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INTEGRATED APPROACH TO ECOLOGICAL AND SOCIO-ECONOMIC RESEARCH TO SUPPORT THE OIL AND GAS INDUSTRY: THE GREAT AUSTRALIAN BIGHT COLLABORATIVE RESEARCH SCIENCE PROGRAM

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ABSTRACT 300506:

BP is investing $A1.43B and drilling four exploratory wells in the hope of discovering a new deep-water oil and gas province in the Great Australia Bight (GAB). The GAB is one of Australia's most valuable marine ecosystems. It supports globally significant populations of seabirds and marine mammals, diverse and endemic benthic assemblages and important fishing, aquaculture and ecotourism industries.

Two research agencies (CSIRO, South Australian Research and Development Institute) and two universities (University of Adelaide, Flinders University of South Australia) recently entered into a collaborative research partnership with BP Australia to undertake an integrated study of the ecological processes and socio-economic importance of the GAB. Uniquely, this four year $20M research program is being undertaken during the exploration phase and conducted as a single integrated program.

The Research Program is comprised of seven themes: physical oceanography; pelagic ecosystem and environmental drivers; benthic biodiversity; ecology of iconic and apex predators; petroleum geology and geochemistry; socio-economic values; and data integration and ecosystem modelling. Sixteen inter-related projects are being undertaken by some of Australia's leading marine scientists and will involve at least seven post-graduate Ph.D. students. Scientific quality assurance is provided by a review process that involves an Independent Science Panel and BP's international Subject Matter Experts. Ecological data collected during the study will be publically available. Findings will be presented to stakeholders and regulators and published in technical reports and scientific papers throughout the course of the program.

The program is one of the few whole of system studies ever undertaken in Australia and is the first large-scale, integrated study of the ecosystems, resources and socio-economic values of the GAB. The approach has several advantages over undertaking discrete projects on key issues near the start of the production phase.

1) BP Australia's financial contribution has leveraged significant investment from the other partners.
2) Establishing baseline environmental conditions during the exploration phase provides the opportunity to conduct temporally replicated analyses of the ecosystem prior to commencement of production, should it occur.
3) Engaging with the local scientific community builds on the existing knowledge base and working relationships with stakeholders and will assist the development of relevant local scientific capability.
4) An integrated program provides for efficient development and validation of whole of system (i.e. ecological and socio-economic) models that elucidate interconnections among components of the system and can inform decisions regarding future development and predict, monitor and assess potential future impacts.

INTRODUCTION:

The Great Australian Bight (GAB) is one of the most prospective unexplored oil and gas provinces in the world (http://www.bp.com/en/global/corporate/press/features/the-great-australian-bight--exploring-a-deep-water-frontier.html). In January 2011, BP was awarded four exploration permits in the Ceduna sub-basin (Figure 1). As a condition of the award, BP committed to a work program comprising the acquisition of approximately 12,500 km^2 of 3D seismic and the drilling of four exploration wells. In 2012, Statoil signed an agreement with BP to obtain a 30% equity share in the four leases. In 2013, additional exploration permits for the GAB were also awarded to Chevron and Murphy Oil Australia/Santos Joint Venture.

The GAB, which extends from Cape Pasley, Western Australia to Cape Catastrophe, Kangaroo Island, South Australia is part of the world's longest southern facing coastline (Figure 1, McLeay *et al.* 2003; McClatchie *et al.* 2006; Rogers *et al.* 2013). It has complex oceanographic features, being influenced by the surface Leeuwin Current from the west and sub-surface Flinders Current from the east. It is characterised by a large coastal upwelling system, the influx of hyper-saline waters from South Australia's two gulfs and a very large swell regime (Middleton and Bye 2007; Petrusevics *et al.* 2009; van Ruth *et al.* 2010).

The GAB supports Australia's largest and most valuable stocks of pelagic fishes, especially southern bluefin tuna and Australian sardine, and regionally important coastal fisheries for crustaceans (e.g. prawns, rock lobster), molluscs (e.g. abalone) and teleosts (e.g. snapper, flathead) (Ward *et al.* 2003, 2006a; Patterson *et al.* 2008). The region has global conservation significance, providing critical habitats and migration pathways for iconic species and apex predators, including Australian sea lions, white sharks, and pygmy blue whales (Gill *et al.* 2011; Bruce and Bradford 2012; Goldsworthy *et al.* 2013). The GAB's unusually broad continental shelf also supports the world's largest temperate carbonate production system and has high levels of benthic biodiversity and endemism (Ward *et al.* 2006b; Currie *et al.* 2009; Williams *et al.* 2001).

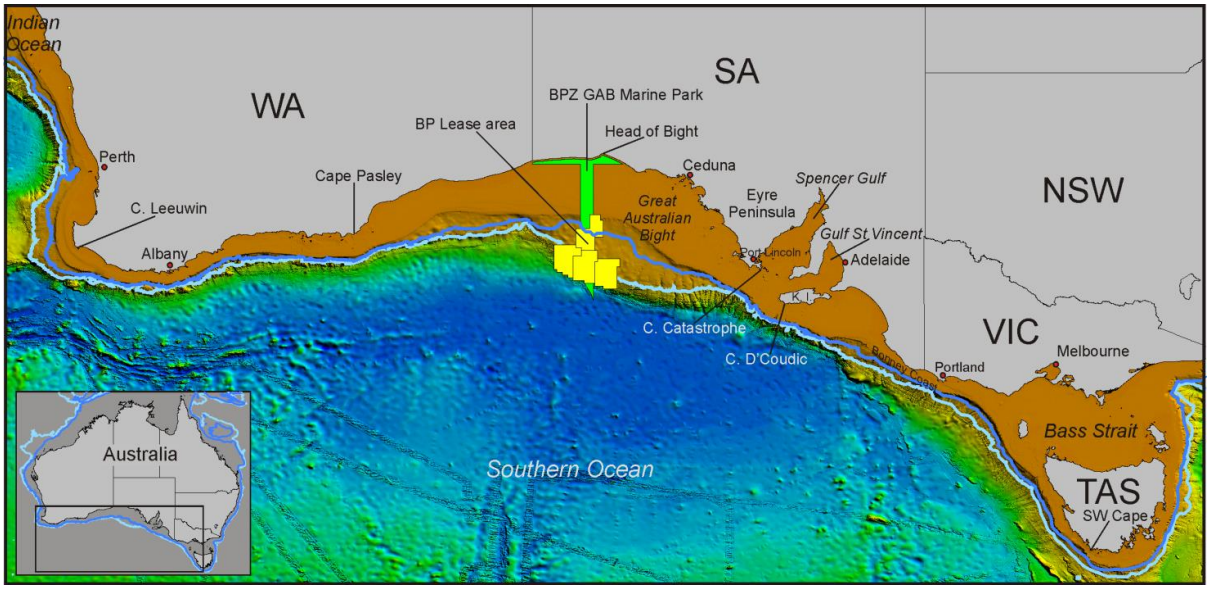

Figure 1 The Great Australian Bight (GAB) showing the coastline of southern Australia (grey). The Great Australian Bight Marine Reserve and the Benthic Protection Zone is shown in lime green and the area permitted for oil and gas exploration by BP is shown in yellow. The orange layer shows the continental shelf (depths ≤200 m), light orange shows the shelf break and continental shelf slope (depths 200-1000 m), green graduating to dark blue shows oceanic waters (depths 1000-5000 m). The blue line represents the 1000 m isobath and the sky blue line represents the 2000 m isobath. (The Australian bathymetry and topography grid 250 m, Geoscience Australia)

Previous marine research in the GAB has been concentrated mainly in coastal waters and more recently on the continental shelf (Rogers *et al*. 2013). The deep water assemblages and ecosystems of the GAB are poorly understood.

Commonwealth and State governments, existing commercial users (such as the fishing, aquaculture and eco-tourism industries) and a diverse range of academic, community and environmental groups have identified the need to develop a better understanding of the region's environmental values, regulatory needs and development potential of the GAB. A complex array of ecological, economic and social issues needs to be addressed to optimize management of future activities in the GAB. These include the potential implications for species with global conservation significance, such as Australian sea lions, and pygmy blue whales, possible effects on the behaviour and catchability of fisheries species, including southern bluefin tuna, and overlap of the leases with the Great Australian Bight Marine Reserve.

This paper describes a large, integrated study of the ecological processes and socio-economic importance of the GAB that is being conducted through a collaborative research partnership involving two research agencies (CSIRO, South Australian Research and Development Institute), two universities (University of Adelaide, Flinders University of South Australia) and BP Australia. The paper outlines the process that was undertaken to

establish this research partnership and identifies the lessons learned along the way and the challenges likely to determine the success of the program.

PROCESS LEADING TO ESTABLISHMENT OF THE PARTNERSHIP:

Preliminary discussions

During 2011, BP initiated discussions with scientists from several research institutes and universities, particularly CSIRO (http://www.cmar.csiro.au/), the South Australian Research and Development Institute (SARDI, http://www.sardi.sa.gov.au/), the University of Adelaide (http://www.adelaide.edu.au/) and Flinders University of South Australia (http://www.flinders.edu.au/) regarding potential research projects in the GAB.

Following a symposium on the GAB hosted by the Australian Marine Sciences Association (South Australia) in October 2011 (http://www.amsa.asn.au/state/sa/symposia2011.php), South Australian researchers agreed to engage with BP collectively under the banner of Marine Innovation Southern Australia (http://www.misa.net.au/). CSIRO and MISA agreed to collaborate in developing and conducting future research to underpin sustainable development of the GAB.

It was recognised that BP would need to undertake specific studies to manage operational and reputational risks and if successful in finding commercial quantities of hydrocarbons to secure regulatory approvals. It was also recognised that these studies could be delivered through an integrated research program that could provide:

- co-ordinated access to knowledge and data held by the region's key research agencies and academic institutions;
- a clear pathway to identify and address key knowledge gaps for deep-water environments of the GAB;
- opportunities for BP to leverage funding through the formation of a strategic research alliance;
- publication of non-proprietary research in peer reviewed scientific journals;
- a sound basis for informing community debate;
- information to support fact-based advocacy.

Working Group

Following a high-level meeting between BP, CSIRO and MISA, a Working Group was convened in January 2012 to support the timely delivery of a Science Plan linked to BP's exploration of the GAB and aligned with BP's operational needs, emerging regulatory priorities and expectations of stakeholders and the broader community. The Working Group was chaired by BP Australia and comprised of representatives from CSIRO and MISA.

The role of the Working Group was to:

- Secure and integrate advice from the relevant local scientists and BP's subject matter experts on research that was:
  - Likely to be necessary to secure future regulatory approvals;
  - Likely to be required to manage operational and reputational risk; and
  - Complementary in that they would allow BP to meet its group research objectives, or the academic community to meet their objectives in a more efficient manner by leveraging BP's presence in the GAB.

- Identify what would be proprietary research and how work streams could be appropriately contracted and managed;
- Develop outlines for a research program, including indicative costs and timeframes;
- Provide advice on the best capability and potential partnerships between BP and research organisations to conduct the studies; and
- Make recommendations to BP on an appropriate governance structure and process to manage these studies and integrate the communication of their outcomes.

The Working Group provided recommendations on the organisational structure and governance processes required to implement and manage the Science Plan.
The Science Plan was finalised by the Working Group in April 2012 following a series of workshops with key researchers, the production of draft proposals by members of the science team and revision following review comments from BP's subject matter experts and technical personnel. The Science Plan provided a preliminary description of the Research Program that would be established under the proposed collaboration.

It was agreed that one of the fundamental objectives of the research was to provide information to support BP's "Privilege to Operate" over the life of the GAB Program in the following areas and support:

- Regulatory risk management; and
- Reputation risk management.

Recommendations of the Science Plan

Research Themes

The Science Plan developed by the Working Group identified seven research themes.

- Physical Oceanography
- Pelagic Ecosystem and Environmental Drivers
- Benthic Biodiversity
- Ecology of Iconic Species and Apex Predators
- Petroleum Geology and Geochemistry
- Socio-economic Analysis
- Data Integration and Ecosystem Modelling

The Working Group noted that the benefits derived from conducting research required by BP in an integrated multi-disciplinary program were the cost-efficiencies and value-adding benefits that accrue from synergies among themes. This approach would also provide logistical benefits, such as integrating cruises to collect data relevant to several themes (e.g. seep distribution, characterisation of benthic biodiversity).

Delivery of research services

The Science Plan identified the following options for delivery of research services:

- Alliance;
- Alliance with co-investment;
- Tender; and
- Sole provider.

The following drivers were identified as inputs to the decision making process on the recommended option for delivery of research services:

- Maximise Australian research content;
- Maximise South Australian research content;
- Best proven research capability in the region;
- Maximise operational synergies (i.e. limit competition for scarce resources);
- Maximise enhancement to relationships and reputation (privilege to operate); and
- Minimise complexity for BP to manage.

The CSIRO-MISA Alliance involves the agencies and scientists that hold the majority of data currently available on the ecosystems of the GAB. They also collectively hold the majority of expert scientific knowledge about the system and have strong working relationships with other stakeholders (e.g., fishing and aquaculture industries) and the relevant regulatory departments of the Commonwealth and State Governments. Members of this team have expertise across a wide range of disciplines and have conducted scientific studies across the spectrum of applied and theoretical ecology, and have considerable experience collaborating in large multidisciplinary studies.

The Working Group recommended to BP that an "alliance with co-investment" was the best research services delivery option. The Working Group recommended that the CSIRO-MISA Alliance be recognised as BP's preferred 'research services supplier' in the GAB because this group has the best regional capability for the majority of the identified research themes. The Working Group recommended that where research expertise outside the Alliance is required, appropriate parties will be brought in as a subcontractor to one of the Alliance partners.

Management Model

The Working Group recommended that the Science Plan should be implemented as a formal collaboration between BP, CSIRO and MISA. The Working Group also recommended that the collaboration be oversighted by a Management Committee comprising representatives of BP, CSIRO and MISA and managed on a day to day basis by a Research Director that reported to the Management Committee. The need for provisions to allow external researchers to be included in the Research Program where needed was also recognised in the Science Plan.

The Working Group recommended that the Management Committee should be advised by an Independent Science Panel (ISP) comprising internationally recognised scientists that would act as a "sub-committee" of the Management Committee. The role of the ISP would be to provide advice on the excellence, relevance and cost effectiveness of projects and review outcomes and publications where appropriate. The ISP would include expertise in marine ecology, benthic ecology, biological oceanography, hydrodynamic modelling, marine mammals, petroleum and economics. The Management Committee could also engage key external international expertise when required.

The Science Plan identified that budget contribution from the partners would be set at A$20 M ($14M BP; $6M CSIRO/MISA). In addition to these funds, it was recognised that in-kind contributions from the Australian Government will be sought through applications to use the National Research Facility (research vessel) to conduct field surveys. Additional

leverage for partner funds will also be sought through applications for competitive research grants (e.g. Australian Research Council Industry Linkage Grants).

RESEARCH PROGRAM:

Governance Structure

The Working Group had recommended that operating entity for the Research Program should be unincorporated joint venture between BP, CSIRO and MISA. However, the legal instrument actually adopted to establish the Great Australian Bight Collaborative Research Science Program in April 2013 was a Collaboration Research Agreement (CRA). The governance structure for the Research Program specified in the CRA followed the recommendations of the Working Group (Figure 2). The Management Committee and ISP were established in April 2013. The Research Director was appointed in July 2013.

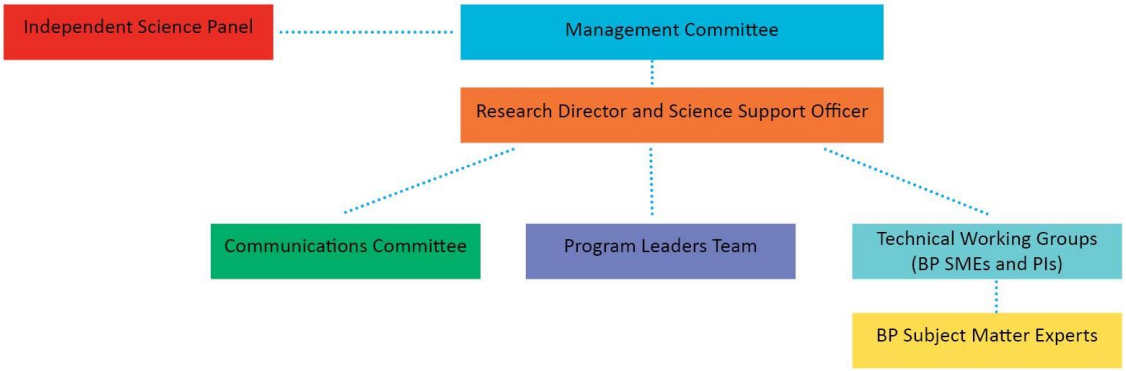

Figure 2. Governance structure for the Great Australian Bight Collaborative Research Science Program

Literature Review

Following a recommendation of the Working Group, a comprehensive Literature Review was undertaken to synthesize existing knowledge in the first four research themes and to identify key knowledge gaps that could be addressed in projects within these themes (Rogers *et al.* 2013). The key knowledge gaps highlighted by the review are summarised below.

Relatively little physical, chemical and biological data have been collected from the deep water ecosystems of the central GAB where exploratory drilling will occur; more data are available for shallow waters of the eastern GAB. Capacity to forecast future weather and sea conditions in the high wave energy region of the GAB across the scales required is limited. Spatial and temporal variability in physical oceanographic processes (e.g. upwelling, downwelling) in the central GAB are also poorly understood. Virtually no data are available on patterns of nutrient enrichment or microbial, planktonic and micro-nektonic community structure, dynamics, biodiversity and endemism in the BP permit area. Some information is available on the distribution, abundance, foraging patterns and migratory patterns of a few

iconic species, however there are considerable gaps in our understanding of the dynamics of these species.

The GAB is a major aggregating area for several species of whales (e.g. southern right whales, pigmy blue whales), as well as dolphins in coastal waters. The factors that influence these aggregations are unclear. The GAB is located in a major migratory pathway for southern bluefin tuna and supports Australia's largest commercial fishery, the South Australian Sardine Fishery. Overall there is limited information from which to predict the likely impacts of oil and gas development on these taxa.

Similarly, some surveys of benthic biodiversity in and around the GAB Marine Protected Area have been conducted on the continental shelf in the eastern GAB, but virtually no data are available for the deep water communities that will be drilled or the shelf communities in the nearby western GAB. The one research cruise that surveyed the region for seeps that may be associated with hydrocarbon deposits met with limited success. No information is available on the capacity of the local bacterial assemblage to degrade hydrocarbons.

Research Prospectus

Findings of the Literature Review were used to refine the focus of each research theme and develop detailed proposals for specific projects. These proposals were reviewed by BPs subject matter experts and the Independent Science Panel and approved by the Management Committee. Project Agreements were finalised in early 2014. The seven research themes and 16 projects that comprise the GAB Research program are described below.

Theme 1: Oceanography

This is a foundational theme that underpins activities in other themes. It will analyse ocean observations and ocean models to produce the best representation of the circulation and connectivity within the GAB, taking into account the uncertainties of the observing and modelling systems. It will provide information on ocean flows that connect the deep, off-shelf regions to the shelf and coastal regions; physical drivers (upwelling, downwelling, mixed-layer thickness, etc) of the dynamics of various trophic levels (from bacteria to top-level predators and iconic species); and determination of bottom stresses on the benthos and effects on transport of matter and benthic diversity.

Project 1.1 Physical oceanography of the GAB: the science that underpins

Project 1.2 Surface waves and their effects on circulation

Theme 2: Pelagic Ecosystem and Environmental Drivers

This theme will provide baseline information on the community structure, dynamics, biodiversity and endemism of microbes, plankton and micronekton. It will assess variation in primary and secondary productivity and food web structure in relation to physical drivers, including currents, turbidity, irradiance, stratification, nutrient concentrations and turbulence. Together with identification of key trophic pathways, this information will inform

assessments of distributions of key species and apex predators in the GAB. The theme will also develop tools and protocols for monitoring ecological indicators of the pelagic system.

Project 2.1 Spatial and temporal variability in the shelf plankton communities of the GAB

Project 2.2 Seasonal and spatial variability of offshore/slope plankton and micronekton communities

Theme 3: Benthic Biodiversity

This theme will quantify spatial patterns in the physical environment, and composition and abundance of benthic fauna in BP leases and adjacent continental slope areas of the GAB to provide baseline metrics relevant to monitoring the potential future impacts of oil and gas development on benthic communities both within and outside the GAB Marine Reserve. It will also use new molecular methods to improve the scope, quantification and cost-effectiveness of benthic monitoring.

Project 3.1 GAB benthic biodiversity

Project 3.2 Molecular assessment of biodiversity in the GAB

Theme 4: Ecology of Iconic Species and Apex Predators

This theme will provide baseline information on the distribution and abundance of key iconic species (whales, seals and dolphins) and apex predators (tuna and sharks). The distribution, movement and behaviour will be studied and movement and habitat models for these species developed. The potential for noise from oil and gas exploration activities to impact wild bluefin tuna will be assessed.

Project 4.1 Status, distribution and abundance of iconic species and apex predators in the GAB

Project 4.2 Identifying Areas of Ecological Significance for iconic species and apex predators in the GAB

Project 4.3 Southern bluefin tuna: spatial dynamics and potential impacts of noise associated with oil and gas exploration

Theme 5: Petroleum Geology and Geochemistry

The objectives of this theme are to identify and characterise natural seepage in, and around the vicinity of, the BP permits in the GAB and to identify the distribution and provenance of asphalites and undertake tar ball surveys to further delineate other possible hydrocarbon leakage points in the area.

Project 5.1 Delineation and characterisation of cold hydrocarbon seeps and their associated benthic communities

Project 5.2 Asphaltite and tar ball surveys Project 5.3 Fluid inclusion study

Theme 6: Socio-economic Analysis

This theme will develop a socio-economic profile of communities that may be affected by the activity in order to establish a baseline against which future changes may be assessed. It will identify key individuals for consultation purposes, community concerns and perceptions of key issues involving the development. It will examine the economic

dependence of individual regional communities on activities related to the GAB and provide baseline data for the economic dependencies.

Project 6.1 Socio economic profile of the Eyre and Western region: literature review and community analysis
Project 6.2 Economic profile of Eyre and Western region
Project 6.3 GAB fisheries benchmark study and potential impacts of the development

Theme 7: Integration and Modelling

This theme will develop a socio-economic profile of communities that may be affected by the activity in order to establish a baseline against which future changes may be assessed. It will identify key individuals for consultation purposes, community concerns and perceptions of key issues involving the development. It will examine the economic dependence of individual regional communities on activities related to the GAB and provide baseline data for the economic dependencies.

Project 7.1 Knowledge integration and application; modelling the marine ecosystems of the Great Australian Bight

CONCLUSIONS AND LESSONS LEARNED:

The GAB Research Program is one of the few whole of system studies ever undertaken in Australia and is the first large-scale, integrated study of the ecosystems, resources and socio-economic values of the region. The approach has several advantages over the more typical approach of undertaking discrete projects on key issues near the start of the production phase. Some of these advantages are listed below.

1) BP Australia's financial contribution has leveraged significant investment from the other partners.
2) Establishing baseline environmental conditions during the exploration phase provides the opportunity to conduct temporally replicated analyses of the ecosystem prior to commencement of production, should it occur.
3) Engaging with the local scientific community builds on the existing knowledge base and working relationships with other stakeholders and will assist the development of relevant local scientific capability. Collaborating with recognised research institutions also aids in gaining research and development tax concessions for eligible investment.
4) An integrated program provides for efficient development and validation of whole of system (i.e. ecological and socio-economic) models that elucidate interconnections among components of the system and can inform decisions regarding future development and predict, monitor and assess potential future impacts.

Establishing the GAB Research Program was a challenging and time-consuming process. Perhaps the most important lesson that we learnt along the way was that it was critically important recognize and address the different priorities and processes of large multi-national petroleum companies, applied research agencies and universities. One of the main reasons that we succeeded in establishing this unique collaboration was that the representatives of the partners took the time to understand the key drivers and critical needs of the other parties.

Crucially, as the collaboration evolved, the key negotiators established strong and effective working relationships that were unpinned by high levels of mutual trust. There is no doubt that achieving this program's ambitious goals will pose even greater challenges. The success of this collaboration in delivering the potential benefits listed above will, no doubt, ultimately be determined by the capacity of the partners to recognize and accommodate the different cultures and capacities of the other parties.

REFERENCES:

Currie DR, Sorokin SJ and Ward TM (2009). Infaunal macroinvertebrate assemblages of the eastern Great Australian Bight: effectiveness of a marine protected area in representing the region's benthic biodiversity. *Marine and Freshwater Research* 60: 459-474.

Gill PC, Morrice MG, Page B, Pirzl R, Levings AH and Coyne M. (2011). Blue whale habitat selection and within-season distribution in a regional upwelling system off southern Australia. *Marine Ecology Progress Series* 421: 243–263.

Goldsworthy SD, Page B, Rogers PJ, Bulman C, Wiebkin A, McLeay LJ, Einoder L, Alastair M.M. Baylis AMM, Braley M, Caines R, Daly K, Huveneers C, Peters K, Lowther AD, and Ward TM. (2013). Trophodynamics of the eastern Great Australian Bight ecosystem: ecological change associated with the growth of Australia's largest fishery. *Ecological Modelling* 255, 38– 57.

McClatchie S, Middleton J, Pattiaratchi C. and Kendrick G. (2006). The South-west Marine Region: Ecosystems and Key Species Groups. The National Oceans Office (DEH, Commonwealth Government of Australia).

McLeay LJ, Sorokin SJ, Rogers PJ. and Ward TM. (2003). Benthic Protection Zone of the Great Australian Bight Marine Park. 1. Literature Review. Final report to National Parks and Wildlife South Australia and the Department for Environment and Heritage. 92 p.

Middleton JF. and Bye JAT. (2007). A review of the shelf slope circulation along Australia's southern shelves: Cape Leeuwin to Portland. *Progress in Oceanography* 75: 1–41.

Patterson TA, Evans K, Carter TI. and Gunn JS. (2008). Movement and behaviour of large southern bluefin tuna (*Thunnus maccoyii*) in the Australian region determined using pop-up satellite archival tags. *Fisheries Oceanography* 17: 352-367.

Rogers P.J., Ward T.M., van Ruth P. D., Williams A, Bruce B. D., Connell, S. D., Currie D. R., Davies C. R., Evans K, Gillanders B. M., Goldsworthy S. D., Griffin D. A., Hardman-Mountford N.J., Ivey A. R., Kloser R.J., Middleton J. K., Richardson A. E., Ross A, Tanner J. E., and Young J. (2013). Physical processes, biodiversity and ecology of the Great Australian Bight region: a literature review. CSIRO, Australia.

van Ruth PD, Ganf GG. and Ward TM. (2010a) Hot-spots of primary productivity: An alternative interpretation to conventional upwelling models. *Estuarine, Coastal and Shelf Science* 90: 142–158.

Ward TM, McLeay LJ. and Rogers PJ. (2003). Benthic Protection Zone of the Great Australian Bight Marine Park. 2. Monitoring Sustainable Use. Report to National Parks and Wildlife South Australia and Commonwealth Department of Environment and Heritage. 82 p.

Ward TM, McLeay LJ, Dimmlich WF, Rogers PJ, McClatchie SAM, Matthews R, Kaempf J, and van Ruth PD. (2006a). "Pelagic ecology of a northern boundary current system:

effects of upwelling on the production and distribution of sardine (*Sardinops sagax*), anchovy (*Engraulis australis*) and southern bluefin tuna (*Thunnus maccoyii*) in the Great Australian Bight, *Fisheries Oceanography* 15 (3): 191–207.

Ward TM, Sorokin SJ, Currie DR, Rogers PJ and McLeay LJ (2006b). Epifaunal assemblages of the eastern Great Australian Bight: effectiveness of a benthic protection zone in representing regional biodiversity. *Continental Shelf Research*. 26: 25-40.

Williams A, Koslow AJ and Last PR (2001). Diversity, density and community structure of the demersal fish fauna of the continental slope off Western Australia (20 to 35° S). *Marine Ecology Progress Series*. 212: 247-263.