtained from the Data Returns Database if the common name for the site is known. For example, to find out the reef ID number for the Cod Hole, use the command string:

```
select distinct reef_id
from permits.return_t
where reef_name =  'Cod Hole';
```

The reef ID is the key identification for data access on this database, hence the importance of ensuring the area of interest is accurately and fully described (see further discussion below).

5.2 Obtaining total visitor numbers

To obtain the total number of visitors to the reef for July 1993, the following SQL*PLUS command string can be used:

```
SQL> select sum(pax), sum(foc) Ø
2  from permits.return_t Ø
3  where rdate between '1-jul-93' and '31-jul-93'; Ø
```

This command is in the basic form of all SQL queries. That is, it has the structure:

```
select <result(s)>
from <table(s)>
where <condition(s)>
```

Line 1 tells the system that it is the independent sum of the values in the *pax* and *foc* columns that meet the conditions desired. Line 2 identifies the location for the data as the

permits.return_t table. Line 3 indicates that only the *pax* values for the rows in which the *rdate* values lie between the 1st of July 1993 and the 31st of July 1993 inclusive should be used. The syntax used is extremely important, or the command will not be carried out. For example, in the third line, the values for the dates are enclosed within single apostrophes. This is the case for all parameter values which can contain letter characters. The final character of any command is the semi-colon, which instructs the system to carry out the command.

If an error is made when the command string is being typed in, the letters can be deleted by using **Ctrl ¨** (Control + backspace)**.** If the error has been made in a previous line, or after the command has been executed, the error can be corrected using the SQL command "change". First the "list" command is used to indicate which line is to be edited, and then the "change" command is used to correct the error. This "change" command takes the form: **SQL> c/<error>/<replacement>** . For example, if we wish to change the command given above, to obtain the values for a different date, we would do the following:

SQL> list 3 Ø
3* where rdate between '1-jul-93' and '31-jul-93'
SQL> c/31-jul-93/30-jun-94 Ø
3* where rdate between '1-jul-93' and '30-jun-94'
SQL>

If you type **list** without giving a specific line, the whole command will be given, and only the last line can be edited. To execute the corrected command, type **run** at the SQL prompt. These methods of correction will prove very useful and time saving, by eliminating the need to retype the whole command to correct a single typing error.

Using this process it is possible to obtain the *pax* and *foc* numbers carried to the reef by commercial operators for each month of the 1993-94 financial year. Using the "change" command, makes this task much easier and faster. The monthly figures obtained from the database can then be double-checked by obtaining the *pax* and *foc* totals for the entire financial year from the database, and comparing that figure with the sum of the monthly figures. Users are advised that the structure of this database and the control system used makes it very easy to produce errors and careful checking of commands is important.

5.3 Obtaining visitor numbers for a specific reef

When the site of the visitation becomes specific, it is necessary to use parameter values in any command to identify the areas of interest. There are several columns which allow data from the database to be restricted to that for the area of interest:

permits.return_t table
vname
vregno
permits.rsite_t table
reef_id, reef_sub_id (the *reef_sub_id* must be used in association with a *reef_id* value)
reef_name
longitude-latitude coordinates (using a combination of the *lat_deg, lat_min, long_deg,* and *long_min* columns)

The nature of the information required from the database will determine which of the columns is the most appropriate to be used to set the location parameters. For example, if a specific site at a specific reef is of interest, the name of that site would probably be the most appropriate location column to use in the "where" section of the command string. However, if the total number of visitors to a given reef is of interest, then it would probably be best to use the *reef_id* column.

Of great importance when deciding which of the location columns to use, is how often they occur in the table with "null data". That is, how often does that column contain rows with no datum? Using data for the 1993-94 financial year, the following figures were obtained:

Column	Number of rows containing data (% of total rows)
return_id	89582 (100)
vname	85995 (96%)
vregno	29674 (33%)
reef_id	89373 (99.8%)
reef_name	89578 (~100%)
long_deg	78877 (88%)

Although it is also possible to use a reef name or a long-lat coordinate value as the location parameter, there are problems with both methods.

As indicated earlier (see box above), only 88% of locations are entered as long-lat coordinates, and this in itself limits the viability of using them as a location parameter. Although the column *reef_name* has the lowest number of null data entries for location parameters, the exact name used for a given site can vary from operator to operator. For example, to find visitor numbers to Ribbon Reef, the parameter "and reef_name = 'Ribbon Reef No. 10" could be used. However, using the reef ID for Ribbon Reef to double check the distinct names used for the Ribbon Reef ID number, it is found that the names Cod Hole, Cod Hole/Fish Tank and Robbin Reef no. 10 are also used as reef names. This means that the initial search using the reef name Ribbon Reef No.10 would have missed the visitor numbers for those operators which have used an alternative name for the Ribbon Reefs. There is also a less serious error with using the reef ID numbers to indicate location, in that 0.2% of current (Feb '95) entries do not contain a reef ID value.

As an example, to access the visitor numbers to Hardy Reef, we could simply use the *reef_name* 'Hardy Reef'. However, we can't be certain that some operators have not used the Hardy Reef system, or a part thereof, and called it something else. Therefore the first step would be to use a zone map or the database to find out the reef ID for Hardy Reef. To do it using the database, we would use the following command string:

```
SQL> select distinct reef_id Ø
2   from permits.rsite_t Ø
3   where reef_name = 'Hardy Reef'; Ø
```

Using the resulting reef ID number (19135) it is then possible to find out any reef sub IDs, site names, or longitude-latitude coordinates used for the Hardy Reef area. In this situation, another SQL*PLUS command becomes essential. That is the "distinct" command. If, as in the Hardy Reef example, it is suspected that there is more than one answer to the select query and the given parameter, then only each distinct answer is of interest. For example, by using the command:

```
SQL> select reef_name Ø
2   from permits.rsite_t Ø
```

```
3   where reef_id = '19135'; Ø
```

Then the answer would be every row which contains the *reef_id* number 19135. This would involve the computer scrolling through rows and rows of answers for well over 10 minutes.

If this type of problem occurs, the scrolling process can be broken using **Ctrl Pause**. In the above case it would be impossible to identify each distinct reef name associated with the given reef ID number. The "distinct" command overcomes this problem. To obtain each distinct site name and reef sub-ID combination associated with the reef ID number 19135, use the following command string:

```
SQL> select distinct reef_name,  reef_sub_id Ø
2   from permits.rsite_t Ø
3   where reef_id = 19135; Ø
```

The return answer would be:

```
REEF_NAME                 R
------------------------  --
Fantasea Pontoon
Fantasia
Hardy Lagoon
Hardy Reef                S
Hardy Reef                s
```

From the above answer it can be seen that there are five distinct *reef_name* entries used for the Hardy Reef *reef_id* number. It is also important to note that only the name Hardy Reef has a value for the *reef_sub_id* column, and that the database is sensitive to upper vs lower case entries. If we were to use 'hardy reef' as a *reef_name* parameter in a command string, then we would get an answer of "no rows selected", because the correct *reef_name* entry should be 'Hardy Reef'.

If we are only interested in visitor numbers for Fantasea Pontoon, we can use the *reef_name* entry as the parameter to isolate it from the other sites at Hardy Reef. Because we are now using data from both the *permits.return_t* and *permits.rsite_t* tables they must both be listed and "linked" in the command string. They are both listed in the “from” section of the command

string, by listing one after the other with a comma and a space between them. They must also be “linked” in the fist line of the "where" section of the command string, by identifying the primary key between the two tables. In this database the two tables are linked by the primary key column *return_id*. Because the primary key column has the same name in both tables, it is also necessary to clarify that both tables have a primary key column named *return_id*.

This is done by placing the table name in front of the column name:

(ie **3 where permits.return_t.return_id = permits.rsite_t.return_id**).

To obtain the number of free of charge visitors to the Fantasea Pontoon for July 1993 the following command string could be used:

SQL> select sum (foc) Ø
2 from permits.return_t, permits.rsite_t Ø
3 where permits.return_t.return_id = permits.rsite_t.return_id Ø
4 and reef_name = 'Fantasea Pontoon' Ø
5 and rdate between '1-jul-93' and '31-jul-93'; Ø

However, to obtain the visitors to the whole of the Hardy Reef system, then the command string to use is:

SQL> select sum (foc) Ø
2 from permits.return_t, permits.rsite_t Ø
3 where permits.return_t.return_id = permits.rsite_t.return_id Ø
4 and reef_id = 19135 Ø
5 and rdate between '1-jul-93' and '31-jul-93'; Ø

This answer would include any specific sites at Hardy Reef and all operators using the reef.

Overall, probably the most effective way to specify a reef is to use the reef ID value. It has been suggested to GBRMPA that a searchable table be provided on the web page enabling a reefID to be obtained from a reef name and *vice-versa*.

5.4 Obtaining visitor numbers for a wide area

There are two possible ways to retrieve data for a particular area.

(i) List the specific *reef_id* values for the reefs which occur in the area, or use the between statement to take advantage of the latitude coordinate at the beginning of the reef ID value.

(ii) Link the search to the IRIS Database which will allow the search to be carried out by section.

6. REAL AND POTENTIAL PROBLEMS EXPERIENCED WITH THE DATA RETURNS DATABASE

The most significant problem experienced with the database during this review was that some data were lost from the system. It is not known exactly how the data were lost, but is suspected that the loss was caused by an operator during a data search. The lost data were identified by GBRMPA staff as entries for reef_id numbers 16001 to 16049 inclusive, prior to the 1st of October 1994. These data have now been replaced using backup tapes. However, it is possible that other undetected data losses may have occurred.

A second problem relates to data associated with roving permits. Although GBRMPA recommends that roving permit holders enter data for each site visited on any trip, there is not consistent compliance. Some roving permit operators enter visitor numbers for each site and others only enter data for the first site visited. The most appropriate method would be to enter data for each site visited, as that would allow more accurate user numbers for the secondary sites. Perhaps the best way to overcome this problem would be to provide information to operators with roving permits and explain the correct way to enter data and the reasons for this.

One limitation of the database is the amount of information available without having to link the search with other databases. For example, to limit a search to a given section, it must be linked to the IRIS Database. And to get an indication of activities carried out at any particular reef, the search must be linked to the Permits Database. The need to link a search to a secondary database has two main disadvantages. First it makes the SQL command string much more complex and difficult, as well as introducing the difficulties of use associated with the

secondary database. Secondly there is the problem of access. To get information on activities undertaken at specific reefs, which are ecologically important but that are not commercially sensitive, requires access to the permits database, which is commercially sensitive and involves access limitations. It may be useful to consider adding columns to the *permits.return_t* table at a future data, which contain activity data from the permits database.

There is also the problem of no "not null" data columns in the *permits.rsite_t* table which indicate the site of visitation. This means that no single column can be sure to include all visitors numbers to the site of interest. Although the column *reef_name* has an entry for almost all cases, there are problems with using a reef name to identify a site. Primarily, because the naming of reefs and sites is not standardised, it is unreliable to use a reef name to identify a site, and requires a cross check with the appropriate reef ID number to review other names given to the same site. The use of longitude-latitude coordinates is difficult if not impossible to use as a means of identifying a site. This leaves reef ID numbers as the most viable alternative, and the easiest to use. If the column reef_id contained data for every entry, it would make the database more effective, and in some cases more accurate.

The final major problem involves data entry. Because the database is sensitive to differences of upper and lower cases, as well as minor spelling mistakes, the correct entry of data is essential to minimise difficulty in using the database. For example, for a reef with several reef sub-IDs, it may be the case that the reef section of interest is associated with a particular sub-ID. If this is the case, it is possible to limit a data search to that reef sub-ID. If, however, the sub-ID character has been entered as uppercase in some instances and lowercase in others, then a search using both the uppercase and lowercase sub-ID characters is necessary. This unnecessarily increases the search time and becomes frustrating. Several instances have been observed where the sub-ID has indeed been entered as both uppercase and lowercase characters. Spelling mistakes can have the same effect. For example, reef ID number 14146 is used for Ribbon Reef No.10 and the Cod Hole. However, one reef name entry is Robbin Reef No.10. In that case, if a reef ID number had not been included in the data entry the Robbin Reef No.10 data would never be accessed as part of the visitor numbers to Ribbon Reef No.10.

7. CONCLUSIONS AND RECOMMENDATIONS

It is clear that the Data Returns Database established by GBRMPA has great potential to provide considerable detail on commercial tourist patterns of use of the Great Barrier Reef over time. Despite initial difficulties it has been possible to interrogate the database and extract a variety of information. As noted above there are some concerns about the quality of the data collected, the quality of the data entry and the user unfriendliness of the actual database. Connections to other databases (some even more unfriendly) could be improved. The development in late 1996 of a web page interface is a dramatic improvement for users and it is anticipated that further enhancements will be made during 1997. As the user interface becomes even more improved then researchers could make much greater direct use of the data and thereby diminish demands on GBRMPA staff time. Protocols concerning access are also in need of review to ensure maximum advantage can be taken of the data without impinging on any commercial sensitivities. Specific suggestions for improvement have been made in this report and these include revision of the EMC logbook to ensure improved data. Inclusion of some visitor use information on the EMC logbook may be possible with minor inconvenience to operators and major improvements in data for managers. For example most large scale operators could easily enter numbers of scuba divers and numbers who fish at each site used if requested. It is also clear that recreational (non-commercial) use of the reef by boat owners is likely to be very high and there is a need to better quantify this, perhaps by extension of previous studies.

8. SPECIFIC RECOMMENDATIONS

In the light of the significant value of the EMC data collected it is recommended that GBRMPA take the following steps:

1. Appoint an EMC data manager with responsibility and resources to ensure improved data entry, data verification and data quality controls (ie ensure accuracy of operator provided data and of data entry processes);
2. Further enhance and widen access options through extension of public availability of information and improvement of GBRMPA Info Exchange including:
   a) enlarged user select search options especially for temporal and spatial aggregations;
   b) minimise the need for Authority approval for publication of data analyses by clarification of the confidentiality issues;

c) move as much of the data as possible into the public domain.

d) work with the CRC and Queensland Government Departments to develop a long term database covering non-commercial use of the GBR World Heritage Area.

9. ACKNOWLEDGMENTS

The project staff wish to acknowledge the very considerable assistance received from staff at GBRMPA (see Appendix V) who set aside time to help us understand the nature of the EMC processes, the development of databases, the operation of the Data Returns Database and the variety of other databases held. At a time when the process was just being developed we were able to access initially raw data files and then subsequently, through some specific assistance with techniques, the database itself. Without this valuable cooperation we would not have been able to complete this project.

10. AUTHORSHIP

The three authors had different responsibilities. David Wachenfeld undertook the initial review of databases and the early collation of data directly from the EMC logbook returns. Damon Newling grappled with the mysteries of SQL and the problems of direct access to the database from a remote terminal. Peter Valentine completed the review of the web interface options and wrote most of the report including revision following referees' comments and suggestions, with help from the other authors.

11. REFERENCES

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Appendix I

List of Permit Types Used in the Permits Database

Type	Description
AIR	Operation of an aircraft
ALA	Construction and/or conduct of aircraft landing areas
COL	Collecting
DF	Developmental Fisheries
EDF	Educational Facilities
EDP	Educational Program
HBP	Harbour works, beach protection works, or other works
JAWS	Program for the taking of an animal or animals which pose a threat to human life or safety or which threaten existing use and amenity of an area
MAR	Farming of marine resources
MOR	Construction and/or conduct of mooring facilities
OBS	Construction and/or conduct of underwater observatories
OFFS	Offshore Structures
OP	Any other purpose
PLTF	Commercial pole and line tuna fishing
RES	Research
SD	Dumping of Spoil
SHIP	Navigation and operation of vessels
TF	Tourist facilities
TP	Tourist program
TRAD	Traditional hunting and/or fishing
WAST	Discharge of waste from a fixed structure
ROVE	Roving (tourist program)
SITE	Site specific (tourist program)

When the Permits Database was originally set up, all tourist programs were given the code TP. However, since then GBRMPA decided it would be useful to distinguish between roving and site-specific tourist programs and the codes ROVE and SITE were introduced. Tourist programs now receive the codes TP and ROVE and/or SITE as appropriate. ROVE and SITE are also used to qualify research programs under the code RES.

Appendix II

List of Possible Entries for Activity Fields in the

Permits and Data Returns Databases

Category	Code
Camping	Camper Drop Off Commercial Recreational
Collecting (commercial)	Aquarium fish Beche-de-mer Coral Shell Trochus
Collecting (recreational)	Aquarium fish Coral Shell
Fishing	Game-fishing Line Spear fishing Trolling
Motorised	Bareboat Beach hire Boom-netting Glass bottom boats Jet Skis Para flying Semi-submersibles Transfers Tunnel diving Water skiing Water taxis
Non-motorised	Bareboat Beach hire Dinghy Hire Kayaking Sailing SCUBA diving Snorkelling Surfing Wind surfing

Appendix II (cont.)

List of Possible Entries for Activity Fields in the

Permits and Data Returns Databases

Other activities	B-B-Q Bush walking Coral viewing Fish feeding Functions Island tours Mother-shipping Nil activity Other QDEH Patrols Reef Walking Scenic flights Subcontractor Touch tank Visit only Whale watching
Research	Algae/seagrass Assoc. structures Clams Coral Fish Invertebrate Mangroves Monitoring Other Pollution Prawns/crabs Sea mammals Sediment sampling Starfish Trochus Water Sampling

Appendix III

Appendix IV

Appendix V

GBRMPA Personnel Consulted

Environmental Impact Management:

Mike Bugler:	(former Director)
Carol Honchin:	Planning Officer
Tania Adami:	Project Officer - Charging
Kelly Whiting:	Assistant Project Officer - Charging
Wayne Amisano:	Computer Systems Officer
Margaret Hagan:	Permits Officer
Michael Lusis:	Permits Officer

Planning and Management:

David Hamilton:	Information Systems Manager
Greg Smith:	Assistant Director - Planning
Darin Honchin:	Surveillance and Enforcement Officer
James Aston:	Planning Officer - GIS
Chris Thomas:	Research Assistant

Research and Monitoring:

Dominique Benzaken:	Social Science Program Officer
Christine Dalliston:	Research Assistant
Alix Walker:	Database System Operator