

**SOUTHERN RIGHT WHALE COASTAL
HABITAT PREFERENCE**

BRIDGING PROJECT

Final Report - revised

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1. Overview

The distribution of southern right whales in coastal Australian waters indicates a preference for certain locations where aggregations of whales are consistently observed. Little is known of the factors influencing such distribution patterns, and work conducted under this consultancy formed the initial stages of a longer term study to determine whether observed distribution patterns indicate preferential use of certain coastal habitats, and whether such habitats can be characterised by environmental attributes.

As the basis for such an assessment this project set out to:

- identify and arrange access to suitable southern right whale distribution data sets
- create a system for managing southern right whale distribution data and incorporate available sightings data
- establish a geographic information system (GIS), including software purchase
- identify relevant environmental attribute GIS layers, including remote sensed data
- develop a research plan for the longer term (three year) habitat preference project

These outcomes were successfully met during the consultancy. Recent and historical southern right whale distribution information and datasets were identified. Access to all of those datasets has been arranged, with one data access licence agreement awaiting finalisation. Data management protocols were established and a southern right whale distribution database developed and linked to an ArcView GIS for mapping and analysis. Relevant environmental attribute datasets, including bathymetry, coastline maps, sea surface temperature and weather parameters were identified and sourced. Access arrangements to these data have been negotiated, with several data licence agreements currently being finalised.

A full research plan with clear objectives and milestones has been developed for the major three year habitat preference project, which commenced in July 2002. The database and GIS components established under this consultancy will undergo further development and adaptation as future data management and analysis requirements are identified.

2. Southern right whale distribution data

2.1 Datasets

All known datasets containing southern right whale sightings were identified and arrangements for access made. The available information comprises dedicated survey data and opportunistic sightings. Most of the right whale's wintering grounds in coastal Australian waters are covered to some extent, but the level of effort, method of data collection and reliability and quality of the data vary.

Dedicated aerial surveys for census and photo-identification studies have been conducted for most of the right whale's coastal Australian range at some time, with the exception of the Tasmanian coast where no dedicated surveys have been carried out. Annual survey data are available for the southern coast of Western Australia and western South Australia (furthest extent Augusta, WA to Ceduna, SA) from 1979 to 2001 (J Bannister, WA Museum), the central South Australian coast (furthest extent Adelaide to Twilight Cove) from 1984 to 1994 (J Ling, P Needham), and the southeast coast (furthest extent Adelaide, SA to Sydney, NSW) from 1991 to 1994 (C Kemper, SA Museum).

Raw data from these surveys has been provided by the respective holders for use in the southern right whale coastal habitat project. Data from Western Australian aerial surveys 1979-1989 (J Bannister) have not yet been included. Access to this material has been arranged, but requires a visit to the Western Australian Museum in Perth, which is planned for later in 2002.

Studies conducted at the Head of Bight, SA provide detailed data on whale numbers within that calving area from 1991 to 2001 (S Burnell, Eubalaena Pty Ltd). Access to these data will be available for the fine scale component of habitat assessment to be carried out during the longer term project linked to this consultancy.

Opportunistic sightings datasets (those not part of dedicated surveys) compiled and held by state agencies were also identified. Sightings records are available for Tasmania beginning in 1977 and hard copy data has been provided for 1977 to July 1999 (Tasmanian Parks and Wildlife Service). Records 1999 to present and an electronic copy of data are expected to be available once a review of the database currently being undertaken by the holders is complete, probably in about two months.

Access to data contained in the New South Wales Wildlife Atlas, maintained by the New South Wales National Parks and Wildlife Service, has been negotiated under a data licence agreement. The dataset contains records from 1986 to present, with one record from 1970. Similarly, Victorian Wildlife Atlas records, maintained by the Arthur Rylar Institute have been provided under a data licence agreement with the Victorian Department of Natural Resources and Environment. Sightings contained in that dataset span the years 1962 to present. Data from each of these sources has been provided electronically.

Opportunistic records were not used for WA because of the comprehensive nature of aerial surveys. The database containing opportunistic records for South Australia is currently inaccessible, however, dedicated survey data for this state has been accessed. The cetacean sightings database maintained by Environment Australia is currently undergoing review and correction of corrupt fields, and an arrangement has been made to extract relevant records when available.

Table 1: Summary of southern right whale distribution datasets available

Dataset	Data type	Years	Approximate no. records*	Data format	Holder/Provider
WA aerial surveys	dedicated	1977-1998 1998-2001	? 1404	map lat long	J Bannister, WA Museum
SA aerial surveys	dedicated	1984-1994 (excl. 1992)	441	elapsed flight time/description	J Ling, P Needham
SE aerial surveys	dedicated	1991-1994	90	lat long (except 1991)	C Kemper, SA Museum
Tasmanian fauna database	opportunistic	1977-1999 1999-present	342 ?	lat long	Tasmanian Parks & Wildlife
Victorian Wildlife Atlas	opportunistic	1962-present	1092	lat long	Arthur Rylar Institute
New South Wales Wildlife Atlas	opportunistic	1986-present (1 record 1970)	77	lat long	NSW National Parks and Wildlife Service
Cetacean Sightings Database	opportunistic	?-present	?	lat long	Environment Australia

*NB: Number of records, not number of animals and excluding duplicate sightings on same day.

Each dataset was assessed for suitability for inclusion in the southern right whales distribution database. Dedicated survey datasets were considered reliable as observations were undertaken by suitably trained and experienced observers. Each record in opportunistic datasets was reviewed for reliability, as the quality of these data varied. When available, the Environment Australia dataset will also be reviewed before inclusion in the main dataset, as data quality again varies, and it is likely that many records will be duplicates of those contained in state agency datasets.

The combined datasets provide a spatial and temporal coverage of the southern right whale's range adequate to progress with analysis of recent broad scale distribution patterns of right whales in Australian coastal waters.

2.2 Data management system

A data management system for the compilation of southern right whale sightings information has been established. It has been developed to cater for the range of existing data formats described in section 2.1 and Table 1, and to provide an ongoing tool for the management of southern right whale sightings information. The system is adaptable to changing needs, and will continue to be developed throughout the longer term habitat assessment project as future needs dictate.

The data management system comprises two parts: a series of principles and practices for collecting, entering and archiving data, and a relational database developed in Microsoft Access 2000.

2.2.1 Data management practices:

(a) Record verification and reliability - Existing right whale sightings data have been obtained from a wide range of sources (Table 1). Some records have been verified or collected by experts and species identification and related information can be used with confidence. Others are unconfirmed or of dubious reliability.

Several data management practices have been established to ensure the integrity of data stored in the database.

- Data entry is performed by an experienced person who can accurately interpret data sheets or records, and if necessary make judgements as to the accuracy of species identification and other sightings details.
- Each record is given a reliability code of 1, 2 or 3. 1 = confirmed, 2 = probable, 3 = unconfirmed.
- Where sightings details are unclear, the most conservative interpretation is used. A note is made describing the uncertainty.

(b) Type of data - There are two main categories of data. The first is dedicated survey data collected during targeted scientific studies, the second is opportunistic sightings reported on an ad hoc basis. Data type is an important attribute of each record and dictates some limitations for the way in which the data are used. Each record is identified as D=dedicated or O=opportunistic.

(c) Storage and retrieval – Each record is stored both electronically and in hard copy, with reference to any requirements or limitations of data licence agreements. The records are stored electronically in the southern right whale distribution database, where queries

are used to specify retrieval parameters for customised outputs. Hard copies of raw data or compiled records are archived.

(d) Data contributors – The data supplier is noted for each record of a particular dataset to ensure appropriate use and acknowledgement of data contribution, and to allow for cross checking to original source if necessary.

2.2.2 Southern right whale sightings database

A relational database has been developed in Microsoft Access 2000 to facilitate storage, retrieval and querying of southern right whale distribution information. The database has been developed for the express purpose of facilitating analysis of the relationship between southern right whales and environmental attributes in a GIS context. It has not been designed as a general sightings database, a number of which are maintained by various individuals and institutions in Australian.

The relational database is comprised of five linked tables (Table 2), providing an efficient structure that prevents duplication of data storage and allows for expansion to meet future needs.

Table 2: Structure of the southern right whale distribution database

Table name	Purpose	No. fields
tblSouthernRightSightings	Stores core sightings information and fields linking records to additional information	22
tblDataSource	Contains name and contact details for individuals and organisations contributing data and is linked to each sighting record by an ID code	10
tblDataType	Lists the data type classifications (eg. dedicated or opportunistic) and provides data validation for this field in tblSouthernRightSightings	2
tblRecordReliability	Lists the record reliability classifications (eg. 1 = confirmed) and provides data validation for this field in tblSouthernRightSightings	2
tblPlatform	Lists the platform type classification (eg. aerial, vessel) and provides data validation for this field in tblSouthernRightSightings	2

TblSouthernRightSightings is the core database table, and contains attribute information for each southern right whale sighting (Table 3). To date the database contains 1494 records.

Table 3: Fields contained in the core table tblSouthernRightSightings

Field	Description
RecordID	A unique number code with which to identify each record.
Date	The date on which the sighting was made.
Time	The time at which the sighting was made.
LatDeg	The degrees of latitude at which the sighting was made.
LatMin	The minutes of latitude at which the sighting was made.
LatDec	The decimal latitude at which the sighting was made (required for GIS)
LongDeg	The degrees of longitude at which the sighting was made.
LongMin	The minutes of longitude at which the sighting was made.
LongDec	The decimal longitude at which the sighting was made (required for GIS)
Location	A description of the geographic location at which the sighting was made.
NumAdults	The number of adult whales recorded.
NumCalves	The number of calves recorded.
NumSubadults	The number of subadult whales recorded.
NumUnknown	The number of whales of unknown age class recorded.
RecordReliabilityID	The reliability of the sighting: 1=confirmed; 2=probable; 3=unconfirmed
DataTypeID	The type of sightings data used: O=opportunistic; S=dedicated survey
DataSourceID	The source from which the data was obtained or derived.
PlatformID	The platform from which the sighting was made: V=vessel; L=land; A=air
EnviroInfo	Information on environmental attributes of sighting (eg. distance offshore)
Notes	Additional comments in relation to the sighting.
RecordSummary	Description of part of coastline surveyed and date of survey.

All dedicated survey data for which latitude and longitude were provided have been entered. Several older datasets do not provide latitude and longitude, and are recorded on paper maps or as time elapsed during aerial surveys (see Table 1). The integration of these sightings by determining latitudes and longitudes by hand would be extremely time consuming, and an alternative method utilising GIS techniques will be used (Section 4). Opportunistic datasets have been compiled in an Excel template and final review and verification is currently being completed before importing to the main dataset.

Data have been provided by individuals and organisations specifically for use in the postgraduate project on southern right whale habitat preferences. Any access to the information contained in the database for other purposes would need to be negotiated separately with the relevant data holders.

2.3 Historical

An assessment of important coastal southern right whale habitat would not be complete without taking into account the impact of commercial whaling. Such a dramatic decline in the population, slow recovery and site fidelity patterns have important implications for understanding current distribution patterns.

Several sources of historical distribution information have been examined. These include catch and whale oil statistics (colonial returns, whaling vessels, newspaper articles); pelagic whaling charts; and the location of shore and bay whaling activities.

In the context of identifying historically preferred coastal habitat for right whales, catch statistics and whale oil returns have proved to be only marginally useful. These data are problematic due to the practise of reporting right and humpback whale oil together, the inability on the majority of occasions to link catch or oil yields to a specific geographic

location, and the problem of inconsistent and incomplete record keeping. They are therefore of limited use in identifying areas of important coastal habitat.

Pelagic whaling charts (eg. Townsend 1935) provide useful information on the offshore distribution of whales, and in some cases their seasonal distribution closer to shore. They are not, however, of direct use in determining areas of important coastal habitat as their coverage is too general.

The most effective method of determining areas of historical importance to right whales has proved to be an examination of shore and bay whaling effort. Although information is sometimes patchy, a reasonable amount of archaeological and other historical research on shore whaling has been conducted for each state. It has been possible to derive a detailed database of shore whaling sites. This will be enhanced by a closer examination of bay whaling information and levels of effort at each site, and its usefulness as an index to describe the importance of particular areas for right whales will be examined.

Table 4: Summary of historical Australian shore and bay whaling sites where southern right whales were taken

State	Number of separate localities*	Number of leases*
Tasmania	13	104
Victoria	5	11
New South Wales	4	8
South Australia	10	13
Western Australia	19?	?

* requires refinement on access to necessary material and/or reports held in some states

3. Environmental attribute data

The primary environmental attribute datasets for incorporation into the GIS were selected with reference to issues of scale, the life history characteristics of southern right whales, and long term broad scale distribution patterns of the species. The availability of data at appropriate scales and the continuity of spatial and temporal coverage were also important considerations, particularly as the geographic area and time span is large. The choice of primary environmental datasets aimed to capture environmental attributes acting at a scale relevant to the selection of preferred habitats by right whales, in order that analyses would effectively elucidate links between distribution and underlying environmental processes or features. As the project develops, and in light of future findings, further environmental datasets may need to be examined.

Bathymetry - A number of organisations were contacted with respect to the availability of bathymetric data. The best available broad scale data is currently the Geoscience Australia 0.01° gridded bathymetry model, which provides resolution at about one kilometre intervals for the entire area of interest. These data have been obtained and incorporated into the GIS. Geosciences Australia is currently working on a 250m gridded bathymetric data model, but this will not be complete until second quarter 2002. Better depth resolution data is available from the Royal Australian Navy Hydrographic Service for some areas, although it is expected to be patchy and concentrated in areas of naval and shipping interest. Access to these data is currently being finalised under a data agreement between Deakin University and the RAN Hydrographic Service.

Coastal maps - The best available broad scale coastline map data is at 1:100 000 scale, and is adequate for broad scale analyses. These were obtained from Geosciences Australia, and have been incorporated into the GIS. Coastline data will be used to assess whether preferred habitat areas share certain features such as orientation. Finer scale maps are available for certain coastal locations and will be incorporated as needed for finer scale studies.

Substrate/sediment – Substrate and sediment mapping has been undertaken for some locations, for example some broad scale mapping has been done in the Great Australian Bight, including coastal areas. The availability of data appropriate for this project is still being investigated, and no layers are included in the GIS as yet.

Sea surface temperature – Remotely sensed sea surface temperature data is held by CSIRO. The data is accessible in GIFF format. The temporal sampling regime for sea surface temperature is currently under consideration and will be finalised before ordering data as there is a cost per week of data supplied. Sea surface temperature data will be used to determine whether water temperature plays a role in selection of preferred right whale habitat.

Meteorological data – The Bureau of Meteorology has a number of established weather stations recording a variety of meteorological variables. These data are accessible under licence agreement, and while there are gaps in terms of coverage and variables recorded, information is available for some areas of interest. The weather parameters of most relevance are prevailing wind and swell direction. Raw data accessed under licence agreements will need to be translated into a suitable GIS format.

4. Geographical Information System

The geographical information system (GIS) has been established using ArcView software. The package was selected as it is widely used for similar studies and provides features suitable for the kind of analyses envisaged. The software can be run on a desktop computer and is supported by Deakin University GIS laboratories, technical staff and training programs - important considerations with respect to the ongoing postgraduate studies linked to the current project.

Whale distribution data is incorporated as GIS layers by converting whale positions to decimal latitude and longitude coordinates and linking the Microsoft Access database tables and queries to ArcView. Whale position data has not been stored directly in ArcView attribute tables because ArcView tables can not be modified once established. It is better practise to store such information in a database application to permit manipulation of fields and records as necessary, with the spatial analysis capabilities provided by linking to a GIS.

In order to create accurate GIS projections of whale locations in relation to environmental features, GIS layers need to be referenced to the same datum. It is therefore necessary to determine the datum in which whale positional information was originally collected. This has not yet been verified for most datasets, and is likely to be unavailable for some. Further work to manipulate the data into a single datum, and perhaps discarding some records, will be required to correct current GIS whale location layers.

While much whale location data was given as latitude and longitude, a significant amount of older raw data from dedicated aerial surveys is in the form of plotted points on paper maps, or time elapsed since last landmark (see Table 1, Section 2.2.2). The options of digitising or map referencing these data to convert them to a format that could be included in the distribution database were investigated. It was ultimately determined that the most effective way of entering these data into an electronic storage system is by visual 'point and click' on a digital ArcView map overlay. This method is considered accurate enough for the purposes of broad scale distribution analyses. Related attribute data would be added to an ArcView table and the records imported into the Microsoft Access database to be treated with other datasets.

Environmental attribute data layers that have been identified and accessed are described in Section 3. Coastal map data at 1:100 000 scale (Geosciences Australia) were converted from the supplied format into an ArcView map layer. Bathymetric data at 0.01° scale (Geosciences Australia) has similarly been incorporated and a data licence agreement for access to additional digital depth for some regions is currently being arranged (Royal Australian Navy Hydrographic Service). Access to a finer scale bathymetric model (Geosciences Australia), possibly available by mid-2003, will be investigated as part of the longer term habitat preference study, and would provide more acceptable resolution.

Sea surface temperature (CSIRO) data has been sourced and will be requested when appropriate sampling intervals are decided. Sea surface temperature data will require conversion to ArcView layers. Further environmental data of relevance has been identified and is either being further investigated (substrate/sediment) or is in the process of being accessed via licensing agreements (meteorological data).

The Spatial Analyst extension of ArcView will be used for analyses of southern right whale distribution and environmental features. This will require vector data to be converted to grid data. Utilising GIS as an analysis tool has implications for the way in which field data is collected. These requirements have been taken into consideration in the development of the research plan and program of field studies for the longer term habitat assessment project.

The GIS established under this consultancy is a dynamic system. It will be adapted to meet emerging analysis needs of the longer term habitat preference project, including further development to incorporate fine scale habitat use data. The GIS will also evolve to include any new environmental data layers relevant to the study as they become available.

5. Research plan

A research plan for the longer term component of the work initiated in this project has been developed. The plan provides a sound framework for progress and identifies timeframes and milestones. It is envisaged that the research program will evolve to accommodate findings as the project progresses.

Overall aims:

- identify preferred areas of southern right whale habitat on the Australian coastline and examine habitat usage patterns on broad and fine scales

- identify and where possible quantify the environmental features of preferred coastal habitat
- utilise GIS techniques to integrate distributional and environmental information for analysis of critical habitat parameters

Outcomes:

- a description of the preferred coastal habitats of southern right whales and a definition of critical habitat requirements for the species
- identification of existing (anthropogenic) threats that will contribute to loss or displacement of southern right whales from critical habitat sites
- identification of conflicting resource uses within critical habitats
- analysed data that identifies, and provides evidence for, current priority areas for conservation or protection
- a framework for ongoing monitoring of southern right whale habitat usage around the Australian coastline

Research plan

Year 1: July 2002-June 2003

Aims:

- to identify preferred areas of right whale habitat historically and currently
- to continue integrating environmental and distributional data into a GIS
- to undertake initial field studies

Milestone 1: Sources of remotely sensed data will be identified and field sites will be selected (6 months).

Milestone 2: Initial field studies will be completed to trial methodology for fine scale whale distribution studies, and quantify basic environmental features and variables (12 months).

Activities will include:

- continue development of the database and GIS established under the bridging project to combine environmental data and cetacean distribution data
- undertake broad scale analyses
- develop methodology and data management systems for fine scale studies
- select and ground truth field study sites.
- undertake initial field studies to trial methodology for fine scale distribution studies, and quantify environmental and topographic features and variables.

Year 2: July 2003-June 2004

Aims:

- to complete further field studies and fine scale assessment of right whale habitat use
- to examine fine scale habitat usage patterns by right whales at selected sites using GIS

Milestone 3: Remotely sensed data will be ground truthed and the GIS corrected as appropriate (24 months).

Milestone 4: Fine scale habitat use will be documented and integrated into the GIS (24 months).

Milestone 5: A GIS model will be designed to predict broad scale habitat use (24 months)

Activities will include:

- continue fine scale habitat usage assessments and ground truthing field work as necessary
- continue integration of fine scale data into GIS and incorporating any additional recent broad scale data.
- continue development of GIS analysis and modelling techniques

Year 3: July 2004 – June 2005

Aims:

- to verify the GIS predictive model on habitat usage patterns
- to complete all habitat attribute data collection and integrate into the GIS
- to complete integrating environmental and distributional data into a GIS for analysis of the relationship between right whales and their coastal environment

Milestone 6: Document the predictive capacity of a GIS model to describe habitat selection by southern right whales (36 months)

Milestone 7: Complete final refinements to the GIS (30 months)

Milestone 8: Describe the relationship between southern right whales and their coastal environment (36 months)

Activities will include:

- completion of integration of environmental and distributional data, and its analysis
- undertaking gap analysis for the data sets and rectify through field work
- producing reports detailing criteria for recognition and protection of critical habitats
- collection of repeat seasonal data to increase rigour of some analyses

6. Assessment of outcomes against scope items

The degree to which the project has achieved outcomes against specified scope items is assessed below in accordance with requirements for the final report. Detail relating to the scope items is contained in earlier sections of the report.

(a) Purchase of GIS software (utilising funds carried over from 1999/2000)

An ArcView GIS software licence was purchased for the project and obtained by the consultant in late January 2002. An ArcView spatial analyst extension was also acquired as a necessary component of GIS software to enable analyses of right whale distribution data in relation to environmental features.

(b) Finalisation of design for the GIS database that will form the core of the ongoing collaborative project over three years.

A GIS for the investigation of the relationship between southern right whales and environmental attributes of preferred habitat has been designed and established using ArcView software (Section 4) The design of the southern right whale distribution database, a core component of the GIS, has been finalised (Section 2.2.2), and environmental data layers have been identified and sourced (Section 3). GIS files for environmental data layers are managed within a simple electronic filing system. A metadata table has been created to catalogue information on each dataset included in the GIS (eg. data type, source, projection, resolution, datum etc).

The nature of the longer term project is such that the GIS will be adapted overtime to meet changing needs and analysis requirements as findings of the project dictate. The GIS is so far focussed on broad scale data analyses, and fine scale information will be incorporated as field data collection progresses.

(c) Creation of the data management system and entering of the southern right whale sightings data compiled to date.

A data management system for the collation of southern right whale distribution information has been established. It comprises a series of principles and practices for collecting, entering and archiving data, and a Microsoft Access database. Details are provided in Section 2.2.

A large number of southern right whale sightings have been compiled and entered into the database. Six main data sources have been accessed and in excess of 3500 records obtained. All dedicated survey data for which latitude and longitude positional information was available have been entered and the database currently contains 1494 records. A further 1092 opportunistic records have been compiled in an Excel template to be imported when final data checks are complete. The remaining dedicated survey data is to be entered using ArcView GIS and additional opportunistic sightings will be compiled as they become available from data holders.

(d) Identification and arrangement for access to datasets that can provide appropriate environmental and topographic layers within the database, including remotely sensed data.

Relevant datasets, including remotely sensed data, have been identified and access has been arranged. Details are contained in Section 3.

(e) Outline of the work schedule and research plan for the ongoing industry-linked project due to commence in July 2002.

A full work schedule and research plan for the ongoing habitat assessment project has been prepared and is provided in Section 5.

7. Appropriateness

The approach taken to identifying and sourcing southern right whale distribution datasets, and examining their suitability for inclusion in the database was appropriate. All major data holders have generously provided access to their survey results. This has resulted in a combination of datasets that provide spatial and temporal coverage adequate to progress with analysis of recent broad scale distribution patterns of right whales in Australian coastal waters. Further detail is contained in Section 2.1.

A consideration of historical distribution was an essential element of the project given that commercial whaling, slow recovery rates and site fidelity patterns have important implications for understanding current distribution patterns. A number of sources of historical information were examined (Section 2.3). The approach of examining shore and bay whaling locations as an indication of areas historically preferred by southern right whales proved to be appropriate, given the limitations of catch and whale oil records. Its usefulness as an index to describe the importance of particular areas for right whales will be further examined.

The two part data management system established during the project and detailed in Section 2.2, meets its intended purpose well. The first component, a series of principles and practices for collecting, entering and archiving data, ensures a reliable dataset on which to base analyses. The second component, a Microsoft Access 2000 relational database, facilitates storage, retrieval and querying of southern right whale distribution information, and analysis of the relationship between southern right whales and environmental attributes in a GIS context. The data management system caters well for the range of existing data formats and provides an ongoing tool for the management of southern right whale distribution information. The system can be adapted as future needs dictate, and will continue to be developed throughout the longer term habitat assessment project.

The primary environmental attribute data layers for the GIS were selected with reference to issues of scale, the life history characteristics of southern right whales, and long term broad scale distribution patterns of the species. The availability of data at appropriate scales and the continuity of spatial and temporal coverage were important considerations, particularly as the geographic area and time span is large. The choice of primary environmental datasets aims to capture environmental attributes acting at a scale relevant to the selection of preferred habitats by right whales in order that analyses will effectively elucidate links between distribution and underlying environmental processes or features. The approach to identifying and sourcing environmental data layers is suitable for this consultancy, but as the longer term project develops, and in light of future findings, further environmental datasets may need to be examined. Section 3 contains further detail on environmental attribute data.

A geographical information system provides a powerful tool for examining relationships between southern right whales and environmental attributes, and is a suitable technique for achieving the aims of the ongoing habitat study. The approach taken to establishing a GIS under this consultancy as the basis for ongoing work has been appropriate (Section 4). ArcView software was selected as it is widely used for similar studies and provides features suitable for the kind of analyses envisaged. In addition, the software can be run on a desktop computer and is supported by Deakin University GIS laboratories, technical staff and training programs. These are important considerations with respect to the ongoing postgraduate studies linked to the current project.

The GIS established under the current project is a dynamic system. It will be adapted to meet emerging analysis needs of the longer term habitat preference project, including further development to incorporate fine scale habitat use data. The GIS will also evolve to include any new environmental data layers relevant to the study as they become available.

The research plan developed as part of the current project (Section 5) establishes a suitable framework for the ongoing southern right whale habitat preference project. It has been developed specifically to meet the objectives of the ongoing research, and identifies appropriate timeframes and milestones. It is envisaged that the research program will evolve to accommodate findings as the project progresses.

8. Effectiveness

The approach taken to sourcing available southern right whale distribution data was effective and has resulted in the compilation of a comprehensive broad scale dataset. The

combined southern right whale distribution datasets accessed during this project provide a spatial and temporal coverage of the southern right whale's range adequate to progress with analysis of recent broad scale distribution patterns in Australian coastal waters. Further detail is contained in Section 2.3.

The most effective method of determining areas of historical importance to right whales proved to be an examination of shore and bay whaling effort (Section 2.3). It was possible to derive a detailed database of shore whaling sites and further work will determine whether this can provide a useful index to describe the historical importance of particular locations.

The data management system for the compilation of southern right whale distribution information establishes an effective data storage, retrieval and querying system, and successfully addresses the issues of record verification and reliability (Section 2.2). It caters well for the range of existing data formats described in Section 2.1, and provides an ongoing tool for the management of southern right whale sightings information. Importantly, the system is adaptable to changing needs, and will continue to be developed throughout the longer term habitat assessment project as future needs dictate.

The current project has been effective in identifying and arranging for access to appropriate environmental data sets, as described in Section 3. The choice of primary environmental datasets is intended to capture environmental attributes acting at a scale relevant to the selection of preferred habitats by right whales, in order that analyses will effectively elucidate links between distribution and underlying environmental processes or features. As the project develops, and in light of future findings, further environmental datasets may need to be examined.

An effective GIS framework was established during the current project (outlined in Section 4) and it is envisaged that GIS based analyses will be a valuable component of the ongoing habitat preference project. Requirements in relation to the form of field data required for incorporation into the GIS have been taken into consideration in the development of the research plan and program of field studies for the longer term habitat assessment project. The GIS is dynamic and will be adapted to meet the emerging analysis needs of the longer term project, including further development to incorporate fine scale habitat use data. The GIS will also evolve to include any new environmental data layers relevant to the study as they become available.

The research plan (Section 5) is expected to be effective in meeting the objectives of the ongoing southern right whale habitat preference research project. The research plan will be reviewed and revised as necessary to accommodate findings as the project progresses.

9. Transferability

There is a degree of transferability of the methods employed during the current project. While some work is specific to the species and topic under consideration, many of the general approaches employed in sourcing and compiling datasets, and developing a database and GIS could be transferred to other similar projects. The research plan has been developed to meet specific project aims and is not directly transferable to other work.

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Appendix 1. Eubalaena Pty. Ltd. and Environment Australia only.

Receipt and expenditure of funds:

<i>expenditure to date:</i>	<i>budgeted</i>	<i>spent/committed</i>
Compiling and data-basing project data		
- Contract consultant payments (R.Pirzl)	9,000	9,000
- Project management (S.Burnell)	950	2,650
Consumables	300	300
Project management and on-costs (12%)	1,350	1,350
Purchase software and project hardware	4,500*	2,500#
budget for contract:	\$15,800	
approx. total to date:		\$15,800

* carried over from 2001 (total contract 2002 = \$11,300)

primary GIS software obtained at academic rate and identification of requirement for e-charts of coastline committed

funds received (and due):

1st instalment - paid	\$9,300 (excl. GST)
2nd instalment - due on acceptance of final report	\$2,000 (excl. GST)