Santos Limited

VIC/P44 and VIC/P51 2D Seismic Program

Environment Plan

September 2003
CR 1084_4_v6

Santos Limited

VIC/P44 and VIC/P51 2D Seismic Program

Environment Plan

September 2003
CR 1084_4_v2

Prepared by: NSR Environmental Consultants Pty Ltd
124 Camberwell Road
Hawthorn East, Victoria 3123
Australia
Tel: 61-3-9882 3555 Fax: 61-3-9882 3533
e-mail: nsr@nsrenv.com.au
http://www.nsrenv.com.au

Principal	David Gwyther
Senior consultant	Andrew Pym
Consultant	Sandra Parreira, Giulio Pinzone
Draftsperson/graphic designer	Hanna Blaszkiewicz
WP/DTP	Jill O'Neil
Production	Ros Denhert
Version/s:	**Distribution:**
CR 1084_4_v2 September 2003	Santos – 1 copy NSR – 1 copy

Contents

Figures

Tables

Appendices

1. Introduction

1.1 Project Outline

1.1.1 Seismic Survey

Santos Limited (Santos) propose to acquire approximately 1000 km of two-dimensional (2D) seismic data in the petroleum permit areas VIC/P44 and VIC/P51 located in Commonwealth waters off the southwest coast of Victoria (Figure 1.1). These two permit areas are located adjacent to each other and cover an area of approximately 5,090 km^2. The project is referred to as VIC/P44 and VIC/P51 2D Seismic Program.

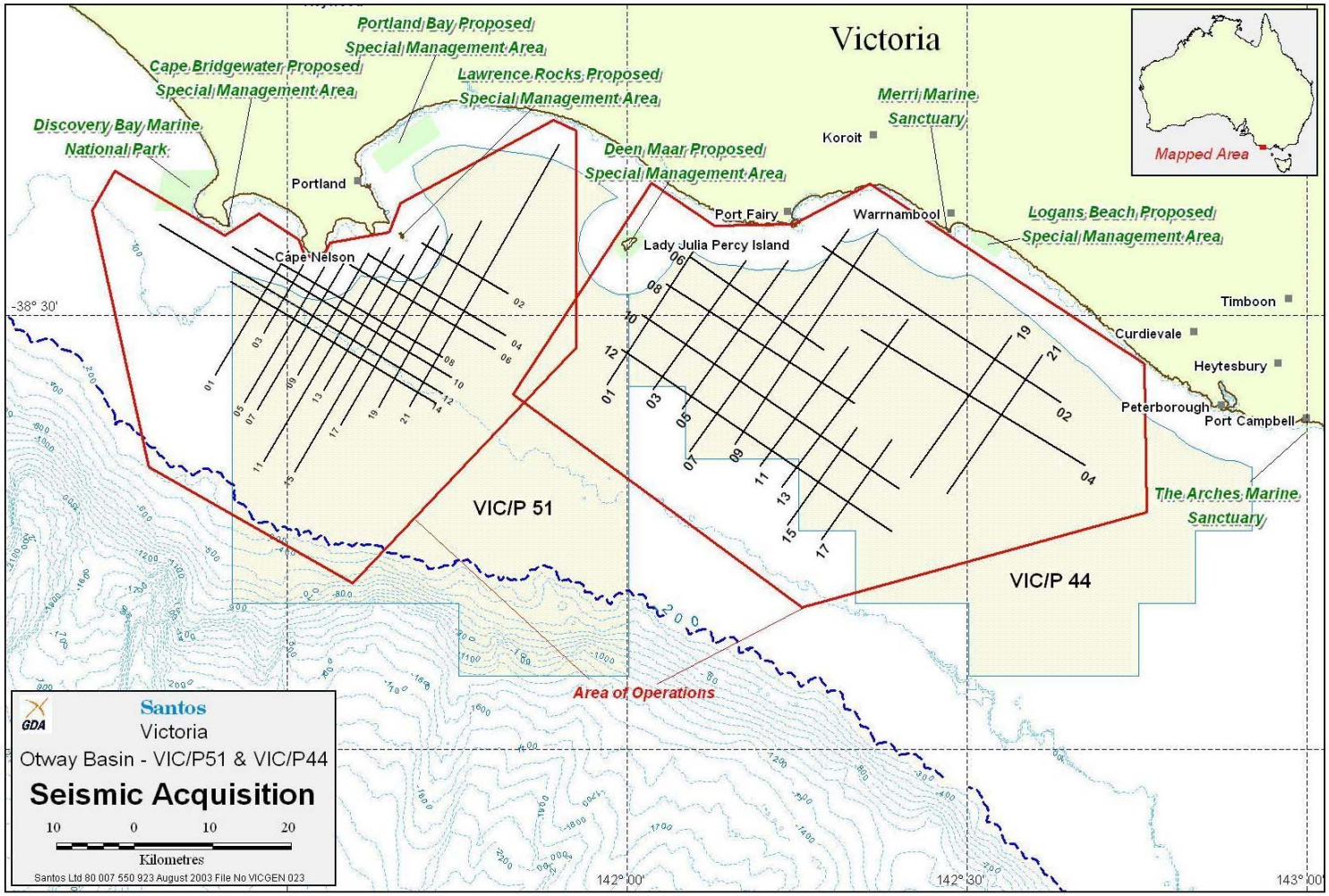
Seismic exploration is conducted to facilitate mapping of the subsurface geology of an area and enable the identification of potential hydrocarbon traps comprising petroleum reservoir rock, such as sandstone and limestone. The seismic data will be acquired using a specialised seismic survey vessel towing an acoustic source airgun and one or more hydrophone cables. The acoustic source in this instance will comprise one airgun array (consisting of 28 airguns), generating a pressure wave pulse at approximately 11 second intervals, which travels as a seismic signal down through the geological layers. The seismic signals are reflected back and recorded by hydrophones towed behind the vessel as a single streamer cable 5 km in length. The airgun will have an operating pressure of 1,800 to 2,000 psi and a volume of approximately 3,500 cubic inches. The source point interval (spacing between acoustic pulses) will be 25 metres.

The seismic pulse is in the order of 220-240 dB re 1µPa-m at frequencies extending up to approximately 110 Hz (McCauley, 1994). The outgoing sound levels vary depending on sound propagation characteristics of the area (McCauley, 1994), such as water depth and seabed features, and with distance and direction from the source, eg. downgoing sound levels will be higher than horizontally travelling sound levels.

The seismic survey vessel will traverse the survey area along the 35 seismic lines identified (see Figure 1.1). The hydrophone cable streamers travel between 5 and 10 m below the sea surface aided by mechanical devices called ‘birds’, which maintain the travel depth, preventing the equipment from surfacing or making contact with the seabed.

Helicopter crew changes at sea are not planned for this program. A support vessel (or ‘chase’ boat) will not be required to undertake port calls and supply deliveries to the seismic vessel, but a smaller reconnaissance vessel may be used to scout for potential hazards, streamer cable maintenance and minor logistics. The vessel may call in at the nearest suitable port prior to or after the survey for crew changes, victualling, refuelling or to transfer recorded data before moving on to the next permit area.

Figure 1.1 Seismic survey location



1.1.2 Types of Seismic Surveys

Seismic surveys can be undertaken as 2D or three-dimensional (3D) surveys, with the type of survey conducted affecting the type and quality of data acquired. There are a number of key differences between these methods, which are outlined in Table 1.1.

Table 1.1 Key differences between 2D and 3D seismic surveys

Parameter	2D	3D
Survey method	Relatively simple acquisition and processing and considerably less expensive than 3D	Acquisition and processing is complex and expensive
Gun array	One only	Multiple, fired alternatively
Hydrophone streamer	One only	Multiple (up to 12), in parallel
Survey tracks (swathes)	Single, predetermined	Parallel regularly spaced lines
Swathe orientation	Orthogonal or oblique	Same orientation
Distance between parallel survey tracks	1 km or more surface coverage	200-500 m surface coverage
Noise source	Strong	Staggered firing of gun array to reduce signal interference, however airgun sound the same as for 2D
Distance between each seismic pulse	25 m in this case	Guns can fire alternatively every 15 m
Period of noise exposure (length of survey, typically)	Regional surveys, typically lasting days-week or two	Detail surveys, lasting in range of weeks-month
Data	Results in a cross-section of the earth sub-surface. Positional accuracy can be questionable due to complex geological features	Results in an accurate 3D "terrain model" of the various geological features.
Coverage	Regional survey over large geographic areas	Details a smaller area but requires a more intense effort
Percentage of seismic data acquired worldwide	~5%	~95%
Exploration wells	Higher risk due to uncertainty associated with subsurface structures	Greater chance of success due to higher accuracy of seismic data

Source: Simmonds et al. (2003), Gausland (2000), Tasker et al (1998).

1.1.3 Background

The purpose of the program is to acquire seismic data, which will assist in identifying and defining petroleum prospects in the Otway Basin.

The seismic survey area is within petroleum exploration licences VIC/P44 and VIC/P51. VIC/P44 was awarded to Strike Oil NL in August 1999 for an initial period of three years. Santos assumed operatorship of the permit in late 2002 and the permit has since been extended for another three years (due to end August

2005). The VIC/P51 permit was awarded in 2002 and is current for a period of 6 years. As holder of the exploration permits Santos is obliged to undertake any exploration programs within the permit areas.

1.1.4 Location

The survey will be undertaken in Commonwealth waters, with some seismic lines in VIC/P51 extending slightly into Victorian state waters. The proposed survey will be conducted between 4 and 40 km from the coast, in ocean depths ranging from 25 to 200 m, with the majority occurring in water depths between approximately 80 to 150 m. Coordinates of the survey area are listed in Table 1.2.

1.1.5 Survey Timeframe

Data acquisition is scheduled to occur for approximately 16 days (including six days inclement weather down time) during November 2003. The precise commencement and completion dates are dependent on vessel availability and weather conditions, however the survey operations will be terminated at midnight on 30 November 2003 to avoid the onset of the blue whale migration period from early December.

1.2 Project Proponent

Santos was first formed in South Australia in 1954 and is now a major Australian oil and gas exploration and production company. The core business of the company is oil and gas exploration and production with interests in every major Australian petroleum province. Santos is the largest producer of natural gas for the Australian market supplying all mainland states and territories.

The core gas operations for Santos are in the Cooper Basin with gas being distributed to customers in South Australia, New South Wales, Queensland and the ACT. There are also other gas producing areas located in the Northern Territory, Western Australia and Victoria.

In the Otway Basin, Victoria, Santos holds interests in three exploration permits onshore and three exploration permits and two retention licences offshore. Santos has been an operator of exploration acreage in the offshore Otway Basin since late 2001. Since this time Santos has undertaken seismic and exploration drilling activities in several Otway Basin exploration permit areas. Offshore, the two permits Santos has interests in are those containing the Minerva and La Bella gas fields. Santos is also the operator of the VIC/P44 exploration permit (Santos interest 50%) and in August 2002 was awarded VIC/P51 (Santos interest 80%) and VIC/P52 (Santos interest 33.3%) exploration permits.

Table 1.2 Seismic survey area coordinates

VIC/P44 (clockwise from top left corner)	
Latitude	**Longitude**
38°21'00"S	142°02'45"E
38°24'00"S	142°08'15"E
38°24'00"S	142°15'15"E
38°21'15"S	142°22'00"E
38°34'00"S	142°46'00"E
38°44'15"S	142°46'00"E
38°50'30"S	142°15'30"E
38°35'30"S	141°50'15"E
VIC/P51 (clockwise from top left corner)	
Latitude	**Longitude**
38°20'00"S	141°14'45"E
38°24'30"S	141°24'30"E
38°23'00"S	141°27'30"E
38°24'45"S	141°31'00"E
38°25'45"S	141°31'30"E
38°26'15"S	141°33'00"E
38°25'00"S	141°33'45"E
38°24'15"S	141°39'00"E
38°22'15"S	141°40'00"E
38°16'30"S	141°53'30"E
38°17'15"S	141°55'30"E
38°32'15"S	141°55'30"E
38°48'30"S	141°35'45"E
38°40'30"S	141°17'45"E
38°22'45"S	141°12'45"E

Santos also has exploration and production interests in the United States and exploration acreage in Indonesia and Papua New Guinea.

Santos' head office is located in South Australia at:

Level 29, Santos House
91 King William Street
Adelaide, South Australia 5000.

1.3 Purpose of Environment Plan

NSR Environmental Consultants Pty Ltd (NSR) was commissioned by Santos to undertake an assessment of the potential environmental implications of the VIC/P44 and VIC/P51 2D Seismic Survey and to prepare environmental management guidelines.

This Environment Plan (EP) has been prepared in accordance with the requirements of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999. It includes a risk-based environmental assessment of the seismic acquisition program and specifies environmental performance objectives, standards and criteria.

The assessment aims to identify and assess the potential environmental impacts associated with the seismic survey and to identify suitable mitigation measures to avoid and/or minimise any adverse impacts to the marine environment, including:

- A description of the marine environment in the proposed survey area.
- Identification of potential effects and risks.
- Procedures for minimising impacts and for monitoring.
- The implementation of strategy and responsibilities.
- Auditing and reporting.

1.4 Stakeholder Consultation

Impact mitigation planning and implementation relies significantly upon consultation with key stakeholders. In the course of planning the seismic program and developing the EP, Santos will undertake consultation with relevant stakeholders to identify regulatory processes, potential environmental issues and management requirements.

Relevant stakeholders include:

- Victorian Department of Primary Industries (DPI):
  - Minerals and Petroleum.
  - Fisheries.
- Commonwealth Department of Industry Tourism and Resources (DITR).
- Environment Australia (EA):
  - Assessments Section.
  - Referrals Section.
  - Marine Section.
- Warrnambool Professional Fishermen's Association.
- Portland Professional Fishermen's Association.
- Victorian Abalone Divers Association.
- Deakin University - Whale Research Unit.

The seismic contractor will also be required to consult with various stakeholders including port authorities, shipping, commercial fishing vessels, the Australian Maritime Safety Authority and other petroleum operators in the area with regard to operational activities.

Consultation and information dissemination will be undertaken through a range of media including:

- Meetings with regulators.
- Meetings with key stakeholders.
- Project information brochures, as appropriate.
- Invitation for public comment on the EPBC referral via Environment Australia's website.
- Vessel communication systems with maritime traffic.

In addition, Santos will report on seismic operations in accordance with regulatory requirements to demonstrate that the environmental performance objectives and standards outlined in this EP have been met (see also Section 6).

2. Legislative Framework

A range of Commonwealth and State legislation, industry procedures and guidelines and international treaties and obligations may apply in relation to environmental considerations of the proposed offshore seismic exploration program (refer Section 2.1).

Key legislation and the statutory approvals processes governed by each are discussed in Section 2.1.

2.1 Applicable Legislation and Industry Standards

2.1.1 Commonwealth Legislation

- *Australian Heritage Commission Act 1975.*
- *Environmental Protection and Biodiversity Conservation Act 1999.*
- *Hazardous Waste (Regulation of Exports and Imports) Act 1989.*
- *Historic Shipwrecks Act 1976.*
- *Navigation Act 1912.*
- *Ozone Protection Act 1989.*
- *Petroleum (Submerged Lands) Act 1967.*
- Petroleum (Submerged Lands)(Management of Environment) Regulations 1999.
- *Protection of the Sea (Civil Liability) Act 1981.*
- *Protection of the Sea (Oil Pollution Compensation Fund) Act 1993.*
- *Protection of the Sea (Powers of Intervention) Act 1981.*

2.1.2 Victorian Legislation

- *Dangerous Goods Act 1985.*
- Dangerous Goods (Storage and Handling) Regulations 2000.
- Dangerous Goods (Transport) Regulations 1987.
- Draft State Environment Protection Policy: Prevention and Management of Contaminated Land (1999).
- *Environment Protection Act 1970.*
- Environment Protection (Prescribed Waste) Regulations 1998.
- *Fisheries Act 1995*.

- *Petroleum (Submerged Lands) Act 1982.*
- State Environment Protection Policy: Waters of Victoria (1982).
- State Planning Policy.

2.1.3 International Treaties and Obligations

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth government to take action to prevent pollution and to protect specified habitats, flora and fauna. Those conventions and agreements relevant to offshore seismic exploration operations include:

- United Nations Framework Convention on Climate Change (1992).
- Vienna Convention on the Protection of the Ozone Layer (1985) and the Montreal Protocol; on Substances that Deplete the Ozone Layer (1987).
- Convention on Biological Diversity (1992).
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (1979).
- Bilateral Agreements on the Protection of Migratory Birds (1988).
- UN Convention on the Law of the Sea (1982).
- *London Convention (1972), and 1996 Protocol, formerly* London (Dumping) Convention (1972).
- International Convention for the Protection of Pollution from Ships (1973) and Protocol (1978).
- International Convention on Oil Pollution Preparedness, Response and Co-operation (1990).
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969).
- International Convention on Civil Liability for Oil Pollution Damage (1969).
- United Nations Convention on the Law of the Sea (UNCLOS) (1994).
- Convention on Conservation of Nature in the South Pacific (Apia convention) (1976).
- Japanese / Australian Agreement on the Protection of Migratory Birds (JAMBA) (1981).
- Chinese / Australian Agreement on the Protection of Migratory Birds (CAMBA) (1988).

2.1.4 Industry Codes of Practice and Guidelines

The petroleum exploration and production industry operates within an industry code of practice and individual member environmental policies, as follows:

- APPEA Code of Environmental Practice (1996).
- EA Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interaction between Offshore Seismic Operations and Larger Cetaceans, October 2001.
- IAGC Environmental Guidelines for Worldwide Geophysical Operations.
- ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance (1997). This Code of Practice applies to the use of products designed to keep marine vessels and structures free of marine organisms.
- Diving Medical Advisory Committee (1979). A Note Regarding Diving Distance from Seismic Surveying Operations.

2.2 Statutory Approvals

2.2.1 *Petroleum (Submerged Lands) Act 1982*

Petroleum exploration and production in Commonwealth petroleum permit areas is governed by the provisions of the Commonwealth *Petroleum (Submerged Lands) Act 1967* (Commonwealth PSLA).

Part 2, Division 2.3 (sections 13, 14, 15 and 16) of the Petroleum (Submerged Lands) (Management of Environment) Regulations 1999 (PSLME) requires an Environment Plan, comprising a description of the environmental effects and risks and proposed mitigation measures, to be accepted by the Designated Authority prior to any activities being undertaken. The Designated Authority for Commonwealth waters adjacent to Victorian State waters and out to the Australian Exclusive Economic Zone at 200 nm is the Victorian DPI who act on behalf of the Commonwealth.

The requirements of the EP, as specified in the PSLME Regulations, include:

Environmental Assessment

Description of the Activity

(1) The environment plan must contain a comprehensive description of the activity including the following:
   (a) the location or locations of the activity;
   (b) general details of the construction and layout of any facility or other structure;
   (c) an outline of the proposed operations (for example, seismic surveys, exploration drilling or production) and proposed timetables;
   (d) any additional information relevant to consideration of environmental effects and risks of the activity.

Description of the Environment

(2) The environment plan must:
   (a) describe the existing environment that may be affected by the activity, as well as any relevant cultural, social and economic aspects of the environment that may be affected; and
   (b) identify the particular relevant values and sensitivities (if any) of that environment.

Description of Environmental Effects and Risks

(3) The environment plan must contain an assessment of environmental effects and risks for the activity that:
   (a) identifies and evaluates environmental effects and risks arising directly or indirectly from the normal operations of the activity (including construction where applicable); and
   (b) includes an assessment of risk of the potential effects on the environment resulting from reasonably possible operations (whether accidental or otherwise) that are not normal operations for the activity.

Environmental Performance Objectives and Standards

(4) The environment plan must include environmental performance objectives, environmental performance standards and measurement criteria that:
   (a) define the objectives, and set the standards, against which performance by the operator in protecting the environment is to be measured; and
   (b) include measurement criteria for determining whether the objectives and standards have been met.

Implementation Strategy for the Environment Plan

(1) The environment plan must contain an implementation strategy for the activity in accordance with this regulation.
(2) The implementation strategy must include measures to ensure that the environmental performance objectives and standards in the environment plan are met.
(3) The implementation strategy must identify the specific systems, practices and procedures to be used to ensure that:
   (a) the environmental effects and risks of the activity are reduced to as low as reasonably practicable; and
   (b) the environmental performance objectives and standards in the environment plan are met.
(4) The implementation strategy must establish a clear chain of command, setting out the roles and responsibilities of personnel in relation to the implementation, management and review of the environment plan.
(5) The implementation strategy must include measures to ensure that each employee or contractor working on, or in connection with, the activity is aware of his or her responsibilities in relation to the environment and has the appropriate skills and training.
(6) The implementation strategy must provide for the monitoring, audit and review of the operator's environmental performance and the implementation strategy.

(7) The implementation strategy must provide for the maintenance of a quantitative record of emissions and discharges (whether occurring during normal operations or otherwise) to the air, marine, seabed and sub-seabed environment, that is accurate and can be monitored and audited against the environmental performance standards and measurement criteria.
(8) The implementation strategy must provide for the maintenance of an up-to-date emergency response manual (including an oil spill contingency plan) including detailed response arrangements.
(9) The implementation strategy must provide for appropriate consultation with:
    (a) relevant authorities of the Commonwealth, a State or Territory; and
    (b) other relevant interested persons or organisations.
(10) The implementation strategy must comply with the Act, the regulations and any other environmental legislation applying to the activity.

Reporting etc. Arrangements

The environment plan must include arrangements for:
(a) recording, monitoring and reporting information about the activity (including information required to be recorded under the Act, the regulations and any other environmental legislation applying to the activity) sufficient to enable the Designated Authority to determine whether the environmental performance objectives and standards in the environment plan are met; and
(b) reporting to the Designated Authority at intervals agreed with the Designated Authority, but not less often than annually.

Other Information in the Environment Plan

The environment plan must contain the following:
(a) a statement of the operator's corporate environmental policy;
(b) a report on any consultations between the operator and relevant authorities, interested persons and organisations in the course of developing the environment plan;
(c) a list of all environmental legislation of the Commonwealth, or a State or Territory, that may apply to the activity.

2.2.2 *Environment Protection and Biodiversity Conservation Act 1999*

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), enables the Commonwealth to join with the States and Territories in a national scheme of environment protection and biodiversity conservation. Under the EPBC Act, actions that are likely to have a significant impact on a matter of national environmental significance will trigger Commonwealth assessment and approval.

Matters defined as nationally significant include:

1. World Heritage properties.
2. Ramsar wetlands of international importance.
3. Nationally threatened animal and plant species and ecological communities.
4. Internationally protected migratory species.

5. Commonwealth land and marine areas.
6. Nuclear actions.

A referral and assessment process determines the application of the EPBC Act. Where activities are deemed by the Minister to have a potential for significant impacts on matters of national environmental significance, the project is deemed to be a controlled action and assessment under the EPBC Act is triggered. Santos lodged a referral with Environment Australia in mid September 2003 which was then exhibited for public comment over a 10-working day period. A determination from Environment Australia is due by mid October 2003. Santos anticipates that the project will be deemed to not be a controlled action based on it being scheduled to avoid the key whale migration season and recent precedents.

2.4 Environmental Policy Statement

The Santos environmental policy is included in Appendix 1.

3. Description of Environment

3.1 Physical Environment

3.1.1 Climate

The climate of the study area is cool temperate, consisting of warm, dry summers and cool winters with minimum temperatures averaging 9-12°C and maximum temperatures averaging 18-21°C (Bureau of Meteorology, 2003a). Climate averages for the two largest towns closest to the survey area, Warrnambool and Portland, are shown in Table 3.1.

Table 3.1 Climate averages for Warrnambool and Portland

Parameter	Warrnambool[1]	Portland[2]
Average annual rainfall (mm)	743	836.7
Mean number of rain days	166.8	183
Mean daily maximum temperature (°C)	17.9	17.8
Mail daily minimum temperature (°C)	9.7	9.7
Mean relative humidity (9am) (%)	77	77
Mean relative humidity (3pm) (%)	69	66

[1] Bureau of Meteorology, 2003b.
[2] Bureau of Meteorology, 2003c.

The Otway region encounters approximately seven days of thunder per year, which are most likely to occur in late spring and early autumn. The likelihood of encountering hail is slightly less (four days) and frosts in the Otway region are not common (BHP Petroleum and Santos (BOL) Ltd, 1999).

Winds in the area are predominantly westerly with north westerly winds increasing in winter and east north east winds increasing in summer and autumn (BHP Petroleum and Santos (BOL) Ltd, 1999). The windiest period of the year occurs from June to October with the highest mean wind and gust speeds of 7.86 and 12.2 metres per second (m/s) respectively recorded in August (Woodside, 2003). However during severe storms (often occurring in winter months) wind speeds of 12-18 m/s are common with gusts of up to 40 m/s also occurring (Woodside, 2003).

3.1.2 Oceanography

High energy wave conditions are characteristic of the coastal areas, with more severe wave conditions occurring in winter. Wave heights in the Port Campbell region commonly range between 2.0 to 3.5 m for 50% of time however in winter they can reach 7.6 m (BHP Petroleum and Santos (BOL) Ltd, 1999).

Tidal range is considered microtidal, 0.8 – 1.2 m (IMCRA, 1998) with two high tides and two low tides per day. Wind driven currents are the most predominant in the area (BHP Petroleum and Santos (BOL) Ltd, 1999; Woodside, 2003).

These generally run parallel to the coast and in a majority of the cases from west to east (BHP Petroleum and Santos (BOL) Ltd, 1999; Woodside, 2003).

Tidal currents are in the order of 0.1 m/s and run in an east to south-east direction for most of the time, and occasionally currents swing around to the west and north-west (BHP Petroleum and Santos (BOL) Ltd, 1999).

The typical thermocline temperature is 16.5°C, with surface temperature varying from 14.5 to 19°C and bottom temperatures in the area of 13.5°C to 14.5°C. There is a seasonal thermocline at a depth of 30 m in December which moves to 100 m in May and is then rapidly destroyed as mixing occurs during winter months (BHP Petroleum and Santos (BOL) Ltd, 1999).

Upwelling is known to occur along the Bonney Coast (Robe to Port Campbell) throughout the summer period (approximately November through to March) (Butler et al., 2002). The 'Bonney Upwelling' is a result of south-east winds generating water movements from the deeper waters to the surface. The surface water is replaced by colder water drawn from greater depths off the continental shelf that is generally nutrient rich and plays an important role in the generation of plankton blooms (Woodside, 2003).

3.1.3 Seabed Bathymetry

The VIC/P44 and VIC/P51 2D Seismic Program is located in water depths ranging from 25 to almost 200 m in depth, entirely within the continental shelf between four and 40 km (2 nm and 21 nm) from the coast. VIC/P44, however, is located entirely in waters no deeper than 100 m (see Figure 1.1).

The nearshore seabed is characterised by irregular rocky reefs extending out to a distance of about 550 m offshore (Woodside, 2003). From about 20–36 m depth (approximately 1.8 km offshore), the seabed is characterised by flat areas of sand (Woodside, 2003), though this is not uniform, with areas of low rocky reef, interspersed with extensive areas of sand and shell rubble. Further offshore (and some 30 km east of the survey area, though still likely to be representative of the ocean floor in the region and at these depths), Woodside (2003) found that the seabed comprises a mix of flat limestone pavement interspersed with areas of coarse mobile sand, and some high outcrops of limestone reef.

The southern tip of VIC/P51 extends close to the continental slope, where a marked change in seabed bathymetry occurs. Over a distance of about 40 km (21 nm), the seafloor depth grades from 200 m to over 2,000 m. The continental slope is conducive to nutrient-rich upwelling of bottom waters, referred to previously as the 'Bonney Upwelling' (see Section 3.1.2). Along the continental shelf the seabed is mainly calcareous sands with patchily distributed biological communities (McCauley and Duncan, 2001).

3.2 Biological Environment

3.2.1 Marine and Coastal Classification

The Interim Marine and Coastal Regionalisation for Australia (IMCRA) (1998) has adopted an ecosystem-based classification system for marine and coastal environments. The area of the seismic survey encompasses several scales of classification, as outlined in Table 3.2.

Table 3.2 IMCRA bioregional classification of the seismic survey area

Name	Classification	Scale Hierarchy	Description
Otway	Meso-scale (Provincial)	100s-1000s of km	Characterised by very steep to moderate offshore gradients. Wave energy is high, currents are generally slow, and the waters are cold temperate, subject to localised, regular and cold nutrient-rich coastal upwelling.
West Bassian Biotone	Demersal province	89,000 km^2	Zone of faunal overlap of elements from the Tasmanian and Bassian Provinces to the east, and a small suite of extralimital species from the Central Eastern Province.
Southern Pelagic Province	Pelagic province	482,000 km^2	Extends from near Albany, WA, to Lakes Entrance, Victoria, encapsulating all of Bass Strait. Comprised of temperate species, with the endpoint disjunctions representing the southern limits for tropical species.

Provinces and biotones are based on a classification of demersal fish species diversity and richness.

3.2.2 Marine Fauna

The Commonwealth-listed (under the EPBC Act) and State-listed (Atlas of Victorian Wildlife [AVW]) marine species that may potentially occur in the seismic survey area are identified in Table 3.3. Marine birds are not listed in Table 3.3 (with the exception of penguins) as they are mostly migratory, and may overfly the project area but are highly unlikely to be influenced by the presence of the seismic vessel in the area.

Table 3.3 Commonwealth and state-listed marine threatened species that may occur in the survey area

Species	Common Name	Commonwealth Status	Victorian Status
Mammals			
Arctocephalus forsteri	New Zealand fur seal*	-	LR
Arctocephalus pusillus	Australian fur-seal	L	-
Balaenoptera acutorostrata	Minke whale	LC	-
Balaenoptera bonaerensis	Antarctic minke whale	M	-

Table 3.3 Commonwealth and state-listed marine threatened species that may occur in the survey area (cont'd)

Species	Common Name	Commonwealth Status	Victorian Status
Mammals (cont'd)			
Balaenoptera borealis	Sei whale	M	-
Balaenoptera edeni	Bryde's whale	M	-
Balaenoptera musculus	Blue whale	T, E, M	FFG, CEn
Berardius arnuxii	Arnoux's beaked whale*	LC	-
Caperea marginata	Pygmy right whale	M	-
Delphinus delphis	Common dolphin*	LC	-
Eubalaena australis	Southern right whale	T, E, M	FFG, CEn
Globicephala macrorhynchus	Short-finned pilot whale*	LC	-
Globicephala leptonyx	Long finned pilot whale*	-	-
Grampus griseus	Risso's dolphin*	LC	-
Hydrurga leptonyx	Leopard seal*	-	-
Kogia breviceps	Pygmy sperm whale**	-	-
Kogia simus	Dwarf sperm whale**	LC	-
Lagenorhynchus obscurus	Dusky dolphin*	LC	-
Lissodeplphis peronii	Southern right whale dolphin	LC	-
Megaptera novaeangliae	Humpback whale	T, V, M	FFG, Vul
Mesoplodon bowdoini	Andrew's beaked whale*	LC	-
Mesoplodon densirostris	Blainville's beaked whale*	LC	-
Mesoplodon ginkgodens	Ginkgo-toothed whale*	-	-
Mesoplodon grayi	Gray's beaked whale*	LC	-
Mesoplodon hectori	Hector's beaked whale*	LC	-
Mesoplodon layardi	Strap-toothed whale*	-	-
Mesoplodon mirus	True's beaked whale*	-	-
Mirounga leonina	Southern elephant seal*	-	-
Neophoca cinerea	Australian sea lion*	-	-
Orcinus orca	Killer whale	M	-
Physeter macrocephalus	Sperm whale	-	-
Pseudorca crassidens	False killer whale*	LC	-
Tursiops aduncus	Spotted bottlenose dolphin	LC	-
Tursiops truncatus s. str.	Bottlenose dolphin	LC	-
Ziphius cavirostris	Cuvier's beaked whale*	-	
Sharks			
Carcharias taurus	Grey nurse shark (east coast population)	T, CE	-
Carcharodon carcharias	Great white shark	T, V, M	-

Table 3.3 Commonwealth and state-listed marine threatened species that may occur in the survey area (cont'd)

Species	Common Name	Commonwealth Status	Victorian Status
Other species			
Aptenodytes patagonicus	King penguin	-	-
Dermochelys coriacea	Leathery turtle	-	FFG, CEn
Eudyptes pachyrhynchus	Fiordland penguin	-	-
Eudyptes sclateri	Erect-crested penguin	-	-
Eudyptula minor	Little penguin	L	-
Heraldia nocturna	Upside-down pipefish	L	-
Hippocampus abdominalis	Eastern potbelly seahorse, New Zealand potbelly seahorse, bigbelly seahorse	L	-
Hippocampus breviceps	Short-head seahorse, short-snouted seahorse	L	-
Histiogamphelus briggsii	Briggs' crested pipefish, Briggs' pipefish	L	-
Histiogamphelus cristatus	Rhino pipefish, Macleays's crested pipefish	L	-
Hypselognathus rostratus	Knife-snouted pipefish	L	-
Kaupus costatus	Deep-bodied pipefish	L	-
Leptoichthys fistularius	Brushtail pipefish	L	-
Lissocampus caudalis	Australian smooth pipefish, Smooth pipefish	L	-
Lissocampus runa	Javelin pipefish	L	-
Maroubra perserrata	Sawtooth pipefish	L	-
Mitotichthys semistriatus	Half-banded pipefish	L	-
*Mitotichthys tucker*i	Tucker's pipefish	L	-
Notiocampus ruber	Red pipefish	L	-
Phycodurus eques	Leafy seadragon	L	-
Phyllopteryx taeniolatus	Weedy seadragon, Common seadragon	L	-
Pugnaso curtirostris	Pug-nosed pipefish	L	-
Solegnathus robustus	Robust Spiny pipehorse, Robust pipehorse	L	-
Solegnathus spiniosissimus	Spiny pipehorse, Australian spiny pipehorse	L	-
Stigmatopora argus	Spotted pipefish	L	-
Stigmatopora nigra	Wide-bodied pipefish, Black pipefish	L	-
Stipecampus cristatus	Ring-backed pipefish	L	-
Urocampus carinirostris	Hairy pipefish	L	-

Table 3.3 Commonwealth and state-listed marine threatened species that may occur in the survey area(cont'd)

Species	Common Name	Commonwealth Status	Victorian Status
Other species (cont'd)			
Vanacampus margaritifer	Mother-of-pearl pipefish	L	-
Vanacampus phillipi	Port Phillip pipefish	L	-
Vanacampus poecilolaemus	Australian long-snout pipefish, Long-snouted pipefish	L	-

* No key localities known in Australian waters (Bannister et. al., 1996).

** No specific localities recognised.

Status Key

Victoria		**Commonwealth**	
FFG	Listed under the *Flora and Fauna Guarantee Act 1988*	T	Threatened
CEn	Critically Endangered	E	Endangered
End	Endangered	CE	Critically endangered
Vul	Vulnerable	V	Vulnerable
R/R	Rare	L	Listed
LR	Lower risk near threatened	LC	Listed cetacean
Cmp	Comprising several taxa	M	Migratory

Those species and marine fauna groups that may occur in the project area at various times of the year (e.g., for feeding, breeding or migration) are discussed below.

Marine Mammals

A number of marine mammals (whales, dolphins and seals) are known to occur in the Otway Basin. The following species are discussed below:

- Blue whale.
- Southern right whale.
- Humpback whale.
- Sei whale.
- Fin whale.
- Pygmy right whale.
- Killer whale.
- Minke whale.
- Brydes' whale.
- Sperm whale.
- Risso's dolphin.
- Dusky dolphin.
- Common dolphin.
- Bottlenose dolphin.
- Australian fur seal.
- New Zealand fur seal

Cetaceans

The two subspecies of blue whale, the true blue whale and pygmy blue whale, are difficult to distinguish from one another and thus far have been treated as one for the purposes of the EPBC Act. Blue whales (*Balaenoptera musculus*) have widespread migratory paths and although they can occur relatively close to the

coast they are not known to follow coastlines or oceanographic features (Bannister et al., 1996). Sightings of blue whales in the Otway region have been between December and May). Most blue whales are sighted during the March/April period and on the continental shelf in water depths less than 200 m between longitudes 139°18'E - 143°03'E (Gill, 2002). Observations suggest that the areas off western Victoria and southeast South Australia are used for feeding, at least in summer and early autumn (Environment Australia, 2002a; Gill, 2002) however, the exact time and location of the blue whale appearance is difficult to predict (Gill, pers. comm., 2003). Aggregations of the krill species, *Nyctiphanes australis,* which are common along the Bonney Coast upwelling region, attract the blue whales to the area for feeding (Gill, 2002). Annual surveys undertaken by Deakin University between February 1998 and May 2002 show that blue whales congregate along this upwelling region, strongly correlated with the 100 m isobath (Gill, 2002), which aligns through the centre of VIC/P51 and is just south of VIC/P44.

Southern right whales (*Eubalaena australis*) occur along the southern coast of Australia in winter and spring (Kemper et al., 1997). Calving females have a preference for shallow, northeast trending bays over sandy bottoms, almost always within 2 km of the shore (Bannister et al., 1996). Warrnambool is an important calving and nursery area, with a majority of sightings just outside the break at approximately 5-6 m water depth. Southern right whales congregate around this area every year from about May to October (Environment Conservation Council, 2000; Watson, pers. comm., 2003) and they breed approximately every three years (Environment Conservation Council, 2000). The use of Warrnambool as a nursery area by the southern right whales could be due it being a high-energy coast with associated high levels of sound which would make it difficult for acoustically-sensitive predators such as the killer whales to detect the presence of calves (Bannister et al., 1996). The Warrnambool calving and nursery area is about 10 km (5.5 nm) north of the nearest proposed seismic line.

Humpback whales (*Megaptera novaeanglia*) (listed as vulnerable) can be found off the coast in winter and spring. Victorian coastal waters are however not a key location for this whale species (Bannister et al., 1996). A discrete population of humpback whales migrates annually along the east coast of Australia between summer feeding grounds in the Antarctic and winter breeding and calving grounds in the tropics. In recent years, an increased number of sightings have been made along the Victorian coastline from May to early August and also December (Gill, pers. comm., 2003). During the autumn period sightings were made from the shore of humpback whales heading east off Portland and Warrnambool (Woodside, 2003). Humpbacks observed along Victoria's southwest coast are likely to be travelling north to the east coast of Australia and are believed to migrate up via Tasmania's west coast.

Fin and sei whales (*Balaenoptera physalus* and *Balaenoptera borealis* respectively) are rare in Australian waters (Bannister et al., 1996), but have been observed in krill aggregation areas associated with the Bonney upwelling (Gill, 2002), with peak feeding times between mid-December to mid-March.

Pygmy right whales (*Caperea marginata*) are generally found in temporal subantarctic waters, and oceanic, pelagic and inshore sightings have also been made. There have been sightings recorded in Victoria (Bannister et al., 1996).

Killer whales (*Orcinus orca*) are likely to be found in oceanic, pelagic and neritic (shallow marine environment extending from mean low water down to 200 m depths, generally corresponding to the continental shelf) habitats but are more commonly found in cold deep waters. Off Australia, they are often seen along the continental slope and on the shelf as well as often being seen near seal colonies (Bannister et al., 1996). Although not a migratory species, their movements vary seasonally and are related to food supply (Bannister et al., 1996). There are frequent sightings of killer whales in Victorian waters (Bannister et al., 1996), mainly in autumn and spring to early summer.

Minke whales (*Balaenoptera acutorostrata*) tend to migrate from cold water feeding grounds to warmer waters to breed during the winter period (Thiele and Gill, undated; Bannister et al., 1996). The mating period for minke whales occurs from August to September and calving occurs from June to July (Bannister et al., 1996).

There are two forms of the Bryde's whale (*Baleonopetra edeni*); an inshore and an offshore form. It is typically found in tropical and temperate waters from the equator to approximately 40°S both in deeper oceanic waters and inshore (IFAW, undated; Bannister et al., 1996). Mating occurs throughout the year for the inshore form and during autumn/winter for the offshore form (Bannister et al., 1996). Bryde's whale is less likely to be found along Australia's south coast compared to the east and west coasts (Bannister et al., 1996).

The sperm whale (*Physeter macrocephalus*) is found in deep waters off the continental shelf, with a strong preference for the 1,000 m depth contour (Perry et al., 1999; Anonymous, 2001) and rarely seen at depths less than 300 m (Anonymous, 2000). Concentrations of sperm whale populations are generally found where the seabed rises steeply from great depths. This may coincide with areas where potential food sources (cephalopods) are concentrated in particular, areas of upwelling (Bannister et al., 1996). A key locality for the sperm whale is off Tasmania's west coast. Several sperm whales have also been sighted from a 3D seismic vessel at approximately the 1,000 m water depth during the VIC/P51 and VIC/P52 survey in late 2002 (Hughes and White, 2003). The sperm whale mating season is between September to December, with calving occurring between November to March (Bannister et al., 1996; Perry et al., 1999). There are no known specific calving locations in Australian waters for the sperm whale but they are known to occur in temperate and tropical oceanic waters (Bannister et al., 1996).

A summary of the timing of peak whale activities in and around the Otway Basin is provided in Table 3.4. The timing of these activities are peak only, and individuals of the species listed still have the possibility of occurring in the Otway Basin outside of the times indicated in Table 3.4.

Table 3.4 Summary of peak whale activities in the Otway Basin

Species	Activity	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Southern right whale	Migration, calving, nursing												
Blue whale	Feeding aggregation												
Humpback whale	Migration												
Sei whale	Probably feeding												
Fin whale	Probably feeding												
Minke whale	Probably feeding												
Beaked whale*	Probably feeding												

* Species unknown.

Risso's dolphin (*Grampus griseus*) has been recorded in Victoria, generally found inshore as well as offshore. It is considered a pelagic and oceanic species also frequently seen over the continental slope (Bannister et al., 1996). Dusky dolphins (*Lagenorhynchus obscurus*) predominantly occur in temperate subantarctic zones inshore but also pelagic at times (Bannister et al., 1996). The common dolphin (*Delphinus delphis*) is found in Victorian waters, where their habitat is generally neritic, pelagic and oceanic. This species has been associated with high topographical relief of the ocean floor, escarpments and areas of upwelling (Bannister et al., 1996). The bottlenose dolphin (*Tursiops truncatus*) is generally found in coastal, estuarine, pelagic and oceanic habitats. In southern Australia, this species can occur close to shore (i.e., within a few hundred metres of the coastline) as well as in waters beyond the continental slope all year round (Bannister et al., 1996).

Pinnipeds

The Australian fur-seal (*Arctocephalus pusillus*) has established four breeding areas on islands in Victoria (Shaughnessy, 1999). Preferred habitat includes rocky shores of islands with flat open terrain. The largest breeding colonies are at Lady Julia Percy Island and Seal Rocks in Victoria (Shaughnessy, 1999). The closest breeding colony to the seismic program is at Lady Julia Percy Island which is situated approximately 8 km west from the nearest survey line. Births occur from late October to late December (Menkhorst, 1995; Shaughnessy, 1999). There are several small non-breeding colonies; the closest to the survey area is at Cape Bridgewater (approximately 5 km south east of the survey area), where approximately 650 fur seals reside (Glenelg Shire Council, 2003).

New Zealand fur-seals (*Arctocephalus forsteri*) from populations at Kangaroo Island may also forage in western Victoria but are not common.

Seabirds

Marine birds in the survey area are mostly migratory (with the exception of penguins), and may overfly the project area but are highly unlikely to be impacted by the survey due to the lack of suitable roosting sites. The Bay of Islands (west of Peterborough) and the offshore limestone stacks close to the

coast are important roosting and breeding colonies for many bird species, including the pacific gull (*Larus pacificus*).

Of the Commonwealth-listed marine bird species, there are 12 species of albatross listed, all of which are migratory species, with three species listed as endangered and nine considered vulnerable. There are four threatened species of petrel (two endangered, two vulnerable) that are migratory species or overfly the area. A full list of Commonwealth-listed species is provided in Appendix 2.

Among the Victorian-listed threatened marine bird species, there are six albatross (four vulnerable, two endangered), one endangered egret, the endangered white-bellied sea-eagle, eight petrel species (ranging from vulnerable to lower risk), the critically endangered orange-bellied parrot, four shearwaters and four penguin species (none of which are threatened). A full list of Victorian-listed species is provided in Appendix 3. The records from the AVW database are confirmed sightings of species, with positional data recorded for each sighting.

Little penguins (*Eudyptula minor*) are known to nest in the talus slopes on the beaches at the base of the cliffs of this area of coast and forage for food in nearby marine habitat. The number of birds in a penguin colony decreases between moulting (February to April) and at the start of the breeding season in August (BHP Petroleum and Santos (BOL) Ltd, 1999). During the breeding season, adult birds rarely venture more than 10 km (5.5 nm) offshore from their colony to collected food for their young and so are unlikely to be impacted by the survey. Shoaling fish and cephalopods are common prey items (BHP Petroleum and Santos (BOL) Ltd, 1999).

Pipefish and Seahorses

Pipefishes, seahorses and seadragons are associated with kelp forests in sheltered to moderately exposed reef areas at a range of depths 0-50 m depending on the species (Edgar, 1997). The majority of the survey will be undertaken in an area where water depth is likely to be too deep for such kelp to exist as large forests and therefore offer limited habitat for these species. Although the shallower portion of the survey will be conducted in water depths of approximately 25 m, it is unlikely that pipefish and seahorse communities will be found here due to the exposed and high-energy nature of this coastline. A full list of Commonwealth-listed pipefish and seahorses is provided in Appendix 2.

Turtles

The leathery turtle (also known as the leatherback turtle), *Dermochelys coriacea*, is mostly a pelagic species rarely found inshore (except when found in its breeding grounds). It is a regular however rare species to Bass Strait and unlikely to be found in the proposed survey areas. There are no breeding areas or areas of importance for feeding for marine turtles in Victoria. However the leathery turtle is listed as a threatened species under the Victorian *Flora and Fauna Guarantee Act, 1988* (Environment Australia, 2003).

Fish

A great diversity of bony fish (teleosts) occurs within the waters of the project area. These include anchovy (*Engraulis australis*), barracouta (*Thyrsites atun*), black bream (*Acanthopagrus butcheri*), eastern school whiting (*Sillago flindersi*), jack mackerel (*Trachurus declivis*), jackass morwong (*Nemadactylus macropterus*), John Dory (*Zeus faber*), King George whiting (*Sillaginodes punctuata*), luderick (*Girella tricuspidata*), mulloway (*Argyrosomus hololepidotus*), ocean jacket (*Nelusetta ayraudi*), ocean perch (*Helicolenus* spp.), pilchard (*Sardinops neopilchardus*), pink ling (*Genypterus blacodes*), sand flathead (P*latycephalus bassensis*), sea mullet (*Mugil cephalus*), silver trevally (*Pseudocaranx dentex*), snapper (*Pagrus auratus*), southern bluefin tuna (*Thunnus maccoyii*), southern sea garfish (*Hyporhamphus melanochir*), tailor (*Pomatomus saltatrix*), tiger flathead (*Neoplatycephalus richardsoni*), Tommy ruff (*Arripis geogianus*), yellow-eye mullet (*Aldrichetta fosteri*), and yellow-tail king fish (*Seriola lalandi*) (BHP Petroleum and Santos (BOL) Ltd, 1999).

Coastal areas off Portland appear to be seasonally important for juvenile white sharks (*Carcharodon carcharias)*. These are likely to be pupping grounds. Pups are born between the months of December to June (Environment Australia, 2002b). Grey nurse sharks (*Carcharias taurus)* are not common in Victorian waters (Environment Australia, 2002c).

Crustaceans

The main crustacean species in the project area is the southern rock lobster (*Jasus edwardsii*). Southern rock lobster are abundant on reefs in western Victorian waters from the shoreline to waters 200 m in depth (Department of Primary Industries, 2003a). Southern rock lobster have a complex lifecycle – fertilised eggs are carried under the female's tail for 3 months and then released during September to November. Once released, lobster larvae (phyllosoma) undergo an 11 stage larval development while being carried on ocean currents for one to two years. They have little control of direct lateral movement, but can use diurnal vertical migration (shallower at night and deeper during the day to use current movements) (Hobday & Smith, 2001). During the final larval stage, the 25 mm long puerulus settle on reefs occurring at depths of less than 40 m and grow into juvenile lobsters. Adult lobsters are carnivorous, feeding mostly at night on epibenthic (bottom-dwelling) invertebrates (Department of Primary Industries, 2003a).

Molluscs

Molluscs are aquatic invertebrates with soft bodies, comprising gastropods (snails), bivalves (clams and mussels) and cephalopods (squids and octopus). Species of commercial and recreational importance found in the project area include southern scallop (*Pecten fumatus*), arrow squid (*Nototodarus gouldi*) and several octopus species (*Octopus* spp.) (BHP Petroleum and Santos (BOL) Ltd, 1999). The main commercial mollusc catch in the region is the blacklip abalone (*Haliotis rubra*). It is found and harvested in the shallow waters from the shoreline out to about the 20 m depth.

Abalone gain spawning condition during mid spring and spawn mainly over the summer months. Spawning is not synchronised between populations, and is variable from reef to reef. Unlike the southern rock lobster, egg and larval life is extremely short (3-7 days) and the larvae do not feed while in the planktonic stage. They mainly remain concentrated in eddies of currents or beneath kelp canopies and the juveniles attach to a hard substrate, almost exclusively on pink crustose coralline algae (Gorfine & Walker, 1997). Research in south eastern Australia has shown that eggs are relatively heavy and stay close to the parent reef (i.e., they are not generally mobile in the water column) so that larval dispersal is limited (McShane et al., 1988; Prince et al., 1987; 1988). The habitat of the abalone is usually reef, often in gutters and crevices that offer protection from high wave energy and that funnel drift algae, the abalone's main food source (Gorfine & Walker, 1997).

Sponges

An assessment of the sponge beds of central Bass Strait was undertaken by CSIRO (2002), based on Museum Victoria sea bed surveys between 1979 and 1984. 'Sponge bed' is a collective term for the communities of habitat-forming sessile, filter feeding fauna that contain species of sponges, octocorals, bryozoans and ascidians. Because sponge beds can form large and complex benthic structures, they also host other faunal species such as crustaceans, molluscs and worms. While this assessment did not extend westward enough to be completely relevant to the VIC/P44 and VIC/P51 2D seismic survey, it was found that the deeper reef areas (greater than 20 m in depth) of Bass Strait contain a diverse array of invertebrates such as sponges, bryozoans and gorgonians that flourish in low-light conditions. The extensive areas of sponge beds are largely unexplored (surveys limited to diving depths and fishing trawl bi-catch), but are likely to be species-rich, high in endemism and likely to include many species not yet identified and named.

Plankton

Plankton is the collective term for a vast number of microscopic organisms, made up of plants (phytoplankton) and animals (zooplankton) that are carried within the surface layers of ocean. Phytoplankton is the major basis of the marine food chain. The zooplankton consists of two main elements; those that permanently spend their life within the plankton (haloplankton), and those that temporarily exist within the plankton, such as the eggs and larvae of fish and invertebrates (meroplankton).

Victorian oceanic waters are generally low in nutrients, resulting in low plankton productivity. However, along the western coastline of Victoria, the Bonney Upwelling (see Section 3.1.2) leads to blooms of phytoplankton that provide food for the zooplankton, which in turn provide most of the food requirements of many whale species migrating through the region. Zooplankton associated with the Bonney Upwelling include krill, the euphausiid (*Nyctiphanes australis*), which is the main food source for the blue whale (Woodside, 2003).

3.2.3 Marine Flora

The southern oceans of Australia contain the most diverse marine benthic flora in the world, and the highest levels of species endemism (National Oceans Office, 2002). The marine flora found in the region is typically cold temperate flora (IMCRA, 1998).

Several kilometres north of the survey area, closer to the coast in the intertidal and sublittoral fringe, bull kelp (*Durvillea potatorum*) is dominant, while the rocky sub-tidal macro-algal communities are dominated by other large brown algae such as *Macrocystus angustifolia* and *Phyllospora comosa*. Seagrass meadows occur in the few sheltered bays in the region, dominated by *Posidonia australis* in the shallower areas, with *P. sinuosa*, *P. angustifolia* and *Amphibolus antarctica* in the deeper waters (IMCRA, 1998). Kelp forests (leather kelp, *Ecklonia radiata*, the deepest growing of the brown algae found at 5-25 m depth) and red seaweeds are important habitats supporting high biodiversity including sponges, bryozoans, gorgonians, hydroids and seastars (Parks Victoria, undated). About 1150 species of seaweeds (macroalgae) are recorded from southern Australia, with red algae having the highest number of species (about 800), followed by brown (240 species) and green algae (140 species) (National Oceans Office, 2002).

Woodside (2003) undertook video survey of the seabed along a proposed subsea pipeline corridor in water depths ranging from 16 to 99 m, about 30 km (16 nm) east of the VIC/P44 and VIC/P51 2D seismic survey area. In the deeper areas of the pipeline corridor were found sponge dominated, filter feeding communities (Woodside, 2003).

3.3 Heritage

3.3.1 Aboriginal

Aboriginal groups inhabited the southwest Victorian coast as is evident from the terrestrial sites of Aboriginal archaeological significance throughout the area. During recent ice age periods (the last ending approximately 14,000 years ago), sea levels were significantly lower and the coastline was a significant distance seaward of it present location, enabling occupation and travel across land that is now submerged. However, it is highly unlikely that any evidence of occupation or sites of significance would remain in such a high-energy or marine environment.

3.3.2 Shipwrecks

The stretch of coastline along which the VIC/P44 and VIC/P51 2D seismic survey is proposed is known as the ‘Shipwreck Coast.’ Most of the ships were wrecked during the late nineteenth century. The strong waves, rocky reefs and cliffs of the region contributed to the loss of these ships. The wrecks represent significant archaeological, educational and recreational (i.e., diving) opportunities for locals, students, and tourists and include the Victorian heritage-listed Jane, SS Barwon and Marie (all near Cape Bridgewater), Napier, Newfield

and Antares (Heritage Victoria, 2003). These shipwrecks are all within a few hundred metres of the shore (i.e., not in the survey area) as a result of striking rocks and rocky reefs, and the latter three are found several kilometres northeast of the survey area along the coast. None are within the survey area.

3.4 Socio-Economic Environment

3.4.1 Coastal Towns and Services

The coastal communities of Apollo Bay, Princetown, Port Campbell, Peterborough, Warrnambool, Port Fairy and Portland all provide services to the commercial and recreational fishing industries in Western Victoria. Portland is Victoria's western most commercial port, and is a deep water port with breakwaters sheltering a marina and boat ramp. The Port of Warrnambool has a breakwater and yacht club, and provides shelter for commercial fishing boats. Port Fairy has fish processing facilities (Department of Sustainability and Environment, 2003).

The Glenelg and Moyne Shire Councils and Warrnambool City Council are responsible for the operation and maintenance of the coastal ports, including planning, issuing permits and licences, allocating moorings, maintaining wharves, jetties and navigation aids, dredging, operating facilities such as slipways, and the construction of new facilities (Department of Sustainability and Environment, 2003).

Portland, Port Fairy and Warrnambool are the nearest coastal towns to the seismic survey, with Warrnambool being the largest. At the time of the 2001 census, the populations for each town were >10,000, >2,600 and >28,000 respectively (Australian Bureau of Statistics, 2003).

3.4.2 Petroleum Exploration and Production

Petroleum exploration has been undertaken within the Otway Basin since the early 1960s. Hydrocarbons discovered by these exploration activities have been developed or are now undergoing assessment for development.

The Minerva Gas Field (currently being developed by BHP Billiton and Santos) is located about 10 km offshore from Port Campbell (in water deeper than 50 m), with a pipeline coming to shore just west of Port Campbell and connecting to a gas plant 5 km inland of the coast. The Geographe and Thylacine Gas Fields (currently being assessed for development by Woodside and Origin Energy) are located further offshore, directly south of Port Campbell, in waters about 100 m in depth.

Petroleum exploration and production has regional benefits for southwest Victoria. Not only have the numerous onshore and offshore studies undertaken for these developments led to a greater understanding of the region's terrestrial, coastal and marine environments, but they have resulted in a boost to the regional economy through the provision of services to project personnel and

through the creation of direct and indirect employment in construction and project support.

3.4.3 Marine Conservation

The development of marine conservation parks has, resulted in the establishment of 13 marine national parks and 11 marine sanctuaries proclaimed by the Victorian government in November 2002. The marine conservation areas located close to the proposed seismic survey area (none are located within the seismic area) are identified in Table 3.5.

Table 3.5 Existing marine conservation areas near the survey area

Park	Area	Distance to Closest Seismic Line	Features
Discovery Bay Marine National Park[1]	3,050 ha	4 km	20 km west of Portland, it is part of the largest basalt formation in western Victoria. High diversity of intertidal and subtidal invertebrates and sponge and kelp covered reefs.
Merri Marine Sanctuary[2]	25 ha	9 km	Offshore from the mouth of the Merri River, containing deep canyons that support a diversity of fish, while islands within the sanctuary are home to penguin colonies.

[1] Parks Victoria, 2003a.
[2] Parks Victoria, 2003b.

The proclaimed Twelve Apostles Marine National Park and the Arches Marine Sanctuary are located approximately 30 km east of the survey area.

A number of special management marine areas are proposed along the coast near the survey area. These are:

- Cape Bridgewater Proposed Special Management Area.
- Lawrence Rocks Proposed Special Management Area.
- Portland Bay Proposed Special Management Area.
- Deen Mar Proposed Special Management Area.
- Logans Beach Proposed Special Management Area.

Seismic acquisition is not proposed within any of these areas.

3.4.4 Shipping

The main shipping channel for vessels (e.g., cargo tankers) travelling between major Australian and foreign ports is located south of the seismic survey area, about 60 km (32 nm) south of Portland and about 75 km (40 nm) south of Warrnambool. This shipping channel is used by over 1,000 vessels per year (1999-2000 figures), or about 3-4 vessels per day (National Oceans Office, 2003).

The less frequently travelled shipping passages between the southern ports of Australia [Adelaide to Melbourne to Sydney] and between Portland and northern Tasmania that carry up to 500 vessels (1999-2000 figures) passes through the survey area (National Oceans Office, 2003). This passage is located about 25 km (13 nm) south of Portland and 40 km (21 nm) south of Warrnambool.

3.4.5 Commercial Fisheries

Australia's fishing zone is the fifth largest in the world, but has a low productivity due to nutrient-poor ocean currents. About 10% of the known fish, crustacean and mollusc species are commercially fished, and commercial fishing is the fifth most valuable Australian rural industry (Department of Agriculture, Fisheries and Forestry, 2003). Fisheries production relies heavily on the high unit value species such as prawns, tuna, rock lobster and abalone (Department of Agriculture, Fisheries and Forestry, 2003).

A variety of marine species are commercially harvested from the survey area. Relevant industry bodies representing these fisheries include Seafood Industry Victoria (SIV), Portland Professional Fisherman's Association, Warrnambool Professional Fisherman's Association (WPFA) and the Victorian Abalone Divers Association (VADA). Commonwealth government Management Advisory Committees (MACs) have also been established for the management of issues pertaining to most fisheries in Commonwealth waters (Australian Fisheries Management Authority, 2003).

Abalone Fishery

The abalone fishery is the most valuable Victorian fishery, currently worth about $70 million (Department of Natural Resources and Environment, 2002). Abalone fishing is only possible by SCUBA diving, and in Victoria, this is generally between the shoreline down to a depth of 20 m (McShane et al., 1986; Garnham, pers. comm, 2003), but often at depths shallower than 15 m (Gorfine & Walker, 1997). The portion of the proposed seismic survey that will be conducted in waters of approximately 25 m depth may potentially impact on the Abalone Fishery.

Southern Rock Lobster Fishery

The Southern rock lobster (*Jasus edwardsii*) occurs from the southwest of the Western Australian coast to southern New South Wales, including waters around Tasmania and New Zealand. The southern rock lobster fishery is the second most valuable Victorian fishery - in 2000/2001, it was worth $21.3 million to the Victorian economy (Department of Primary Industries, 2003a).

Southern rock lobsters are abundant from the shoreline to depths up to 200 m (Department of Primary Industries, 2003a), but generally fished from rocky reefs in shallower waters up to 150 m deep.

Commercial fishers use lobster pots while recreational fishers use SCUBA and hook netting (Department of Primary Industries, 2003a). Pot numbers and

dimensions are restricted (pot and escape gap size) to ensure sustainable commercial harvests.

The survey area lies within the Victorian Western Zone, which extends from Apollo Bay to the South Australian border. There are 89 Rock Lobster Fishery Access Licences (RLFAL) in the Western zone, with 5,388 licensed pots (Hobday & Smith, 2001), out of a total of 139 licences for Victoria (2001/2002) (Department of Primary Industries, 2003a). The 2000/2001 commercial catch from the Western Zone was 507 tonnes (Hobday & Smith, 2001).

South East Fishery

The South East Fishery (SEF) fishes more than 100 species, but 17 species or species groups provide the bulk (>80%) of trawl landings. Such species include the orange roughy, gemfish, flathead, blue grenadier, redfish, school whiting, warehou and jackass morwong (Bureau of Resource Sciences, 1994; Department of Agriculture, Fisheries and Forestry Australia, 2003).

Southern (and Western) Tuna and Billfish Fishery

This fishery extends south of the 200 m isobath, outside the survey area. The primary species caught in the Southern Tuna and Billfish Fishery include bigeye, skipjack and albacore tunas. There are 124 fishing permits for the fishery, with the value of production at $4.3 million in 1998/1999 (Australian Fisheries Management Authority, 2003).

Southern Bluefin Tuna Fishery

Southern bluefin tuna (*Thunnus maccoyii*) is a migratory species and has a wide distribution through the southern oceans. The principal method of fishing in South Australian waters is purse seine for ongrowing in aquaculture pens. Southern bluefin tuna stocks are severely depleted and at historically low levels. As at October 2000, there were 99 Statutory Fishing Right owners in the fishery, who caught 5,262 tonnes of tuna in 1999-2000, worth $88 million (Australian Fisheries Management Authority, 2003).

Gillnet, Hook and Trap Fishery (formerly the Southern Shark Fishery and South East non-Trawl Fishery)

The Gillnet, Hook and Trap Fishery (GHTF) extends from southeast Queensland to the South Australia/Western Australia border. Among the 21 species subject to quota arrangement include blue eye trevalla, blue grenadier, flathead, gemfish, john dory, orange roughy, royal red prawn and silver trevally (Australian Fisheries Management Authority, 2003). Shark species caught include school and gummy shark, with school shark overfished (Bureau of Regional Science, 2003). Methods of fishing include demersal longline, dropline, trotline and handline for scalefish, hook to target sharks, gillnets in waters deeper than 200 m and fish traps (Australian Fisheries Management Authority, 2003).

Southern Squid Jig Fishery

The Southern Squid Jig Fishery, which mainly targets the arrow squid (*Nototodarus gouldi*), is located in Commonwealth waters of southeast Australia in water depths ranging from 50 to 200 m, with peak catches being between January and June (AFMA, 2003). In August 2002, there were 84 squid jig entitlements. The 2000-2001 catch was 1,830 tonnes, worth $2.8 million (AFMA, 2003).

Giant Crab Fishery

The giant crab (*Pseudocarcinus gigas*) is only found in southern Australian waters from central NSW to south western Australia, including Tasmania. In Victoria, the fishery in based in the Western Zone and is relatively small with a catch in 2000/01 of 20 tonnes valued at A$600,000. The giant crab is a by-product of the rock lobster fishery, however, there are a small number of vessels that target the giant crab specifically (Department of Primary Industries, 2003b).

Giant crabs occur at the continental shelf break and upper slope to depths greater than 400 m, however, they are most abundant at depths between 150 m to 350 m (Department of Primary Industries, 2003b).

Closed seasons have been established particularly during the spawning season for the protection of female giant crabs. The closed season for female giant crabs is 1 June to 15 November and closed season for males is 1 September to 15 November (Department of Primary Industries, 2003b).

There is no recreational fishery due to the offshore distribution and depths at which the giant crabs occur.

3.4.6 Recreation and Tourism

Recreational and tourism activities are extremely valuable foundations for the local and regional economy. Key activities include sight-seeing, surfing and fishing, however, these are generally land-based or nearshore activities and are unlikely to be impacted by the proposed survey. Scuba diving and snorkelling are the only recreational activities that may potentially be affected by the proposed seismic survey.

Sight-seeing

The visual beauty of the rugged coastal cliffs and the surf beaches make up the primary attractions to the area. This part of the Victorian coastline is promoted nationally as the ‘Shipwreck Coast.’ The sheer vertical coastal cliffs attract tourism, as does the promise of seeing migrating whales, such as the southern right whale, from vantage points around Warrnambool.

The Great Ocean Road tourist drive facilitates most tourist visits to the region. Numerous self-guided tours (e.g., Great South West Walk), picnic facilities and coastal lookouts are provided along the coast, with camping sites, caravan parks,

guesthouses, motels and hotels encouraging tourism stays in the area. The Portland and Warrnambool visitor information centres provide visitors to the area with information on all these local attractions.

Surfing

The high energy of the ocean in western Victoria and high waves (associated with the rocky reefs) make this section of coastline ideal for surfing. Surfing is concentrated at Shelly Beach, Crumpets, Murrell's, Yellow Rock, Blacknose Point, White's Beach, Bridgewater, Water Tower, Rifle Range and Narrawong. The Bridgewater Bay surfing competition is held during summer (Glenelg Shire Council, 2003).

Surfing, by its very nature, takes place close to the shoreline, some distance from the survey area (generally more than 3 km).

Recreational Fishing

Recreational fishing includes rock, beach, boat and estuary fishing, using rod and line. Fishing licences are required for inland and ocean fishing. Common inshore fish species caught by recreational fishers include sand flathead (*Platycephalus bassensis*), John dory (*Zeus faber Linnaeus*), jackass morwong (*Namadactylus macropterus*), silver trevally (*Pseudocaranx dentex*), snapper (*Pagrus auratus*), barracouta (*Thyrsites atun*) and mullet (*Aldrichetta forsteri*). Common species caught at Curdies Inlet include black bream (*Acanthopagrus butcheri*), estuary perch (*Macquaria colonorum*), mullet (*Aldrichetta forsteri*) and Australian salmon (*Arripis sp.*) (BHP Petroleum and Santos (BOL) Ltd, 1999).

The survey area is likely to be too far offshore for recreational fishing to be impact on as it is generally undertaken in nearshore areas.

Diving and Snorkelling

Scuba diving and snorkelling usually take place around the offshore reefs and historic shipwrecks along the Discovery Coast between Warrnambool and Portland. The time of the seismic survey coincides with the period of least favourable sea conditions (strong surge and wave action) for recreational diving and snorkelling.

4. Description of Environmental Effects and Risks

The following section provides a description of potential environmental hazards and consequences of the proposed seismic survey to the environmental values of the survey area.

4.1 Potential Environmental Effects

The components (or hazards) of the seismic survey that could result in environmental effects include:

- Operation of the seismic vessel and towing of the airgun and streamer (hydrophone) array through the survey area.
- Interference with shipping, commercial fishing and recreational boating.
- Discharge or 'firing' of the airgun arrays.
- Seabed disturbance from anchoring or grounding.
- Accidental damage to, or loss of streamers and associated equipment.
- Routine waste discharges from the survey vessel.
- Accidental fuel and oil spills from the survey vessel.
- Collision with another vessel.

The potential environmental consequences of these activities are:

- Disturbance to marine fauna – disruptions to populations of pinnipeds (seals and sea lions), cetaceans (dolphins and whales), fish, penguins, benthic invertebrates and plankton from the discharge of the airgun arrays.
- Disturbance to benthic habitats – damage and/or destruction of seafloor habitats and palaeo-environments from anchoring, grounding and accidental loss of streamers and associated equipment.
- Interference with shipping and boating in the area – disruption to vessels.
- Interference with commercial fishing – disruption to fishing vessels.
- Waste disposal – sewage, putrescible waste, chemicals and solid and hazardous wastes.
- Fuel and oil spills – spillage from the survey vessel or from the streamer.
- Interference with existing oil and gas production infrastructure.

4.2 Disturbance to Marine Fauna

The initial ten to twenty years of seismic survey occurred around the coast of Australia at a time when there was relatively little information of the potential impacts from seismic activity and little prima facie evidence that significant adverse impacts actually resulted. Technology has improved over the years with cessation of the use of chemical explosive acoustic sources and the refinement of intensity and selection of frequencies to maximise penetration into the seabed. At the same time, little information was available about the nature of responses from marine fauna to underwater noise and the significance of any harm or disturbance that may have been caused. However, understanding of responses has improved with research, particularly since the 1990s. A Norwegian field study in 1993 indicated a temporary startle response by fish (Engås et al., 1993). The independent scientific review (Swan et al., 1994) found no evidence of seismic surveys grossly affecting marine animals (by way of death or severe injury). There is little evidence of physical harm from seismic surveys, unless organisms happen to occur or are held within very close distances from the source. The main effect is therefore considered to be behavioural change and startle response. Since this (1994) scientific review, the Australian Petroleum Production and Exploration Association (APPEA) has funded an offshore seismic effects research project (McCauley et al. 2000), leading to the development of Environment Australia guidelines for minimising acoustic disturbance to whales, and a number of other studies have been undertaken.

4.2.1 Sonic Disturbance

Both physical and biological processes contribute to natural background noise. Physical processes include that of wind and waves whilst biological noise sources include vocalisations of marine mammals and other marine species (Simmonds et al., 2003). Waterborne noise levels are expressed in units of decibels referred to as 1 microPascal (dB re 1μPa). Of the physical processes, wind is the major contributor to noise between 100 Hz and 30 kHz (Simmonds et al., 2003). The dominant source of naturally occurring noise across the frequencies from 1 Hz to 100 kHz is associated with ocean surface waves generated by the wind acting on the sea surface (National Research Council, 2003). Surf noise is specific to coastal locations.

The seismic survey airgun array will produce at source (i.e., within a few metres of the airguns) sound pulses in the order of 220-240 dB re lμPa-m at frequencies extending up to approximately 110 Hz. These levels will decrease to levels in the order of 170–180 dB re lμPa-m within 1 km of the source and approximately 150 dB re lμPa-m within 10 km, dependent on the sound propagation characteristics of the area (McCauley, 1994).

To place these seismic signal levels in perspective, the frequency spectrum for a low level background noise (spectral level) in a normal coastal region is about 60 dB re 1μPa (10–100 Hz). This corresponds to gentle wave action and little wind. In periods of bad weather conditions, the low frequency background noise increases to 90–100 dB re 1μPa. However, background noise in the proposed seismic survey area is expected to exceed average levels, due to the high-energy

wave environment. Heavy ship traffic generates higher levels of background noise, and active trawlers have a noise level of 150-160 dB re 1µPa (Statoil, 2000). Ships in narrow or shallow shipping channels may be in the range of 170–200 dB re 1µPa (McCauley 1994).

Marine mammals and other marine species use sound for social interaction and communication between individuals and pods as well as for echolocation[1], navigation purposes, reproduction, predator avoidance, feeding and in perception of their environment (McCauley, 1994; SCAR, 2002). The frequencies used by marine species cover a broad frequency spectrum (National Research Council, 2003; McCauley, 1994). Table 4.1 is a summary showing the range of frequencies used by various groups of marine species for communication and echolocation purposes.

Table 4.1 Summary of sound frequencies used by marine species for communication and echolocation

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz	Estimated Source Level (dB re 1µPa.m)*	Frequency kHz
Air gun array			220-240#	0.1-0.3#
Odontocetes (Toothed Whales)				
Common dolphin	0.2-150	23-67*	-	-
Bottlenose dolphin	0.05-150	110-130*	218-228	-
Risso's dolphin	0.1-23.7	65	-	-
Killer whale	0.1-35	12-25	180	-
Mysticetes (Baleen Whales)				
Southern right	0.03-2.2	-	172-192	-
Pygmy right	0.06-0.135*	-	165-179	-
Humpback	0.02-10	-	144-192	-
Fin	0.02,1.5-2.5*	-	155-186	-
Blue	0.012-0.4	-	130-188	-
Bryde's	0.124-0.900*	-	152-174	-
Sei	1.5-3.5*	-	-	-
Minke	0.06-6	-	151-175	-
Invertebrates				
Rock lobster	2-10#	-	-	-
Snapping shrimp	2-40#	-	-	-

[1] Echolocation is the ability by which animals can produce mid- or high-frequency sounds and detect echoes of these sounds that bounce back off distant objects to determine physical features of their surroundings.

Table 4.1 Summary of sound frequencies used by marine species for communication and echolocation (cont'd)

Species	Communication Frequency (kHz)	Echolocation Frequency (kHz	Estimated Source Level (dB re 1µPa.m)*	Frequency kHz
Fish				
Fish (general)	0.1-5#	-	-	-
Pinnipeds				
Seals (Otarridae)	2-32#	-	-	-
Seabirds				
Penguins	No known underwater vocalisations#	-	-	-

Source: Richardson et al., 1995; * SCAR, 2002; #McCauley, 1994.

According to McCauley (1994), baleen whales have calls that overlap the frequency range of seismic sources, therefore making them more susceptible to interference from seismic airgun noise, because their behaviour is based on sound. Dominant frequency of calls produced by the toothed whales is above 1 kHz which is above the range of most energy produced by seismic survey air-gun arrays (McCauley, 1994). The effect of seismic sources on the behaviour of marine mammals is complex and depends on factors such as:

- Hearing capability of individual species.
- Level and nature of noise exposure experienced.
- Habituation to seismic noise.
- Background noise.

The worldwide scientific literature on the impact to marine biota of the low frequency noise from seismic surveys and the implications in Australian conditions have been reviewed in detail (Swan et al., 1994; McCauley et al., 2000). As demonstrated in Table 4.1, the frequencies used by marine species vary over a broad spectrum (Gausland, 2000) and therefore the response of these species to the seismic survey sounds will range from no effect to various behavioural changes (McCauley, 1994). The scale of direct effects from seismic airgun noise are listed from most to least severe, and include:

- Lethal.
- Sub-lethal (pathological damage).
- Behavioural effects.
- Masking of temporary noise (induced changes in hearing ability).
- No direct effect.

Lethal Effects

Lethal effects are experienced only at very short ranges from the airgun array and very high noise levels are required. Although not well documented, plankton are likely to experience lethal effects at close ranges (5 m) to the airgun array due to their lack of ability to avoid exposure (McCauley, 1994).

Sub-lethal (Pathological) Effects

Sub-lethal effects refer to pathological damage by loud noise to the hearing system. Pathological damage may include ablation or dislodgment of receptive hair cells from the basilar membrane, damage to the middle ear apparatus in mammals, damage to the receptive epithelia of the otolith system or rupture of the swim bladder in fish (McCauley, 1994). A summary of the reported pathological effects of high level sound emissions adapted from the review by Turnpenny and Nedwell (1994) (with additional references added) is found in Table 4.2. It is clear that pathological effects were observed only at extremely close proximity to the source (around 1 m), and even at this distance, effects were not always observed. Table 4.2 reveals that both crustacean larvae and adults appear to be resilient to seismic airguns within very close distances to the noise source (range 0.5 to 3 m). It is most likely that southern rock lobster larvae would produce a similar response (e.g., to the dungeness crab larvae) in such airgun tests. The 5 m impact zone described by McCauley (1994) is therefore likely to be conservative.

Table 4.2 Pathological effects resulting from high level sources (adapted from Turnpenny and Nedwell, 1994)

Species	Source	Level (dB re 1µPa @ 1m)	Distance From Source (m)	Exposure Level (dB re 1µPa)	Observed Effect	Reference
Fish and Plankton						
Cod (adults)	Single airguns and arrays, 1,000 – 20,000 cm3	220-240 (estimated)	0.5	226 – 246	Haemorrhaging and eye damage	Kosheleva, 1992
			1.0	220 - 240	No harmful effects	
Cod (adults)	Electrically generated signal in laboratory conditions	Not stated	Not stated	192 – 198	Transient stunning, no subsequent mortalities	Hastings, 1990
Cod (larvae 5 days)	Single airgun	250	1	250	Delamination of the retina	Matishov, 1992
Cod (larvae 2- 110 days)	Single airgun	222	1	222	No injuries detected	Dalen and Knutsen, 1987
			10	202	No injuries detected	
Fish eggs Anchovy	Single airgun	230 dB (estimated)	1	230	7.8% of eggs injured relative to control	Kostyvchenko, 1973
			10	210	No injuries detected	

Table 4.2 Pathological effects resulting from high level sources (adapted from Turnpenny and Nedwell, 1994) (cont'd)

Species	Source	Level (dB re 1µPa @ 1m)	Distance From Source (m)	Exposure Level (dB re 1µPa)	Observed Effect	Reference
Fish eggs Red Mullet			1	230	No injuries detected	
			10	210	No injuries detected	
Benthic Invertebrate Species						
Dungeness crab (larvae)	Seven airgun array	244 (estimated)	1	233.5	No significant difference in survival rate relative to controls	Pearson et al., 1994
			3	230.9		
			10	222.5		
Brown shrimp (*Crangon crangon*) Adult		-	1	190	No mortality	Webb & Kempf (1998)
Mussel Periwinkles Crab Amphipod	Single airgun	223 (estimated)	0.5	229	No detectable effect, all groups continued to function normally after airgun exposure. Monitoring over next 30 days revealed no adverse effects.	Kosheleva, 1992
Sea Urchin	Single airgun	223 (estimated)	2	217	15 % of spines fell off	Matishov, 1992

Behavioural Effects

Behavioural reactions to seismic airgun noise involves movement of marine animals away from the source. The low frequencies produced by airgun arrays propagate well through the water and thus avoidance by some species may occur out to considerable distances from the source (McCauley, 1994; Richardson et al., 1995). Behavioural effects also include the interruption to normal activities or changes in migratory paths and increased exposure to predators, disturbance to normal behaviour pattern as well as attraction to the source, which may initially occur from long distances, but once close enough to the source, the species will be repelled (McCauley, 1994). These behavioural responses are elicited at sound levels much lower than that required to cause harm so that mobile organisms cannot suddenly find themselves within the impact few metres without being aware of the approach for some time, or through slow start-up procedures.

Masking of Temporary Noise

Seismic survey signals are also likely to interrupt or mask natural underwater physical or biological signals, causing some interference in communication between animals, although animals with poor or a lack of hearing or that are used to noise at low frequencies may be less affected (McCauley, 1994).

4.2.2 Pinnipeds

It has been suggested that seals may tolerate seismic pulses of high intensity and may be able to approach operating seismic vessels to a close range, because their hearing is poor in low frequencies (McCauley, 1994). However, McCauley also suggests that seismic activities may affect seals' prey abundance or behaviour, particularly if the seismic survey runs for long periods. Seal breeding success may be affected by long surveys over feeding areas during the breeding season (mating occurs in November to early December and pups are born in late November to early December). The seals commonly found in Australian waters belong to family Otariidae which are less sensitive to low frequency sounds (<1 kHz) than to higher frequencies (>1 kHz). McCauley (1994) suggests that the sound frequency of seismic air gun pulses is below the greatest hearing sensitivity of Otariid pinnipeds, but data are lacking for Australian species. Aerial sounds produced by the Australian fur seal (*Arctocephalus pusillis*) have strong tonal components at frequencies that are less than 1 kHz, although they all range up to 6 kHz with most energy between 2-4 kHz. If the low frequency components of calls are used then seals may also hear at low frequency and may be at some risk from seismic air-gun pulses. However, Shaughnessy (1999) states that seismic activity will only be a threat to pinnipeds if it takes place close to critical habitats.

The largest breeding colonies of Australian fur seal occur at Lady Julia Percy Island located in state waters southwest of Port Fairy, and between the two permit areas. The closest known non-breeding colony is at Cape Bridgewater, west of Portland (HoogAntink, pers. comm, 2003). Both colonies are within 6 km of their closest seismic lines, but not within the survey area.

The operation of a soft start is considered sufficient mitigation for potential impacts on pinnipeds. Seals are unlikely to travel significant distances from their colony and therefore unlikely to occur within proximity of the survey vessel. When combined with the short duration of survey and their apparent tolerance to seismic surveys, no adverse impact to seals or seal populations is expected.

4.2.3 Cetaceans

There is no evidence to suggest that noise resulting from marine seismic surveys has lethal effects on whales (National Oceans Office, undated). Behavioural changes may be the largest impact to marine mammals caused by seismic surveys. (Turnpenny and Nedwell, 1994; Richardson et al. 1995, Gausland, 2000). Physical damage to the auditory system of cetaceans is likely to occur at noise levels of about 230-240 dB at a distance of 1-2 m from the energy source (Gausland, 2000). However experiments on smaller whale species have shown

evidence of only temporary effects with no long term damage detected (National Oceans Office, 2002).

Noise disturbance to cetaceans summarised by McCauley and Duncan (2001) is listed below:

- There is evidence of behavioural response by whales to various noise sources ranging from no response to active avoidance.
- Whales of the same species may respond differently to a given noise depending on their behavioural state or habits at a particular time.
- Response of whales to artificial noise may change over time due to familiarisation or sensitisation to the noise.

Baleen whales communicate by low frequency sounds and are therefore considered to be the most sensitive of the marine mammals to specific low frequency sounds. The hearing of baleen whales is thought to overlap the energy output of seismic related noise (McCauley, 1994; Evans, 1998). However, Richardson et al. (1995) suggest that baleen whales may be tolerant to low and moderate level noise pulses from distant seismic surveys (i.e., greater than 8 km) and usually continue normal activities when exposed to pulses with levels as high as 150 dB re 1µPa, and sometimes higher.

Baleen whales show a gradation of behavioural responses to seismic activities with evidence of subtle shifts in respiratory and diving patterns, suggesting that the seismic discharge is audible to whales at considerable distances from the source, but that the whales are not disrupted from normal activities (McCauley, 1994). Stone (2003) suggests that different groups of cetaceans respond differently to acoustic disturbance from seismic survey, with baleen whales displaying localised avoidance behaviour for an hour or more (Richardson et al., 1995). Because marine mammals are good swimmers and able to avoid either the vessel or the airgun array, it is highly unlikely that many marine mammals will be exposed to levels likely to cause pathological damage (McCauley, 1994).

A study carried out by McCauley et al. (1998) monitored the effects of seismic survey noise on humpback whales in the Exmouth Gulf region of Western Australia, from which the following conclusions were drawn:

- Only localised avoidance was seen by migrating whales during the seismic operation, indicating a comparatively short period and small range displacement.
- The generalised response of migrating humpback whales to a 3D seismic vessel was avoidance at 4 km from the vessel.
- Humpbacks were seen actively utilising the ‘sound shadow’ near the surface, suggesting that it is unlikely that animals will be at any physiological risk unless at very short range from a large airgun array, perhaps in the order of a few hundred metres.

- Short and localised displacement suggests a low overall risk for migrating animals.
- Humpback pods containing resting cows (as opposed to migrating) were more sensitive and showed an avoidance response estimated at 7–12 km from a large seismic source.

McCauley et al. (2000) recommended that the cow/calf responses should define the spatial limits for management and mitigation measures (Table 4.3). In areas where humpback whales remain for socialising, resting, calving, mating, feeding or other purposes, the continual displacement by any operating seismic survey vessel may have more profound effects on individual animals and populations. For example, calves 4-8 weeks old are small, comparatively weak and possibly vulnerable to predation and exhaustion. The continual dislocation of these animals in a confined area could disrupt their resting and feeding with potentially more serious consequences for the population. Similarly, any repetitive displacement or disruption of animals in their calving grounds could also affect the population level.

Table 4.3 Summary of effects of nearby airgun operations on humpback whales

Level (dB re 1µPa rms)	Effects
140	Resting pods with cows in key habitat begin avoidance.
143	Resting pods with cows in key habitat type stand-off range.
157-164	Standoff range for migrating humpbacks.
179	Maximum level tolerated by investigating probable male humpbacks to single airgun, although this possibly due to visual clues.

Richardson (1999) suggests that migrating bowhead whales show an avoidance area up to 20 km from seismic activity. Migration paths returned to normal, however, within 12-24 hours after seismic survey shutdown. Gill (pers. comm., 2003) considers that blue whales may also have an extended avoidance area, given their communication dependence on low frequency sound. McCauley and Duncan (2001) suggest that blue whales in the Otway basin may respond to approaching seismic from approximately 10-30 km and may avoid seismic activity from 3-20 km.

There is a lack of data available on the pathological effects of seismic activities on the southern right whales or whether their response is similar to that of other whales species. It is suggested that southern rights are likely to be less sensitive to noise disturbance than humpback whales (National Oceans Office, undated).

Toothed cetaceans (beaked whales, dolphins) produce echolocation clicks which have the highest source levels of any recorded marine mammal sound ranging up to 220-230 dB re 1µPa-m (National Oceans Office, undated). Most components of these sounds are well above the low frequency range where marine seismic survey noise is concentrated (Richardson et al., 1995). According to McCauley (1994), smaller toothed cetaceans have poor hearing in the low frequency range

of seismic pulses and so are able to approach operating seismic vessels without adverse behavioural or pathological effects. However there are limited data available on these species to determine the significance of these reactions (Bowles et al., 1994; Davis et al., 1995 in Richardson et al., 1995). However, apparent behavioural responses by sperm and beaked whales to low frequency sound pulses at long ranges have been documented. Recent speculation suggests that the Cuviers beaked whale is susceptible to ensonification by tones in the frequency range of 100-500 Hz (McCauley and Duncan, 2001). During Santos' 2002 Southern Margins seismic surveys dolphins, pilot whales and sperm whales often appeared in close proximity to the operating seismic vessel, and dolphins were often seen riding the bow wave during recording operations (Hughes and White, 2003).

The survey area (particularly VIC/P51) is located within the feeding grounds of blue whales along the 100 m isobath, where they are seasonally observed feeding on krill aggregations associated with the nutrient fluxes of the Bonney upwelling at the edge of the continental shelf. Blue whales routinely produce intense low frequency sounds for sustained periods so it is likely that they can tolerate moderate levels of low frequency noise without any changes in hearing sensitivity (McCauley and Duncan, 2001). The survey is also timed to occur before the main arrival of the blue whales to the summer feeding grounds.

The Logan's Beach exclusion zone near Warrnambool was established to protect the regular visiting southern right whales that use the area as a nursery during winter-spring following calving. The exclusion zone is located approximately 10 km (5.5 nm) north of the nearest seismic line. Southern right whales are often sighted closer to shore than other cetacean species (Watson, pers. comm. 2003); however, the timing of the proposed survey is outside the peak migration period of winter-spring (Kemper et al., 1997; Environment Australia, 2001) and in waters deeper than those preferred for nursing following calving along the Victorian coast.

Cetaceans employ an extremely acute acoustic sense to monitor their environment and are correspondingly sensitive to sounds below and, to a lesser extent, above the water surface. Sound waves created from seismic operations may interfere with the acoustic perception and communication of cetaceans in the vicinity, and may have the potential to induce stress. The combination of soft start-up procedures and whales' natural avoidance behaviour is expected to avoid causing actual harm. In the longer term, the risk that repetitious acoustic disturbance could cause abandonment of important habitats such as feeding, calving and nursery sites is also avoided by the timing, short duration of survey and distance of the survey area from the critical habitats.

Much of the published research relating to the effects of seismic surveys on cetaceans relates to the larger species and older style air-gun arrays, which are different to those currently in use. Modern airguns have been designed to maximise downward direction of the acoustic pulse, with the result that the energy dissipated laterally into the wider environment is reduced (JNCC, 1998).

Seismic surveys at sea do not necessarily constitute a threat to marine mammals if care is taken to avoid situations which could potentially harm the animals (JNCC, 1998). The proposed survey covers a relatively small area and is of a short duration (approximately 10 days data acquisition). It is intended that the survey is completed during November to avoid the known migration period of whales in the survey area, subject to the contracted vessel maintaining its schedule and the occurrence of a fair sea state for the survey. In addition, Environment Australia's guidelines for avoiding interference with cetaceans during seismic surveys (Environment Australia, 2001) will be applied and includes:

- Visual observation for 90 minutes prior to start of seismic acquisition.
- No commencement of acoustic source where whales are within a minimum 3 km (1.6 nm) radius of the vessel.
- Soft starts of acoustic discharge.
- Visual observation during seismic data acquisition.
- Where an individual whale or pod of whales are seen within 3 km (1.6 nm) of the vessel, the acoustic source will be shut down.
- Seismic acquisition will not recommence unless the whale(s) have been seen to move outside of the 3 km (1.6 nm) range or have not been seen for at least 20 minutes.
- All cetacean sightings will be reported to Environment Australia.

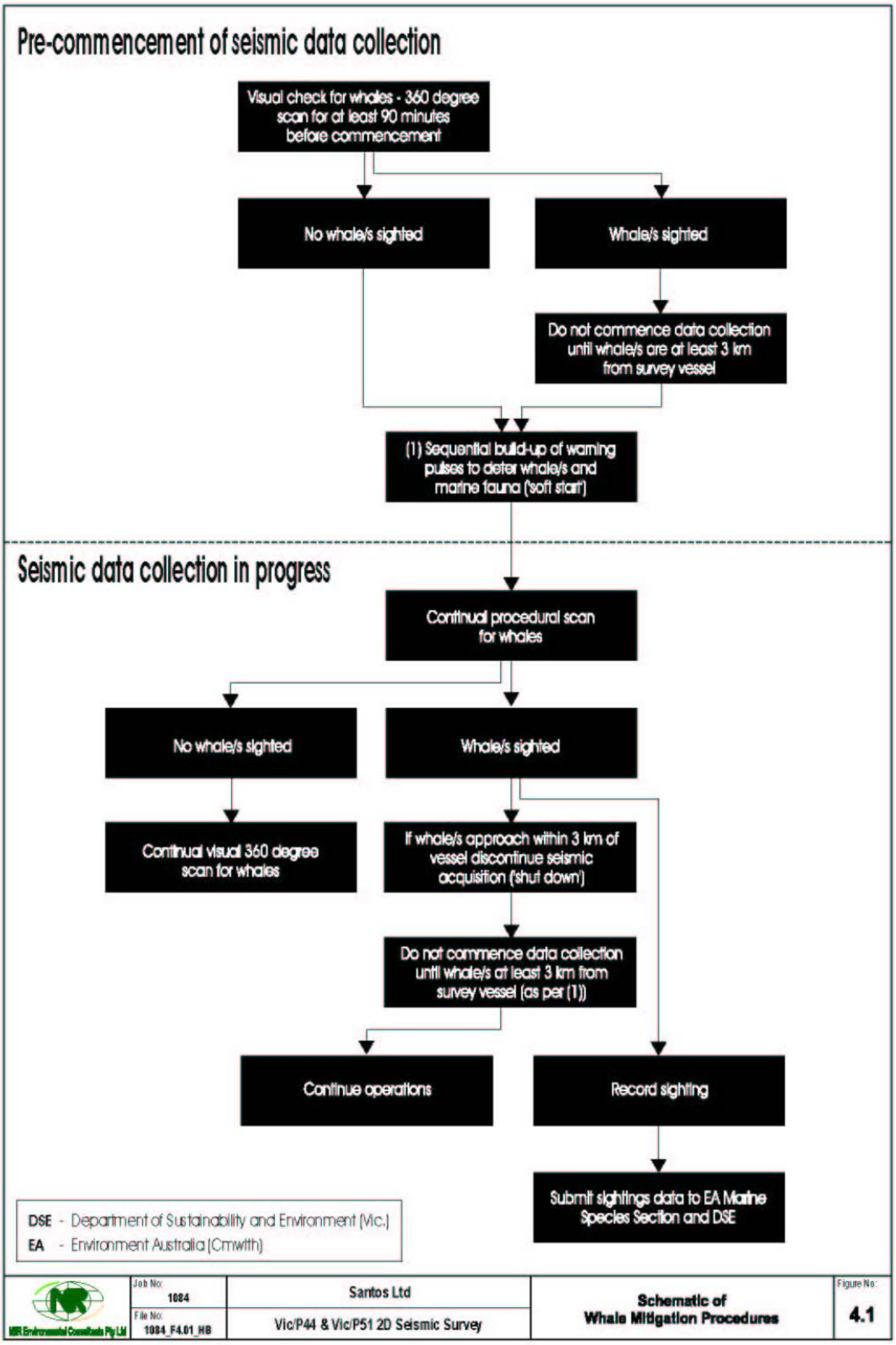
A schematic diagram outlining the above-listed cetacean mitigation procedures during the seismic survey is presented in Figure 4.1.

4.2.4 Fish

Lethal effects of seismic pulses on fish have not been reported, but those with a swim bladder closely connected to the inner ear are more susceptible than those without (McCauley 1994). The studies reviewed by McCauley (1994) and subsequent research suggests that discharge of airgun seldom causes physical injuries to marine organisms, unless they are very close to the source, where the main effect of the seismic survey to fish is a behavioural response. These behavioural responses are elicited at sound levels much lower than that required to cause harm so that mobile organisms cannot suddenly find themselves within the impact few metres without being aware of the approach for some time, or through slow start-up procedures. For the larval stages unable to move away, the impact at population level is consistently considered in the scientific literature as inconsequential in comparison with natural mortality and unaffected proportion.

However, pathological effects have been observed in fish held captive close to the acoustic source. Trials of effects of nearby airgun operations on captive fish, undertaken by McCauley et al., (2000), showed a generic fish 'alarm' response of

Figure 4.1 Schematic of cetacean mitigation procedures



swimming faster, swimming to the bottom, tightening school structure, or all three, at an estimated 2–5 km from a seismic source.

From their review of trials and published information, McCauley et al. (2000) concluded the following behavioural effects in fish:

Demersal fish could be expected to begin to change their behaviour by increasing speed and swimming deeper in the water column.

- As airgun level increases, these fishes would be expected to form compact schools probably near the bottom in continental shelf depths (less than 200 m).
- Eventually levels may be reached at which involuntarily startle responses occur in the form of the classic C-turn.
- In deeper water (greater than 200 m) any effects would be expected to lessen with increasing depth, as the airgun signal level dropped accordingly.
- Startle responses may be generated by fish within 300 m of, and up to 2,000 m from an airgun array.
- Flight response could be expected up to several kilometres.

The threshold for the initial increases in swimming behaviour recorded were of the order of 156 dB re 1µPa rms, and at levels of around 161-168 dB re 1µPa rms active avoidance of the airgun source would be expected to occur. For the 3D array measured (2,678 cubic inch 100–120 m water depths) as part of the study, this corresponded to a range of around 3–5 km and 1–2 km, respectively (McCauley et al., 2000). Serious injuries to fish only appear to occur at sound levels in the order of 220 dB re 1µPa, that is, very close to the source (Turnpenny and Nedwell, 1994). However, avoidance by fish occurs at approximately 160-180 dB re 1µPa.

Exposure of caged fish to seismic pulses has been shown to have detrimental effects to fish ears, in particular pink snapper (McCauley et al., 2003). Damage to fish sensory epithelia was apparent as ablated hair cells, and repair or replacement of these damaged sensory cells was not evident up to 58 days after exposure (McCauley et al. 2003). The fish in this study were exposed to a seismic pulse with a source level at 1 m of 222 dB re 1µPa peak to peak. Although this study provides information on the potential effects of seismic pulses on fish, it was carried out in cages where the fish were not able to swim away from the noise source. Turnpenny and Nedwell (1994) state that there is no recorded evidence that airguns have killed fish or caused injury during seismic operations and that the information available pertaining to damage to fish derives from caged experiments which are unrepresentative of normal operational use, as fish and other fauna would avoid an approaching seismic vessel as the intensity of the acoustic source is increased.

Fish populations that form only a few concentrated breeding aggregations may be at risk from impaired reproductive effort if the seismic vessel operating in the

area causes dispersion or behavioural modifications of aggregations. However for this to cause significant impact surveys would have to be run close to breeding sites over sustained periods (weeks) when fish are spawning (McCauley, 1994). This concentrated seismic effort does not occur with 2D seismic surveys (see Section 1.4) and the VIC/P44 and VIC/P51 2D seismic survey will only involve 10 days of seismic data acquisition.

Gausland (2000) postulates that seismic airgun operation causes little direct physical damage to fish at distances greater than 1 to 2 m from the source, that it is evident that fish respond to sounds emitted from airguns; and that avoidance seems to be the primary response for all species. Damage to seismic survey hydrophone cables in the Gippsland Basin by pelagic fish imply that some fish species show no long distance avoidance reaction to seismic sounds (McCauley, 1994).

The above information suggests some temporary startle response of fish or tightening of shoals. Fish eggs and larvae may be at risk if very close (less than 1 m) to the seismic source, the actual number of eggs and larvae affected is expected to be very small compared to the overall population size and the normally very high mortality rates (McCauley, 1994).

4.2.5 Penguins

There is no information about underwater sounds being generated by little penguins but it is considered unlikely, because most birds produce sound only during the expiratory phase of respiration (McCauley, 1994).

Penguins communicate via calls (vocalisations) that allow partners to recognize each other and their chick. There is a lack of information on the auditory systems and communication of penguins however the hearing range of most birds lies between 0.1-8 kHz (McCauley, 1994; Seaworld, 2002). It is therefore inferred that penguins have relatively poor hearing thresholds in the lower frequencies, where seismic surveys have the most energy (10-300 Hz) (McCauley, 1994).

Little penguin pairs usually build their nests at the end of September, incubate the eggs in October and raise their nestlings through November and December (Stahel and Gales, undated). The little penguin usually forages for food within 10-15 km of the nesting beach during the breeding season, with maximum diving depths of 10-30 m (their diet being predominantly fish and squid) (Stahel and Gales, undated; McCauley, 1994).

Like seals, penguins may be indirectly affected if seismic affects the abundance or behaviour of prey. However, the extent to which temporary “descending” or “tightening” responses of schooling prey fish such as pilchards (if it occurs) affects availability to penguins either positively or negatively, is not known.

Evidence is sparse on the response of little penguins to seismic airgun discharges. However, it is suggested that their poor hearing response in low frequencies may indicate little direct adverse effects (McCauley, 1994). This is supported in part by observations made by dedicated on-board marine mammal

observation personnel of little penguins approaching seismic vessels during airgun discharge in eastern Bass Strait during 2001 and 2002 (Doodie, pers. comm., 2003; Pinzone, pers. comm., 2003). It may be that the penguins are unaffected as they are in the seismic "shadow" area, predominantly above the downward focus of the pulse. Given the short duration of the survey, the apparent tolerance of penguins and minimal expected impact to prey (fish) species, no adverse impacts to penguins are anticipated. In addition, much of the survey area is offshore and beyond the normal foraging area of the penguin.

4.2.6 Invertebrates

Marine invertebrates lack sensory organs to perceive sound pressure, but many do have organs or tactile hairs which are sensitive to hydrostatic disturbances (McCauley, 1994). It has been postulated that shellfish, crustaceans and most other invertebrates can only detect seismic survey sounds at very close range, approximately less than 15 m away from the source (McCauley, 1994). Any disturbance to benthic invertebrates immediately beneath an airgun array is likely to be short-lived as only a single 'shot' is fired before the array moves to the next firing location (25 m further on). The response of marine invertebrates at close range to the airgun arrays may be an alarm response such as closing the siphons in sponges or 'tail flip' response in crustaceans (McCauley, 1994).

Of the Australian invertebrates, rock lobster, some intertidal decapod crabs, snapping shrimps, stomatopods and some urchins have been reported to produce sounds (McCauley, 1994). Rock lobster uses sound for predator avoidance and there is currently no evidence to suggest that it is used for other purposes; no behavioural description has been attributed to sounds made by urchins (McCauley, 1994).

Pelagic invertebrates, such as squid and cuttlefish, are an exception and are capable of detecting vibrations. And, while the reaction to seismic surveys by cuttlefish in open water is unknown, McCauley et al. (2000) undertook three trials on caged squid (*Sepioteuthis australis*) to gauge their response to nearby airgun operations, outlined in Table 4.4.

Table 4.4 Summary of effects on caged squid of nearby airgun operations

Level (dB re1mPa rms)	Effects
174	Startle (ink sac fire) and avoidance to start up nearby.
166	Significant alteration in swimming speed patterns, possible use of sound shadow near water surface.
161-156	Noticeable increase in alarm behaviours.

Part of the assessment by Parry et al. (2002) of environmental effects of seismic testing on the scallop fishery in Bass Strait found that the mortality and adductor muscle strength of scallops suspended 19 m below the surface in the path of the airgun array was not significantly different from scallops in a control area 20 km away.

The VIC/P44 and VIC/P51 2D seismic survey is not likely to traverse extensive areas of habitat, such as shallow rocky reefs, preferred by many benthic invertebrate fauna communities (crustaceans, molluscs, echinoderms, polychaetes) and sessile benthic fauna (sponges, hard and soft corals, bryozoans and tunicates). The effect on such species would nevertheless be minimal due to their poorly developed mechanosensory systems and distance from the acoustic source (McCauley, 1994).

4.2.7 Plankton and Planktonic Larvae

Except for larvae, fish eggs and other minute planktonic organisms within a few metres of an airgun, no planktonic organisms are likely to be significantly affected by airgun array discharges (McCauley, 1994). Damage to larval organisms is reported at levels of sound that occur only very close (within 1-2 metres) of the acoustic source. However, this has been quantified in a number of studies on larvae of prawns, western rock lobster and bluefin tuna, and in all cases, impacts are extremely low (<1%), even when the most conservative assumptions on impact distance and timing were applied (McCauley 1994).

The study by Parry et al. (2002) also found no evidence of large changes to planktonic taxa in the surface waters to a depth of 20 m. Studies show that effects on fish eggs and planktonic larvae are insignificant compared with the size of the planktonic population in a survey area or natural mortality rates for planktonic organisms (McCauley, 1996; Parry et al., 2002).

The foregoing review of the literature suggests that any adverse impacts to planktonic larvae would be restricted to a few metres from the air gun at the point of discharge. However, the importance of the southern rock lobster fishery near the survey area (within the same longitudinal range as the survey area but primarily occurring in shallower waters) may be considered to affect future recruitment. The seismic survey is timed at the very end of Southern rock lobster spawning and beginning of the fishing season, hence much of the spawning effort will already have occurred. Given the extent of the overall habitat, duration and distances covered by the phyllosoma larvae, and short duration of the survey, the proportions potentially within metres of the airguns would be extremely small.

4.3 Disturbance to Benthic Habitats

Disturbance to benthic habitat from the survey is highly unlikely given the depth of water in the survey area (25 - 200 m) and the fact that the survey vessel will not be anchoring during the survey. The accidental loss of equipment that could sink to the seabed is most unlikely, but should it occur would be followed by recovery, where possible.

4.4 Effects of Acoustic Discharge to Divers

There are three main physiological effects on divers associated with underwater acoustic discharges. These are:

- Pacinian corpuscle – this is a sensor of the nervous system that is distributed through the epidermis and provides vibrotactile sensitivity. The frequency response of the Pacinian corpuscles peaks at about 250 Hz, and at this frequency, leads to complaints from divers of tingling and numbness.
- Acoustically forced vibrations of gas pockets in the gastrointestinal tract – may be responsible for complaints related to abdominal discomfort.
- Temporary shifts in hearing threshold.

Other physiological effects on divers may include arterial resonance and lung haemorrhage (NATO, undated).

Adverse affects on divers have been reported from exposure to underwater sounds of greater than160 dB re 1µPa received over several minutes or more and of frequency content 200-400 Hz (McCauley and Duncan, 2001).

Recommended maximum peak pressure for humans in water is 170 kPa for a single exposure (translating to 224 dBre1µmPa). Non-auditory injuries can occur at these pressures (e.g., resonance in body cavity) (SCAR, 2002). Research indicates that prolonged exposure to sounds greater than 190 dBre1µmPa at 0.4, 3, 10, 20 and 75 kHz would produce permanent hearing impairment (SCAR, 2002).

Recreational diving and commercial abalone diving, are undertaken in water depths less than 20 m and are therefore restricted to the nearshore area. The seismic vessel will approach the coastline to 25 m water depth in some instances. Due to the close proximity of the seismic survey to the coast, the acoustic energy discharged during the survey may potentially be harmful to recreational and commercial (abalone) divers where they are within 800 m of the source.

Construction of the offshore pipeline for the BHP Billiton and Santos sponsored Minerva Gas Field Development is scheduled for October to November 2003 and may coincide with the proposed seismic survey. The pipeline will be laid in the seabed by a specialised lay barge vessel and will require specialised diving teams to complete pipeline tie-in and rock bolting, if required. The Minerva pipeline route is located at least 20 km from the nearest seismic line.

While risks to divers are considered minimal, the Diving Medical Advisory Committee (DMAC) considers that a safe distance between the source of seismic activity and a diver should be 1,500 m (Diving Medical Advisory Committee, 1979). At this distance, divers should not be exposed to sounds exceeding 130 dB, as recommended by the U.S. Navy's Bureau of Medicine and Surgery (California Coastal Commission, 2000). Santos will liaise with the Victorian Abalone Divers Association, local dive tour operators and dive shops prior to and during the survey to advise of program progress and should it be deemed necessary employ scout vessels to warn in advance any vessels displaying the 'diver down' flag encountered in the vicinity of the survey or potentially within 1,500 m of the proposed path. Past U.S. Navy acoustic tests avoided active acoustic operations within 0.8 km (0.4 nm) of diving activities. The seismic

vessel, or scout vessel will radio ahead to any ships, fishing or recreational boats in the survey path to give notice to move out of their path (the seismic vessel must run on a pre-determined course of tracks).

4.5 Interference with Commercial Shipping

As the main shipping channel (i.e., the passage travelled by over 1,000 vessels between major Australian and foreign ports) is located to the south of the seismic survey area, no major impacts to vessels in this shipping lane are anticipated.

The less frequently travelled shipping passages between the southern ports of Australia (Adelaide to Melbourne to Sydney) and between Portland and northern Tasmania (that carried between 1 and 500 vessels in 1999-2000) passes through the permit areas. The issue for these ships will be the seismic vessel's requirements for towing streamers and turning, influencing the areas of navigation. The seismic vessel will radio ahead to travelling ships in the survey swathe to give notice to move out of their path.

All vessel operations will be conducted in compliance with the Australian Maritime Safety Authority (AMSA) Offshore Support Vessel Code of Safe Working Practice (OSV Code), which includes standards for radar monitoring and vessel communications.

4.6 Interference with Commercial Fishing

The main issue for the commercial fisheries described in Section 3.4.5 will be the seismic vessel's requirements for towing streamers and turning. This potentially affects the areas of operation of fishing vessels that employ demersal longline, dropline, trotline and handline, hooks, gillnets and fish traps as well as lobster and crab pots.

A strategy for managing (and minimising) interaction with fishing activities on a day-to-day basis is being developed by Santos in consultation with local fishing industry groups during previous seismic surveys in the region. Methods for communication and avoiding interference with fishing vessels during the survey are outlined in a Memorandum of Understanding (MOU) and includes the use of daily bulletins to advise which lines will be worked on in the next 24 and 48 hours. The seismic vessel will radio ahead to any fishing boats in the survey swathe to give notice to move out of their path.

In addition to these measures that can be taken to minimise impacts on a fisheries-wide basis, fisheries-specific impacts and mitigation measures (where appropriate) are included for the fisheries listed below.

4.6.1 Southern Rock Lobster Fishery

The potential exists for the seismic vessel's submerged gun arrays to snag and drag lobster pot lines, causing damage to, or loss of, lobster pots and loss of any lobsters caught in the pots. This would result in financial losses to the fishers

concerned. The survey is proposed to be undertaken during November and may in fact avoid coinciding with the commercial Southern rock lobster fishing which is closed for female lobsters from 1 June and male lobsters from 1 September to 15 November.

Through consultation with fishery representatives, it can be determined whether it is possible to coordinate movements between the seismic and fishing vessels so that the fishers move away from the survey area if the period of survey overlaps with the start of the fishing season. Advice will also be sought from the fishermen on the parts of the survey area that should be completed first where practical, so as to minimise inconvenience to rock lobster fishing activities.

4.6.2 Southern Squid Fishery

Although trawl catches of arrow squid are constant throughout the year, most of the catch is taken between January and June each year. While squid are capable of detecting vibrations (see Section 4.2.6), it is not anticipated that there will be any significant effect to the squid population given the short duration of the survey.

4.6.3 Giant Crab Fishery

Given that most of the survey will be conducted in water depths shallower than areas in which giant crabs are fished (predominantly taken from depths between 140 m and 270 m), and that giant crab stocks are depleted, it is anticipated that impacts to this fishery will be minimal to negligible. Giant crabs are generally fished from the same vessels as those used to catch southern rock lobster, meaning that this fishery is not adding extra boats to the region, minimising the number of fishing boats affected by the survey.

4.7 Waste Disposal

Routine discharges from seismic vessels are restricted to sewage and putrescible wastes (food scraps). All vessels must comply with State and Commonwealth legislation and international protocols for the control of pollution and dumping at sea.

A quantitative waste tracking log will be maintained in accordance with regulatory requirements for all relevant wastes.

4.7.1 Sewage and Putrescible Wastes

Sewage will be treated through an on-board effluent treatment plant that meets regulatory requirements prior to being discharged to sea. Putrescible wastes will be macerated in accordance with regulatory requirements (<25 mm, according to P(SL)Act) prior to being discharged to sea. No discharge shall be undertaken within state waters.

Disposal of sewage and putrescible wastes overboard may increase the nutrient content in the water column and may increase population numbers of some

organisms temporarily. The short-term, infrequent and mobile nature of the discharge is unlikely to have significant impacts.

Procedures for the disposal of minor discharges of treated sewage and macerated putrescible wastes will be detailed in the vessel's Health, Safety and Environment Plan.

4.7.2 Other Wastes

The survey vessel also produces other solid and liquid wastes, including packaging and domestic wastes, such as aluminium cans, bottles, paper and cardboard and hazardous materials such as lithium batteries, acids, solvents and toxic wastes. A variety of chemicals, such as lubricating oils and cleaning chemicals, are also stored and used on the survey vessel. Many of these items are consumed through use and are not accumulated in significant quantities as waste. However, all such materials will be safely stored and returned to port for appropriate disposal.

Solid inert combustible wastes will be incinerated on-board the seismic vessel. Non-combustible solids will be returned to the mainland for disposal.

Hazardous wastes, generally of low quantity (mainly lithium batteries and small volumes of paints and solvents), will be segregated and stored in sealed storage areas and transferred to onshore licensed hazardous material handlers for disposal to a licensed depot.

4.8 Fuels and Oil Spills

Oil spills have the potential to cause adverse impacts to marine organisms. Many marine species have a larval stage, which is free-floating and potentially vulnerable to an oil spill. Shellfish can become tainted if oil is ingested, even at low concentrations. Seabirds that become coated in oil may suffer from hypothermia that can result in death as oil reduces the insulation properties of feathers. Embryo chicks in eggs may be prevented from receiving oxygen if their shells become coated with oil. Seabirds may ingest the oil while feeding or preening having toxic effects.

Oil may contaminate the skin and damage the digestive system of some cetacean species. Indirect effects may include the destruction of habitats and reductions in the population of staple prey. The risk of a fuel or oil spill from the survey vessel is related to the potential for fuel spills due to tank rupture (e.g. collision or grounding), leaking hydraulic hoses, leaking oil drums or puncturing of streamer sections. Procedures and technical design elements are incorporated into the seismic vessel operation to minimise the risk of a spill event to as low as reasonably practicable. These include:

- Satellite navigation and communication with other vessels to minimise collision risk.
- Vessel design and operation to prevent fuel tank rupture by collision.

- Return to port refuelling to minimise at sea spill risk.

Procedures to address spills will be specified in the vessel's Health, Safety and Environment Plan.

In the event of a spill, it will be recorded in a wastes and emissions log, reported to Santos and regulatory authorities in accordance with regulatory requirements.

4.9 Quarantine

As the seismic vessel is likely to arrive in Australian waters from a foreign port (most likely Singapore), it is subject to and must comply with quarantine measures when travelling through Australian waters and docking at Australian ports.

4.9.1 Anti-fouling

Anti-fouling agents, using the chemical tributyltin (TBT) as their main agent, are widely used on ship hulls to prevent the growth of organisms, such as barnacles, to minimise their effect on drag and fuel consumption. The agent is applied during dry dock and gradually leaches off the hull during ocean travel. Tributyltin persists in the environment by attaching itself to muds (accumulating in sediments), and in high concentrations can have toxic effects on marine organisms through bioaccumulation.

The ANZECC Guidelines for Fresh and Marine Water Quality (2000) stipulate that the trigger value for TBT for the protection of 99% of species in marine waters is 0.0004 μgL^{-1}. In 1995, the CSIRO conducted a study on the impact of shipping and dredging on toxicants in Port Phillip Bay, Victoria (Fabris et al., 1995). This study found that the concentrations of metals, including TBT, in water samples collected from behind moving freighters were similar to control samples, indicating that TBT leaching from a single vessel in open waters is likely to have inconsequential effects on marine life.

Should the need for application of anti-fouling agents be deemed necessary prior to the commencement of the seismic survey, it will be applied in dry dock or above the tidal zone at the departing port (not Australian waters). Thus the issue of potential anti-fouling agent spill to coastal waters or localised heavy leaching will not be an issue within the survey area. In Australian waters, the seismic vessel will adhere to the conditions as specified in the ANZECC Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance (1997).

4.9.2 Ballast

Ballast water has the potential to introduce foreign marine species to Australian waters, some of which can become highly invasive and threaten marine biodiversity and commercial and recreational fishing grounds. As the seismic vessel is not a cargo vessel, there is no requirement for the exchange of ballast sea water to or from the seismic survey vessel before, during or after the seismic

program, thus eliminating the risk of introducing foreign organisms to the region through ballast water.

5. Environmental Hazard and Risk Analysis

An analysis of environmental hazard and risk has been conducted for the VIC/P44 and VIC/P51 2D Seismic Program - 2003. Its purpose was to:

- Identify and assess hazards to the public and the marine environment during the seismic survey.
- Undertake a scenario-based risk assessment, using the risk management method developed by Santos based on the Australian Standards Risk Assessment (AS4360).
- Identify and rank major hazards and determine appropriate risk reduction measures.

The following definitions are critical in the understanding of hazard and risk assessment.

Accident: an event capable of causing critical, major, moderate or minor damage to the environment, or negligible damage with no significant environmental effect.

Hazard: a physical situation with the potential for damage to the environment, human injury, damage to property or a combination of these.

Risk: the likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may either be a frequency (the number of specified events occurring in a time unit) or a probability (the probability of a specified event following a prior event), depending on circumstances.

5.1 Hazard Identification

The process of hazard identification and risk management are divided in three main sections (reproduced from AS/NZS 4360:1999):

- External and environmental hazards (global hazards):
  - Project-specific hazards (project implementation issues).
  - Personnel health hazards (a global hazard).
- Individual and special operations hazards during operations that are exceptional because of size, complexity or timing.
- General and routine work performed according to standard procedures.

5.2 Hazard Scenario

A scenario for realisation of each environmental and safety hazard was developed. Each scenario included:

- A description of the scenario and root cause of the hazard.
- Existing risk mitigation or prevention measures (that is, protection systems and management mechanisms) that are currently in place or are standard safety measures.

The likelihood and consequence of each hazard scenario was identified and assessed based on Santos' risk assessment tool (Table 5.1 and Table 5.2). To assess the consequence of an event the first step is to consider the area of impact. Santos has six impact areas to be considered:

- Physical damage.
- Financial.
- Environmental.
- Reputation.
- Safety.
- Production.

Each area has its own set of criteria for consequence measurement (Table 5.1).

Table 5.1 Qualitative measures of consequence or impact

		Physical Damage	Financial	Environmental	Reputation	Safety	Production
Catastrophic	**5**	Critical damage to plant and property.	Financial loss in excess of $50 Million.	Catastrophic ecological impact and/or international media exposure.	Critical impact on business reputation.	Fatality of employees, contractors, or the public.	Critical impact on production.
Major	**4**	Major or extensive damage to plant and property.	Financial loss $10 Million to $50 Million	Significant ecological impact and/or national media exposure impact.	Significant impact on business reputation.	Extensive injury or hospitalisation of employees, contractors, or the public.	Significant impact on production.
Moderate	**3**	Significant damage to plant and property.	Financial loss from $1 Million to $10 Million	Significant local environmental impact and/or regulatory intervention.	Moderate impact on business reputation.	Medical treatment of employees, contractors or the public.	Moderate impact on production.

Table 5.1 Qualitative measures of consequence or impact (cont'd)

		Physical Damage	Financial	Environmental	Reputation	Safety	Production
Minor	**2**	Moderate to minor damage to plant and property.	Financial loss from $0 to $1 Million	Minor local environmental impact and/or regulatory notification.	Some impact on business reputation.	First-aid treatment of an employee, contractor, or a member of the public.	Moderate to small impact on production.
Negligible	**1**	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue	Minimal impact to any issue

Source: Based on Santos' Risk Assessment Tool.

It is critical to remember that when choosing the likelihood of an event that it is made given the level of consequence chosen beforehand. More succinctly, it is the likelihood of the consequence of the particular event. Table 5.2 shows the descriptors of likelihood including the criteria with which to make a decision.

Table 5.2 Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost certain	Likely or certain to occur *Likely to occur several times per year*.
B	Likely	Likely, is expected to occur in most circumstances *Might occur once per year.*
C	Possible	Likely, will probably occur in most circumstances *Might occur once in 10 years.*
D	Unlikely	Unlikely, could occur at some time *Might occur once every 100 years.*
E	Remote	Highly unlikely, may occur in exceptional circumstances *Might occur once in 1000 years*.

Source: Based on Santos' Risk Assessment Tool.

5.3 Risk Matrix

Each scenario was then assessed using the risk matrix approach (Table 5.3). A risk estimate was made on the basis of the probability of the event occurring and the consequence. Matrix locations were chosen on the basis of operational and environmental judgement.

Table 5.3 Qualitative risk analysis matrix – level of risk

Likelihood		Consequences				
		Negligible 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
		Level of Risk				
Almost certain	A	Substantial	Substantial	High	High	High
Likely	B	Moderate	Substantial	Substantial	High	High
Possible	C	Low	Moderate	Substantial	High	High
Unlikely	D	Low	Low	Moderate	Substantial	High
Remote	E	Low	Low	Moderate	Substantial	Substantial

5.4 Risk Reduction Measures

Risk reduction measures are applied to risks deemed to be too high, that is 'High' on the risk matrix.

The hazard scenario was then reassessed and so on. No risks unable to be reduced to an acceptable level were identified.

5.5 Environmental Hazard and Risk Assessment

Table 5.4 presents the environmental hazard and risk assessment for the VIC/P44 and VIC/P51 2D Seismic Program - 2003. The risk analysis impact and likelihood (columns 4 and 5) draw from the definition of risk in Table 5.1 and likelihood in Table 5.2. The risk evaluation draws from the matrix in Table 5.3.

Some of the mitigation measures presented in Table 5.4 are also addressed in Section 4. These mitigation measures have been developed from NSR's experience in offshore exploration environmental management in Australia and are based on Australian petroleum industry best practice environmental management guidelines, as defined by the Australian Petroleum Production and Exploration Association (APPEA) *Code of Environmental Practice* (1996).

There are no activities assessed as being of 'high' risk for the VIC/P44 and VIC/P51 2D Seismic Program - 2003. This reflects the temporary and low impact nature of the activity, and the application of appropriate mitigation measures.

Table 5.4 Environmental risk assessment

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge	Impacts to cetaceans	• Alteration of cetacean behaviour. • Interference with normal activities such as breeding, feeding and migration. • Temporary threshold shift.	• Part of survey is located along the 100 m isobar which correlates to blue whale feeding grounds and aggregation areas, however; - Survey is scheduled for November to avoid key whale migration and aggregation period. - Survey is of short duration (16 days including weather standby time). - Soft start-up procedures will be employed. - Likely to evoke avoidance response in whales only, but unlikely to displace species from key habitat or migration paths. • Dolphins noted riding bow waves of seismic vessels during air-gun operations. • Environment Australia (2001) cetacean observation and seismic operations guidelines employed (see Appendix 4 and Figure 4.1).	C	2	Moderate
	Impacts to pinnipeds	• No direct effects noted due to likely tolerance of high intensity seismic. • May effect prey species (see Impacts to fishes).	• Breeding colony at Lady Julia Percy Island and non-breeding colony at Cape Bridgewater. Colonies within 6 km of their closest seismic line but not within the seismic survey area. • Operation of soft start-up procedures will enable an avoidance response from pinnipeds. • Survey is of short duration.	C	2	Moderate
	Impacts to fishes	• Potential pathological effects. • Behavioural changes, startle response. • Prey dependent species may be affected indirectly.	• No harmful pathological effects >1 m from seismic source. • Behavioural changes likely to be localised and temporary (alarm, avoidance, tighter schooling). • The survey is of short duration and soft-start-up procedures prevent sudden exposure.	C	1	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge (cont.)	Impacts to seabirds	• Potential for survey to disrupt little penguin chick feeding (Oct-Dec). • Effect abundance of prey species.	• Soft-start-up procedures prevent sudden exposure. • Likely to be little adverse effects from seismic airguns as penguins have relatively poor hearing thresholds in the lower frequencies, where seismic surveys have the most energy. • Effects on prey abundance refer to fishes above. • Survey is of short duration and occurs in nearshore area for limited period.	C	2	Moderate
	Impacts to invertebrates (crustaceans, shellfish, squid, etc.)	• Potential hydrostatic disturbance to organs or tactile hairs at very close range (<0.5 m).	• No detectable effects beyond 0.5 m therefore potential to impact on population is negligible. • Most invertebrates are believed unable to detect seismic airguns beyond 15 m from source. No body cavity/air space to be affected by seismic activity. • Effects on prey abundance refer to fishes above.	C	1	Low
	Impacts to plankton or planktonic larvae (e.g., fish eggs, lobster)	• Potential lethal or pathological effects.	• Seismic sounds only detectable to most invertebrates at very close range (ie. within <15 m). • No detectable effects beyond 1-5 m. • Lobster larvae significantly dispersed and not concentrated in surface of water column therefore negligible proportion of larvae within impact distances of air guns. • Abalone larvae mainly remain close to the parent reef surface at depths well away from the impact distance of air guns. Major reefs inshore and shallower than the operating area.	C	1	Low
	Geological features (reef or terrestrial)	• Potential damage to natural heritage features or habitat.	• Forces of seismic activity are negligible when compared to the wave energy sustained by the subsea geological features.	D	1	Low
	Shipwrecks	• Potential damage to heritage sites or features.	• No known wrecks within survey area. All located within a few hundred metres of the shore north east and west of the survey area. • Forces of seismic activity are negligible when compared to the wave energy sustained by shipwrecks.	D	1	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Acoustic airgun discharge (cont.)	Impacts to submerged aquatic recreation activities.	• Potential health effects for submerged aquatic activities (surfing, diving, snorkelling and swimming) within close proximity to acoustic source. • Temporary displacement of aquatic recreation activities (including swimming, diving, snorkelling and surfing).	• Survey area is within 25-200 m water depth located approximately 4 km from the maximum dive depth (20 m), therefore no impact on divers. • Recommended operating buffer of 1,500 m advised for diving (DMAC, 1979).	D	3	Moderate
Vessel presence	Impacts to commercial fisheries.	• Reduction in fish catches or interference with fishing activities likely to be localised and short term.	• Consultation with commercial fishing industry during planning phase to agree on impact mitigation measures. • Liaison and communication with commercial fishing operators regarding daily schedules and work plans during operations. • Planned compensation agreement for actual losses.	C	2	Moderate
	Collision with large cetaceans	• Death or injury of large cetaceans.	• Program runs through key blue whale aggregation areas but is timed to avoid whales being present. • Whales tend to display avoidance behaviour and so risk of collision is very low. • Seismic vessels move slowly permitting greater response time for evasive action by vessel and/or whale to avoid collision, ie., risk is less than for normal commercial shipping. • Environment Australia (2001) cetacean observation and seismic operations guidelines employed (see Appendix 4 and Figure 4.1).	D	3	Moderate
	Seabed disturbance from anchor dragging	• Disturbance to benthic habitats	• Disturbance to benthic habitats in the survey area is highly unlikely given the depth of the survey. • The survey vessel is unlikely to anchor during the survey.	D	2	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont.)	Waste discharge to sea	• Waste discharge may cause changes in planktonic or benthic communities due to reduced water quality and added nutrients. • Cause injury to marine life (eg., plastics injuring marine birds)	• No waste discharges to the marine environment in State waters. • Sewage shall be treated prior to disposal offshore. • Putrescible wastes shall be macerated in accordance with regulatory requirements (maximum particle size 25mm – according to P(SL) Act) prior to being discharged to sea. • Solid wastes shall be incinerated on-board. • Non-combustible solids will be returned onshore for appropriate disposal. • Waste register shall be maintained to record waste management practices and audited to verify compliance. • Procedures for disposal of minor discharges of treated swage and macerated putrescible wastes will be detailed in the vessel's Health, Safety and Environment Plan.	D	2	Low
	Small volume spill occurring (e.g., from streamer cable rupture, diesel refuelling).	• Mortality of planktonic or benthic organisms due to reduced water quality or hydrocarbon toxicity. • Smothering of marine and coastal flora and fauna.	• Risk of a spill due to streamer loss extremely low. Risk is significantly lower than risk posed by current boating activity in area (fisheries, recreation, transportation). • Seismic program shall be carried out in the shortest, safest time possible. • Undertake the seismic program outside periods of extreme weather conditions. • Streamers are segmented limiting potential spill volume. • Streamers are filled with light kerosene type petroleum, 95% of which evaporates or degrades (from light exposure) within 24hours of spill. • An approved Oil Spill Contingency Plan (OSCP) will be in place and staff will be appropriately trained in its execution. • All necessary oil spill contingency plan and equipment is to be maintained to ensure it is functional and must be accessible.	D	2	Low

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont.)	Small volume spill occurring (cont.)		• No at sea refuelling is planned for the seismic survey. Return to port for refuelling where practicable. • If at-sea refuelling becomes unavoidable, there will be no at-sea refuelling within State waters. • Ensure that refuelling operations are monitored by either the vessel's Master or First Officer. • Ensure that fuel will not be transferred during inappropriate weather conditions. • Ensure that equipment and procedures used for transferring fuel (e.g., 'Dry-Break' hose couplings), conform to the AMSA Code for the safe working of support vessels. • In the unlikely event of a spill during fuel transfer, ensure that the volume spilled is minimised by the automatic operation of shutdown pumps or safety valves and activate Emergency Response Manual and Oil Spill Contingency Plan (OSCP), as appropriate.			
	Moderate fuel spill - rupture of support vessel fuel tanks resulting from a collision with another vessel or offshore structure, resulting in a fuel spill.	• Mortality of planktonic or benthic organisms due to reduced water quality or hydrocarbon toxicity. • Smothering of marine and coastal flora and fauna.	• Ensure that all vessel operations are conducted in compliance with the AMSA OSV Code (eg. radar monitoring, vessel communications). • Establish daily communication schedule with commercial fishing boats. Smaller craft used for nearshore reconnaissance work. • Installation of real time current metres to predict impact in path of vessel and trailing cables. • Apply seismic contractors Emergency Response Manual and OSCP to the operation.	D	3	Moderate

Table 5.4 Environmental risk assessment (cont'd)

Risk Identification			Risk Treatment	Risk Analysis		Risk Evaluation
Activity	**Hazard/Risk**	**Potential Environmental Consequence**	**Assessment/Safeguards/Mitigation Measures**	**Likelihood**	**Impact**	**Risk Ranking**
Vessel presence (cont.)	Moderate fuel spill (cont.)		• Ensure that senior personnel on vessels are familiar with the contents of the Emergency Response Manual and OSCP such that the initial response to an oil spill is carried out efficiently. • Ensure that all personnel are aware of the existence and location of the above-listed documents. • Ensure that the Emergency Response Manual and OSCP is up to date and staff are appropriately trained. • Ensure that necessary oil spill contingency plan and equipment is maintained functional and accessible.			
	Impacts to water based leisure craft recreation activities	• Temporary displacement of aquatic recreation activities and potential collision hazard.	• Survey is largely outside areas of leisure craft operation. • Period of displacement limited to short survey duration particularly because most of the survey is offshore (>3nm). • Ensure that all vessel operations are conducted in compliance with the AMSA OSV Code (eg. radar monitoring, vessel communications). • Watch maintained on survey vessel for other craft.	C	1	Low
	Introduction of marine pests	• Exotic marine species will compete with local endemic species for food and habitat.	• 'Code of Practice for Antifouling and In-water Hull Cleaning and Maintenance' will be applied	D	3	Moderate

6. Environmental Performance Objectives and Standards

This section summarises the Santos Environment, Health and Safety Management System and identifies the project specific environmental performance objectives for the seismic survey. The performance objectives are directly linked with the identified risks and effects discussed in Table 5.4 (Section 5).

This section also identifies the standards (i.e., legislation, industry guidelines and codes of practice), by which operations will be carried out to achieve each stated environmental objective, consistent with industry's best practice. Performance criteria by which Santos will measure its environmental performance are also presented. The performance criteria are measurable and relate directly to the environmental objectives. The criteria provide an overview of the commitments for environmental management detailed in the Implementation Strategy in Section 7.

6.1 Santos Environment, Health and Safety Management System

Santos has developed an Environment, Health and Safety Management System (EHSMS) based on international standards and industry best practice for application to all Santos operations (Figure 6.1). The Santos EHSMS consists of two sets of standards; “management” and “hazard”.

The framework has been developed to ensure that Santos’ system is compliant with Australian Standard 4801 2000 Occupational Health and Safety Management Systems, and AS/NZS ISO 14001:1996 Environmental Management Systems. Development of the Santos EHS Management Standards was completed in May 2003. This has involved the drafting, management review, and approval of 18 Management Standards, which all sites are required to implement. Environmental Hazard Standards will be finalised by the end of 2003.

Management Standards are documents, which define the requirements necessary to ensure that environmental, health and safety risk is systematically managed. Hazard Standards are documents which detail the specific controls required to manage the risks of specific hazards to acceptable levels.

For each standard, an assessment guide and auditor guide has or will be developed. The assessment guides are used to evaluate the status of implementation of the standard while auditor guides are used to determine the level of conformance to the standard. The auditor guides provide additional detail as to the requirements for practical implementation.

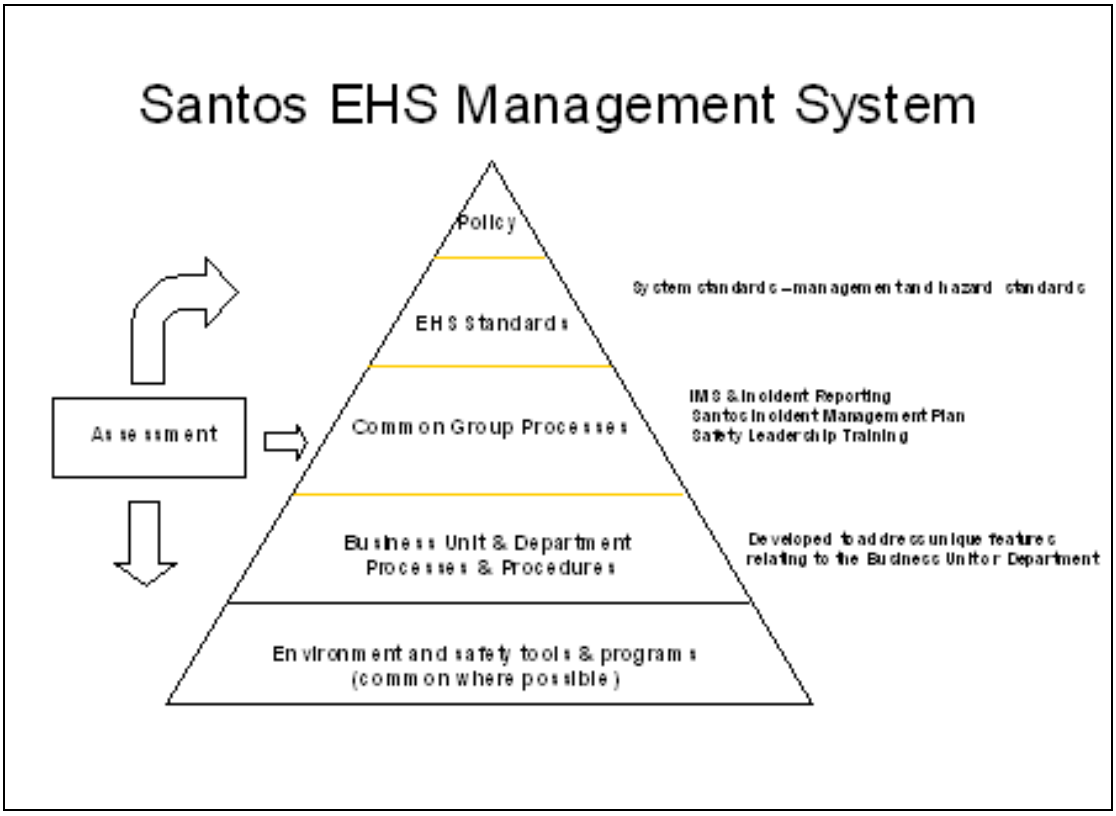


Figure 6.1 Santos EHS Management System

6.2 Environmental Objectives, Standards and Criteria

The environmental objectives, standards and measurement criteria are outlined in Table 6.1.

Table 6.1 Summary of environmental management objectives, standards and performance criteria

Aspect	Objectives	Standards	Criteria
Policy	Communicate Santos Environmental Policy statement and procedures.	• Santos Environment Policy statement (section 2.4).	Audit shows environment policy statement in place and personnel awareness undertaken.
Seismic operation	Minimise effects of acoustic airgun discharge to marine fauna.	• Environment Australia (2001) administrative Guidelines for determining whether an action is likely to have a significant impact on a matter of national significance under the EPBC Act.	Documentation / verification of whale impact mitigation procedures.

Table 6.1 Summary of environmental management objectives, standards and performance criteria (cont'd)

Aspect	Objectives	Standards	Criteria
Seismic operation (cont'd)		• Mitigation measures specified in section 5 of this EP.	
	Minimise impact of seismic survey vessel on commercial fishing operations.	• Mitigation measures specified in section 5 of this EP.	Verification of consultation/ daily radio schedules with commercial fishing operators.
	Minimise impacts to recreation and tourism activities.	• Mitigation measures specified in section 5 of this EP.	Verification of mitigation measures (notifications and consultation) through audit.
Quarantine	Prevent introduction of exotic species	• Mitigation measures specified in section 5 of this EP.	Verification of mitigation measures and their implementation through audit.
Waste Management	Manage wastes to avoid any marine discharge and therefore any environmental impacts.	• Mitigation measures specified in section 5 of this EP.	Verification through audit of waste log.
Fuel and oil spills	Manage operations to avoid spills and minimise safety and environmental risks.	• Santos Environment Policy statement (section 2.4) • Seismic contractor operating procedures.	Verification through audit of the spill record database.
Training	To ensure personnel are aware of their roles, responsibilities, obligations and management procedures.	• Santos Environment Policy statement (section 2.4). • Seismic contractor operating procedures.	Audit verification via training log.

7. Implementation Strategy for the Environment Plan

This section describes the implementation strategy for the EP, specifically detailing the measures to ensure that the environmental performance objectives and standards are met.

The implementation strategy identifies:

- Systems, practices and procedures.
- Specific roles and responsibilities.
- Employee training.
- Monitoring, auditing and recording requirements.
- Emergency response planning.
- Consultation with government and stakeholders.

The implementation strategy is summarised in Table 7.1.

7.1 Environmental Management System

Santos is responsible for assuring that the proposed seismic survey is managed in accordance with the Santos Environment Health and Safety Management System (EHSMS) and its procedures. Santos' Environment Policy is contained in Appendix 4. The Santos Responsible Officer for operations must ensure that the EHSMS procedures are implemented as necessary.

The Contractor, Fugro Geoteam (operator of the 'Polar Duke' vessel), will undertake the operations on Santos' behalf. Under its contractual arrangements with Santos, Fugro Geoteam is required to implement and comply with the EHSMS Procedures or have their own equivalent procedures in place.

The Implementation Strategy (Table 7.1) references the relevant contractor and Santos procedures.

7.1.2 Roles and Responsibilities

Key roles and responsibilities of Santos personnel with respect to meeting environmental management and performance objectives during the drilling program are described below.

The Santos Quality Assurance Supervisor (SQAS) is located on the vessel and is responsible for day-to-day conduct of the program to Santos' satisfaction. The SQAS is ultimately responsible for the safe and environmentally acceptable conduct of the seismic survey. They must ensure that during the survey, the contractor (and all sub-contractors), perform operations in a manner consistent with the performance objectives and environmental management procedures detailed in this Environment Plan. They must ensure that:

- All project personnel are given full briefing on environmental sensitivities of the permit area and environmental management procedures and commitments detailed in this EP.
- The Santos Environmental Vision, Commitment and Policy is applied in areas of responsibility.
- The Santos Chief Operations Geophysicist (on shore) is immediately alerted to any changes in operations which could impact negatively on environmental performance.
- Reportable incidents are immediately reported to Chief Operations Geophysicist (who then must promptly notify the Designated Authority).
- Environment review/vessel inspection is conducted on completion of the survey.

The Chief Operations Geophysicist is the interface between personnel and activities undertaken on the seismic vessel, the company and regulators. The Chief Operations Geophysicist is also the seismic survey Contractor Manager who oversees the routine operation of the vessel, including the operations of contractors. The Contract Manager has overall responsibility for, and authority with regard to, safety of the vessel and all aboard, and is responsible for implementing safety policies and procedures and ensuring all survey work is completed.

7.1.2 Record Keeping Requirements

The following list summarises the internal environmental reporting required for the proposed survey program:

- Non-conformance with Environmental Performance Objectives
- Cetacean surveillance and sighting form (refer Appendix 4)
- Waste emissions - in accordance with PSLA Environmental Requirements
- Emergency response according to Contractor HS & E Manual, Report to Southern Business Unit (SBU) using SBU Emergency Management Plan[1]

The contractor shall forward copies of all environmental reports to Santos, who will store and maintain documents or other records for a period of 5 years. These records shall be available to regulatory authorities upon written request.

---

[1] NOTE: Frontline response to emergencies will be conducted in accordance with the contractor's Vessel Safety Case and associated Emergency Response Plans. This will in turn trigger the SBU Emergency Response Plan, which largely deals with internal and external liaison/notification rather than on-site procedures.

7.1.3 Continual Improvement

Continual improvement is the process of enhancing the Santos Management System to achieve improvements in overall environmental performance. The Santos Environmental Commitment, Vision and Policy and the Santos EMS aims to assist this process by providing guidelines for the implementation and criteria for ongoing assessment of environmental performance. Both documents are updated as required to include changes of procedure, corrective actions and new guidelines.

Table 7.1 Implementation Strategy

Hazard	Objectives	Mitigation Measures	Responsibility	Management System/Procedure
Sound discharge	• Minimise effects to fauna.	• Cetacean observation and response. • Soft start-up procedures. • Short duration and timing of survey.	• Operations Geophysicist.	• Environment Australia cetacean observation and seismic operations guidelines. • Contractor operating guidelines.
	• Avoid effects to humans.	• Maintain safe distance from humans. • Exclusion zone (1500 m).	• Operations Geophysicist.	• Scout vessel for reconnaissance. • Consultation with fisheries and divers both recreational and commercial. • Public notices advising of operations. • VADA 1800 number for abalone diver advisory.
Collision	• Avoid collision with cetaceans and other vessels.	• Cetacean observation and response. • Use of scout vessel for reconnaissance. • Communication with other vessels.	• Operations Geophysicist.	• Environment Australia cetacean observation and seismic operations guidelines. • Contractor operating guidelines. • AMSA OSV Code
Disruption to commercial fishing operations	• Minimise disruption to operations.	• Planned compensation agreement for financial losses incurred by fishers. • Communication with fishers prior and during survey.	• Operations Geophysicist.	• Consultation with commercial fishing industry during planning phase to agree on impact mitigation measures. • Liaison and communication with commercial fishing operators regarding daily schedules and work plans during operations.
Seabed disturbance	• Reduce disturbance to benthic habitats.	• Tail buoys and 'birds' to maintain streamer depth. • Minimum depth of survey is at 20 m. • Avoid anchoring in nearshore reef environment.	• Survey Contractor	• Contractor operating guidelines.
Introduction of marine pests	• Avoid introduction of marine pests.	• Adhere to Code of Practice for Antifouling and in-water hull Cleaning and Maintenance.	• Survey contractor.	• Contractor operating guidelines.

Table 7.1 Implementation Strategy (cont'd)

Hazard	Objectives	Mitigation Measures	Responsibility	Management System/Procedure
Spill (fuel and oil)	• Minimise the risk of spills.	• Survey undertaken outside extreme weather conditions. • Segmented streamers limiting spill volume to <35 L. • Streamers filled with light kerosene type petroleum - evaporates quickly. • Vessel will not operate in less than 20 m water depth at any time. • No at sea refuelling planned. If unavoidable will be done outside State waters. • Personnel will be trained in OSCP and ERM procedures. • Appropriate spill response equipment will be available on vessel with additional equipment available through AMOSC.	• Survey contractor. • Master or First Officer (refuelling). • Incidents immediately reported to Operations Geophysicist.	• Oil Spill Contingency Plan (OSCP). • Emergency Response Manual (ERM). • Reporting of oil spills to AMSA (via AusSar) • AMSA Code for the safe working of support vessels (in case of fuel transfer requirements). • AMOSC Plan (through AMOSC).
Waste	• Minimise waste discharge at sea.	• No waste discharges to the marine environment in State waters. • Sewage treated prior to disposal offshore. • Putrescible wastes to be macerated in accordance with regulatory requirements (maximum particle size 25mm – according to P(SL) Act) prior to being discharged to sea. • Solid wastes to be incinerated on-board or transported to shore for disposal. • Non-combustible solids will be returned to shore for appropriate disposal.	• Survey contractor.	• Contractor Health, Safety and Environment Plan. • Adhere to waste discharge regulatory requirements of the P(SL) Act. • Waste register to be maintained to record waste management practices and audited to verify compliance. • Procedures for disposal of minor discharges of treated swage and macerated putrescible wastes will be detailed in the vessel's Health, Safety and Environment Plan.

8. Reporting Arrangements

8.1 Auditing and Reporting on Routine Operations

Santos will report on seismic operations to demonstrate that the environmental performance objectives and standards outlined in this EP have been met. Santos will undertake audits as appropriate to show that the actions detailed in this EP have been undertaken. Reporting to the DPI will be undertaken within 12 months of closeout of the seismic survey program. All cetacean sightings will be reported to Environment Australia at the completion of the survey.

8.2 Reporting on Non-routine Incidents

The Vessel Master must report any environmental incidents that occur during the survey to the Santos Representative on board the vessel. These incidents in turn must be reported to the Chief Operations Geophysicist using the Santos Incident Management System (IMS) Forms (refer Appendix E page E-19 of the Otway Basin Marine Oil Spill Contingency Plan). Santos will report to DPI any reportable incidents in accordance with the requirements of the *P(SL)A*.. These mandatory reporting requirements include:

- An escape of discharge into the sea of a mixture of petroleum and water in which the petroleum concentration was greater than 50 mg/L;
- An escape or discharge into the sea of more than 80 L of petroleum, not being the above; and
- Any uncontrollable escape or ignition of petroleum or any other flammable or combustible material causing a potentially hazardous situation.
- Additional regulatory reporting for the survey will consist of:
    - All oil pollution incidents in Commonwealth waters must be reported to AMSA (via AusSar), under Marine Notice 1/1996;
    - Any spills greater than 10 tonnes in Commonwealth waters must be reported to AMSA (via AusSar) within one hour, via the national 24 hour emergency notification;
    - Recording of all cetacean sightings on Environment Australia Whale and Dolphin Sighting Report sheets (refer Appendix 4); and
    - Any non-conformance with the procedures outlined in the Implementation Strategy.

Any incident that is outside the environmental performance conditions for this activity, as agreed by Santos and DPI, will be reported in the annual report to DPI in accordance with requirements of the PSLME Regulations 1999.

The Chief Operations Geophysicist must report all incidents (internal or external) onto IMS. The IMS, and related incident investigation and close out procedures, will be used for all safety and environmental related incidents.

9. Concluding Comments

The following concluding comments regarding the VIC/P44 and VIC/P51 2D seismic survey are based on:

- An extensive literature review of national and international studies on the impacts of seismic surveys on marine fauna.
- Specialist studies and the public impact assessments conducted for the Minerva Gas Field Development and the Otway Gas Project – both located very close to the survey area.
- Consultation with government agencies in Melbourne and Victoria's western region.
- Consultation with recognised marine research organisations and individuals (e.g., Deakin University, MAFRI).
- Consultation with commercial fisheries operators and Seafood Industries Victoria.

This Environmental Plan provides a detailed assessment of potential impacts to the biological, commercial and recreational values of the survey area. The key points of the assessment are summarised below.

Marine Flora and Fauna

- Impacts to marine fauna (lethal or pathological) from acoustic discharge are unlikely outside of the immediate vicinity of the source (i.e., 1-2 m). The majority of species display avoidance behaviour.
- The survey is scheduled for November, thus avoiding the key migration period of threatened whales in the survey area (blue, southern right and humpback whales).
  - The survey is timed to occur before the main arrival of the blue whales to their summer feeding grounds, in which the survey area is located. If delays are experienced, the survey will be terminated at midnight on 30th November (or not commenced at all).
  - Humpback whales are likely to display localised avoidance of the seismic vessel during migration, and it is unlikely that animals will be at any physiological risk unless at very short range from an acoustic discharge. The survey is timed to occur before the main migration season of humpback whales.
  - The timing of the proposed survey is outside the peak migration period (winter-spring) for the southern right whale and will be in waters deeper than those preferred for nursing. They are also likely to be less sensitive to noise disturbance than humpback whales

- Environment Australia's guidelines for mitigating impacts from seismic surveys to cetaceans will be employed, including cetacean observation and shut down procedures.
- The potential for fuel or oil spills is negligible and less than that posed by current levels of shipping in the area.
- Data acquisition is scheduled for a ten day period, representing a temporary and low risk to marine flora and fauna.

Commercial Fisheries

- No effects to adult southern rock lobster are likely. The seismic survey is likely to coincide with the southern rock lobster closed season. If however, the survey extends beyond the 14th November, Santos will closely cooperate with the relevant rock lobster fishing associations.
- The larvae of southern rock lobster are distributed throughout the water column, with potential impacts from seismic limited to individuals within the immediate vicinity of the airgun source. Any rock lobster larvae in such close proximity to the source represent an infinitesimal proportion of the entire planktonic population, where mortality is naturally extremely high. On this basis, impacts from the proposed seismic survey to recruitment of the species are unlikely.
- The seismic vessel's requirements for towing streamers and turning may temporarily influence the areas of operation for fishing vessels that employ demersal longline, dropline, trotline and handline, hooks, gillnets and fish traps. Daily bulletins will be issued advising which traverses the seismic vessel will be working on in the next 24 & 48 hours and the seismic vessel will radio ahead to any fishing boats in the survey area to warn of the survey.
- The risk to Abalone divers is minimal due to the limited period that the survey will near the coast (likely to be less than 1 day). However, Santos will liaise with the Victorian Abalone Divers Association prior to and during the survey to advise of program progress and warn in advance any vessels displaying the 'diver down' flag encountered in the vicinity of the survey or potentially within 1,500 m of the proposed path.
- Santos is consulting with commercial fishing interests in the area with a view to agreeing on appropriate impact mitigation and management measures.

Navigation Safety

- The seismic program is located north of the most heavily trafficked national and international commercial shipping channel through Bass Strait
- The period of any displacement will be limited to the short duration of the survey.
- All vessel operations are conducted in compliance with the AMSA OSV Code (e.g., radar monitoring, vessel communications).

- Watch will be maintained on the survey vessel for other craft.
- Santos is consulting with fisheries, Parks Victoria and petroleum operators regarding the implementation of appropriate mitigation strategies to avoid impacts to commercial or leisure craft.

Recreation and Tourism

- The seismic vessel will not significantly impact visual amenity (i.e., sightseeing) as it is constantly mobile, will be distant from the coast and in the area for only a 16 day period.
- The risk to divers is minimal due to the limited period that the survey will be within 800 m of the 20 m maximum dive depth (likely to be less than 1 day). However, Santos will liaise with local dive tour operators and dive shops prior to and during the survey to advise of program progress.

In summary, the VIC/P44 and VIC/P51 2D seismic survey proposed by Santos will not disturb the seabed, will not result in detrimental impacts to populations of marine flora and fauna and will not result in significant impacts (biological or commercial) to commercial fisheries.

10. References

10.1 Literature

Anonymous. 2000. A WWW publication accessed on 25 August 2003 from SCIRUS scientific search engine at www.scirus.com.

Anonymous. 2001. Appendix H – Endangered species act section 7 consultation biological opinion. A WWW publication accessed on 25 August 2003 from SCIRUS scientific search engine at www.scirus.com.

ANZECC. 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Australian Bureau of Statistics. 2003. Basic Community Profiles and Snapshots. A WWW publication accessed at http://www.abs.gov.au in September 2003.

Australian Fisheries Management Authority. 2003. Commonwealth Fisheries. A WWW publication accessed in September 2003 at http://www.afma.gov.au.

Australian Heritage Commission. 2003. Register of the National Estate. Australian Heritage commission. A WWW publication accessed on 15 July 2003 at http://www.ahc.gov.au. AHC 2003

Bannister, J.L., Kemper, C.M. and Warneke, R.M. 1996. The Action Plan for Australian Cetaceans. Prepared by Environment Australia,

BHP Petroleum, Santos (BOL) Ltd. 1999. Environmental Impact Statement/Environment Effects Statement: Minerva Gas Field Development.

Bureau of Meteorology. 2003a. Detailed Climate Maps: Victoria. A WWW publication accessed in September 2003 at http://www.bom.gov.au.

Bureau of Meteorology. 2003b. Averages for Warrnambool Post Office. A WWW publication accessed in September 2003at http://www.bom.gov.au.

Bureau of Meteorology. 2003c. Averages for Portland. A WWW publication accessed in September 2003 at http://www.bom.gov.au.

Bureau of Resource Sciences. 1994. The South East Fishery. A scientific review with particular reference to quota management. Bureau of Resource Sciences, Canberra.

Bureau of Regional Science. 2003. Southern Shark Fishery. A WWW publication accessed in September 2003 at http://www.affa.gov.au.

Butler, A., Althaus, F., Furlani, D. and Ridgway, K. 2002. Assessment of the conservation values of the Bonney Upwelling area: A component of the Commonwealth Marine Conservation Assessment Program 2002-2004.

December. A report to Environment Australia. Published by CSIRO Marine Research.

California Coastal Commission. 2000. Tu 12c. Staff Recommendation on Consistency Determination. State of California - the Resources Agency. United States of America. A WWW publication accessed in August 2003 at http://www.ceres.ca.gov/coastalcomm/cd/cd-32-99.pdf.

CSIRO. 2002. Assessment of the Conservation Values of the Bass Strait Sponge Beds Area. A component of the Commonwealth Marine Conservation Assessment Program 2002-2004. CSIRO Marine Research, Hobart, Tasmania.

Department of Agriculture, Fisheries and Forestry Australia (AFFA). 2003. About Australia's Fisheries. A WWW publication accessed at http://www.affa.gov.au in August 2003.

Department of Natural Resources and Environment. 2002. Victorian Abalone Fishery Management Plan. April, 2002. DNRE, East Melbourne.

Department of Primary Industries. 2003a. Rock Lobster Fishery Management Plan, 2003. Compiled by the Rock Lobster and Giant Crab Fishery Management Plan Steering Committee. Fisheries Victoria Management Report Series; No. 1. Department of Primary Industries. East Melbourne.

Department of Primary Industries. 2003b. Giant Crab Fishery Management Plan. Compiled by the Rock Lobster and Giant Crab Fishery Management Plan Steering Committee. Fisheries Victoria Management Report Series; No. 2. Department of Primary Industries. East Melbourne.

Department of Sustainability and Environment. 2003. Local Ports. A WWW publication accessed at http://www.dse.vic.gov.au in August 2003.

Diving Medical Advisory Committee. 1979. A Note Regarding Diving Distance from Seismic Surveying Operations. DMAC. London.

Edgar, G.J. 1997. Australian Marine Life: The plants and animals of temperate waters. Reed Books. Victoria.

Engås, A., Løkkeborg, S., Ona, E. and Soldal, A.V. 1993. Effects of seismic shooting on catch and catch-availability of cod and haddock. Fisken Og Havet 9, Institute of Marine Research, Norway.

Environment Australia. 2001. Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions Between Offshore Seismic Operations and Larger Cetaceans.

Environment Australia. 2002a. Blue Whales: Migration and recognised aggregation areas. Environment Australia.

Environment Australia. 2002b. White Shark (*Carcharodon carcharias*) Recovery Plan, Environment Australia, Canberra.

Environment Australia. 2002c. Recovery Plan for Grey Nurse Shark (*Carcharitas taurus*) in Australia. Environment Australia, Canberra

Environment Australia. 2003. Recovery Plan for Marine Turtles in Australia. Marine Species Section Approvals and Wildlife Division, in consultation with the Marine Turtle Recovery Team. Environment Australia. Canberra.

Environment Conservation Council. 2000. Marine Coastal and Estuarine Investigation: Final Report. Prepared by Environment Conservation Council, East Melbourne, Victoria

Evans, P. 1998. Biology of cetaceans of the North-east Atlantic (in relation to seismic energy). In: Weir, C. (Ed.), Proceedings of the Seismic and Marine Mammals Workshop, London.

Fabris, G.J., Monahan, C.A., Werner, F. and Theodoropoulos, T. 1995. Impact of Shipping and Dredging on Toxicants in Port Phillip Bay. Technical Report No. 20. CSIRO. Melbourne.

Gausland, I. 2000. Impact of seismic surveys on marine life. SPE International Conference on Health, Safety and the Environment in Oil and Gas Exploration and Production.

Gill, P. 2002. A blue whale (*Balaenoptera musculus*) feeding ground in a southern Australia coastal upwelling zone. Journal of Cetacean Research and Management 4, 179-184.

Glenelg Shire Council. 2003. Visiting the Region: Cape Bridgewater & Heritage Country. A WWW publication accessed in September 2003 at http://www.glenelg.vic.gov.au/cape.htm.

Gorfine, H.K. and Walker, T.I. (eds). 1997. Abalone 1996. Victorian Fisheries Assessment report. Compiled by Abalone Stock Assessment Group. (Marine and Freshwater Resources Institute: Queenscliff).

Heritage Victoria. 2003. Victorian Heritage Register Online - Shipwrecks. A WWW publication accessed in August 2003 at http://www. doi.vic.gov.au/doi/hvolr.nsf.

Hobday, D. and Smith, D.C. (eds). 2001. Rock Lobster 2001. Draft. Fisheries Victoria Assessment Report Series. Report No. 44.

Hughes, J. and White, A. 2003. Cetacean Monitoring on the 2002 Southern Margins Seismic Surveys. Santos Ltd (unpublished report).

IFAW. Undated. A WWW publication accessed on 25 August 2003 from http://www.ifawct.org/whaledb/whale12.htm

IMCRA. 1998. Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. prepared by Environment Australia, Commonwealth Department of Environment, Canberra.

JNCC. 1998. Guidelines for minimising acoustic disturbance to marine mammals from seismic surveys. April 1998. Report prepared by Joint Nature Conservation Committee, UK

Kemper, C.M., Mole, J., Warneke, R.M., Ling, J.K., Needham, D.J., and Wapstra, J.E. 1997. Southern Right Whales in southeastern Australia - aerial surveys during 1991-93 and incidental information from 1904. In: Kemper, H.C. (Ed.), Marine Mammal Research in the Southern Hemisphere. Surrey Beatty & Sons, Chipping Norton, NSW.

Kosheleva, V. 1992. The impact of air guns used in marine seismic explorations on organisms living in the Barents Sea. Contr. Petro Piscis II '92 Conference F-5, Bergen, 6-8 April, 1992: 6 p

McCauley, R.D. 1994. Seismic Surveys. In: Swan, J.M., Neff, J.M., Young, P.C. (Eds.), Environmental implications of offshore oil and gas development in Australia - the findings of an independent scientific review. Australian Petroleum Exploration Association, Sydney, pp. 19-121.

McCauley R.D., Jenner M.N., Jenner C., McCabe K.A. and Murdoch J. 1998. The response of humpback whales (*Megaptera novaeangliae*) to offshore seismic survey noise: preliminary results of observations about a working vessel and experimental exposures. APPEA Journal, 38 (1): 692-707.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.N., Penrose, J.D., Prince, R.I.T., Adhitya, A., Murdoch, J. and McCabe, K. 2000. Marine seismic surveys – A study of environmental implications. APPEA Journal.

McCauley, R.D. and Duncan, A.J. 2001. Marine Acoustic Effects Study, Blue Whale Feeding Aggregations, Otway Basin, Bass Strait Victoria. Unpublished report for Ecos Consulting. Centre for Marine Science and Technology, Curtin University of Technology.

McCauley, R.D., Fewtrell, J. and Popper, A.N. 2003. High intensity anthropogenic sound damages fish ears. Journal of Acoust. Soc. Am. Volume 113(1), January 2003, p638-642.

McShane, P.E., Beinssen, K.H.H. and Foley, S. 1986. Abalone reefs in Victoria – a resource atlas. Marine Science Laboratories. Technical Report 47. Department of Conservation Forests & Lands, Fisheries and Wildlife Service.

McShane, P.E., Black, K.P. and Smith, M.G. 1988. Recruitment processes in *Haliotis rubra* (Mollusca: Gastropoda) and regional hydrodynamics in southeastern Australia imply localised dispersal of larvae. Journal of Experimental Marine Biology and Ecology 124: 175-203.

Menkhorst, P.W. 1995. Mammals of Victoria: distribution, ecology and conservation. Oxford University Press, Melbourne, in association with the Department of Conservation and Natural Resources.

National Oceans Office. Undated. Impact of Petroleum. A WWW publication accessed online at http://www.oceans.gov.au/impacts_petoleum in July 2003.

National Oceans Office. 2002. Ecosystems - Nature's Diversity. The South-east Regional Marine Plan Assessment Reports. National Oceans Office, Hobart, Tasmania.

National Oceans Office. 2003. Maps of the South-East Marine Region. National Oceans Office. Tasmania.

National Research Council. 2003. Ocean noise and marine mammals. Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. Ocean studies Board, Division of Earth and Life Studies. The National Academic Press. A WWW publication read online at http://www.nap.edu/books/0309085365/html/.

NATO. Undated. Part II: SACLANTCEN Marine Mammal and Human Divers Risk Mitigation Rules - Planning. A WWW publication accessed in August 2003 at http://www.solmar.saclantc.nato.iat/reports/planning.pdf.

Parks Victoria. Undated. Twelve Apostles Marine National Park. A WWW publication accessed at http://www.parkweb.vic.gov.au in July 2003.

Parks Victoria. 2003a. Discovery Bay Marine National Park. A WWW publication accessed in September 2003 at http://www.parkweb.vic.gov.au.

Parks Victoria. 2003b. Merri Marine Sanctuary. A WWW publication accessed in September 2003 at http://www.parkweb.vic.gov.au.

Parry, G.D., Heislers, S., Werner, G.F., Asplin, M.D. and Gason, A. 2002. Assessment of environmental effects of seismic testing on scallop fisheries in Bass Strait. Prepared by Marine and Freshwater Resources Institute, Queenscliff.

Pearson, W.H., Skalski, J.R., Sulkin, S.D. and Malme, C.I. 1994. Effects of seismic energy releases on the survival and development of zoeal larvae of Dungeness crab (*Cancer magister*) Marine Environmental Research 38: 93-113.

Perry, S.L., Demaster, D.P., Silber, G.K. 1999. The sperm whale. Marine Fisheries Review, 61(1), pp.59-74.

Prince, J.D., Sellers, T.L., Ford, WB. and Talbot, S.R. 1987. Experimental evidence for limited dispersal of Haliotid larvae (genus *Haliotis*; Mollusca: Gastropoda). Journal of Experimental Marine Biology and Ecology 106: 243-263.

Prince, J.D., Sellers, T.L., Ford, WB. and Talbot, S.R. 1988. Confirmation of a relationship between the localised abundance of breeding stock and recruitment for *Haliotis rubra* (genus *Haliotis*; Mollusca: Gastropoda). Australian Journal of Marine and Freshwater Research 122: 91-104.

Richardson W.J., Greene Jnr. C.R., Malme C.I. and Thomson D.H. 1995. Marine Mammals and Noise. Academic Press, California.

Richardson W.J. 1999. Marine mammal and acoustical monitoring of Western Geophysical's open-water seismic pogrom in the Alaskan Beaufort Sea, 1998. Report prepared by LGL Ltd., environmental research associates and Greeneridge Sciences Inc. for Western Geophysical and National Marine Fisheries Service. LGL Report TA2230-3, September 1999.

SCAR Ad Hoc Group on marine acoustic technology and the environment. 2002. Impacts of Marine Acoustic Technology on the Antarctic Environment. Version 1.2. July 2002. A WWW publication accessed in August 2003 at http://www.scar-ggi.org.au/geophysics/acoustics_1_2.pdf

Seaworld. 2002. Penguins: Senses. A WWW publication accessed on 19 August 2003 at http://www.seaworld.org/infobooks/Penguins/scientific.html.

Shaughnessy, P.D. 1999. The Action Plan for Australian Seals. Prepared by Environment Australia, Canberra.

Simmonds, M., Dolman, S. and Weilgart, L. (eds). 2003. Oceans of noise. Whale and Dolphin Conservation Society (WDCS).

Stahel, C. and Gales, R. Undated. A WWW publication accessed in August 2003 at http://dannyreviews.com/h/Little_Penguin.html.

Statoil, I.G. 2000. Impact of seismic surveys on marine life. Victorian Fisheries Research Institute Final Report to Fisheries Research and Development Corporation project 90/11.

Stone, C. 2003. The effects of seismic activity on marine mammals in UK waters, 1998-2000. January. Report prepared by Joint Nature Conservation Committee,

Swan, J.M., Neff, J.M. and Young, P.C. 1994. Environmental Implications of Offshore Oil and Gas Development in Australia: The Findings of an Independent Scientific Review. Australia Petroleum Exploration Association (APEA) and Energy Research and Development Corporation (ERDC), Sydney.

Tasker, M.L, Karwatowski, J., Evans, P.G.H and Thompson, D. 1998. 'Introduction to seismic exploration and marine mammals in the north-east Atlantic.' In *Proceedings of the Seismic and Marine Mammals Workshop London 23-25 June 1998*. Edited by M.L. Tasker and C. Weir.

Thiele, D. and Gill, P. Undated. A WWW publication accessed in August 2003 from http://www.antdiv.gov.au/default.asp?casid=2449.

Turnpenny A.W.H. and Nedwell J.R. 1994. The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. Consultancy Report to UKOOA by Fawley Aquatic Research Laboratories Ltd FCR 089/94.

Webb, C.L.F. and Kempf, N.J. 1998. The impact of shallow-water seismic in sensitive areas. Society of Petroleum Engineers, Technical Paper SPE 46722.

Wilkinson, R. 1995. Speaking of Oil and Gas. June 1995. Report prepared by BHP Petroleum Pty Ltd,

Woodside. 2003. Environmental Impact Statement/Environmental Effects Statement: Otway Gas Project. prepared by Woodside Energy, Perth

10.2 Personal Communications

Doodie, H. Personal communication, Heath Doodie, NSR Environmental Consultants Pty Ltd., dedicated marine mammal observation team member – 2001-2002 Bass Strait seismic surveys. July 2003.

Garnham, J. Personal Communication, John Garnham, Department of Primary Industries, Fisheries Division, Melbourne -Manager Policy and Business Development. Meeting 3 July, 2003.

Gill, P. Personal communication, Peter Gill. Blue whale researcher. Deakin University, Warrnambool. Meeting. 28 July 2003.

HoogAntink, M. Personal communication, Marcel HoogAntink. Parks Victoria ranger, Glenelg Office. Phone. 4 September, 2003.

Pinzone, G. Personal communication, Giulio Pinzone, NSR Environmental Consultants Pty Ltd., dedicated marine mammal observation team member – 2002 Bass Strait seismic surveys. August 2003.

Watson, M. Personal communication, Mandy Watson, Victorian Department Sustainability and Environment, Southern Right Whale research officer, Warrnambool, 23 July 2003.

Appendix 1

Santos Environmental Policy

Santos

Environmental Vision, Commitment & Policy

As Santos' Managing Director, I am personally committed to working with our Environmental Committee of the Board, management and supervisors to ensure that the staff and contractors working for the Company have the knowledge and tools to act with high levels of environmental responsibility and achieve a standard of excellence in this field.

At Santos, the term Environment encompasses not only nature and the physical environment in which we work, but includes people, their work and the things they value. We believe that people are part of the environment - part of the problems but also very much a part of innovative solutions.

We intend to shrink and lighten the environmental footprint of our operations. We will build on past successes and continue to learn from past mistakes. This requires us to work together, strengthen the partnerships with our stakeholders and admit our dissatisfaction with the status quo.

As with safety, environmental stewardship is the responsibility of all Santos employees and contractors. Environmental and cultural heritage induction and training will continue to receive high priority and will be supplemented with a renewed focus on our Company-wide goal of meeting our corporate responsibilities in full.

New ideas and new ways of avoiding or minimising our environmental impacts will be encouraged and rewarded. Our prime objective of growing Santos will be nurtured not at the expense of, but on the basis of, ethical behaviour, safe operations, partnerships with the community and an environmental objective of continuous improvement.

We intend to be a leader in the petroleum industry. Excellence in environmental performance, safety and community partnerships will be a fundamental component of this goal.

J. Ellice-Flint
Managing Director

November 2001

Appendix 2

Commonwealth-listed Marine Fauna Species

Appendix 2: Commonwealth-Listed Marine Fauna Species

The species list in Table 1 was obtained form the Environment Australia (EA) Environment Protection and Biodiversity Conservation (EPBC) Online Database.

Table 1 Marine fauna of national significance that may occur in the seismic survey area

Scientific Name	Common Name	Status
Whales		
Balaenoptera acutorostrata	Minke whale	LC
Balaenoptera bonaerensis	Antarctic minke whale	M
Balaenoptera borealis	Sei whale	M
Balaenoptera edeni	Bryde's whale	M
Balaenoptera musculus	Blue whale	E, M
Berardius arnuxii	Arnoux's beaked whale	LC
Caperea marginata	Pygmy right whale	M
Eubalaena australis	Southern right whale	E, M
Globicephala macrorhynchus	Short-finned pilot whale	LC
Globicephala melas	Long-finned pilot whale	LC
Kogia breviceps	Pygmy sperm whale	LC
Kogia simus	Dwarf sperm whale	LC
Megaptera novaeangliae	Humpback whale	V, M
Mesoplodon bowdoini	Andrew's beaked whale	LC
Mesoplodon densirostris	Blainville's beaked whale	LC
Mesoplodon grayi	Gray's beaked whale	LC
Mesoplodon hectori	Hector's beaked whale	LC
Mesoplodon layardii	Strap-toothed beaked whale	LC
Mesoplodon mirus	True's beaked whale	LC
Orcinus orca	Killer whale	M
Physeter macrocephalus	Sperm whale	M
Pseudorca crassidens	False killer whale	LC
Ziphius cavirostris	Cuvier's beaked whale	LC
Sharks		
Carcharias taurus	Grey nurse shark (east coast population)	CE
Carcharodon carcharias	Great white shark	V, M
Seals		
Arctocephalus pusillus	Fur-seal	L
Dolphins		
Delphinus delphis	Common dolphin	LC
Grampus griseus	Risso's dolphin	LC

Table 1 Marine fauna of national significance that may occur in the seismic survey area (cont'd)

Scientific Name	Common Name	Status
Dolphins (cont'd)		
Lagenorhynchus obscurus	Dusky dolphin	LC
Lissodeplphis peronii	Southern right whale dolphin	LC
Tursiops aduncus	Spotted bottlenose dolphin	LC
Tursiops truncatus s. str.	Bottlenose dolphin	LC
Birds		
Diomedea amsterdamensis	Amsterdam albatross	E, M
Diomedea dabbenena	Tristan albatross	E, M
Diomedea epomophora	Southern royal albatross	V, M
Diomedea exulans	Wandering albatross	V, M
Diomedea gibsoni	Gibson's albatross	V, M
Diomedea sanfordi	Northern royal albatross	E, M
Phoebetria fusca	Sooty albatross	V, M
Thalassarche bulleri	Buller's albatross	V, M
Thalassarche cauta	Shy albatross	V, M
Thalassarche chrysostoma	Grey-headed albatross	V, M
Thalassarche impavida	Campbell albatross	V, M
Thalassarche melanophris	Black-browed albatross	M
Thalassarche salvini	Salvin's albatross	V, M
Thalassarche chlororhynchos	Yellow-nosed albatross, Atlantic yellow-nosed albatross	L
Macronectes giganteus	Southern giant petrel	E, M
Macronectes halli	Northern giant petrel	V, M
Halobaena caerulea	Blue petrel	V
Pterodroma mollis	Soft-plumaged petrel	V
Pelecanoides urinatrix	Common diving-petrel	L
Puffinus tenuirostris	Short-tailed shearwater	M
Haliaeetus leucogaster	White-bellied sea-eagle	M
Catharacta skua	Great skua	L
Eudyptula minor	Little penguin	L
Fish		
Heraldia nocturna	Upside-down pipefish	L
Hippocampus abdominalis	Eastern potbelly seahorse, New Zealand potbelly seahorse, bigbellly seahorse	L
Hippocampus breviceps	Short-head seahorse, short-snouted seahorse	L
Histiogamphelus briggsii	Briggs' crested pipefish, Briggs' pipefish	L
Histiogamphelus cristatus	Rhino pipefish, Macleays's crested pipefish	L
Hypselognathus rostratus	Knife-snouted pipefish	L
Kaupus costatus	Deep-bodied pipefish	L

Table 1 Marine fauna of national significance that may occur in the seismic survey area (cont'd)

Scientific Name	Common Name	Status
Fish (cont'd)		
Leptoichthys fistularius	Brushtail pipefish	L
Lissocampus caudalis	Australian smooth pipefish, Smooth pipefish	L
Lissocampus runa	Javelin pipefish	L
Maroubra perserrata	Sawtooth pipefish	L
Mitotichthys semistriatus	Half-banded pipefish	L
Mitotichthys tuckeri	Tucker's pipefish	L
Notiocampus ruber	Red pipefish	L
Phycodurus eques	Leafy seadragon	L
Phyllopteryx taeniolatus	Weedy seadragon, Common seadragon	L
Pugnaso curtirostris	Pug-nosed pipefish	L
Solegnathus robustus	Robust Spiny pipehorse, Robust pipehorse	L
Solegnathus spiniosissimus	Spiny pipehorse, Australian spiny pipehorse	L
Stigmatopora argus	Spotted pipefish	L
Stigmatopora nigra	Wide-bodied pipefish, Black pipefish	L
Stipecampus cristatus	Ring-backed pipefish	L
Urocampus carinirostris	Hairy pipefish	L
Vanacampus margaritifer	Mother-of-pearl pipefish	L
Vanacampus phillipi	Port Phillip pipefish	L
Vanacampus poecilolaemus	Australian long-snout pipefish, Long-snouted pipefish	L

L - listed, LC - listed cetacean, V - vulnerable, E - endangered, M - migratory, CE - critically endangered

Appendix 3

Victorian-listed Fauna Species

Appendix 3: Victorian-listed Fauna Species

The fauna species list in Table 1 was obtained from the Atlas of Victorian Wildlife (AVW) in September 2003 for the survey area. It contains records of confirmed fauna species sightings, which are entered into the database as a grid record. Thus, many of the bird species in the table are likely to be terrestrial birds only, rather than marine. They are included in the table for completeness.

Table 1 Victorian fauna species in the study area and their status

Common Name	Species Name	Status
Mammals		
New Zealand Fur Seal	*Arctocephalus forsteri*	L
Australian Fur Seal	*Arctocephalus pusillus*	
Blue Whale	*Balaenoptera musculus*	C
Balaenoptera sp.	*Balaenoptera sp.*	
Common Dolphin	*Delphinus delphis*	
Southern Right Whale	*Eubalaena australis*	C
Long-finned Pilot Whale	*Globicephala melas*	
Leopard Seal	*Hydrurga leptonyx*	
Pygmy Sperm Whale	*Kogia breviceps*	
Humpback Whale	*Megaptera novaeangliae*	V
Ginkgo-toothed Whale	*Mesoplodon ginkgodens*	
Strap-toothed Whale	*Mesoplodon layardi*	
True's Beaked Whale	*Mesoplodon mirus*	
Mesoplodon sp.	*Mesoplodon sp.*	
Southern Elephant Seal	*Mirounga leonina*	
Australian Sea Lion	*Neophoca cinerea*	
Killer Whale	*Orcinus orca*	
Sperm Whale	*Physeter macrocephalus*	
Bottlenose Dolphin	*Tursiops truncatus*	
Cuvier's Beaked Whale	*Ziphius cavirostris*	
Birds		
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	
Brown Thornbill	*Acanthiza pusilla*	
Common Sandpiper	*Actitis hypoleucos*	V
Magpie Goose	*Anseranas semipalmata*	V
Red Wattlebird	*Anthochaera carunculata*	
Little Wattlebird	*Anthochaera chrysoptera*	
Richard's Pipit	*Anthus novaeseelandiae*	
King Penguin	*Aptenodytes patagonicus*	

Table 1 Victorian fauna species in the study area and their status (cont'd)

Common Name	Species Name	Status
Fork-tailed Swift	*Apus pacificus*	
Great Egret	*Ardea alba*	V
Cattle Egret	*Ardea ibis*	
White-necked Heron	*Ardea pacifica*	
Ruddy Turnstone	*Arenaria interpres*	
Galah	*Cacatua roseicapilla*	
Long-billed Corella	*Cacatua tenuirostris*	
Striated Fieldwren	*Calamanthus fuliginosus*	
Sharp-tailed Sandpiper	*Calidris acuminata*	
Sanderling	*Calidris alba*	L
Curlew Sandpiper	*Calidris ferruginea*	
Red-necked Stint	*Calidris ruficollis*	
Great Knot	*Calidris tenuirostris*	E
South Polar Skua	*Catharacta maccormicki*	
Great Skua	*Catharacta skua*	
Double-banded Plover	*Charadrius bicinctus*	
Red-capped Plover	*Charadrius ruficapillus*	
Whiskered Tern	*Chlidonias hybridus*	L
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*	
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	
Brown Songlark	*Cincloramphus cruralis*	
Swamp Harrier	*Circus approximans*	
Golden-headed Cisticola	*Cisticola exilis*	
Banded Stilt	*Cladorhynchus leucocephalus*	
Grey Shrike-thrush	*Colluricincla harmonica*	
Rock Dove	*Columba livia*	
Australian Raven	*Corvus coronoides*	
Little Raven	*Corvus mellori*	
Corvid	*Corvus sp.*	
Forest Raven	*Corvus tasmanicus*	
Stubble Quail	*Coturnix pectoralis*	
Brown Quail	*Coturnix ypsilophora*	L
Cape Petrel	*Daption capense*	
Rufous Bristlebird	*Dasyornis broadbenti*	L
Buller's Albatross	*Diomedea bulleri*	
Shy Albatross	*Diomedea cauta*	V
Royal Albatross	*Diomedea epomophora*	V
Wandering Albatross	*Diomedea exulans*	E
Little Egret	*Egretta garzetta*	E
White-faced Heron	*Egretta novaehollandiae*	

Table 1 Victorian fauna species in the study area and their status (cont'd)

Common Name	Species Name	Status

Black-shouldered Kite	*Elanus axillaris*	
Black-fronted Dotterel	*Elseyornis melanops*	
Eastern Yellow Robin	*Eopsaltria australis*	
White-fronted Chat	*Epthianura albifrons*	
Crimson Chat	*Epthianura tricolor*	
Red-kneed Dotterel	*Erythrogonys cinctus*	
Fiordland Penguin	*Eudyptes pachyrhynchus*	
Erect-crested Penguin	*Eudyptes sclateri*	
Little Penguin	*Eudyptula minor*	
Brown Falcon	*Falco berigora*	
Nankeen Kestrel	*Falco cenchroides*	
Australian Hobby	*Falco longipennis*	
Peregrine Falcon	*Falco peregrinus*	
Eurasian Coot	*Fulica atra*	
Southern Fulmar	*Fulmarus glacialoides*	
Latham's Snipe	*Gallinago hardwickii*	L
Dusky Moorhen	*Gallinula tenebrosa*	
Black-tailed Native-hen	*Gallinula ventralis*	
Buff-banded Rail	*Gallirallus philippensis*	
Grey-backed Storm-Petrel	*Garrodia nereis*	
Western Gerygone	*Gerygone fusca*	
Musk Lorikeet	*Glossopsitta concinna*	
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	
Magpie-lark	*Grallina cyanoleuca*	
Australian Magpie	*Gymnorhina tibicen*	
Sooty Oystercatcher	*Haematopus fuliginosus*	L
Pied Oystercatcher	*Haematopus longirostris*	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	V
Whistling Kite	*Haliastur sphenurus*	
Grey-tailed Tattler	*Heteroscelus brevipes*	C
Little Eagle	*Hieraaetus morphnoides*	
Black-winged Stilt	*Himantopus himantopus*	
White-throated Needletail	*Hirundapus caudacutus*	
Fairy Martin	*Hirundo ariel*	
Welcome Swallow	*Hirundo neoxena*	
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	V
White-winged Triller	*Lalage sueurii*	
Kelp Gull	*Larus dominicanus*	
Silver Gull	*Larus novaehollandiae*	
Pacific Gull	*Larus pacificus*	L

Table 1 Victorian fauna species in the study area and their status (cont'd)

Common Name	**Species Name**	**Status**
Yellow-faced Honeyeater	*Lichenostomus chrysops*	
Singing Honeyeater	*Lichenostomus virescens*	

Kerguelen Petrel	*Lugensa brevirostris*	
Southern Giant-Petrel	*Macronectes giganteus*	V
Northern Giant-Petrel	*Macronectes halli*	L
Giant-Petrel sp.	*Macronectes sp.*	
Superb Fairy-wren	*Malurus cyaneus*	
Hooded Robin	*Melanodryas cucullata*	L
White-naped Honeyeater	*Melithreptus lunatus*	
Cape Gannet	*Morus capensis*	
Australasian Gannet	*Morus serrator*	
Satin Flycatcher	*Myiagra cyanoleuca*	
Scarlet Honeyeater	*Myzomela sanguinolenta*	
Orange-bellied Parrot	*Neophema chrysogaster*	C
Blue-winged Parrot	*Neophema chrysostoma*	
Wilson's Storm-Petrel	*Oceanites oceanicus*	
Rufous Whistler	*Pachycephala rufiventris*	
Slender-billed Prion	*Pachyptila belcheri*	
Fairy Prion	*Pachyptila turtur*	V
Osprey	*Pandion haliaetus*	
White-faced Storm-Petrel	*Pelagodroma marina*	L
Common Diving-Petrel	*Pelecanoides urinatrix*	L
Australian Pelican	*Pelecanus conspicillatus*	
Great Cormorant	*Phalacrocorax carbo*	
Black-faced Cormorant	*Phalacrocorax fuscescens*	L
Little Pied Cormorant	*Phalacrocorax melanoleucos*	
Little Black Cormorant	*Phalacrocorax sulcirostris*	
Pied Cormorant	*Phalacrocorax varius*	L
Grey Phalarope	*Phalaropus fulicaria*	
New Holland Honeyeater	*Phylidonyris novaehollandiae*	
Yellow-billed Spoonbill	*Platalea flavipes*	
Royal Spoonbill	*Platalea regia*	V
Crimson Rosella	*Platycercus elegans*	
Pacific Golden Plover	*Pluvialis fulva*	L
Hoary-headed Grebe	*Poliocephalus poliocephalus*	
Purple Swamphen	*Porphyrio porphyrio*	
Australian Spotted Crake	*Porzana fluminea*	
Grey Petrel	*Procellaria cinerea*	
Great-winged Petrel	*Pterodroma macroptera*	
Little Shearwater	*Puffinus assimilis*	

Table 1 Victorian fauna species in the study area and their status (cont'd)

Common Name	Species Name	Status
Flesh-footed Shearwater	*Puffinus carneipes*	
Fluttering Shearwater	*Puffinus gavia*	
Hutton's Shearwater	*Puffinus huttoni*	
Short-tailed Shearwater	*Puffinus tenuirostris*	

Lewin's Rail	*Rallus pectoralis*	V
Grey Fantail	*Rhipidura fuliginosa*	
Willie Wagtail	*Rhipidura leucophrys*	
White-browed Scrubwren	*Sericornis frontalis*	
Arctic Jaeger	*Stercorarius parasiticus*	
Pomarine Jaeger	*Stercorarius pomarinus*	
Crested Tern	*Sterna bergii*	
Caspian Tern	*Sterna caspia*	L
Common Tern	*Sterna hirundo*	
Fairy Tern	*Sterna nereis*	E
Arctic Tern	*Sterna paradisaea*	
White-fronted Tern	*Sterna striata*	L
Pied Currawong	*Strepera graculina*	
Spotted Turtle-Dove	*Streptopelia chinensis*	
Australasian Grebe	*Tachybaptus novaehollandiae*	
Yellow-nosed Albatross	*Thalassarche chlororhynchos*	V
Grey-headed Albatross	*Thalassarche chrysostoma*	V
Black-browed Albatross	*Thalassarche melanophris*	E
Hooded Plover	*Thinornis rubricollis*	V
Australian White Ibis	*Threskiornis molucca*	
Straw-necked Ibis	*Threskiornis spinicollis*	
Sacred Kingfisher	*Todiramphus sanctus*	
Common Greenshank	*Tringa nebularia*	
Marsh Sandpiper	*Tringa stagnatilis*	
Masked Lapwing	*Vanellus miles*	
Silvereye	*Zosterops lateralis*	
Other		
Leathery Turtle	*Dermochelys coriacea*	C

KEY

C Critically endangered

E Endangered

L Lower risk

V Vulnerable

Appendix 4

Environment Australia (2001) Cetacean Observation and Seismic Operations Guideline

Guidelines on the application of the
Environment Protection and Biodiversity Conservation Act
to interactions between offshore seismic operations and larger cetaceans
October 2001

Purpose

The purpose of these Guidelines is to assist proponents of offshore seismic operations address certain of their obligations under the Environment Protection and Biodiversity Conservation Act 1999 (the Act) relevant to interactions with whales and certain other larger cetaceans.

Limitations

These Guidelines set out in plain English general advice about how Environment Australia intends to apply relevant provisions of the Act. They do not provide definitive advice relevant to any particular case. In each application of the Act, the particular circumstances of that case will need to be taken into account.

These Guidelines do not in any way fetter the discretion or responsibilities of the Minister for the Environment and Heritage or Environment Australia under the Act.

These Guidelines refer only to seismic operations and interactions with those cetaceans or whales listed at attachment 1. They do not relate to interactions with small cetaceans (such as dolphins) or other marine species (such as turtles or dugong). Whether a seismic survey will have a significant impact on a species at Attachment 3, other than those species listed at Attachment 1, should be considered prior to undertaking a survey. Other matters of national environmental significance such as the protection of World Heritage areas, Ramsar Convention listed wetlands of international importance, or the wider aspects of the Commonwealth marine environment trigger are also not addressed in these guidelines.

In relation to seismic operations and interactions with cetacean species other than those listed at Attachment 1, proponents need to determine the likelihood of the operation having a significant impact on the species or a population, or of interfering with individual animals of these species.

It is essential that all proponents make themselves familiar with the detail of their obligations under the Act. The Act can be found at www.ea.gov.au/epbc/about. The Government has separately published general Administrative Guidelines for the Act on whether a proposed action is likely to have a significant impact on any matter of national environmental significance. See www.ea.gov.au/epbc/assessapprov/guidelines/index.html or attachment 2.

When would a seismic operation that is likely to interact with whales require approval under Part 9 of the EPBC Act?

In the following circumstances a proposed seismic operation would be considered a 'controlled action' under the Act and so would require the approval of the Minister for the Environment and Heritage.

- Where a proposed seismic operation, whether in Commonwealth waters or in coastal waters, would be likely to have a significant impact on any threatened or migratory cetacean species. A full list of threatened or migratory cetacean species is at attachment 3.
- Where a seismic operation in Commonwealth waters would be likely to have a significant impact on any cetacean species.

Seismic operations will be regarded as being likely to have a significant impact on a cetacean species (including threatened and migratory cetacean species) in the following circumstances.

- Where the seismic operation is to be carried out in, or within 20 kilometres of, a feeding, breeding or resting area for a relevant cetacean species during the period when cetaceans are present.
  - The known feeding, breeding and resting areas for Southern right whales, Blue whales and Humpbacks - and the times when whales are believed to be present in these areas - are set out in the maps at Attachment 4. Areas for other species will be delineated in future as our knowledge increases.
- Under some circumstances seismic operations in or near migratory paths for cetaceans (as set out in maps at Attachment 5) at specified times may be likely to have a significant impact.
  - Proponents should consider referring relevant proposed operations in or near migratory paths to the Minister for decision on a case-by-case basis. Factors that may be relevant include: whether the migratory species is endangered; whether the seismic operations would be in a migratory path adjacent to a feeding, breeding or resting area; whether young calves or pregnant females may be affected; whether significant numbers (relative to the species or populations) of migrating cetaceans may be affected.

Should a proponent wish to remove uncertainty whether the action is a controlled action, the proposed action can be referred to the Minister for a decision about whether the action is a controlled action. Such a decision must be given in 20 days. (See section 75(5) of the Act.)

The undertaking of two surveys simultaneously in adjoining areas may lead to significantly greater interference than might be expected from a single survey and may lead to each of the surveys being considered to have a significant impact on the species.

When should you apply for a permit under Part 13 of the EPBC Act for a seismic operation that may interact with whales?

With limited exceptions, an action that will injure, take or interfere with a cetacean in Commonwealth waters is an offence under the Part 13 of the Act unless a permit has been granted. In general, permits will not be granted to injure or take cetaceans. Accordingly, these two circumstances will not be considered further here.

A seismic operation that would interfere with a cetacean in Commonwealth waters would not be an offence under Part 13 of the Act if a permit has been granted.

Interference is defined in the Act to include harass, chase, herd, tag, mark or brand the cetacean. For the purposes of these Guidelines a precautionary approach has been taken to the definition of interference; that is causing a significant change in behaviour, including a

significant deviation from their migratory path or a substantial change in respiration or swimming pattern, will be considered harassment and so interference.

Under the following circumstances Environment Australia may consider a seismic operation as interfering with a cetacean.

- Where a seismic operation is a controlled action under Part 3 of the Act (and so must be approved by the Minister) as a result of its potential interactions with cetaceans. In these cases the permitting and approvals processes will be managed together.
- Seismic operations that are not controlled actions under Part 3 of the Act, but nonetheless take place in or near migratory paths around the time when migrations may occur. Such seismic operations may cause any present whales to modify their behaviour (for example deviate from their migratory path) and so may interfere with them.
  - Maps of migratory pathways for Humpback whales, Blue whales and Southern right whales are at attachment 5. Seismic operations in these areas during the peak of the Humpback migratory season and for all of the Blue whale and Southern right whale migratory season will be considered to be likely to interfere with any present whales. As areas important for other species become known, additional areas will be delineated.

In general, a seismic operation will **not** be regarded as interfering with cetaceans under the following circumstances.

- The seismic operation will take place outside of the migratory pathways and migration period for whales and outside of the breeding, feeding and resting areas during the times when these areas are occupied; and
- the management prescriptions set out in attachment 6 are observed.
  - These management prescriptions are intended to ensure that the proponent will take proper efforts to identify whether whales are in the area where seismic operations are to commence, and should there be whales in the area that every reasonable effort is taken to undertake the seismic operations in a manner that eliminates or minimises impacts on them.

What is the relationship between Part 3 approvals and Part 13 permitting processes in the Act?

From the above it is clear that, given the different objectives of the approvals and permitting provisions under the Act, proponents of seismic operations should have regard to a number of possible outcomes. These are broadly set out below.

Some seismic operations will not require an approval and nor will the permit provisions apply.

- That is, where there is no significant impact on a cetacean species and there is no interference with any individual cetacean (and other NES matters are not affected).

For some seismic operations only the permit provisions will apply.

- For example, where a seismic operation in Commonwealth waters may interfere with migrating whales the permit provisions will apply, but if a significant impact on the species or a population of species is not likely no approval will be required.

Some seismic operations will require approval but the permit provisions will not apply.

- For example, a seismic operation in coastal waters that is likely to impact significantly on a population of a threatened cetacean will require approval. However, because the action is in coastal waters (and not Commonwealth waters) the permit provisions would not apply.

For some seismic operations in Commonwealth waters, both an approval will be required and the permit provisions will apply.

- This will be the case where a proposal will have both a significant impact on a species of cetacean and will also interfere with individual cetaceans. In such cases, approvals and permits will be processed together to avoid any delay or duplication. For practical purposes, there will be one process and the same documentation from the proponent can be used to meet both requirements.

What do you have to do for the Part 3 approvals process?

Where a proposed action has been referred to the Minister for the Environment and Heritage and found to have or be likely to have a significant impact on a matter of national environmental significance (a controlled action), the action will require the approval of the Minister. The process for obtaining approval is outlined at Attachment 7. Further information on the process can be gained at www.ea.gov.au/epbc/assessapprov/index.html.

What do you have to do for the Part 13 permitting process?

Under the EPBC Act applying for a permit to undertake an action that may interfere with a cetacean automatically requires that the action be treated like a controlled action.

From this step a similar process as described for the Part 3 approval is followed, though at the end of the process a permit is issued (or refused) rather than an approval being given (or refused). Conditions may be placed on the permit.

The permit process has a simultaneous step of advising persons on the Register for consultation about permits of the permit application and seeking their comment on the application.

Standard Conditions

As a general rule proponents of seismic operations should expect to be subject to conditions applying to approvals or permits.

The conditions will be based on the set of management prescriptions set out at Attachment 6. These are for guidance only and specific conditions will be determined for each proposal depending on the particular circumstances of the operational environment.

In general these conditions are intended to ensure that:

- every reasonable effort is taken to identify whether whales are in the vicinity of a seismic operation;
- should whales be in the vicinity, avoidance of interference and mitigating action takes place, and
- if whales do not appear to be in the vicinity, the operation is commenced and managed in a precautionary manner to minimise interference with whales that may not have been

identified and to cease operations quickly should whales be identified and interference be avoidable.

Supporting notes

Feeding, breeding and resting areas

Whales that are feeding, breeding and resting (in particular with calves) are considered susceptible to disturbance. Generally the conditions supporting these activities are unlikely to be available in other locations. Disturbing whales under these circumstances is likely to have an impact on the population of the species. The sensitivity of cow/calf pairs to disturbance when resting during migrations requires that a substantial buffer of 20 kilometres around these resting areas is applied to allow the calves to regain strength for the migration.

Migratory paths

Generally whales are robust animals able to travel long distances. Under most circumstances, a whale making a small deviation within its general migratory path to avoid seismic operation is unlikely to be adversely affected in terms of successful migration. However, in some circumstances precautionary management suggests that causing such deviations should be avoided where possible. These would best be judged on a case-by-case basis, considering factors such as the conservation status of the relevant species, or the likelihood of young calves or pregnant females being in the area.

Sound levels

The impact of sound from seismic sources is the subject to ongoing work in many parts of the world, including Australia. The impact of disturbance on whales in the short and long term is also unknown. Evidence to date shows that sounds heard by whales of over approximately 140db in feeding, breeding or resting areas may be considered likely to significantly disturb whales that are present. Sounds heard by whales of over 150db in other areas, such as migratory paths, may significantly disturb whales that are in the area. A document outlining the current justification for these sounds levels is available from Environment Australia).

Contact

For further information on the operation of these guidelines contact:

Director
Marine Species Section
Environment Australia
GPO Box 787
CANBERRA ACT 2601

Environment Australia, October 2001
ISBN 064254784X

List of whales species to which these guidelines relate

Common name	**Scientific name**
Shepherd's beaked whale	*Tasmacetus shepherdi*
Dense-beaked whale	*Mesoplodon densirostris*
Hector's beaked whale	*Mesoplodon hectori*
Longman's beaked whale	*Mesoplodon pacificus*
Andrew's beaked whale	*Mesoplodon bowdoini*
True's beaked whale	*Mesoplodon mirus*
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*
Strap-toothed whale	*Mesoplodon layardii*
Gray's beaked whale	*Mesoplodon grayi*
Arnoux's beaked whale	*Berardius arnuxii*
Cuvier's beaked whale	*Ziphius cavirostris*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Short-finned pilot whale	*Globicephala macrorhynchus*
Southern bottlenose whale	*Hyperoodon planifrons*
Sperm whale	*Physeter macrocephalus*
Southern right whale	*Eubalaena australis*
Pygmy right whale	*Caperea marginata*
Minke whale	*Balaenoptera acutorostrata*
Sei whale	*Balaenoptera borealis*
Bryde's whale	*Balaenoptera edeni*
Blue whale	*Balaenoptera musculus*
Fin whale	*Balaenoptera physalus*
Humpback whale	*Megaptera novaeangliae*

Criteria for significance under the three matters of NES, listed threatened species, listed migratory species and Commonwealth marine environment.

Listed Critically endangered and endangered species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed critically endangered or endangered species.

Criteria
An action has, will have, or is likely to have a significant impact on a critically endangered or endangered species if it does, will, or is likely to:

1. lead to a long-term decrease in the size of a population,
2. or reduce the area of occupancy of the species, or fragment an existing population into two or more populations,
3. or adversely affect habitat critical to the survival of a species,
4. or disrupt the breeding cycle of a population, or
5. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
6. result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat*,
7. or interfere with the recovery of the species.

(*Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a critically endangered or endangered species by direct competition, modification of habitat, or predation.)

Listed Vulnerable species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed vulnerable species.

Criteria
An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

1. lead to a long-term decrease in the size of an *important* population of a species,
2. or reduce the area of occupancy of an *important* population, or
3. fragment an existing *important* population into two or more populations, or
4. adversely affect habitat critical to the survival of a species, or
5. disrupt the breeding cycle of an *important* population, or
6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
7. result in invasive species that are harmful a vulnerable species becoming established in the vulnerable species' habitat*, or
8. interferes substantially with the recovery of the species.

(* Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.)

An important population is one that is necessary for a species' long-term survival and recovery. This may include populations that are:
1. key source populations either for breeding or dispersal,
2. populations that are necessary for maintaining genetic diversity, and/or
3. populations that are near the limit of the species range.

In addition to the above information, Commonwealth adopted Recovery Plans may also provide further guidance on whether an action is likely to be significant.

Listed Migratory Species
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species.

Criteria
An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

1. substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
2. result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
3. seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

(* Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.)

An area of important habitat is:

1.Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2.habitat utilised by a migratory species which is at the limit of the species range, or
3.habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated)

Commonwealth marine environment
An action will require approval from the Environment Minister if the action has, will have, or is likely to have a impact on the environment of the Commonwealth marine area.

Criteria
An action has, will have or is likely to have a significant impact on the environment in a Commonwealth marine area if it does, will, or is likely to:

1. result in a known or potential pest species becoming established in the Commonwealth marine area*, or
2. modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results, or
3. have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (eg breeding, feeding, migration behaviour, and life expectancy) and spatial distribution, or
4. result in a substantial change in air quality** or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health, or
5. result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected.

(* Translocating or introducing a pest species may result in that species becoming established.
** The Commonwealth marine area includes any airspace over Commonwealth waters.)

Guidelines for the Mining Industry

Guidelines on significance have been published for the mining industry. These include a reference to seismic activity in the marine environment which states:
'Seismic exploration (using air guns) is not likely to have a significant impact on a matter of national environmental significance unless the activity is undertaken in an area that contains habitat for threatened or migratory species and the seismic activity is likely to interfere with breeding, feeding or migration. Similarly, seismic exploration using air guns would not normally be expected to have a significant impact on the Commonwealth marine environment unless it was undertaken in an area that contains habitat for threatened or migratory species and the seismic activity is likely to interfere with breeding, feeding or migration. In addition, seismic activity in shallow or near shore environments in or adjacent to a Commonwealth marine area or a Ramsar wetland is likely to have a significant impact on a matter of national environmental significance.'

Cetaceans occuring in Australian waters that are listed as a listed threatened species or a listed migratory species or both.

At least 44 species of cetaceans have been reported in Australian and Antarctic waters. This includes 26 species of whale, 17 species of dolphins and one species of porpoise (which occurs in sub-Antarctic waters).

Five of the whale species found in Australian waters are also considered threatened and are listed as endangered or vulnerable under the Act. In addition, a number of the whale and dolphin species are migratory (visiting Australia for only part of the year or having populations that straddle international borders) and are listed under the Convention on the Conservation of Migratory Species of Wild Animals (the CMS or Bonn Convention).

Both a listed **critically endangered or endangered species** and a listed **migratory species**

Blue whale	(*Balaenoptera musculus*) - Appendix 1 Bonn Convention
Southern right whale	(*Eubalaena australis)*

Both a listed **vulnerable species** and a listed **migratory species**

Humpback whale	(*Megaptera novaeangliae)* - Appendix 1 Bonn Convention

Listed **vulnerable species**

Sei whale	*(Balaenoptera borealis)*
Fin whale	*(Balaenoptera physalus)*

Listed **migratory species**

Spectacled porpoise	(*Phocoena diotropica)* - listed Appendix 2 Bonn Convention
Indo-Pacific humpback dolphin	(*Sousa chinensis)*
Dusky dolphin	(*Lagenorhynchus obscurus)*
Indian Ocean bottlenose dolphin	(*Tursiops aduncus)*
Pantropical spotted dolphin	(*Stenella attenuata)*
Spinner dolphin	(*Stenella longirostris*)
Fraser's dolphin	(Lagenodelphis hosei)
Irrawaddy dolphin	(*Orcaella brevirostris)*

All cetaceans occurring in Commonwealth waters are protected. The impact a proposal may have on an important population of any cetacean species is considered under the marine environment matter of national Environmental Significance. A permit is required to interfere with any individual cetacean of any species within Commonwealth areas

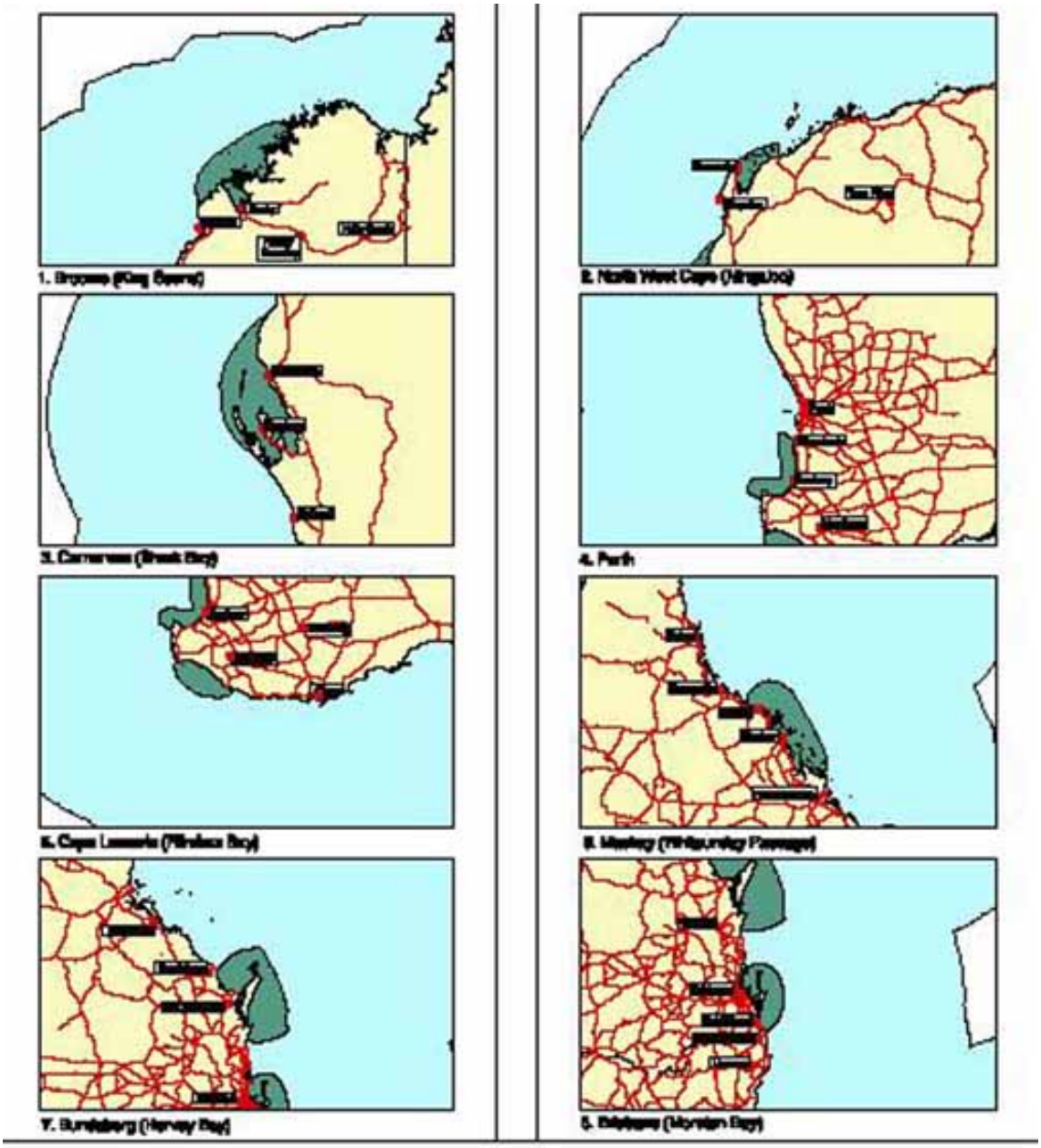
Recognised aggregation, breeding and resting areas

1. Rottnest, Western Australia

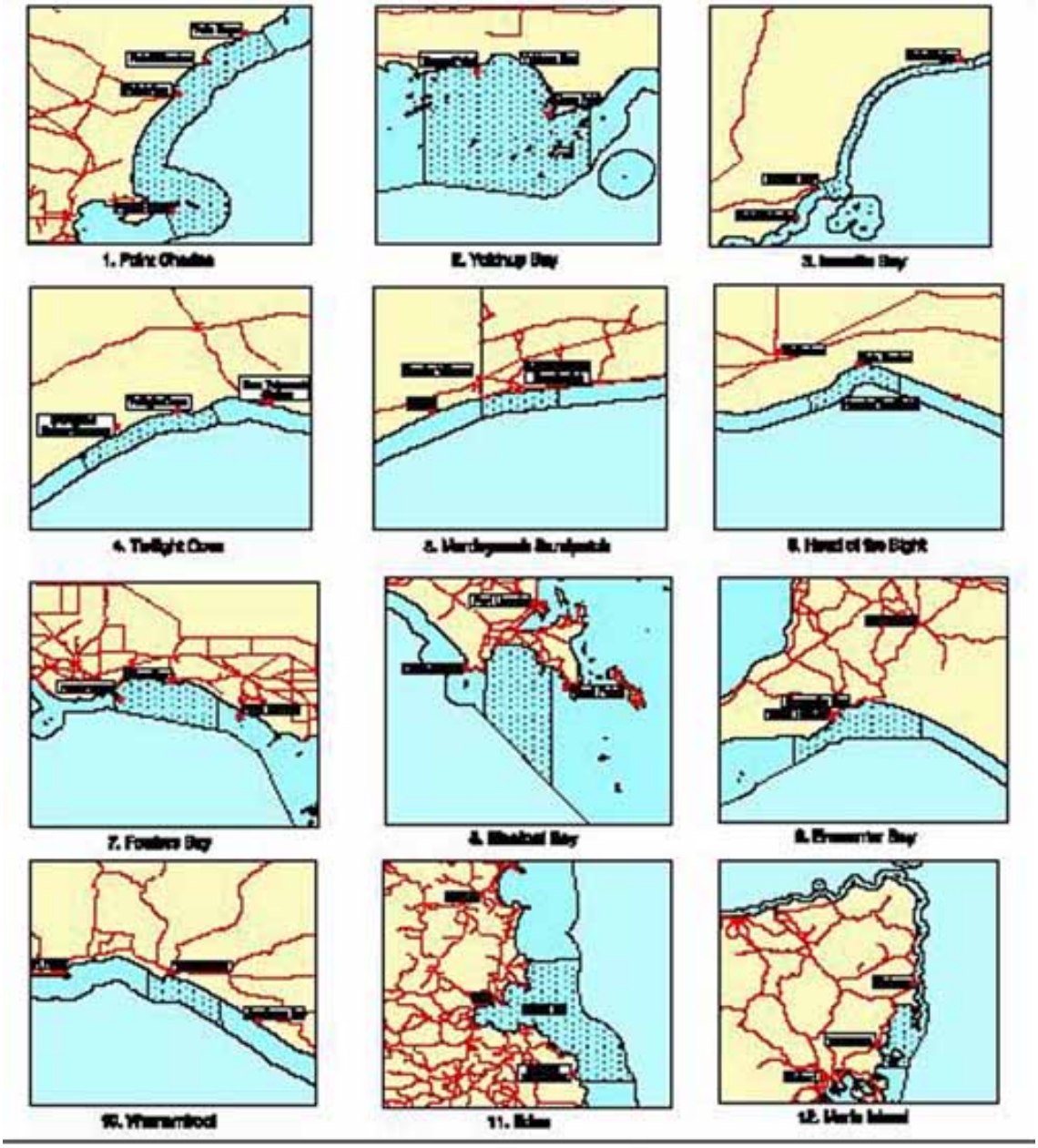
2. Otway, Victoria

3. Eden, New South Wales

Blue Whales - Recognised aggregation areas



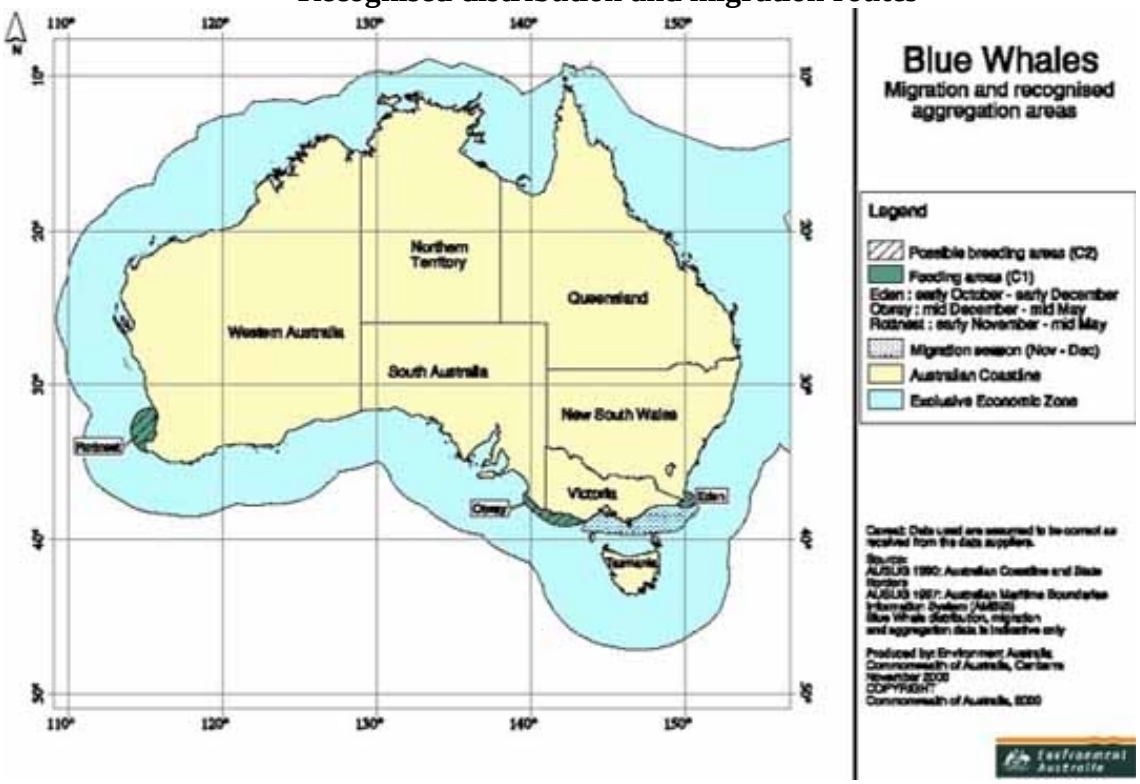
Breeding and resting areas of Humpback Whales (Megaptera novaeangliae)

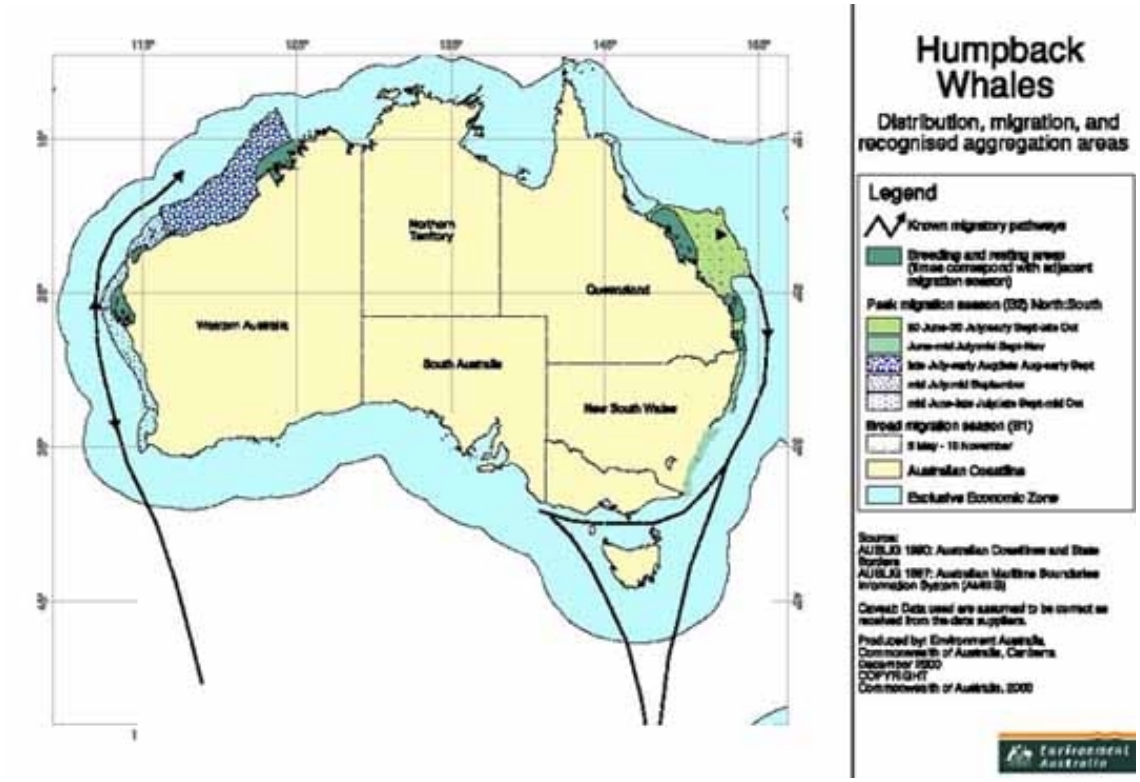


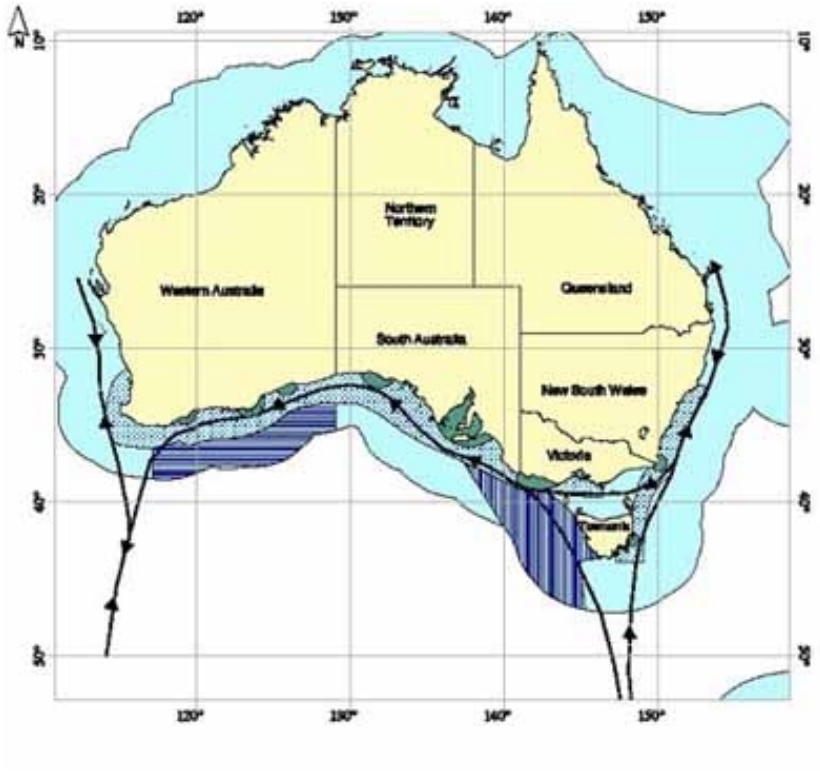
Aggregations of the Southern Right Whale

Aggregation area boundaries are given as an indication only and provide no basis for management.

Recognised distribution and migration routes







Southern Right Whales

Distribution, migration and recognised aggregation areas

Legend

- Breeding areas (C2) mid May - end September
- Known migratory pathways

Migration seasons
- mid May - end September (R2)
- early September - mid October (B2)
- early May - end June (B2)
- Australian Coastline
- Exclusive Economic Zone (200 nm)

Coast Data used are assumed to be correct as received from the data suppliers.

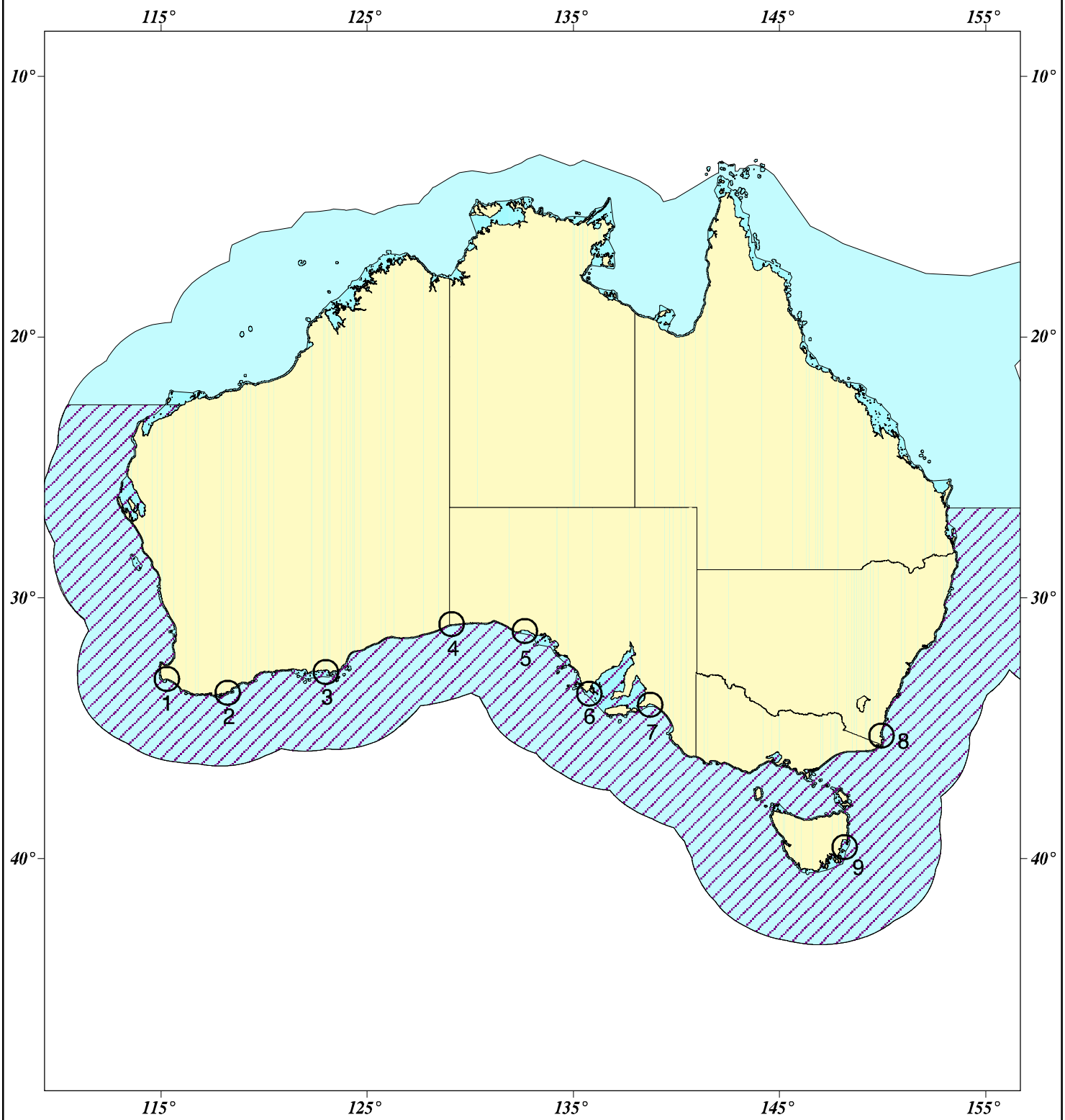
Source:
AUSLIG 1990b Australian Coastline and State Borders

AUSLIG 1997: Australian Maritime Boundaries Information System (AMBIS)

Southern Right Whale distribution, migration and aggregation data is indicative only

Produced by: Environment Australia
Commonwealth of Australia, Canberra
December 2000

Environment Australia



Southern Right Whale - Areas of frequent use

Legend

- Frequent use areas - letters refer to thumbnail maps
- Whale distribution within the EEZ (indicative only)
- Australian Mainland
- State Waters
- Exclusive Economic Zone (EEZ)

Frequent use area data was derived using State waters (3 nautical miles) and land-based geographic features as landmarks. They are indicative only.

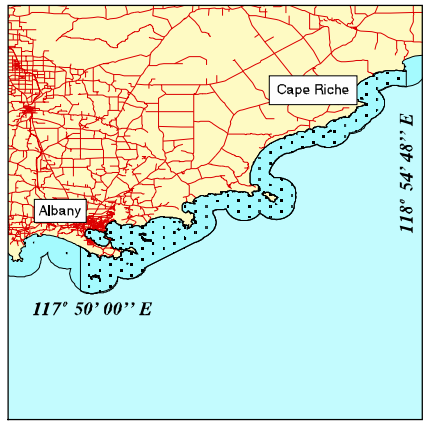
Source:
AUSLIG 2001: Australian Maritime Boundary Information System (AMBIS).
AUSLIG 1990: Australian Coastline and State Borders (100K)

Caveat: Data used are assumed to be correct as received from the data suppliers.

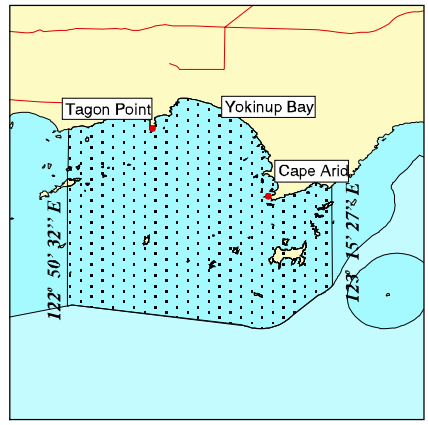
Produced by: Environmental Resources Information Network (ERIN), Environment Australia, Canberra.

Environment Australia

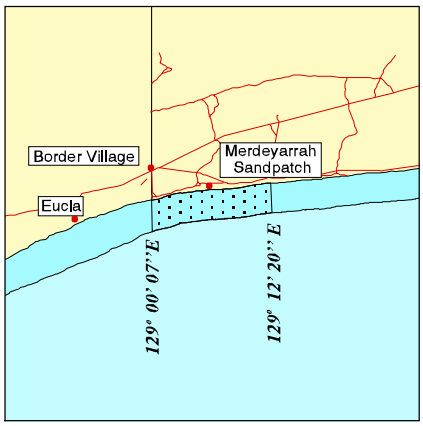
1. Flinders Bay



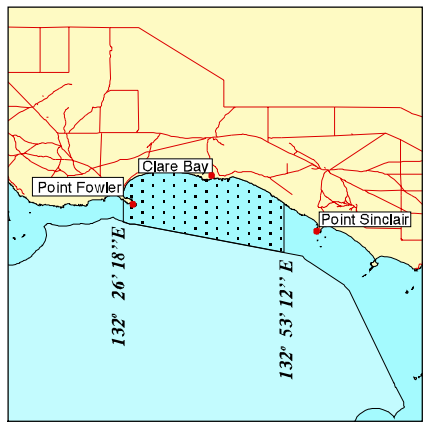
2. Albany/Cape Riche



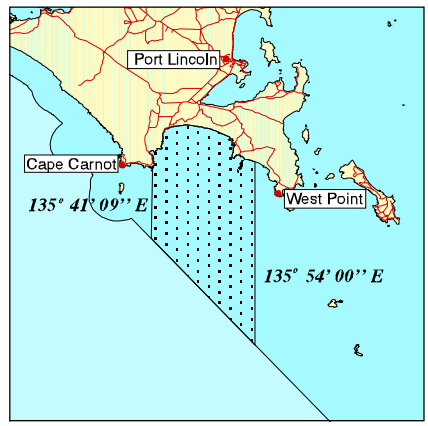
3. Yokinup Bay/Cape Arid



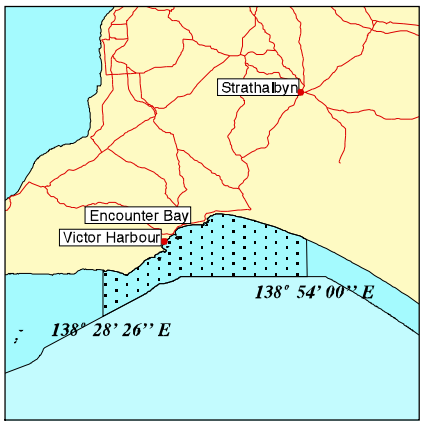
4. Merdeyarrah Sandpatch



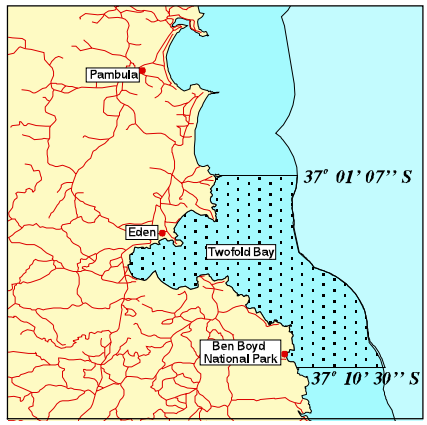
5. Fowlers Bay



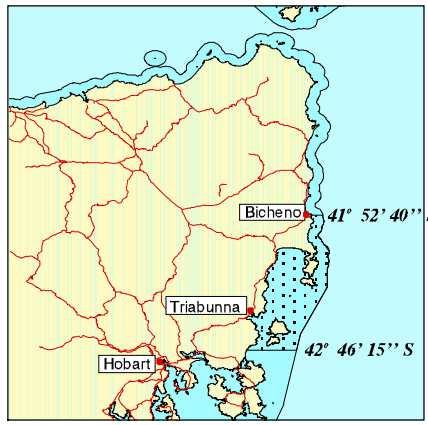
6. Sleaford Bay



7. Encounter Bay



8. Eden



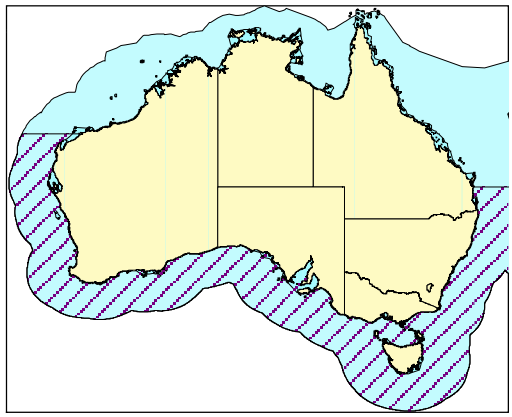
9. Maria Island

Southern Right Whale - Areas of frequent use

Legend

- Areas of frequent use
- Australian Mainland
- Main Roads
- Exclusive Economic Zone
- State Waters

Boundaries of these frequent use areas are given as an indication only and provide no basis for management. Dotted areas extend to the state waters although important habitat may stretch further offshore, or not as far as is shown in some localities.
Coordinate values are for guidance only and should not be used for navigation purposes



Source:
AUSLIG 2001: Australian Maritime Boundary Information System (AMBIS).
AUSLIG 1990: Australian Coastline and State Borders (100K)
AUSLIG 1996: Gazetteer of Australia.

Caveat: Data used are assumed to be correct as received from the data suppliers.

Produced by: Environmental Resources Information Network (ERIN), Environment Australia, Canberra.

June 2002

Environment Australia

Attachment 6

MANAGEMENT GUIDELINES FOR SEISMIC VESSELS OPERATING IN AUSTRALIAN WATERS SO AS TO AVOID OR MINIMISE INTERFERENCE WITH WHALES AND CERTAIN OTHER LARGER CETACEANS.

The following procedures should be followed by all seismic vessels operating in Australian waters during all seismic surveys so as to avoid interference with whales and other larger cetaceans as set out in the attached list.

PRE START-UP VISUAL OBSERVATION PROCEDURES

For all seismic surveys in all waters the following checks should be made:

- During daylight hours, visual checks (using binoculars from a suitable, high observation platform on the survey vessel) for the presence of whales will be undertaken before the commencement of operations.
- During night time operations, Infra-Red (IR) or night-vision binoculars will be used to undertake visual checks before the commencement of operations.
- Observations will begin at least 90 minutes prior to use of any high-energy acoustic sources, with particular focus on a 3 kilometres radius around the survey vessel. (See attached diagram).

⇒ For Information, indicators of whale activity may be in the form of blows and surface activity resulting in large splashes.

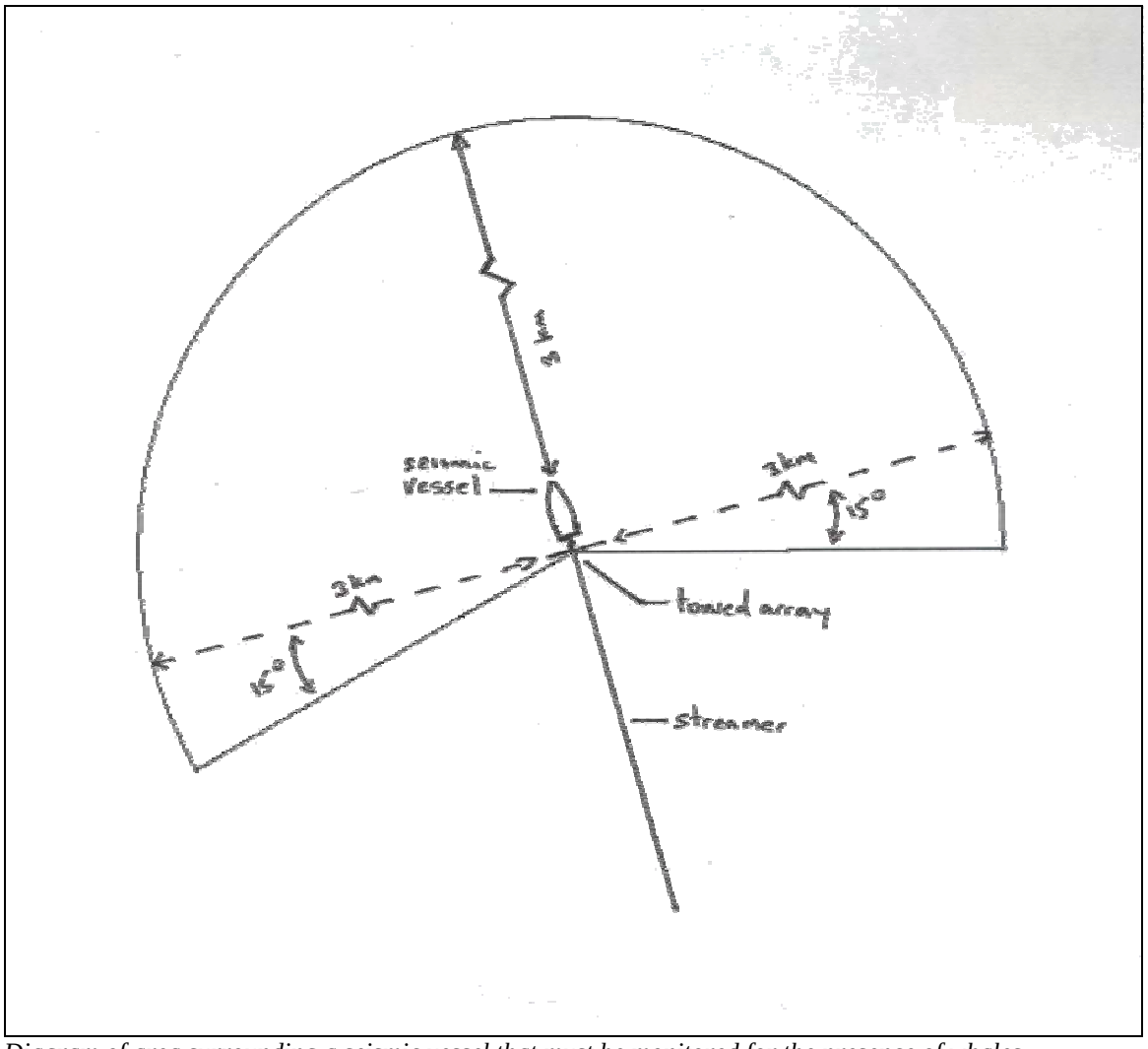


Diagram of area surrounding a seismic vessel that must be monitored for the presence of whales

⇒ For information, a practical and reliable method to accurately determine the range of a marine mammal from a ship's bridge is to measure the angle of the whale below the horizon. By then using standard formula which take into account the earth's curvature and refraction, and using the known height of eye of the observer, a reasonable estimate of the whale range can be calculated. The Norie's Nautical Almanac has standard tables and formula for calculating range from angles below the horizon. There are two methods of measuring angles below the horizon:

- Range finding binoculars which have a graticule of set angle increments fixed in one eyepiece. The number and fraction of graticule units from the whale to horizon gives the angle below the horizon;
- Sextant angles below the horizon. These provide the most accurate measure, and although require some experience at using and reading a sextant, are relatively easy to measure, although care needs to be taken whether reading the angle off or on the arc.

⇒ For information, acoustic monitoring, either ship based using signals taken from the streamer, or externally based from sonar buoys, is becoming an increasingly practical method of monitoring the presence of many whales species. There is merit in the continued exploration of this method of monitoring the presence of cetaceans. Where acoustic monitoring is used on a vessel, the signal should be continuously monitored on the bridge. The use of acoustic monitoring should be used to assist visual monitoring rather than replace it.

START-UP DELAY PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- Discharge of the acoustic sources will not commence unless there are no whales within a minimum distance of 3 km from the survey vessel.
- If whales are detected within this zone the start up of acoustic sources will be delayed until they have been observed to move away outside the 3km radius or, if they are no longer observable, 30 minutes after the last sighting within 3km.

SOFT START PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- A sequential build-up of warning pulses will be carried out at the commencement of all surveys. The whole array will not be fired without a full soft start. Soft starts will be used even if no whales have been seen.
- Visual observation will be maintained continuously during soft starts to establish the presence or absence of whales within 3 km of the vessel.
- If whales are sighted during this soft start procedure within the 3km zone, the seismic source will be shut down. Re-commencement of soft start procedures will take place after 30 minutes has lapsed since the last whale sighting within the 3km zone.
- There may be continued discharge of the acoustic source during line turns or changes. Discharge of only a limited number of air-guns in the acoustic array would be sufficient in this case.
- Alternatively the array may be completely shut down between the lines of a survey. In the event that the array is completely shut down between the lines of a survey, the full start-up delay and soft start procedures will be undertaken prior to the whole array being fired.

⇒ For information, the soft start procedure involves a gradual increase in the number of air-guns fired over a 20 minute period prior to commencement of a line, and serves to send out a series of warning pulses to whales and give them adequate time to leave the vicinity.

VISUAL OBSERVATION PROCEDURES DURING SURVEY LINE

For all seismic surveys in all waters where a permit under Part 13 Division 3 of the *Environment Protection and Biodiversity Conservation Act 1999* (the Act), or approval under Part 3 of the Act, is not required the following procedures should be followed at a minimum:

- Visual observations of 10 minute duration per hour will be carried out during seismic operations.
- During night time operations, Infra-Red (IR) or night-vision binoculars will be used for the hourly observations. Night time visual observations will also be of 10 minute duration per hour.
- Where a whale of a species included in Attachment 1 is seen as part of the observation procedures, continual observations should occur until 2 hours have passed since the last observation of a cetacean of a species included in Attachment 1.
- All cetacean observations, whether within 3km or not, should be documented and reported.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, wherever practicable a trained, independent observer should be used for the task of undertaking visual monitoring both to ensure that the required observations are undertaken and to ensure that the best information is obtained from these opportunties to monitor cetaceans.

⇒ For information, aerial surveys can increase the amount of information available on the presence of cetaceans in an area and assist in monitoring these animals. Where planning and safety considerations permit aerial surveys of the area to be surveyed could be undertaken to supplement shipboard observeration.

For all seismic surveys in circumstances where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps) the following procedures will form the basis for the consideration of conditions. The exact conditions will be assessed on a case-by-case basis to ascertain if the requirements should be varied.

- In or near migratory paths, other than non-peak Humpback migration paths, 30mins per hour observation by a trained and dedicated cetacean observer will normally be required.
- In feeding, breeding or resting areas, continuous observation by a trained and dedicated cetacean observer will normally be required.
- In addition, an independent observer may be required to ensure that the best information is obtained from these opportunities to monitor cetaceans.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, the nominated observer is additional to standard bridge crew members and will have some experience with whale observationsNote: Whale observations become increasingly difficult as sea state increase. An upper limit for practical whale observation is sea state 5. This coincides with the operational weather limits for most seismic vessels.

⇒ For information, aerial or stand-off vessel observation is likely to be required as part of any permit or approval.

STOP WORK PROCEDURES

For all seismic surveys in all waters the following procedures should be followed:

- Where a seismic vessel with an operating acoustic source approaches within 3km of an individual whale or pod of whales, the acoustic source will be shut down.
- Where an individual whale or pod of whales approaches within 3 km of a seismic vessel, the acoustic source will be shut down unless the animal or animals are seen to be skirting the edge of the 3km limit.
- Seismic source operations will not recommence until the animal or pod has been seen to move outside of a 3 km range, or has not been seen for 20 minutes.

⇒ For information, the area to be monitored for the presence of whales is the same as that applying for pre-start surveys.

⇒ For information, it is important to monitor the behaviour of any whales that may be approaching the stop-work distance. Ascertain what the whale is doing and the direction it is travelling. If it is seen to be heading away from the seismic vessel and is outside the 3km zone, a shut down may not be necessary.

⇒ For information, particular care should be exercised in the monitoring for cetaceans under conditions of reduced visibility.

AERIAL SURVEY AND STAND-OFF VESSEL PROCEDURES

For all seismic surveys in waters where a permit or approval is required (feeding, breeding and resting areas and migratory routes, as identified in the accompanying maps), additional surveys are likely to be required as permit conditions or as part of the approval, if granted. These surveys will in most cases be aerial surveys except where vessel based surveys are required to collect special information or where aerial surveys are impractical. Two types of surveys are envisaged and the requirement for either or both will be assessed on a case-by-case basis.

1. Surveys to identify where cetaceans are in relation to seismic activity and to identify when seismic vessels should be especially vigilant. These surveys would be run between the areas to be surveyed by the seismic vessel and the likely approach direction of cetaceans, or in the area in advance of the survey vessel.
2. Scientific surveys to identify which areas are important to cetaceans eg to identify feeding, breeding and resting areas and times of peak migration. In particular these surveys may be required in areas of potential increased sensitivity (areas C or D on the attached maps) where insufficient information currently exists to determine timing and appropriate management arrangements.

RECORDING AND REPORTING PROCEDURES

- Any whale sightings will be recorded on the *Environment Australia Whale and Dolphin Sighting Report* form (attached). This form is also available in electronic format and can be found at www.ea.gov.au/coasts/species.
- At completion of the seismic survey, copies of all report forms will be submitted to:

  Environment Australia
  Marine Species Section
  GPO Box 787
  Canberra ACT 2601

EPBC Act - basic referral, assessment and approval steps