RV *Investigator* Voyage Plan

Voyage #:	**IN2017_V05**		
Voyage title:	Long-term recovery of trawled marine communities 25 years after the world's largest adaptive management experiment		
Mobilisation:	Wednesday 20 September, 2017 Garden Island, Sydney, NSW.		
Depart:	0800, Wednesday 11 October 2017, Broome, WA.		
Return:	0800, Friday November 10, 2017, Henderson (Fremantle), WA.		
Demobilisation:	Friday 10 November, 2017, Henderson (Fremantle) WA.		
Voyage Manager:	Max McGuire MNF CSIRO	**Contact details:**	max.mcguire@csiro.au
Chief Scientist:	John Keesing O&A CSIRO	**Contact details:**	john.keesing@csiro.au
Principal Investigators:	John Keesing, Roland Pitcher, Keith Sainsbury, Alan Williams, Joanna Strzelecki (CSIRO) Stephen Newman, Corey Wakefield (WA Dept. of Fisheries)		
Supplementary Projects	1. Assessment of marine biodiversity as part of determining long-term recovery of trawled communities on the NWS Dr. Monika Bryce, WA Museum. monika.bryce@museum.wa.gov.au 0401 046 729 2. Natural iron fertilization of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry Dr. Andrew Bowie, UTAS. andrew.bowie@utas.edu.au. 0419 389 316		
Piggyback Projects	1. Collection of marine invertebrates, particularly sponges, and a survey of their fluorescent properties correlated to depth and chlorophyll content Prof. Peter Karuso, Macquarie University peter.karuso@mq.edu.au 0410 442 312		

Voyage summary

The aim of the voyage is to determine the extent to which habitat forming benthic invertebrate and demersal fish assemblages of the North West Shelf (NWS) have recovered from high levels of foreign trawling effort between the 1960s and the late 1980s and to compare these with areas which have been continuously fished with lower levels of effort or completely protected from trawling within the area under management of the Pilbara Trawl Fishery since 1990.

Scientific objectives

By contrasting the diversity, abundance, biomass and size/age composition of the demersal fish community and epibenthic, habitat forming invertebrates across these gradients of historical and recent fishing effort, and by comparing these data with that collected in the 1980s using the same methods, we aim to make firm conclusions about the rates of recovery of trawled communities and the sustainability of trawling.

We will test the prediction that areas where trawling effort has ceased or has been dramatically reduced will be characterised by re-establishment of benthic habitats with greater coverage, biomass and complexity of larger habitat-forming filter-feeder communities, and of higher production of key demersal fish species (families: Lethrinidae, Lutjanidae) since comparative surveys in the 1980s. The study will also take into account other environmental gradients (i.e. depth, substrate/habitat type, hydrodynamic forcing at the seabed, pelagic productivity which may influence both the distribution of benthic and demersal community assemblages and their rates of recovery.

Voyage objectives

Sampling design and site selection.

Stratified sampling will take place across gradients of historical trawling effort, depth and other environmental variables. A range of analyses of historical information are currently being undertaken to determine the location of each strata type and the optimal number and location of sites needed to achieve the study objectives. We will conduct sampling at a combination of randomly selected stations within each strata as well as at fixed stations to enable direct comparison with historical surveys by CSIRO and Japanese research vessels. An example of how the distribution of sampling sites may look is given in Figure 1.

Four types of operations will be undertaken: seabed habitat classification, benthic community assemblage sampling (principally invertebrates), demersal trawl sampling (fishes and habitat forming invertebrates), and water column sampling (phytoplankton, zooplankton and biophysical characteristics). Most, but not all operations will be undertaken at each station. Because all trawls need to be undertaken in daylight hours, each site will have to be revisited during both day and night to complete operations at each site.

Seabed habitat classification: High resolution seafloor bathymetry will be continuously acquired using multibeam sonar system EM710 (70-100kHz). This will provide bathymetry in the area and acoustic imagery of the seafloor. Physical habitat features and distribution of key benthic habitats will be collected using a trawl headline camera system (see below). The CSIRO tow video system with habitat type and biological event data recording in real time (tappity system) will be used as a backup in case of problems with or loss of the trawl headline camera. A Smith McIntyre grab will be used to characterise sediments at each site.

Demersal trawl sampling (daylight hours)

McKenna trawl net (see specifications below). These are new nets but the same as nets used on IN2017_V03 and is a similar trawl net design to those used in the 1980s (Frank and Bryce) and 1990s (McKenna) in order to allow a direct comparison. A 30 min shot time will be used for each trawl, again consistent with previous studies. We hope to do four trawls per day and to have the first shot away immediately after breakfast. We would like the crew to make all preparations for the first trawl of the day before breakfast so that the net can be shot away immediately after breakfast each day. A detailed roles and responsibilities list for each person in the scientific party on each operation is to be provided as an attachment to this Voyage Plan

A trawl headline camera will be attached to the net to obtain high frequency digital still images of the seafloor. Image scoring for size and abundance of benthos, especially sponges will be done post-voyage. One of the day shift scientific party will be responsible for ensuring the camera is ready to hand to the gear technician prior to each trawl and for downloading and backing up the imagery after each trawl and ensuring the camera is ready the night before for the first trawl of each day. For the first trawl of each day one of the scientific party one of the night shift will be responsible for handing the camera to the gear technician.

The net cod end will be emptied into 1 or 2 megabins lined with a mesh lifting net on pallet trolleys and transferred to the sheltered science area and the mesh net containing the catch will be hoisted above and emptied onto the sorting table. A site photo of the catch will be taken with ambient light and under UV lights prior to sorting. Catches will be roughly sorted from the sorting table into tubs and transferred by conveyor to the wet lab. Any live fish and cephalopods will be placed into anaesthetic before transfer as per methods approved in our animal ethics application. Any non-targeted bycatch such as turtles and sea snakes will be returned alive if safe to do so. Large sharks and stingrays not required as voucher specimens will be measured and released if alive and safe to do so. Refer the attached animal handling notes prepared by John Wakeford.

The priority information required for the trawl fish catch is to obtain the biomass and abundance of each fish species and the size composition of the catch. To ensure the information of the highest priority is collected from each trawl there will be a priority species list which is to be followed in the event of especially large or diverse catches.

In the wet lab, final sorting to species will take place and the total biomass and abundance of each fish species will be recorded. For species that cannot be readily identified, voucher specimen(s) will be bar coded and retained (frozen or in ethanol)**.** Selected species will have up to 100 measured and/or weighed for size/weight composition. Otolith samples will be obtained from selected fish and tissues and digestive tract removed for diet determination and stable isotope analyses. There is a work flow procedure at the end of this document setting out the roles and responsibilities for each of the scientific party during trawl processing.

The priority information required for the trawl invertebrate catch is to obtain the biomass and size composition of habitat forming sessile invertebrates, especially sponges and octocorals.

The invertebrate catch will be sorted to phyla or class and a bulk weight of each obtained. Sponges will be sorted into size classes (0-10 cm, 10-25 cm, 2550 cm, 50-100 cm, >100cm). A weighable sorting basket or bin will be designated for each taxa/size type. Some groups may be subsequently sorted into more taxonomic categories and vouchers will be preserved in ethanol or frozen. The piggy back sponge project will select and voucher sponges that display fluorescent properties under UV, violet or blue light irradiation.. Especially dominant sponges, octocorals, ascidians and bryozoan from each shot will be vouchered, we are unlikely to be able to retain large volumes of filter feeders and nor will we have time to voucher all species. Due to time constraints it is most likely that the following small taxa will be bulk frozen/preserved as single bar coded lots (worms, molluscs, crustaceans, echinoids, asteroids, holothurians, crinoids, ophiuroids) and offered to the WA Musuem (this is a permit requirement). All vouchers will need a scannable numbered bar code label. To ensure the information of the highest priority is collected from each trawl there will be a priority species list which is to be followed in the event of especially large or diverse catches.

Benthic community assemblage sampling (mostly night operations): An epibenthic sled (mouth is 1.5 m x 0.5 m) will be used to quantitatively sample benthic flora and fauna such as algae, sponges, octocorals and other cnidarians, ascidians, bryozoa, echinoderms, molluscs, worms and crustaceans in 200 m tows at each station. The cod end will be emptied onto a second sorting table located on the main after deck. A site photo of the catch will be taken under ambient light and UV light prior to sorting. The catch will be roughly sorted to tubs from the sorting table and transferred by conveyor to the wet lab. There it will be sorted to phyla or class and a bulk weight of each taxonomic group obtained. Some groups may be subsequently sorted into more taxonomic categories, weighed and preserved in ethanol or frozen. If excessively large catches of sponges or other filter feeders are obtained then only a subsample will be retained after vouchers are selected. Samples of some invertebrates will also be retained for stable isotope analyses back on shore. A camera on the sled will be used to record each tow and will inform whether any especially large sponges were not sampled effectively by the sled.

It is intended that the day shift will prepare everything for the first sled of the night after dinner before knocking off. A detailed roles and responsibilities list for each person and each operation is to be provided as an attachment to this Voyage Plan

Water column sampling: Normal underway sampling, ADCP and acoustic profiling is assumed. Turbulence probe (night) and CTD profiles (night) will be undertaken at each site. Parameters to be recorded will include conductivity, temperature, fluorescence, nitrate, and turbidity. Samples for dissolved inorganic nutrients from depths (0, 10, 25, 50, 75, 100m, depending on station depth) will be collected for nitrate, nitrite, silicate, ammonium and phosphate concentrations. Samples from surface and chlorophyll maximum layer will be collected for size fractionated phytoplankton biomass, species composition, phytoplankton pigments by HPLC and fatty acids, POC, PON. Zooplankton and fish larvae samples will be collected using bongo nets (100 and 355 µm mesh) equipped with electronic flowmeters and a 100 micron MIDOC (opening and closing) net. The latter net will not be deployed at all sites. Proposed sampling will enable densities of organisms along with size fractionated biomass and species composition to be calculated. Samples will be kept for stable isotope and fatty acid analyses. No radioactive isotope work will be done on board.

Data Management:

Data on the voyage will be collected in a number of databases and logging systems. All databases and log files etc. are to be stored on the ships science network drives data can be divided into three main categories:

Ships systems: The ships event log will be used to log operations that take place. Data from the ships navigation, echo sounder, trawl systems etc. will need to be logged at all times. There will also be a requirement for some real time feeds during operations for our equipment such as the bongo net system

User Database: As an addition to the ships database there is also a sample database using MS Access. It is our preference to use this database unless the catch/sample database on board meets our needs. This database will reside on a network share. Interfaces have been developed for the weigh scales and fish measuring boards.

User Logging systems: We have several user systems that will need to be logged and data stored on the science drive. A director will be made for each instrument. Where necessary below that a directory for each deployment will be created to store multiple files such as images from the trawl camera. Real time logging systems such as the Bongo nets will log their data to a network share.

It is of the upmost importance that clocks are synchronised between the various systems. To guarantee this all user pc used for processing data must be synced using the NTP (network time protocol).

Back-ups for camera imagery will be on back-up drives as well as the ships computer

CSIRO Marine Visual Technologies –*RV Investigator* catch footage trial

Background:

High Definition video cameras are replacing human observers on commercial fishing vessels due to cost and safety issues. Observations are needed to collect basic fish catch data, such as catch composition (species identification), numbers caught, and endangered species interactions. Camera footage is then scored by on-land observers. This is costly and time-consuming. CSIRO has established a team called Marine Visual Technologies that is applying novel machine-learning algorithms to automatically and rapidly determine capture events and identify species. In order to train these learning algorithms, large volumes of footage of capture events are needed. The north-west shelf Investigator voyage is an opportunity to obtain fish catch footage that can be added to our library and assist the development of our software.

On-vessel tasks:

Place cameras (2 x GoPro) in suitable, safe positions over (i) the inside sheltered science area (sorting tray footage), and (ii) the outside aft deck area (net capture footage). Cameras once deployed can be remotely turned on and off via a smart phone app. SD card footage will be downloaded to portable hard drives at suitable, convenient and safe times. Alternative camera distances and angles will be tested for quality of footage.

If possible the daily deck footage from Investigator cameras will also be downloaded.

Staff:

Matt Lansdell will be on the vessel and responsible for the care and deployment of cameras, and storage of data.

Geoff Tuck and Rich Little are the co-ordinating O&A MVT members in Hobart (contact 0409237182; Geoff.tuck@csiro.au).

Item	Quantity
GoPro Hero 5 Black	2
Fast super charger	1
Attachment jaws	2
Dual battery charger	1
Spare batteries	2
1Tb portable hard drive	2
64Gb SD card	2
MVT stickers – to ID our gear	2 sheets

Promotional video work using small camera carrying drone

Access to video footage taken from above the vessel to illustrate operations will be useful for promotional work and for communicating the results of the voyage. This would be done only on a limited number of occasions and only when sea conditions are very good. Nick Mortimer would be responsible for operating the drone.

Operational Risk Management

Most operations have been previously conducted from the RV Investigator and Standard Operating Procedures (SOP) will be available for all operations.

Overall activity plan including details for first 24 hours of voyage

The first operation will be to undertake a trial of the new trawl net and its headline camera system. We will choose a station at about 50 nm from Broome. If we leave Broome at 0800 on October 11 the trial station will reached about 1300. This will leave time to make any adjustments and possible do a second trial if required. The first actual station will be about 3 hours away so will be reached about 1800 on October 11. This will be a trawl only which will take 2 hours and then another 3 hours steam to the 2nd site arriving at 2300 for another trawl. The 3rd site is then 14 hours steam time away which will be a trawl, CTD and turbulence Probe site.

The aerosol sampling system will be started soon after leaving port in Broome, and will run continuously until arrival in Fremantle. Rain sampling opportunistically if conditions are suitable. Start trace metal clean underway supply in open waters.

Voyage track

Approximate transit and site plan. Green boxes show approximate start and end points of trawl sites, except most southerly site which is a swath only transect. Subsequent transit to Fremantle not shown.

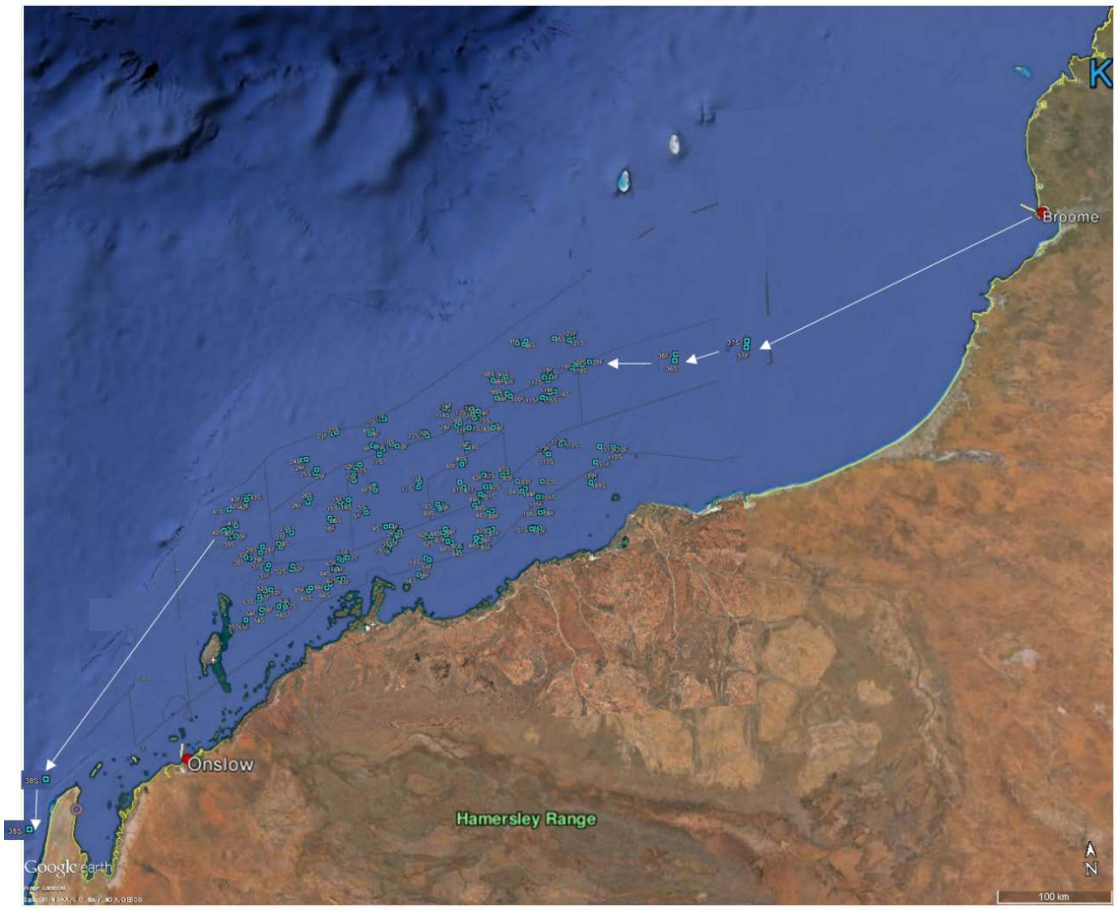


Figure 1a. Large area context of voyage.

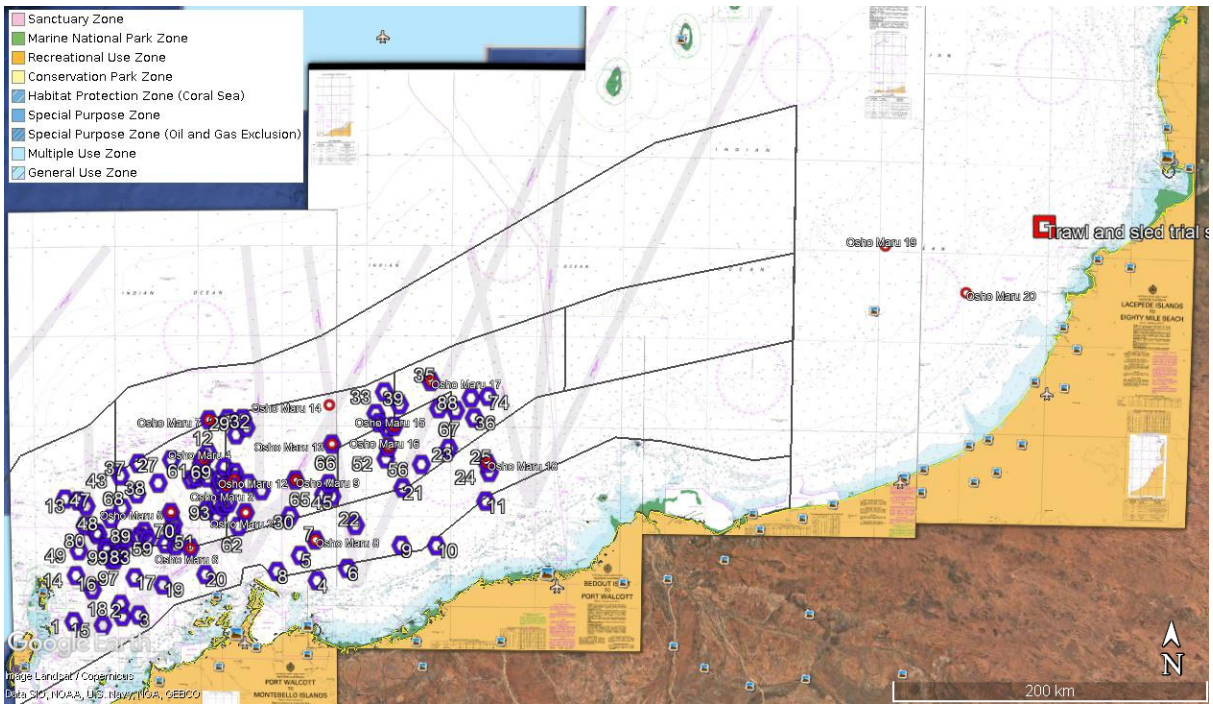


Figure 1b. Location of sites

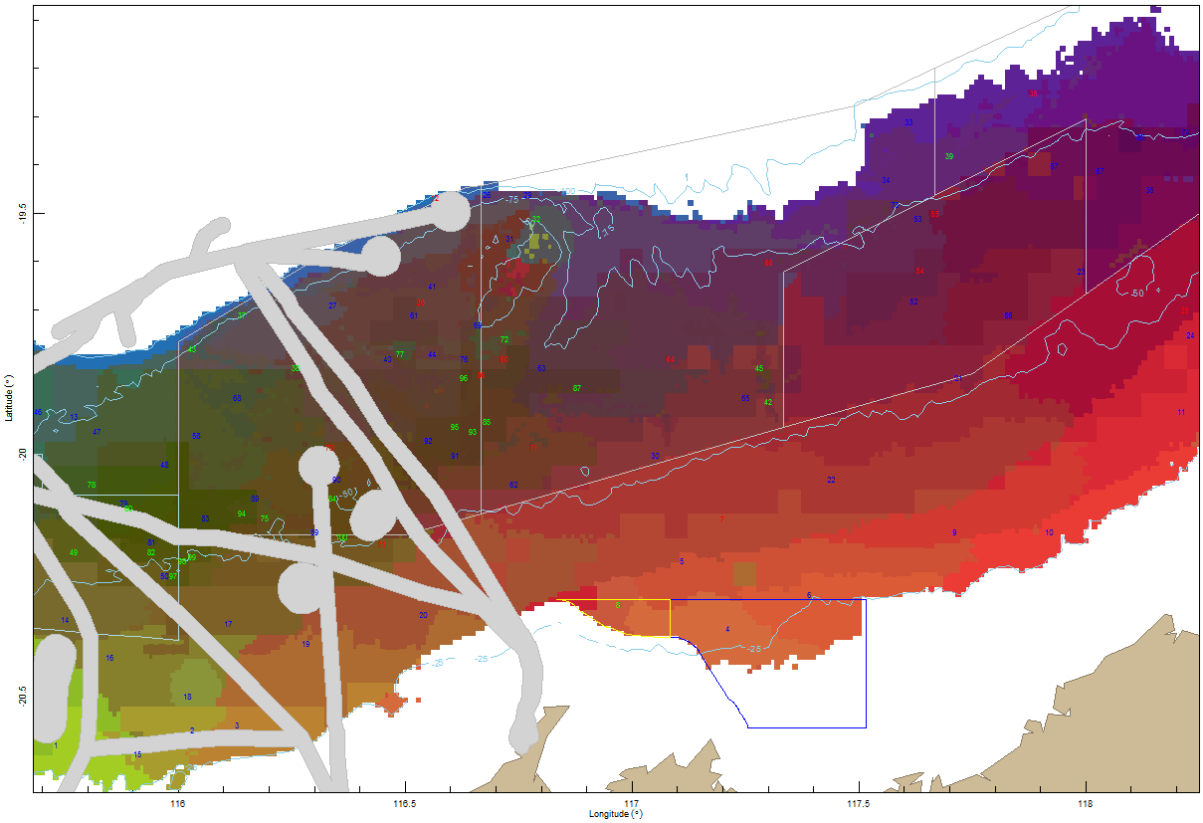


Figure 1c. Detailed area of main sampling, approximate sites shown in small numbers

Waypoints and stations

The exact station positions will be provided closer to commencement of the voyage. T=Trawl, C=CTD, B=Bongo, G=Grab, S=Sled, P=Turbulence probe, M=MIDOC

Wpt	Stn	Steaming time to Wpt/ Stn (hrs)	Date	Approx Time	Time on Stn (hrs)	Ops	Decimal Latitude	Decimal Longitude	Distance (nm)	Comments
1		-	11 Oct	0800			Broome	Broome	-	
2	0	4	11 Oct	1200	3	Trial trawl and trial sled	18° 19.352’	121° 28.208’	46	Trawl trial-
3	1	3	11 Oct	1800	2	Trawl	18° 43.000’	121° 1.000’	34	Oshu Maru 20
4	2	3	11 Oct	2300	2	Trawl	18° 28.000’	120° 32.000’	31	Oshu Maru 19
5	3	14	12 Oct	1300	3	Day T, C, P	19° 42.000’	118° 13.000’	149	Oshu Maru 18
	6-106	Each station occupied	12 Oct-7 Nov	Day and night sampling of	Total of 26/27 days	Day T (all stations), C, P (some stations)	As per map detailed list attached	As per map detailed list attached		

Wpt	Stn	Stea-ming time to Wpt/ Stn (hrs)	Date	Approx Time	Time on Stn (hrs)	Ops	Decimal Latitude	Decimal Longitude	Distance (nm)	Comments
		twice (day and night)		each station need not be on the same day	sam pling from Oct 12 to Nov 7	Night S,G (all stations,B, M (some stations)				
	106			1000 Nov 7	2	T,C,P	20° 07.836' approx	115° 28.200 approx'		
240	Leav e last Stn			1200 Nov 7						
241		11		2300 Nov 7			21° 40.482'	114° 03.115'	121	
242		1		0000 Nov 8			21° 48.670'	113° 52.274'	11	
243		5		0500 Nov 8			22° 39.938'	113° 31.713'	54	
244		2		0700 Nov 8			22° 56.087'	113° 39.582'	19	
245		3		0800 Nov 8			23° 31.759'	113° 37.617' Note stations 241-245 represent a track along the 120 m contour through the Ningaloo Commonwealth Marine Reserve, we will not occupy each station	35	
246		52		0600 Nov 10			31° 46.000'S	114°58.000'E Note request from IMOS to SWATH over the site of a lost mooring in 500 m of water northwest of Rottnest on our way back		
							31 45.910 S	114 57.600E Note request from IMOS to SWATH over the site of their new mooring in 500 m of water northwest of Rottnest on our way back		
248		2		0800 Nov 10			Henderson	Henderson	583	

Note that there will be a small vessel transfer of one or more of the scientific party about halfway through the trip. This will occur via a WA Fisheries Patrol vessel, most likely out of Dampier

Time estimates

The main priority will be to achieve four sites per day. To achieve this we would like to have the trawl catches brought on deck at 0700, 1000, 1300 and 1600 with other activities to fit around this schedule. We would like sled catches to come on board at 1900, 2200, 0100, 0400 with each sled followed by a Grab.

It may not be possible to achieve all proposed operations at each site and once the sites are finalised we will select a subset for CTD, Turbulence probe and plankton nets. The MIDOC net will only be used at a subset of sites. Time estimates will be finalised after final station positions are completed The following estimates for each station are provided:

Day-time operations time/station	**sampling time (minutes)**	**Deployment + retrieval time (minutes)**	**total time (minutes)**	**Total time on station (minutes)**
Swath mapping capturing water column back scatter data as well as seabed data	continuous	0	0	0
McKenna Demersal trawl (Twin trawl winches)	30	60	90	90
CTD (CTD winch)	10	20	30	120
Turbulence probe (Hand lowered off boom)	15	20	35	155
Smith-McIntyre grab (Light sediment winch off coring arm on the starboard) If we need to make up time and depart for next trawl station then grabs will be done at night.	10	20	30	185
Total			185 mins = 3 h and 5 mins	

Night-time operations time/station (usual order)	**sampling time (minutes)**	**Deployment + retrieval time (minutes)**	**total time (minutes)**	**Total time on station**
Swath mapping capturing water column back scatter data as well as seabed data	continuous	0	0	0

Night-time operations time/station (usual order)	**sampling time (minutes)**	**Deployment + retrieval time (minutes)**	**total time (minutes)**	**Total time on station**
200 m Epibenthic sled* (GP winch) *Focus on biomass rather than species diversity except for sites in Commonwealth Marine Reserves	10	50	60	125
Smith-McIntyre grab (Light sediment winch off coring arm on the starboard) ***Only to be done if missed on the day sampling of the same site.	10	20	30	0***
CTD (CTD winch) No bottles just a profile – fluorescence will be used to guide the Bongo and MIDOC net operations	10	20	30	155
Bongo (Tow body wire through A Frame)	15	30	45	200
MIDOC** (GP Winch through A Frame - Bongo and MIDOC will need different block) **Not every station	60	60	120	320
Total			200 mins = 3h 20 mins with out MIDOC 320 mins = 5 h 50 mins wiyh MIDOC	

Supplementary projects

Two supplementary projects:

1. **Assessment of marine biodiversity as part of determining long-term recovery of trawled communities on the NWS (Monika Bryce, WA Museum)**

The WA Museum and Museum of Victoria will assist our project by helping to sort and identify sponges, soft corals and echinoderms and they will take voucher samples of biota for the museum collections which will provide a legacy benefit of this work.

2. **Natural iron fertilization of oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry (Andy Bowie, UTAS).**

Oceans play a vital role in Earth's climate through the control of atmospheric CO2. An important component of this system is the iron cycle, in which iron-rich aerosols are transported from land via atmosphere to ocean. Iron is a key micronutrient for marine phytoplankton, the scarcity of which controls essential biogeochemical processes. This project will facilitate an integrated ship-based atmospheric observational program for trace elements in oceans around Australia. During the voyages, we will sample and conduct experiments on atmospheric particles containing terrestrial dust, bushfire smoke and anthropogenic emissions that are transported from Australia to its surrounding oceans. This will provide the critical information on atmospheric iron supply for ocean fertility and health, providing the science for predicting a key factor in the future impact of the oceans on climate. The project supports the training and research of two postgraduate PhD students from IMAS-UTAS. We will install an atmospheric sampling system for the clean collection of particles in the ship's aerosol lab. This system consists of vacuum pumps (Thomas Sheboygan 2107CD18), flow meters (DiTGM ML-2500) and filtration systems (Savillex PFA). The manifold is connected to air intake lines fed from the sampling nozzle located ~10 m above sea level on the foremast at the bow of the vessel. Samples will be collected on filters housed in 47 mm filtration holders located within a laminar flow hood (AirClean Systems) to avoid contamination. The system is controlled by automated sector control switch (pump controller) to ensure the system only samples 'clean' air from the forward sector (nominally between 270^{o} port and 90^{o} starboard), avoiding air impacted by the ship's exhaust. The system is capable of running up to 4 flow lines in parallel, to enable replicate sampling or to sample for different parameters using different filters on different lines.

Samples will be collected on a range of different filter types (polycarbonate, Whatman-41, cellulose, Teflon) suitable for different analytical needs. Filters will be changed approximately daily, depending on the aerosol loading, flow rates and amount of time the air inlet is in a suitable 'clean' air sector and sampling takes place. The sector sampling switch records the date/times and waypoints when the wind is 'in sector'. A range of procedural and field exposure blanks will be collected at sea, as well as preliminary leaching and dissolution experiments. Sampled filters will be stored frozen and returned to the shore-based laboratory for further experiments and analyses.

We will also opportunistically collect event-based clean rainwater samples using a polyethylene funnel and collection bottle (when conditions allow), to quantify the trace metal deposition in the 'bulk' and 'precipitate-only' fractions. Ideally samples would be collected on upper and forward decks, either above the bridge or at the bow when heading into the wind. Rain samples will be acidified on board with a small amount of distilled concentrated acid (1-2uL/mL) and will be stored in the ship's freezer (in the hallway, (non-walk-in) freezer between laboratories).

The project also requests access to the RV *Investigator* trace metal clean underway supply system (the outlet in the clean wet lab which has been designed for clean filtration and sampling in the fixed laminar flow hood). This will enable us to correlate the atmospheric flux of trace elements with the surface in-water concentrations. Freshly collected surface seawater will also be used for on board leaching and dissolution experiments on the collected atmospheric particles. Both sea water and leaching solution will be acidified using 1uL/L concentrated HCl.

Our sampled aerosols will include terrestrial dust, processed soils, particles generated through biomass burning and industrial processes, and marine aerosols. Analyses and lab-based experiments will provide observations on 'bulk' measurements of micronutrient trace elements (including iron), their solubility in fresh and saline waters, their processing during long-range transport and cycling, and their bioavailability to marine phytoplankton. Isotopic tracers (radon-222, δ56Fe) and back-trajectories will be used to differentiate the source, fetch and air type.

Piggy back project

1. Natural products chemistry (Peter Karuso, Macquarie U)

With a focus on sponges and other benthic invertebrates. Collections will be made as part of developing a natural products library, based on Australian biodiversity. The focus of this collection is on fluorescent sponges and corals collected from sled tows. The primary project is to correlate fluorescence in invertebrates with cyanobacterial content (chlorophyll). Multicomponent analysis will require water clarity, latitude, water temperature and depth. It is critical that we have collections from shallow water all the way to 400 m to complete this study.

Investigator equipment (MNF)

Name	Essential	Desirable
Aerosol Sampling Lab	x	
Air Chemistry Lab	x	
Preservation Lab	x	
Constant Temperature Lab	x	
Underway Seawater Analysis Laboratory	x	
GP Wet Lab (dirty)	x	
GP Wet Lab (Clean)	x	
GP Dry Lab (Clean)	x	
Sheltered Science Area with sorting table set up under lifting gantry	x	
Observation deck 07 level		x
Walk in Freezer	x	
Clean Freezer	x	
Blast Freezer	x	
Ultra Low Temperature Freezer	x	
Walk in Cool Room	x	
Trawl catch sorting table positioned in SSA	x	

Name	Essential	Desirable
Modular HazChem Locker	x	
Stern Ramp	x	
CTD - Seabird 911 with 36 Bottle Rosette	x	
Sonardyne USBL System	x	
Milli -Q System	x	
Electronic Fish Measuring Boards	x	
Heavy Duty Electronic Balance	x	
Medium Duty Electronic Balance	x	
Light Duty Electronic Balance	x	
Bongo Net	x	
Portable pot hauler	x	
Beam Trawl (to be used as back up only if main nets lost)	x	
Dissecting Microscopes with camera	x	
MIDOC with 100 micron mesh size net	x	
Trawl monitoring instrumentation (ITI)	x	
Radiosonde	x	
Liquid N2 in the bank for dry shipper	x	
Deep tow camera	x	
Sherman epibenthic sled (backup in case lighter ones are lost)	x	
Trawl doors (pelagic or demersal)	x	
75kHz ADCP	x	
150kHz ADCP	x	
Multi Beam echo sounder EM710 70-100kHz (0-1000m approx)	x	
Sub-Bottom Profiler SBP120		x
Scientific Echo Sounders EK60 (6 bands, 12kHz-333kHz)	x	
Thermosalinograph	x	
Atmospheric Underway Sensors	x	
Biological Oceanography Underway Sensors	x	
Fluorometer	x	
Optode	x	
PCO2		x
Trace metal clean seawater supply	x	

We plan to transfer the fish catch from the main deck to the sorting table located in the sheltered science area and we will use two large megabins for this. Each megabin will need a pallet trolley suitable for use on the deck (there are sunken tie down points that will be a hazard to wheels).

In addition, the following MNF equipment is required to be installed in the aerosol lab:

1. Air Sampling Pump Controller (built by Ian McRobert, CSIRO) -- Sector control switch used to switch vacuum pumps on/off and enable sampling of air only when the ship is in a 'clean' sector (i.e., prevents contamination of samples by sampling air impacted by the ship's exhaust); requires Ethernet data feed of ship's met data.

User Equipment

Item name	Supporting information
McKenna demersal trawl net x 3	McKenna trawl net similar to Frank & Bryce design (25.6 m headrope, 31.7 m footrope, 1.5-2.5 m net height), deployed from stern, 30 min trawl haul at a speed 2.5 to 3.5 kn
Trawl headline camera assembly	A camera and lights will be deployed from the trawl headline using an arrangement similar to the Evologics package used on IN2017_V03
Cleveland epibenthic sled 1.5 m x 0.5 m and codend (prawn mesh) x 3	Similar design to the MNF Sherman sled but a lighter design able to go off the GP winch
Additional sorting table	We plan to source a sorting table for the night sled work, most likely to be positioned aft on the starboard side of the main deck
Camera and light system to mount inside the sled mouth	200m rated housing and go pro5 camera system with lights will be mounted inside the sled mouth facing outwards
Fluorometer	Turner design 10 Au, benchtop equipment, no computer connection required
Fluorometer	BMG CLARIOstar, fluorescence plate reader, located in the dry lab. No computer connection required
Filtering manifold x 2	manifold to filter sea water size 40x70x40 cm – benchtop equipment, no computer connection required
Turbulence probe	Rockland VMP-200,
Freezer container	- 20^{o}C freezer container (shipping container for main deck)
Deck box	Deck box for bongo nets
Electronic fish boards	Jeff Cordell has these. These provide a rapid method of measuring fish
LISST 100X	Particle sizer to be mounted on CTD rosette
LISST 200X	Particle sizer to be mounted on CTD rosette
Flexible tape measure on reel	To measure large sharks and rays on deck

Item name	Supporting information
Aerosol sampling system (UTAS/CSIRO)	Includes pumps, flow meters, tubing and filtration holders
Laminar flow hood (UTAS)	To be installed in aerosol lab, for clean sampling and sample handling
Sampling bottles (UTAS)	To collect seawater from ship's trace metal clean underway supply (in laminar flow hood outlet in clean wet lab)
Rain sampler (UTAS)	Polyethylene funnel and collection bottle, to be installed on 05 level outside of bridge equipment room (no power required)

Special Requests

1. Shift leader to have radio for easy location and comms with bridge and ops room
2. Aerosols team require access to laminar flow hood in wet clean lab of the ship to sample from the trace metal clean underway supply system
3. Aerosols team require access to chemical storage locker (for up to 3 L of concentrated hydrochloric acid)
4. ASP – please provide advance notice of incineration events and a final record of incineration events for the voyage to the aerosols team.
5. MNF we will need 2 preferably 3 pallet trolleys on back deck for moving Megabins full of water and fish.

Permits

Exemption from WA Fisheries Act for collecting marine organisms (obtained)

Collecting permit from the WA Department of Parks and Wildlife (plants) (obtained)

Collecting permit from the WA Department of Parks and Wildlife (animals) (obtained)

AFMA permit for collecting fish from Commonwealth waters (obtained)

Parks Australia permit for collecting under EPBC Act including in the Montebello Commonwealth Marine Reserve (CMR) (obtained)

Parks Australia permit for collecting in Commonwealth waters (obtained)

Parks Australia permit to collected EPBC listed species (obtained)

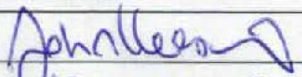
Animal ethics approval from CSIRO for fish and cephalopod capture (obtained)

Personnel List

	Name	Role	Affiliation
1.	Max McGuire	Voyage Manager	CSIRO MNF
2.	Brett Muir	SIT Support	CSIRO MNF
3.	Nicole Morgan	SIT Support	CSIRO MNF
4.	Hugh Barker	DAP Support	CSIRO MNF
5.	Peter Shanks	DAP Support	CSIRO MNF
6.	Peter Hughes	Hydrochemistry Support	CSIRO MNF
7.	Jamie Derrick	Mechanical Technician	CSIRO MNF
8.	Jason Fazey	Mechanical Technician	CSIRO MNF
9.	Amy Nau	GSM Support	CSIRO MNF
10.	Frances Cooke	GSM Support	CSIRO MNF
11.	John Wakeford	Fishing Manager	ASP
12.	Fishing Crew 1	Fishing Crew 1	ASP
13.	Fishing Crew 2	Fishing Crew 2	ASP
14.	John Keesing	Chief Scientist + Fish trawl - Invertebrate sorting	CSIRO
15.	Matt Lansdell	Fish trawl	CSIRO
16.	Keith Sainsbury	Fish trawl	CSIRO
17.	Alan Williams/ Frank Coman	Dep. Chief Scientist	CSIRO
18.	John Pogonoski	Fish trawl	CSIRO
19.	Alistair Graham	Fish trawl	CSIRO
20.	Sue Cheers/ Hector Lozano-Montes	Epibenthic sled	CSIRO
21.	Brett Chrisafulli/Christopher Dowling	Fish trawl	WA Fisheries
22.	Dion Boddington/ Craig Skepper	Fish trawl	WA Fisheries
23.	Margaret Miller	Fish trawl	CSIRO
24.	Nick Mortimer	Night shift Ops room Manager - Biophysics	CSIRO
25.	Joanna Strzelecki	Plankton net and Smith McIntyre grab ops –	CSIRO
26.	Huabin Mao	Hydrodynamics	CAS/CSIRO
27.	James McLaughlin	Phytoplankton	CSIRO
28.	Morgane Perron	Atmospheric monitoring (	UTAS
29.	Mark Green	Fish Trawl Invertebrate and plant sorting and identification. Also responsible for Grab sampling	CSIRO
30.	Maylene Loo	Epibenthic sled	CSIRO
31.	Camilla Novaglio	Fish trawl	CSIRO
32.	Belinda Glasby	Fish Trawl	CSIRO
33.	Monika Bryce	Epibenthic sled	CSIRO
34.	Qingxi Han	Epibenthic sled	CSIRO
35.	Christiano Giordani	Epibenthic sled	Macquarie Uni
36.	Tracee Nguyen	Fish Trawl	CSIRO
37.	Peter Karuso	Fish Trawl	Macquarie Uni

	Name	Role	Affiliation
38.	Kate Naughton	Fish Trawl	Museum Victoria
39.	Tonya Van Der Velde*	Epibenthic sled	CSIRO
40.	Gary Fry*	Epibenthic sled	CSIRO

Signature

Your name	John Keesing
Title	Chief Scientist
Signature	
Date:	10 - 10 - 2017

List of planned sampling sites

Station Number	Long (DDD.dd)	Lat (DD.dd)	Lat (DDMM.mm)	Long (DDDMM.mm)	Comments
1	115.73	-20.6	20° 36'.000S	115° 43'.800E	OK - Between Wellhead and Prod. Linda
2	116.03	-20.57	20° 34'.200S	116° 01'.800E	OK - Shipping Fairway
3	116.13	-20.56	20° 33'.599S	116° 07'.799E	OK - 1.6nm from Communications Cable
4	117.21	-20.36	20° 21'.600S	117° 12'.599E	OK
5	**117.11**	**-20.22**	**20° 13'.199S**	**117° 06'.599E**	**Anchorage Zone**
6	117.39	-20.29	20° 17'.399S	117° 23'.400E	OK - Shipping Fairway
7	117.2	-20.133	20° 07'.997S	117° 12'.000E	OK - Anchorage 1.5nm
8	116.97	-20.31	20° 18'.599S	116° 58'.199E	OK
9	117.71	-20.16	20° 09'.600S	117° 42'.599E	OK
10	117.92	-20.16	20° 09'.600S	117° 55'.200E	OK
11	118.21	-19.91	19° 54'.600S	118° 12'.599E	OK
12	116.5667	-19.467	19° 28'.002S	116° 34'.001E	OK - Edge of Caution Zone - Prod. Platform Angel
13	115.77	-19.92	19° 55'.200S	115° 46'.199E	OK
14	115.75	-20.34	20° 20'.400S	115° 45'.000E	OK
15	115.91	-20.62	20° 37'.200S	115° 54'.599E	OK - Shipping Fairway - Edge of Communications Cable Zone
16	115.85	-20.42	20° 25'.200S	115° 50'.999E	OK - Shipping Fairway
17	116.11	-20.35	20° 21'.000S	116° 06'.599E	OK - 1.2nm from Wellhead
18	116.02	-20.5	20° 30'.000S	116° 01'.199E	OK
19	116.28	-20.39	20° 23'.400S	116° 16'.800E	OK - Shipping Fairway
20	**116.54**	**-20.33**	**20° 19'.799S**	**116° 32'.400E**	**Anchorage Zone**
21	117.72	-19.84	19° 50'.400S	117° 43'.199E	OK - Shipping Fairway
22	117.44	-20.05	20° 03'.000S	117° 26'.399E	OK
23	117.99	-19.62	19° 37'.200S	117° 59'.399E	OK
24	118.23	-19.75	19° 45'.000S	118° 13'.800E	OK
25	118.2167	-19.7	19° 42'.000S	118° 13'.002E	OK

Station Number	Long (DDD.dd)	Lat (DD.dd)	Lat (DDMM.mm)	Long (DDDMM.mm)	Comments
26	116.68	-19.46	19° 27'.600S	116° 40'.800E	OK - Wellhead 1.4nm
27	116.34	-19.69	19° 41'.400S	116° 20'.400E	OK - Wellhead 1.5nm
28	116.5333	-19.683	19° 40'.997S	116° 31'.997E	OK
29	116.77	-19.46	19° 27'.600S	116° 46'.199E	OK
30	117.05	-20	20° 00'.000S	117° 02'.999E	OK
31	116.73	-19.55	19° 33'.000S	116° 43'.800E	OK
32	116.79	-19.51	19° 30'.600S	116° 47'.400E	OK
33	117.61	-19.31	19° 18'.599S	117° 36'.600E	OK
34	117.56	-19.43	19° 25'.800S	117° 33'.600E	OK
35	117.8833	-19.25	19° 15'.000S	117° 52'.998E	OK
36	118.14	-19.45	19° 27'.000S	118° 08'.400E	OK
37	116.14	-19.71	19° 42'.600S	116° 08'.400E	OK
38	116.26	-19.82	19° 49'.200S	116° 15'.600E	OK - Edge of Communications Cable Zone
39	117.7	-19.38	19° 22'.799S	117° 42'.000E	OK
40	116.46	-19.8	19° 48'.000S	116° 27'.599E	OK
41	116.56	-19.65	19° 38'.999S	116° 33'.600E	OK
42	117.3	-19.89	19° 53'.400S	117° 17'.999E	OK
43	116.03	-19.78	19° 46'.800S	116° 01'.800E	OK
44	116.56	-19.79	19° 47'.399S	116° 33'.600E	OK - Wellhead 1.1nm and also Wellheads to Northwest and South
45	**117.28**	**-19.82**	**19° 49'.200S**	**117° 16'.800E**	**Inside Wellhead Zone**
46	115.69	-19.91	19° 54'.600S	115° 41'.399E	OK
47	115.82	-19.95	19° 57'.000S	115° 49'.199E	OK - Shipping Fairway
48	115.97	-20.02	20° 01'.199S	115° 58'.199E	OK
49	115.77	-20.2	20° 12'.000S	115° 46'.199E	OK
50	115.97	-20.25	20° 15'.000S	115° 58'.199E	OK - Wellhead 1.1nm to North
51	116.45	-20.183	20° 10'.997S	116° 27'.000E	OK - Wellhead 1.1nm and edge of Platform Caution Zone
52	117.62	-19.68	19° 40'.800S	117° 37'.200E	OK
53	117.63	-19.51	19° 30'.600S	117° 37'.799E	OK
54	117.6333	-19.617	19° 37'.002S	117° 37'.998E	OK
55	117.6667	-19.5	19° 30'.000S	117° 40'.002E	OK
56	117.83	-19.71	19° 42'.600S	117° 49'.799E	OK
57	117.93	-19.4	19° 23'.999S	117° 55'.800E	OK
58	116.04	-19.96	19° 57'.600S	116° 02'.400E	OK
59	**116.3**	**-20.16**	**20° 09'.600S**	**116° 17'.999E**	**Inside Wellhead Zone**
60	116.7167	-19.8	19° 48'.000S	116° 43'.002E	OK
61	116.52	-19.71	19° 42'.600S	116° 31'.199E	OK
62	116.74	-20.06	20° 03'.599S	116° 44'.399E	OK - Shipping Fairway
63	116.8	-19.82	19° 49'.200S	116° 47'.999E	OK
64	117.0833	-19.8	19° 48'.000S	117° 04'.997E	OK - Shipping Fairway
65	117.25	-19.88	19° 52'.799S	117° 15'.000E	OK
66	117.3	-19.6	19° 36'.000S	117° 17'.999E	OK - Shipping Fairway
67	118.03	-19.41	19° 24'.600S	118° 01'.800E	OK

Station Number	Long (DDD.dd)	Lat (DD.dd)	Lat (DDMM.mm)	Long (DDDMM.mm)	Comments
68	116.13	-19.88	19° 52'.799S	116° 07'.799E	OK
69	116.66	-19.73	19° 43'.800S	116° 39'.599E	OK - Near Wellhead 1.1nm
70	116.3333	-19.983	19° 58'.998S	116° 19'.997E	OK - Near Oil Field Production Platform (Reindeer) Caution Zone
71	116.7833	-19.983	19° 58'.998S	116° 46'.997E	OK
72	116.72	-19.76	19° 45'.600S	116° 43'.199E	OK
73	117.58	-19.48	19° 28'.800S	117° 34'.799E	OK
74	118.22	-19.33	19° 19'.799S	118° 13'.199E	OK
75	116.19	-20.13	20° 07'.799S	116° 11'.399E	OK
76	116.63	-19.8	19° 48'.000S	116° 37'.799E	OK
77	116.49	-19.79	19° 47'.399S	116° 29'.399E	OK
78	115.81	-20.06	20° 03'.599S	115° 48'.600E	OK - Shipping Fairway
79	115.88	-20.1	20° 06'.000S	115° 52'.799E	OK - 1.6nm from Pipeline
80	115.89	-20.11	20° 06'.599S	115° 53'.400E	OK - 1.2nm from Pipeline
81	115.94	-20.18	20° 10'.800S	115° 56'.399E	OK
82	115.94	-20.2	20° 12'.000S	115° 56'.399E	OK
83	116.06	-20.13	20° 07'.799S	116° 03'.600E	OK
84	116.34	-20.09	20° 05'.399S	116° 20'.400E	OK - 1.5nm from Pipeline
85	116.68	-19.93	19° 55'.800S	116° 40'.800E	OK
86	116.6667	-19.833	19° 49'.998S	116° 40'.002E	OK
87	116.88	-19.86	19° 51'.600S	116° 52'.799E	OK - Shipping Fairway
88	118.12	-19.34	19° 20'.400S	118° 07'.200E	OK
89	116.17	-20.09	20° 05'.399S	116° 10'.200E	OK
90	116.35	-20.05	20° 03'.000S	116° 20'.999E	OK - Edge of Caution Zone - Prod. Platform Reindeer
91	116.61	-20	20° 00'.000S	116° 36'.600E	OK
92	116.55	-19.97	19° 58'.199S	116° 32'.999E	OK
93	116.65	-19.95	19° 57'.000S	116° 39'.000E	OK
94	116.14	-20.12	20° 07'.200S	116° 08'.400E	OK
95	116.61	-19.94	19° 56'.400S	116° 36'.600E	OK
96	**116.63**	**-19.84**	**19° 50'.400S**	**116° 37'.799E**	**Inside Wellhead Zone**
97	115.99	-20.25	20° 15'.000S	115° 59'.399E	OK
98	116.01	-20.22	20° 13'.199S	116° 00'.600E	OK
99	116.03	-20.21	20° 12'.600S	116° 01'.800E	OK
100	116.36	-20.17	20° 10'.200S	116° 21'.600E	OK - Between 3 Wellhead Zones