

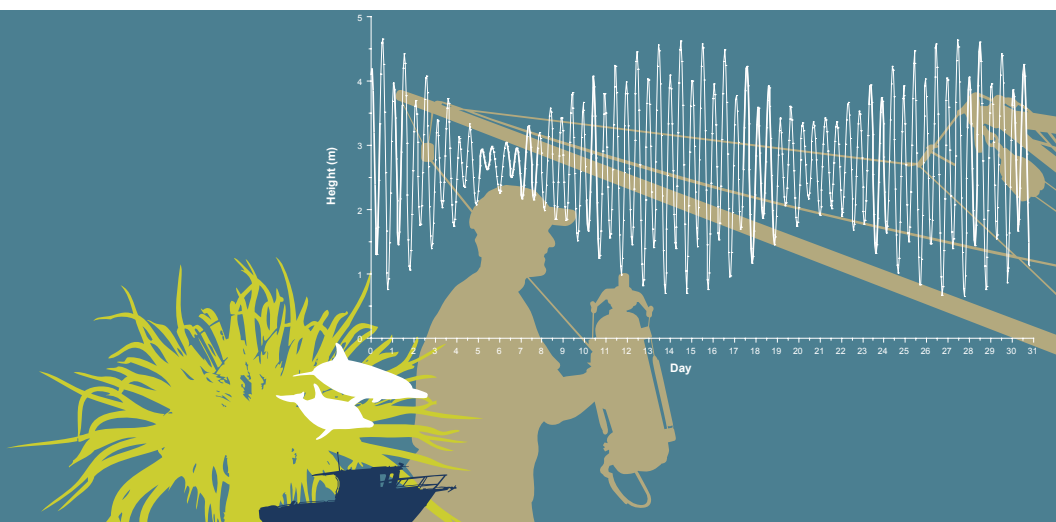


Office of the
Environmental Protection Authority

MTR 4

Petroleum hydrocarbon content of shoreline sediment and intertidal biota at selected sites in the Kimberley bioregion, Western Australia

Marine Technical Report Series



May 2012

Petroleum hydrocarbon content of shoreline sediment and intertidal biota at selected sites in the Kimberley bioregion, Western Australia

C.B. Sim, R.J. Masini, T. Daly, W. Tacey, H.A. Kemps and K.W. M^cAlpine

Office of the Environmental Protection Authority
Perth, Western Australia
Marine Technical Report Series MTR 4
May 2012

Acknowledgments

This survey would not have been possible without the support of the Paspaley Pearling Company (PPCo) which provided the *M.V. Odin II*, its master and crew, tender vessels and all fuel and provisions for the survey. The authors specifically acknowledge Mr Tony Thiel (CEO), Dr Dave Mills (Manager Research and Development), Mr Dave Parker (Manager-Fleet Operations) and Mr Brett Smith (Master) and crew of the *M.V. Odin II* for their assistance and contribution to the field program.

The specialist hydrocarbon chemistry advice provided by Dr Steve Fisher (WA Department of Water, DoW) is greatly appreciated.

Recommended reference

C.B. Sim, R.J. Masini, T. Daly, W. Tacey, H.A. Kemps and K.W. McAlpine (2012). *Petroleum hydrocarbon content of shoreline sediment and intertidal biota at selected sites in the Kimberley bioregion, Western Australia*. Marine Technical Report Series No. MTR4. Office of the Environmental Protection Authority, Perth, Western Australia, May 2012.

For more information contact:

Marine Ecosystems Branch.

Strategic Policy and Planning Division.

Office of the Environmental Protection Authority.

The Atrium, Level 8, 168 St Georges Terrace, Perth, Western Australia.

Locked Bag 33, Cloisters Square, Perth WA 6850.

Telephone (08) 6467 5600

ISSN 1833-5497 (print) 1833-5500 (pdf)

May 2012

Abstract

Following a blowout at the Montara wellhead platform on 21 August 2009, petroleum hydrocarbons flowed effectively unabated into the Timor Sea, approximately 175 kilometres (km) from Western Australian coastal waters, until the leak was contained on 3 November 2009. This report presents findings of a petroleum hydrocarbons survey conducted in July 2010 as part of the response to the Montara incident.

The aim of this survey was to determine the petroleum hydrocarbon content of shoreline sediments and filter feeding organisms some eight months after the flow of hydrocarbons from the Montara wellhead platform was stopped in order to assess the intensity, extent and duration of potential Montara oil-related contamination. To this end, data were collected to allow direct comparisons with baseline data collected during an earlier survey in October 2009 (McAlpine *et al.* 2010). The July 2010 survey involved sampling shoreline sediments and intertidal rock oysters at seven Kimberley islands and two mainland promontory sites visited by McAlpine *et al.* (2010). Cultured pearl oyster tissue samples were also collected from the four pearl farms visited in October 2009 (McAlpine *et al.* 2010).

There were no detectable concentrations of petroleum hydrocarbons found in any of the shoreline sediment or oyster tissue samples collected during this survey. This result was consistent with the findings of the baseline survey (McAlpine *et al.* 2010).

In view of the overall consistency of the results, spatial coverage of the surveys and the lack of evidence of any recent oil impacts at any of the sites, it is likely that if any oil from the Montara spill reached the coastal waters of the Kimberley region, the resulting impact on the coastal environment would have been transitory and at levels that could not be detected by the sampling methods used in these surveys. The values reported in this survey and the previous baseline survey are therefore considered to broadly represent readily-measureable natural background petroleum hydrocarbon conditions in this part of the Kimberley marine bioregion.

The findings of this survey as well as the 2009 baseline survey also suggest that natural petroleum hydrocarbon seeps in the Timor Sea do not appear to have a readily measureable chronic or residual effect on the quality of the Kimberley marine environment at the sites investigated.

These data will be of value to all stakeholders for assessing potential impacts of future development and monitoring the quality of the marine environment in the Kimberley bioregion.

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Note: Appendices are published in a separate document, APPENDICES: Petroleum hydrocarbon content of shoreline sediment and intertidal biota at selected sites in the Kimberley bioregion, Western Australia which is available at www.epa.wa.gov.au.

1. Introduction

There is the potential for petroleum hydrocarbons released during an accidental spill to impact environmental quality at locations distant from the spill site. In 2009 there was an uncontrolled release of hydrocarbons from the Montara wellhead platform, located in the Timor Sea, some 175 km from Western Australian waters off the Kimberley coast. This incident highlighted the need for baseline environmental data in the Kimberley bioregion (*sensu* IMCRA, Commonwealth of Australia 2006) to inform the management and evaluation of the effects of development pressures, including pollution incidents. To address this need, the Marine Ecosystems Branch (MEB) initiated two surveys (conducted during October 2009 and July 2010, respectively) with the objectives of collecting quantitative baseline data for the region and to investigate the potential impact of the Montara incident in particular. Data that address both of these objectives are valuable for informing future management decisions, especially those associated with planning and activating responses to incidents that may cause significant environmental impacts.

1.1 The incident

The *West Atlas* mobile drilling unit and Montara wellhead platform were positioned over the Montara hydrocarbon field in an area of the Timor Sea under Northern Territory jurisdiction (12°40.33S 12°35E). The *West Atlas* rig was located approximately 175 km from the nearest Western Australian coastal waters boundary in the north Kimberley (Figure 1). On 21 August 2009, an uncontrolled release of hydrocarbons commenced at the Montara well head. For just over ten weeks, until the well was capped on 3 November 2009, oil and gas continued to flow unabated into the Timor Sea off the northwest coast of Australia. According to PTTEP Australasia, the initial flow may have been as high as 1,000 to 1,500 barrels a day (1 barrel = ~159 litres (L)) before dropping to around 400 barrels a day and possibly less (Borthwick 2010). Although most hydrocarbons remained within 35 km of the platform, patches of sheen and weathered oil were observed at various distances in different directions from the platform at one time or another within an area of approximately 90,000 km² (Borthwick 2010).

The escaping material was described as a light crude oil, with a pour point of ~27°C and high wax content. Along with the oil, natural gas was also leaking from the wellhead into the atmosphere. Seven types of dispersants with a total volume of approximately 184,000 L were applied to floating oil from aircraft or vessels to assist the natural process of degradation and minimise the risk of oil impacts on wildlife and shorelines (AMSA 2010a). Containment and recovery operations recovered approximately 844,000 L of oil-water product mixture with an estimated oil content of approximately 493,000 L (AMSA 2010b).

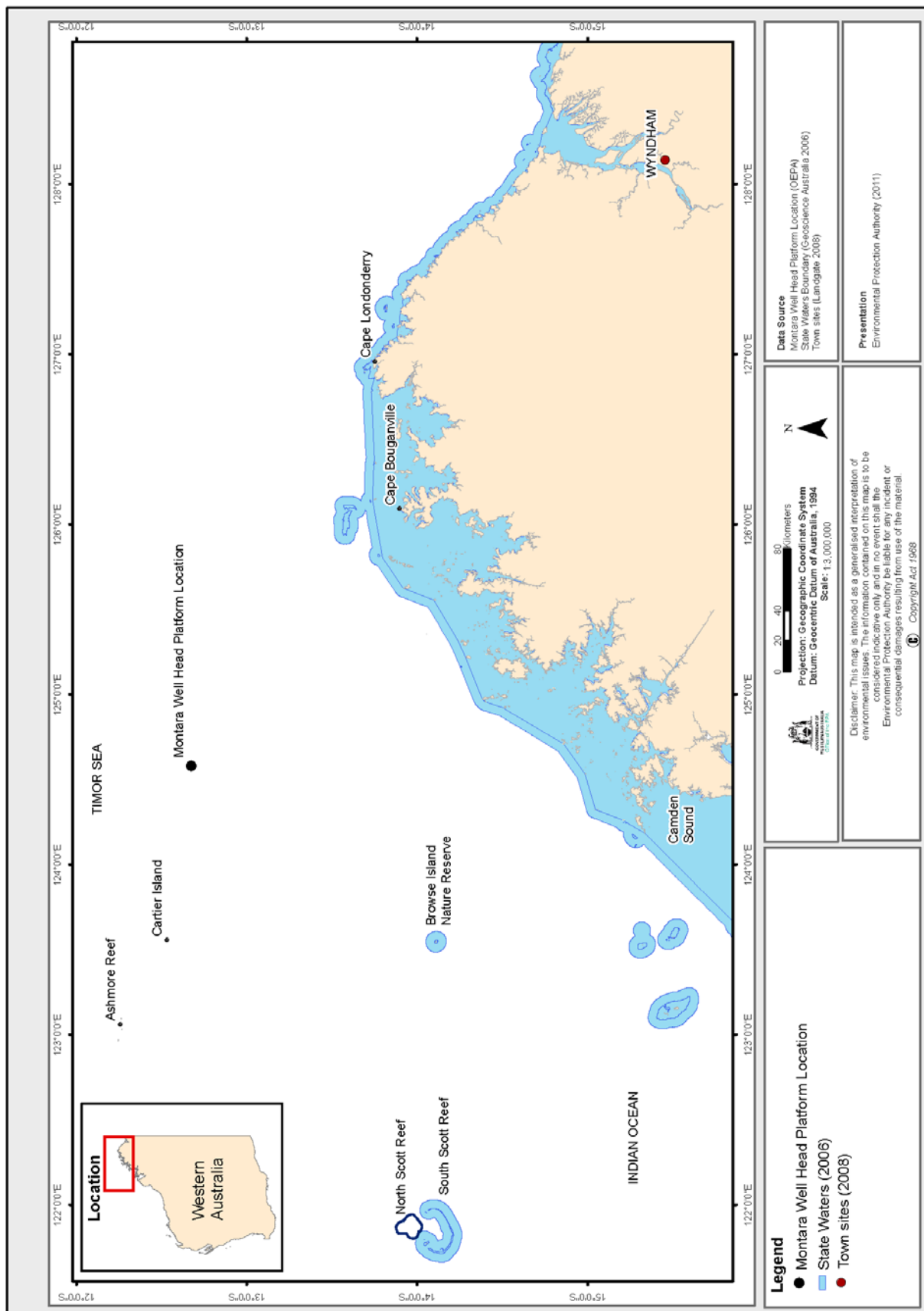


Figure 1: Map showing the location of the Montara wellhead, and the Kimberley mainland, offshore islands and associated Western Australian State coastal waters

1.2 The Kimberley marine environment

The Kimberley marine environment is recognised to be among the world's most pristine and ecologically diverse (Halpern *et al.* 2008 and Masini *et al.* 2009). Its considerable conservation values include diverse coral reefs, extensive mangrove communities and habitats critical to the life histories of listed wildlife such as sea turtles, snubfin dolphins, dugongs and humpback whales. The region also has a growing economic importance and is under rapidly increasing pressure from the development of its natural resources and associated population growth. These pressures have brought into focus the urgent need for a more detailed scientific understanding of the Kimberley's biodiversity and ecological processes and resulted in the State Government's commitment to develop a *Kimberley Science and Conservation Strategy* (Faragher 2009).

The Kimberley presents some significant physical challenges for oil spill response. The region experiences a semidiurnal tidal regime, with daily tidal amplitude up to ~11 m during spring tides in some areas. As indicated in Figure 1, the coastline is highly indented with numerous bays and sounds and some 2581 mapped islands. The length of coastline is estimated to be approximately 12,850 km between Yampi Sound and the King Edward River estuary. The region is also very remote with little coastal infrastructure and few coastal access points.

1.3 The October 2009 baseline survey

In response to the risk posed to Western Australian State coastal waters by the hydrocarbon release from the Montara wellhead, a survey was undertaken in October 2009 to assess environmental values and establish a quantitative baseline for petroleum hydrocarbons in seawater, shoreline sediments, intertidal biota and cultured pearl oysters at selected sites in the Kimberley region. The results of the survey provide a baseline from which to assess the extent and severity of potential impacts (McAlpine *et al.* 2010).

The baseline survey collected data from sixteen shoreline sites between Camden Sound in the south and the Stewart Islands near Cape Londonderry in the north-east. Cultured pearl oyster tissue samples from four pearl farms and three floating surface scum samples within the same region were also analysed. Petroleum hydrocarbons were not detected in any of the water and shoreline sediment samples. Analyses of the oyster samples also showed no contamination by petroleum hydrocarbons. In view of the spatial coverage of the survey and the consistency of the results, it was concluded that the findings were likely to be typical of natural background petroleum hydrocarbon conditions across the region and hence provide a baseline for assessing any future contamination.

1.4 Rationale and aims

The Browse and Timor basins off the Kimberley coast contain vast hydrocarbon reserves and there is increasing pressure to develop the known resources and to explore to identify new ones. Baseline petroleum hydrocarbon data for water, sediment and biota are particularly important for managing petroleum industry development and potential future incidents in an ecologically important region where there is significant prospectivity for oil and gas and natural hydrocarbon seeps are known to occur (Burns *et al.* 2010).

The uncertainties around the ability and time required to successfully stem the hydrocarbon flow from the Montara well head, coupled with the potential for impact

on the State's environmental resources, provided a clear rationale for a *before/after* assessment of potential contamination by Montara hydrocarbons and other environmental impacts that may occur as a consequence. The baseline survey conducted in October 2009 (McAlpine *et al.*, 2010) provided the *before* element of such an assessment.

Data for the *after* component of the *before/after* assessment are provided by the current survey, which was undertaken eight months after the flow of hydrocarbons from the Montara wellhead was stopped. The survey results would be useful in determining the need for an oil spill clean-up program and would also provide a benchmark for evaluating the success of any clean-up operations if significant levels of petroleum hydrocarbon contamination have occurred.

In addition, the results will contribute to our baseline knowledge of the region and will assist future response planning and trend analysis in coastal waters of the Kimberley region.

2. Methods

2.1 Site selection

This July 2010 survey was designed to revisit and collect data at ten of the original 16 shoreline sites in Western Australian coastal waters of the Kimberley bioregion visited in October 2009 to allow direct comparisons with the baseline data reported in McAlpine *et al.* (2010). The eight mid/inner-shelf Kimberley islands and two mainland promontory sites that were considered at most risk of impact, were selected after reviewing observations made during the Montara oil spill response (e.g. satellite imaging and aerial observations of floating oil and spill trajectory modelling (Asia-Pacific ASA 2009)). One of the island sites (Troughton Island) could not be sampled because the weather conditions and sea state made it unsafe to land. The site locations of the July 2010 survey are shown in Figure 2 and Table 1 details the geographic coordinates. The survey also re-sampled cultured pearl oyster (*Pinctada maxima*) tissue from the four Paspaley Pearling Company (PPCo) pearl farms visited during the baseline survey: Kuri Bay; Cape Voltaire; Osborne Islands; and Cape Bougainville (Figure 3).

2.2 Field sampling

The PPCo vessel *MV Odin II* (Figure 4) was used as a platform from which small tender vessels were deployed to transfer the survey team to and from the selected sites. All vessel operations were conducted by PPCo staff.

MV Odin II departed Darwin at 16:00 hours on 4 July 2010 and steamed direct to the northern-most site at the Stewart Islands, which was surveyed during the early morning of 6 July. The vessel then made its way south-west over the next four days visiting the other survey sites. The dates and times that each site was visited are shown in Table 1. The field component of the survey concluded at the Camden Sound site on 10 July 2010.

The survey team comprised four members. Each member of the team was responsible for carrying out specific tasks at each site that included:

- shoreline assessment and documentation;
- digging 0.5 m deep pits along beach strand lines for collection of sediment samples;
- collection and logging of sediment samples; and

- collection, measurement and shucking of rock oysters.

Due to the number of sites visited and the distances between successive sites, the length of time available for surveying each site generally did not exceed one hour.

Table 1: Shoreline survey sites, dates and times

SITE	Sample reference	Date	Time	Latitude*	Longitude*
Shoreline					
Stewart Island East	STI	6-Jul-10	6:30	13° 41.333'	126° 55.019'
Sir Graham Moore Island	SGMI	6-Jul-10	11:40	13° 52.082'	126° 30.913'
Troughton Island	Not surveyed for safety reasons			13° 44.835'	126° 09.030'
Cape Bougainville (sediment)	CBE	7-Jul-10	8:05	13° 54.530'	126° 05.458'
Cape Bougainville (oysters)	CBE	7-Jul-10	8:25	13° 54.105'	126° 06.336'
Low Rocks Nature Reserve	LR	7-Jul-10	13:05	14° 03.745'	125° 52.452'
Cape Voltaire	CV	8-Jul-10	6:45	14° 15.574'	125° 35.088'
Cassini Island - south	CIS	8-Jul-10	11:50	13° 57.326'	125° 38.047'
East Montalivet - southeast	MOI	8-Jul-10	17:05	14° 17.400'	125° 17.934'
South Maret - South	MIS	9-Jul-10	7:07	14° 26.963'	124° 59.070'
Camden Sound	CS	10-Jul-10	6:40	15° 22.098'	124° 18.183'
Cultured pearl oyster**					
Cape Bougainville	CBPF / VBPL [#]	7-Jul-10			
Osborne Islands	NOIPF / OIPL [#]	7-Jul-10			
Cape Voltaire	CVPF / CVL [#]	7-Jul-10			
Kuri Bay	KBPF / PG [#]	9-Jul-10			

[#] The pearl farm references of the follow up survey samples (first mentioned) differed from the baseline survey samples (last mentioned)

* Coordinates in degrees and decimal minutes (datum = WGS84)

** General localities only (see Figure 3)

2.2.1 Shoreline assessment

At each site, a shoreline assessment form was completed and geo-tagged digital photographs were taken to record key features of the site. The shoreline assessment form was used to record key biophysical features of the site such as beach sediment type/texture, general geomorphic features, presence/absence and abundance of wildlife or evidence of their utilisation, size of rock oysters collected for chemical analysis and notes about general accessibility. These notes add to the shoreline assessment information collected during the baseline survey and will be the subject of a separate report.

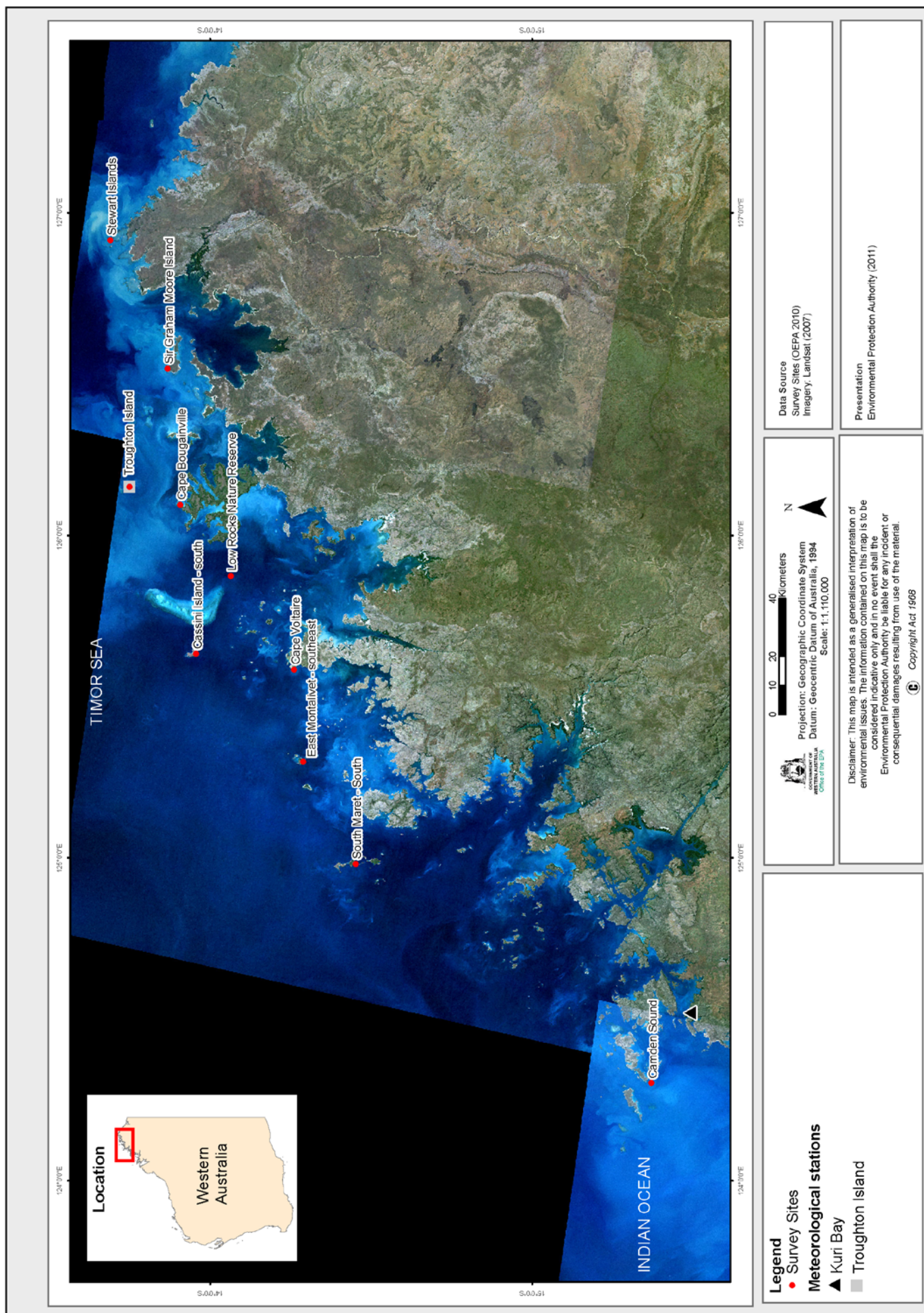


Figure 2. Composite Landsat image showing survey site locations



Figure 4. *MV Odin II* was used as the platform for the baseline hydrocarbons survey

2.2.2 Shoreline sediment sampling

Sampling shoreline sediments involved first identifying the high tide strand line. Holes were dug just below, and seaward from, the strand line to at least 500 millimetres (mm) deep or to the depth of underlying beach rock (whichever was shallower), using a clean stainless steel spade. This position on the beach profile was selected to maximise the chances of encountering hydrocarbons, which tend to accumulate near the strand line, while ensuring that sediments were sufficiently moist to maintain a near-vertical surface down the side of each hole without collapsing. Five of these holes were dug at even intervals along the length of each shoreline sampled. Before samples were taken, a 500 mm vertical face was scraped clean in each hole using the spade in a horizontal motion. This was done to minimize cross profile contamination caused by dragging any materials adhering to the spade down through the deeper profiles when digging.

For the purpose of sampling, the vertical face of each hole was divided into a 'surface' 100 mm horizon and a 'deeper' 100 – 500 mm horizon. In each hole, separate sub-samples were taken from each of the two horizons. Sediment was collected directly into clean labelled 250 mL clear glass sample containers by scraping the lip of the container up the sediment horizon while wearing clean nitrile rubber gloves. Where coral rubble was a significant component of the sediment profile, attempts were made to avoid or minimise the inclusion of large pieces of rubble in the sample. The 250 mL clear glass sample containers were supplied by the analytical laboratory.

The sample from each horizon comprised sub-samples taken from the equivalent horizon in each of the five holes. Sample containers were placed on ice in the dark immediately after each sub-sample was collected and then stored in a 4°C refrigerator on the *MV Odin II* after each site was surveyed until they were transported to the laboratory. The sampling program included one field duplicate for each horizon and one field blank.

2.2.3 Rock and pearl oyster sampling

Sites were first surveyed to determine the presence of rock oysters on safely-accessible rocky intertidal substrates. Rock oysters (*Saccostrea cucullata*) were collected at all sites where it was considered safe to do so and where natural populations were present and individuals were in sufficient numbers to comprise a tissue sample. Where present, rock oysters were either measured, opened, shucked on-site (using clean stainless steel instruments) and then all tissues placed directly into a clean 250 mL clear glass sample container or at some sites individuals were removed whole from the substratum using a clean hammer and stainless steel blade and placed in a clean plastic bag on ice in the dark immediately after collection for processing (i.e. measurement, shucking and storage) on the survey vessel. In the latter case, sample processing commenced within 1.5 hours of oysters being collected. Each sample comprised approximately 50 g (wet weight) of oyster tissue, which generally consisted of tissue from at least 12 rock oysters. The 250 mL clear glass sample containers were supplied by the analytical laboratory.

Rock oysters were collected in the same general vicinity as shoreline sediments at all sites except Cape Bougainville (CBE). At this location, rock oysters were collected from a site approximately 1.2 km northeast of the beach where shoreline sediments were collected.

Pearl oyster (*Pinctada maxima*) samples collected from PPCo pearl farms were supplied in plastic coated mesh panels containing eight shells each, which had been suspended in the water column at a depth of approximately three metres for approximately one year prior to sampling at each location (D. Mills, pers. comm.). Pearl oysters were processed (measured, shucked and prepared for storage) onboard the survey vessel. Each pearl oyster sample of at least 50 g (wet weight) comprised half of the tissue from each of at least three individual oysters. One duplicate sample and one blank sample were collected for each oyster species.

For sampling hygiene purposes, all processing of oysters on board the survey vessel was undertaken on a clean aluminium foil-covered platform. All equipment used to collect oyster tissue samples was stainless steel and nitrile rubber gloves were worn at all times when handling oyster samples. Samples of rock and pearl oyster tissues were stored frozen at -20°C on the survey vessel before being transported to the laboratory.

A chain of custody process was implemented for this survey. All samples were unpreserved.

2.3 Sample analysis

Summaries of the methods and procedures for preparing sample containers and analysing each selected set of contaminants are described in Appendix A.

The suite of petroleum hydrocarbons analysed in all samples, including field blanks and field duplicates, were:

- a) Total Petroleum Hydrocarbons (TPH) at the following carbon chain lengths: C6 – C9, C10 – C14, C15 – C28 and C29 – C36;
- b) BTEX (Benzene, Toluene, Ethylbenzene and Xylenes); and
- c) the 16 polycyclic aromatic hydrocarbons (PAHs) designated as priority pollutants by the United States Environmental Protection Agency – i.e. naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene,

benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd) pyrene, dibenz(ah)anthracene and benzo(ghi)perylene.

All analyses were undertaken by the National Measurement Institute (NMI) using National Association of Testing Authorities (NATA) accredited analytical procedures. All samples were delivered to the laboratory within seven days of collection of the first sample. Sediment samples and oyster tissue samples (stored frozen) were analysed seven and 14 days after being received by the analytical laboratory, respectively.

3. Results

3.1 General conditions

Weather conditions during the period 6 July to 10 July 2010 were variable (Table 2) and allowed sample collection at all sites except Troughton Island.

Table 2. Weather observations recorded at Kuri Bay and Troughton Island

Dates	Kuri Bay				Troughton Island			
	Min. Temp	Max. Temp	9am wind	3pm wind	Min. Temp	Max. Temp	9am wind	3pm wind
July 2010								
6	21.8	28.4	ESE 28	WSW 13	25.3	28.9	SE 28	ENE 26
7	23.0	27.4	W 9	NW 6	23.0	28.3	E 35	ENE 28
8	21.1	28.0	NE 17	NE 19	23.7	27.4	E30	E 30
9	20.1	29.5	N 19	NE 19	24.4	29.3	E 30	ENE 26
10	22.5	31.5	Calm	E 9	24.2	28.7	ENE 13	NNE 13

*Meteorological observations for Troughton Island and Kuri Bay sourced from <http://www.bom.gov.au/climate/dwo/IDCJDW0600.shtml>
Wind speeds are expressed in km/hr. Temperatures are expressed in °Celsius.*

3.2 Shoreline sediments

Results for petroleum hydrocarbon analyses of the shoreline sediments are presented in Table 3. The associated laboratory reports, including scaled Gas Chromatograph – Mass Spectrometry (GCMS) chromatograms and quality assurance data are attached in Appendix B.

There were no measureable concentrations of petroleum hydrocarbons in any shoreline sediment samples, field blanks or field duplicates and the analytical laboratory was also unable to detect any petroleum hydrocarbons at the analytical limits of detection (LoD). The analytical LoD provided by NMI were less than the limits of reporting (LoR) for each compound (NMI pers. com.). For BTEX compounds in sediments, the analytical LoDs were 0.2 – 0.4 mg/kg for each component. The LoDs for individual PAH components in sediments were 0.003 – 0.006 mg/kg. For the TPH components the LoD was 10 mg/kg for hydrocarbons with chain lengths C6-9 and 20 mg/kg for longer chain lengths.

Interim sediment quality guidelines (ISQG-low) from ANZECC & ARMCANZ (2000) for the protection of ecological health were available for twelve of the PAHs analysed as well as for Total PAHs (Table 3). ISQG-low values were all greater than the analytical LoDs and LoRs for these chemicals.

Table 4. Results of petroleum hydrocarbon analyses for oyster tissue samples collected in the Kimberley bioregion, July 2010.
Units = mg/kg dry wt. unless otherwise specified

Sample species	<i>Saccostrea cucullata</i>							<i>Pinctada maxima</i>					
Sample Reference	SGMI	CBE	LR	CIS	CIS dupl.	CS	CS blank	KBPF	CVPF	CVPF dupl.	CBPF	NOIPF	NOIPF blank
Poly Aromatic Hydrocarbons													
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)&(k)fluoranthene	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Benzo(g,h,i)perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total PAHs	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
BTEX													
Benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Ethyl Benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
m, p - Xylene	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
o - Xylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total BTEX	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Petroleum Hydrocarbons													
TPH C6 - C9	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
TPH C10 - C14	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
TPH C15 - C28	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
TPH C29 - C36	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Total TPH	<275	<275	<275	<275	<275	<275	<275	<275	<275	<275	<275	<275	<275
Miscellaneous													
Moisture (g/100g)	75.7	78.3	68.7	79.5	78.1	79.6		84.5	85.2	84.6	83.6	85.5	
Fat (Soxhlet) (g/100g)	0.5	1.5	0.8	0.9	0.7	0.4		<0.2	<0.2	<0.2	<0.2	<0.2	

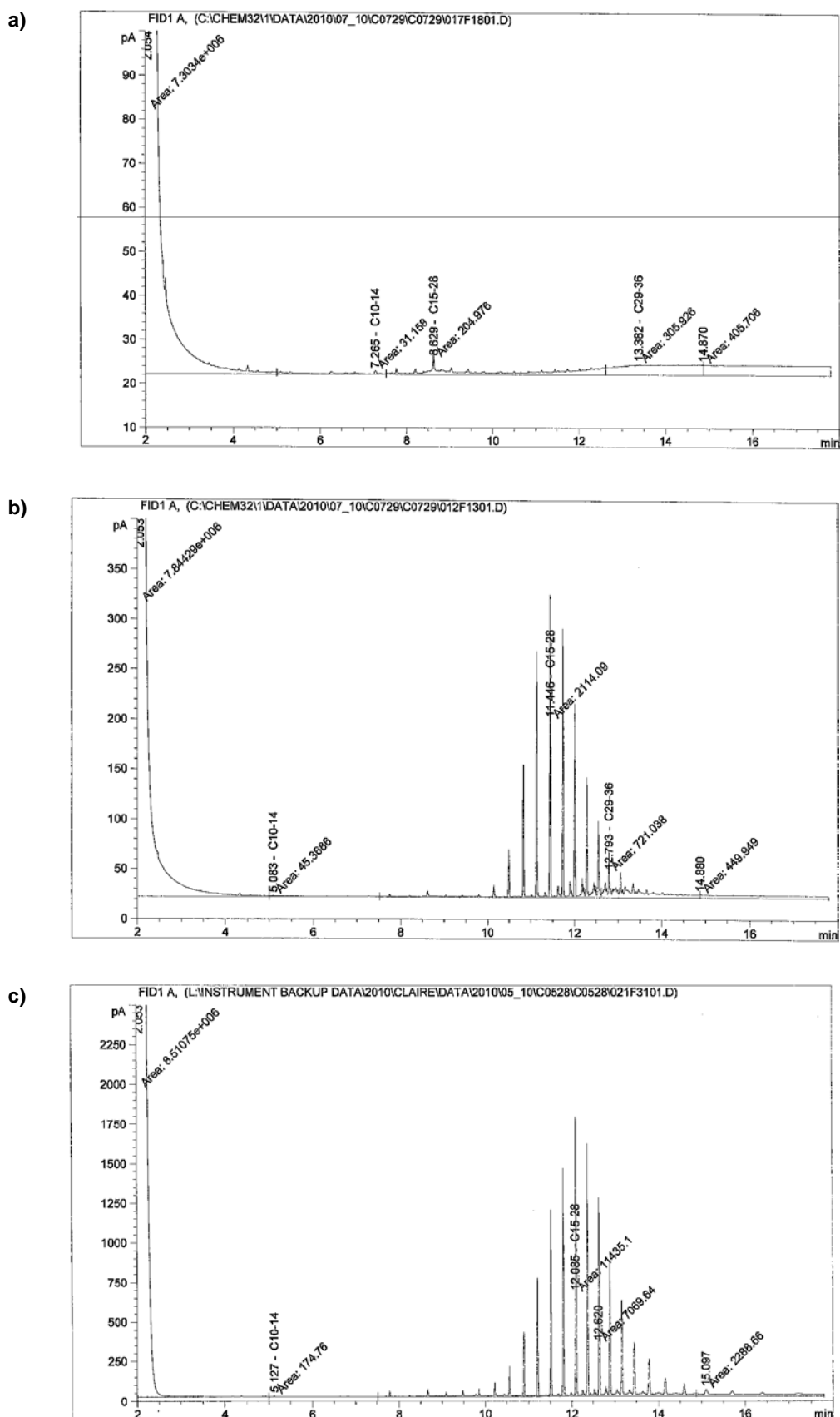


Figure 5. GCMS Chromatograms for: a) the CVPF site sample, typical of an uncontaminated oyster; b) the CBPF site sample, typical of the laboratory-contaminated samples; and c) a trace of the known laboratory contaminant

3.3 Oyster tissues

The results for the analysis of petroleum hydrocarbons in oyster tissue, from naturally-occurring rock oysters and cultured pearl oysters, are presented in Table 4 and the associated quality assurance data are attached in Appendix C. There are no ecological health guidelines in ANZECC & ARMCANZ (2000) for contaminants in oyster tissue.

There were no reported concentrations of petroleum hydrocarbons in any of the pearl or rock oyster samples, field blanks or duplicates.

Nevertheless, it should be noted that the TPH analysis of three of the cultured pearl oyster samples (CBPF, NOIPF and NOIPF blank) identified the presence of longer chain hydrocarbons. However, on further investigation, the chromatogram profile was identified as that of a known laboratory contaminant thought to originate from laboratory gloves, sample container silicon rubber septa or the GC septum (D. Slee, NMI, pers. comm.). The lack of signs of weathering and the tight grouping of the analyte peaks as depicted by the chromatograms of the three survey samples matched the characteristics of the laboratory contaminant profile (Figure 5). The chromatograms, therefore, indicated the presence of a mixture of compounds too simple to have a diesel or crude oil source (S. Fisher, DoW, pers. Comm.).

4. General discussion and conclusions

There is the potential for petroleum hydrocarbons released during an accidental spill to impact environmental quality at locations distant from the spill site. In 2009 an uncontrolled release of hydrocarbons occurred from the Montara wellhead platform, located approximately 175 km from the nearest Western Australian waters off the Kimberley coast.

During the Montara oil spill response, there were aerial observations of oil and surface sheen in the vicinity of Ashmore and Cartier reefs, 300 – 350 km off the WA mainland, and Browse Island, approximately 180 km off the mainland. Traces of Montara crude oil were detected from two samples of patchy surface films which were collected off Browse Island on 14 November 2009, shortly after the leak was contained on 3 November 2009. These samples were collected by Department of Environment and Conservation staff and analysed by Leeder Consulting Laboratories in Victoria. Heyward *et al.* (2010) reported above-background concentrations of a degraded crude oil in a small number of sediment samples collected in the vicinity of Ashmore and Cartier reefs in April 2010, approximately six months after the Montara wellhead spill was stopped. Although the chemical evidence indicated that the detected substance was a degraded crude oil (not Bunker C or light diesel), natural weathering processes had altered it and reduced concentrations sufficiently to prevent full source matching. Heyward *et al.* (2010) also reported no evidence of unusual major disturbance to the benthic communities in the vicinities of Ashmore and Cartier reefs, “suggesting that any biological effects of the oil reaching these reefs was minor, transitory, or sub-lethal and not detectable with the sampling methods used”.

The primary aims of the study reported here were to determine petroleum hydrocarbon concentrations in shoreline sediments and biota at selected sites in the Kimberley, and whether there were any readily detectable increases above baseline concentrations (McAlpine *et al.* 2010) as a result of the 2009 Montara hydrocarbon release.

Petroleum hydrocarbons were not found in any of the sediment samples at concentrations above the analytical LoR, which matched the results obtained for the sediment samples collected by the baseline survey (McAlpine *et al.* 2010). In addition, petroleum hydrocarbons could not be detected at concentrations above the analytical LoD for each analytical method. The ISGQ-low values provided in ANZECC & ARMICANZ (2000) for shoreline sediments were all greater than the analytical LoDs and LoRs for these chemicals. This finding accords with the Office of the Environmental Protection Authority's understanding that there were no confirmed aerial sightings of floating Montara oil within WA State waters adjacent to islands or the mainland Kimberley coastline during the time that the aerial observation program was conducted.

There were also no measureable concentrations of petrogenic TPHs, BTEX or PAHs that could be associated with Montara crude oil found in the oyster tissue samples with all analyses reported at less than the analytical LoR. However, a direct comparison with the analytical results for the oyster tissue samples in the baseline study is problematic because of an improvement in the efficiency of the analytical laboratory's silica-gel clean-up procedure for removing biogenic fatty acids from the sample extracts. All oyster tissue samples analysed in the baseline survey results (McAlpine *et al.* 2010) returned measureable concentrations for the longer chain (C15 – C28 and C29 – C36) TPHs. However, subsequent more detailed analyses of the samples confirmed that these longer chain compounds were actually biogenic lipids and lipid artefacts and not petrogenic, and therefore not attributable to the Montara oil spill or natural hydrocarbon seeps.

In view of the overall consistency of results from this survey, the spatial coverage of the surveys and the lack of evidence of any recent major environmental disturbance at any of the sites, it is likely that if any oil from the Montara oil spill reached WA coastal waters the resulting impact on the coastal environment would have been transitory and at levels that could not be detected by the analytical methods used in this survey. This conclusion is in general accordance with the results from a visual helicopter shoreline assessment survey conducted by the University of Queensland, which reported no identifiable oil slicks or evidence of contamination events at or in close proximity to the mainland Kimberley coastline between 9 and 18 November 2009 (Duke *et al.* 2010).

The findings of the 2009 baseline survey (McAlpine *et al.* 2010) and this 2010 survey suggest that, based on the sampling and analytical methods employed for these surveys, petroleum hydrocarbons released from natural seeps known from the Timor Sea (e.g. Burns *et al.* 2010) do not appear to have a readily-measurable chronic or residual effect on the quality of the Kimberley marine environment at the sites investigated. The values reported in this survey and the previous baseline survey are therefore considered to broadly represent readily-measurable natural background petroleum hydrocarbon conditions in this portion of the Kimberley marine bioregion.

These data will be of value to all stakeholders involved in assessing potential impacts of development or monitoring environmental quality in the WA coastal waters section of the Kimberley marine bioregion. Baseline environmental data are fundamental for managing and evaluating development pressures, including pollution incidents. While direct development-related pressure on the WA coastal waters section of the Kimberley bioregion is presently low, there is considerable existing and increasing petroleum-related development activity in adjacent offshore waters.

5. References

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