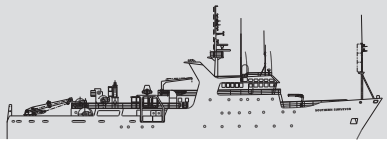


MARINE
NATIONAL FACILITY

2012 program

RV Southern Surveyor

CSIRO

voyagesummaryss2012_t03

ss2012_v01

Voyage: Sources, distribution and fate of floating marine plastics

Voyage Period

Start: 07/06/2012
End: 18/06/2012
Port of departure: Lautoka, Fiji
Port of return: Hobart, Tasmania, Australia

Responsible laboratory

Environmental Systems Engineering & UWA Oceans Institute
The University of Western Australia & CSIRO Marine and Atmospheric Research

35 Stirling Highway, M470,
Crawley, Perth, WA, 6009
Australia

Chief Scientist

Julia Reisser

Scientific Objectives

Marine plastics have become a major hazard to marine life through ingestion and entanglement and are also leading to aesthetic degradation, economic losses and human health hazards. The increase in amounts of marine debris can be attributed to at least three factors:

1. plastics replacing natural fibers in the manufacture of many everyday items;
2. plastics are often less expensive than the materials they replace, thereby decreasing incentives to reuse or recycle items;
3. there are simply more ships and coastal residents that can lose or discard materials. Monitoring studies are needed to assess the effectiveness of governments' actions in reducing the overall amount of marine plastics.

Marine plastics can immediately sink to the seafloor or can float for extended periods before being cast ashore, or can be pushed offshore and kept in regions of convergences. Only limited data exist to quantify and explain the geographical range and content of floating marine plastics (FMP) in our oceans. While shore-based studies may provide a first approximation to their composition and abundance in adjacent seas, they nevertheless represent only the fraction of marine plastics that have been cast ashore. An understanding of FMP dynamics can only be obtained by surveys at sea. Computer models (particle tracking codes and statistical models using tracks of oceanographic buoys) have been used to predict marine debris spatial distribution but the outputs have yet to be validated.

The general aim of this project is to estimate composition and concentration (pieces/km^2) of floating marine plastics at different locations around Australia. Additionally, potential sources of marine plastics will be identified through the development of a dispersal model able to chart the likely pathways taken by plastics at the oceans surface.

Voyage Objectives

Estimate concentration (pieces/km^2) of floating marine plastics along the ss2012 _ t03 transit voyage track using trawling and visual surveys.

Trawling surveys involved the execution of three 15 minutes manta net tows (Figure 1) using a manta net (335 micron mesh). The collected contents were placed in seawater to facilitate the visualization of floating marine plastics. The plastics pieces collected were placed in small glasses containing glutaraldehyde 2.5% and further analysis will be carried out at University of Western Australia. The remaining contents (zooplankton) were placed in 500ml plastic jars containing alcohol. These samples will be weighed at the University of Western Australia and some organisms will be donated to museums and researchers of other universities.

Additionally, this transit voyage also aimed to support other projects

1. measuring greenhouse gases concentrations along the transit voyage route
2. collecting benthic isopods for genetic analysis,
3. towing a Continuous Plankton Recorder (CPR) in waters close to Tasmania,
4. using a Simrad EM300 multibeam system to map the seafloor along the transit voyage route.

Results

Trawling Surveys: The mean concentration of plastic pieces found at locations sampled during this transit voyage (N=12) and in other Southern Surveyor transit voyages can be visualised in Figure 2. These numbers are likely to change due to a potential misclassification of the encountered floating pieces (instead of plastic, they can be made of other natural or man-made materials). Future analyses (microscopic observation and Fourier transform infrared spectroscopy) will confirm the nature of these pieces, giving us a better picture of which types of marine floating plastic occur in waters close to the Australian continent.

Observational Surveys: Figure 3 shows the amount of large marine debris sighted at the different locations (N = 8) sampled during this transit voyage. Rubbish was only found close to the Fijian coast, indicating that this country is a major source of marine plastics to South Pacific. Floating marine debris sighted in Fijian waters (total search time = 2 h and 23 min) included pieces of hard plastic (N = 17), fragments of soft plastic (N = 8), plastic bags (N = 5), plastic bottles (N = 3), fragments of Styrofoam (N = 3), plastic lid (N = 1), kitchen sponge (N = 1), can (N = 1), shoe (N = 1) and slipper (N = 1).

Voyage Narrative

Thursday 7th June 2012

Wind 12 kn from 205°, sea state 3 (17:00, local time)

09:00 safety induction for science party

10:00 transit voyage starts

10:15 visual survey

11:00 ship emergency muster

12:47 visual survey

15:15 visual survey

17:00 continuous swath mapping and greenhouse gases measurements started

17:30 toolbox meeting to discuss deployments and recovery of manta net

18:04-18:55 3 15 minutes net tows (18° 33.8'S, 176° 30.3'E)

Friday 8th June 2012

Wind 15 kn from 215°, sea state 3 (17:00, local time)

06:00-06:52 3 15min net tows (19° 58.4'S, 175° 59.5'E)

12:51 visual survey

18:03-18:54 3 15min net tows (21° 16.1'S, 173° 35.1'E)

Saturday 9th June 2012

Wind 15 kn from 155°, sea state 4 (17:00, local time)

05:58-06:48 3 15min net tows (22° 38.3'S, 172° 02.8'E)

18:00-18:48 3 15min net tows (23° 39.1'S, 170° 40.3'E)

Sunday 10th June 2012

Wind 12 kn from 115°, sea state 3 (17:00, local time)

05:58-06:45 3 15min net tows (25° 04.4'S, 168° 42.5'E)

17:55-18:45 3 15min net tows (26° 11.7'S, 167° 08.6'E)

Monday 11th June 2012

Wind 30 kn from 136°, sea state 6 (17:00, local time)

05:58-06:47 3 15min net tows (27° 31.9'S, 165° 11.4'E)

Tuesday 12th June 2012

Wind 45 kn from 125°, sea state 9 (17:00, local time)

Scientific activities cancelled due to bad weather

Wednesday 13th June 2012

Wind 25 kn from 170°, sea state 7 (17:00, local time)

Scientific activities cancelled due to bad weather

Thursday 14th June 2012

Wind 14 kn from 150°, sea state 4 (17:00, local time)

Scientific activities cancelled due to decreased available time.

Friday 15th June 2012

Wind 16 kn from 355°, sea state 3 (17:00, local time)

10:01-10:52 3 15min net tows (35° 38.5'S 155° 04.6'E)

15:43 visual survey

20:30 toolbox meeting to discuss deployment of CPR

21:58-22:51 3 15min net tows & CPR deployed (37° 22.5'S, 153° 32.3'E)

Saturday 16th June 2012

Wind 16 kn from 310°, sea state 4 (17:00, local time)

Scientific activities cancelled due to decreased available time

Sunday 17th June 2012

Wind 22 kn from 235°, sea state 4 (17:00, local time)

08:59-09:51	3 15 min net tows (42° 19.8'S, 148° 56.0'E)
12:00	visual survey,
13:55-14:45	3 15 min net tows & CPR retrieved (42° 49.5'S, 148° 27.0'E)
15:30	toolbox meeting to discuss deployment and retrieval of grabs
16:11-16:50	2 Smith Mac grabs at ~ 500m (42° 59.3'S, 148° 17.1'E)

Summary

ss2012 _ t03 transit voyage from Lautoka to Hobart was successfully completed. The bad weather conditions did not allow us to sample waters at intermediate latitudes (around 30°S) so we could not test a hypothesis recently proposed by marine researchers: FMD concentrations tend to be higher at subtropical latitudes. The transit voyage was completed on time. It has partially achieved its objectives. We are confident that following our post-voyage analyses of the marine plastics collected at this and other transit voyages, a publication of high impact will be issued. The information collected onboard Southern Surveyor will be a main component of Reisser's PhD thesis and it will also contribute to a national marine debris audit being undertaken by CSIRO's Wealth from Oceans National Research Flagship (PI: Denise Hardesty and Chris Wilcox).

Principal Investigators

A. Julia Reisser - University of Western Australia & CSIRO (Julia.Reisser@csiro.au)

B. Clare Murphy - University of Wollongong (clarem@uow.edu.au)

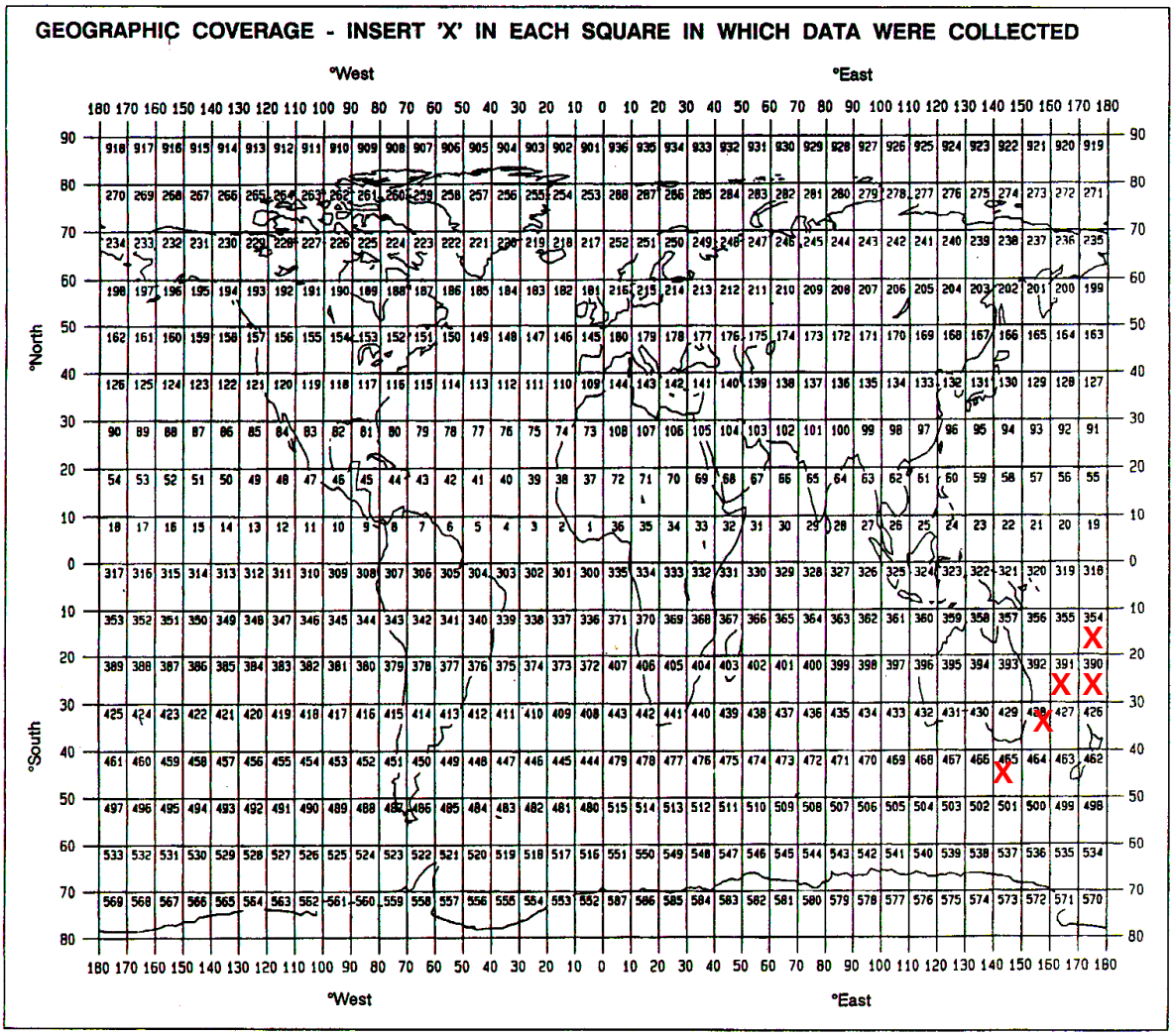
C. Luana Lins - University of Sydney (luana.lins@sydney.edu.au)

D. Anthony Richardson – CSIRO (Anthony.Richardson@csiro.au)

Marsden Squares

Move a red "x" into squares in which data was collected

X

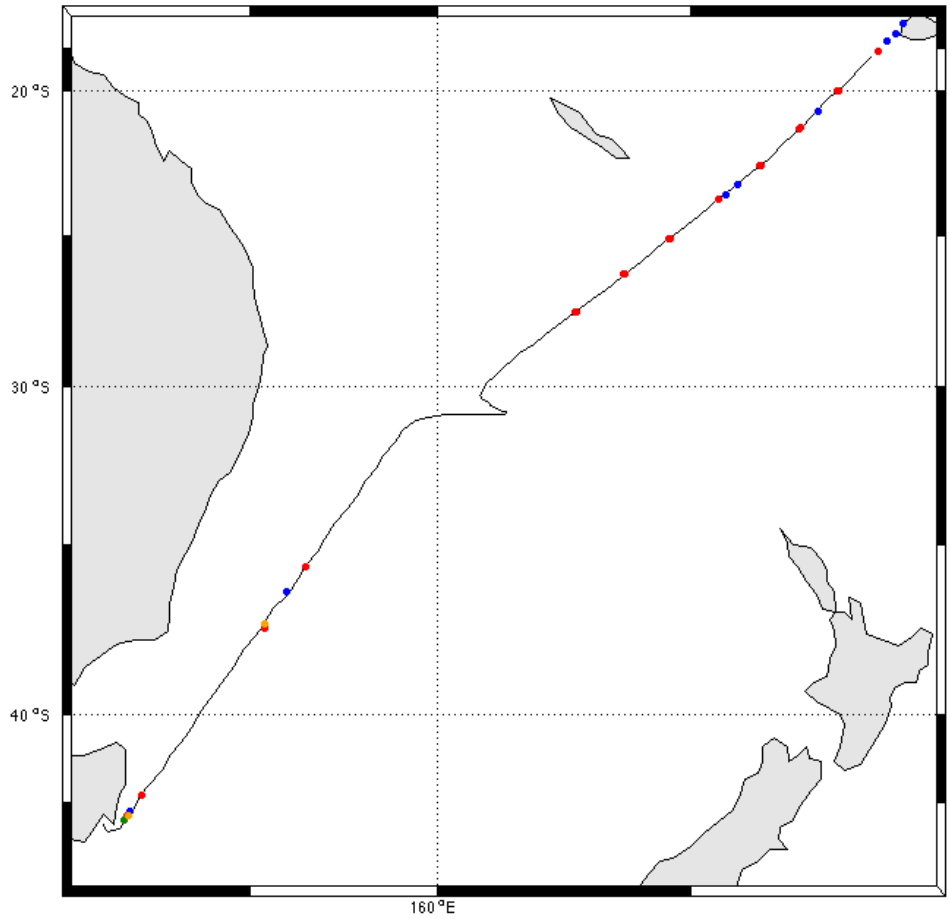


MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS									
Item No	PI See page above.	APPROXIMATE POSITION						DATA TYPE enter code(s) from list on last page.	DESCRIPTION
		LATITUDE			LONGITUDE				
		deg	min	N/S	deg	min	E/W		
1	A	18	33.9	S	176	30.4	E	B10 P90	Equipment: Manta Net 335micron; Depth: water surface (0m); Deployed 7/6/12 06:05 (UTC), Fiji
2	A	19	58.6	S	174	59.4	E	B10 P90	Deployed 8/6/12 18:02 (UTC), Fiji
3	A	21	16.5	S	173	34.9	E	B10 P90	Deployed 8/6/12 06:01 (UTC), Fiji
4	A	22	35.7	S	172	6.7	E	B10 P90	Deployed 09/6/12 17:59 (UTC), New Caledonia
5	A	23	45	S	170	32.1	E	B10 P90	Deployed 09/6/12 06:01 (UTC), New Caledonia
6	A	25	04.3	S	168	42.7	E	B10 P90	Deployed 10/6/12 18:59 (UTC), New Caledonia
7	A	26	17.1	S	167	00.9	E	B10 P90	Deployed 10/6/12 06:57 (UTC), New Caledonia
8	A	27	31.6	S	165	11.7	E	B10 P90	Deployed 11/6/12 18:59 (UTC), Australia
9	A	35	38.6	S	155	04.5	E	B10 P90	Deployed 15/6/12 00:02 (UTC), International waters
10	A	37	22.4	S	153	32.4	E	B10 P90	Deployed 15/6/12 11:59 (UTC), Australia
11	D	37	22.7	S	153	32.2	E	B08 B09	Equipment: Continuous Plankton Recorder; Depth: ~10m; Deployed 15/6/12 12:10 (UTC), Australia
12	A	42	16.9	S	148	58.8	E	B10 P90	Deployed 17/6/12 22:59 (UTC), Australia
13	A	42	49.5	S	148	58.2	E	B10 P90	Deployed 17/6/12 3:57 (UTC), Australia
14	D	42	49.7	S	148	26.9	E	B08 B09	Equipment: Continuous Plankton Recorder; Depth: ~10m; Deployed 17/6/12 04:05 (UTC), Australia
15	C	42	59.5	S	148	17.2	E	B18 G02	Equipment : Smith-McIntyre grab; Depth: 450 Deployed 17/6/12 06:11 (UTC), Australia

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN					
Item No.	PI see page above	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on last page	DESCRIPTION
1	B	2239	Nautical Miles	M71	Continuous green house gases measurements (CH4, CO2, N2O, del13C , CO, O3)
2	E	2239	Nautical Miles	D71	Acoustic Doppler Current Profiler (ADCP)
3	E	2239	Nautical Miles	G74	Echo sounders 12khz, 38 khz, 120 khz
4	E	2239	Nautical Miles	M06	Continuous Navigation (NAV), Sounder, Thermosalinograph (TSG) and Meteorological (MET) data
5	E	2239	Nautical Miles	G74	Swath EM300
6	E	2239	Nautical Miles	M06	Underway pCO2 system
7	A	13	500 ml plastic jars	B10	Zooplankton samples collected with a Manta net 335micron preserved in 70% alcohol
8	A	31	10 ml glass jars	P90	Marine debris samples collected with a Manta net 335micron preserved in 2.5% glutaraldehyde
9	C	2	200ml plastic jars	G02 B18	Sediment samples collected with a Smith Mac grab at approx. 500m
10	D	1	CPR cassette	B08 B09	CPR sample preserved in formalin

Curation Report

Item No.	DESCRIPTION
1	Greenhouse gases data held by Clare Murphy, School of Chemistry, University of Wollongong, email: clarem@uow.edu.au
2	Acoustic Doppler Current Profiler (ADCP) data held by CSIRO Marine and Atmospheric Research, email: pamela.brodie@csiro.au
3	Echo sounders 12khz, 38 khz, 120 khz data held by CSIRO Marine and Atmospheric Research - Hobart, email: pamela.brodie@csiro.au
4	Continuous Navigation (NAV), Sounder, Thermosalinograph (TSG) and Meteorological (MET) data data held by CSIRO Marine and Atmospheric Research, email: pamela.brodie@csiro.au
5	EM300 multibeam data held by CSIRO Marine and Atmospheric Research - Hobart, email: pamela.brodie@csiro.au
6	Underway pCO2 system data held by CSIRO Marine and Atmospheric Research - Hobart, email: pamela.brodie@csiro.au
7	Zooplankton samples held by Julia Reisser, Environmental Systems Engineering & UWA Oceans Institute, University of Western Australia & CSIRO Marine and Atmospheric Research, email: julia.reisser@csiro.au
8	Marine debris held by Julia Reisser, Environmental Systems Engineering & UWA Oceans Institute, University of Western Australia & CSIRO Marine and Atmospheric Research, email: julia.reisser@csiro.au
9	Smith Mac grab samples held by Luana Lins, University of Sydney, email: luana.lins@sydney.edu.au
10	Continuous Plankton Recorder data held by CSIRO Marine and Atmospheric Research CPR group, email: Anthony.Richardson@csiro.au



TRACK CHART – with net tow (red), visual surveys (blue), grabs (green) and CPR deployment and recovery (yellow) positions

GENERAL OCEAN AREA(S)

Southwest Pacific Ocean, Tasman Sea

Personnel List

Scientific Participants

Name	Affiliation	Role
Julia Reisser	UWA/CSIRO	Chief Scientist
Luana Lins	USYD	Benthic Isopods Project
Chris Wilcox	CSIRO	Marine Plastics Project
Dagmar Kubistin	UOW	Greenhouse gases Project
Stephen McCullum	CMAR	MNF Voyage Manager
Brett Muir	CMAR	MNF Electronics Support
Pamela Brodie	CMAR	MNF Computing Support

Marine Crew

Name	Role
Michael Watson	Master
Mike Tuck	Chief Mate
Tom Watson	Second Mate
Nick Fleming	Chief Engineer
Gavin Vaz	First Engineer
Graeme Perkins	Second Engineer
Stephen Leslie	Chief Cook
Peter Graham	2nd Cook
Emma Carlos	Chief Steward
Graham McDougall	CIR
Matt Streat	Integrated Rating
Peter Taylor	Integrated Rating
Nathan Arahanga	Integrated Rating
Robert Spaans	Integrated Rating
Lewis Coombe	TIR

ACKNOWLEDGEMENTS I would like to thank the crew of the RV Southern Surveyor, as well as the Marine National Facility staff for their help. The experiences on board 2011-2012 Southern Surveyor Transit voyages provided me with some useful knowledge, giving me a stronger PhD journey.

Julia Reisser

Chief Scientist

Figure 1. Manta net being towed by research vessel Southern Surveyor.

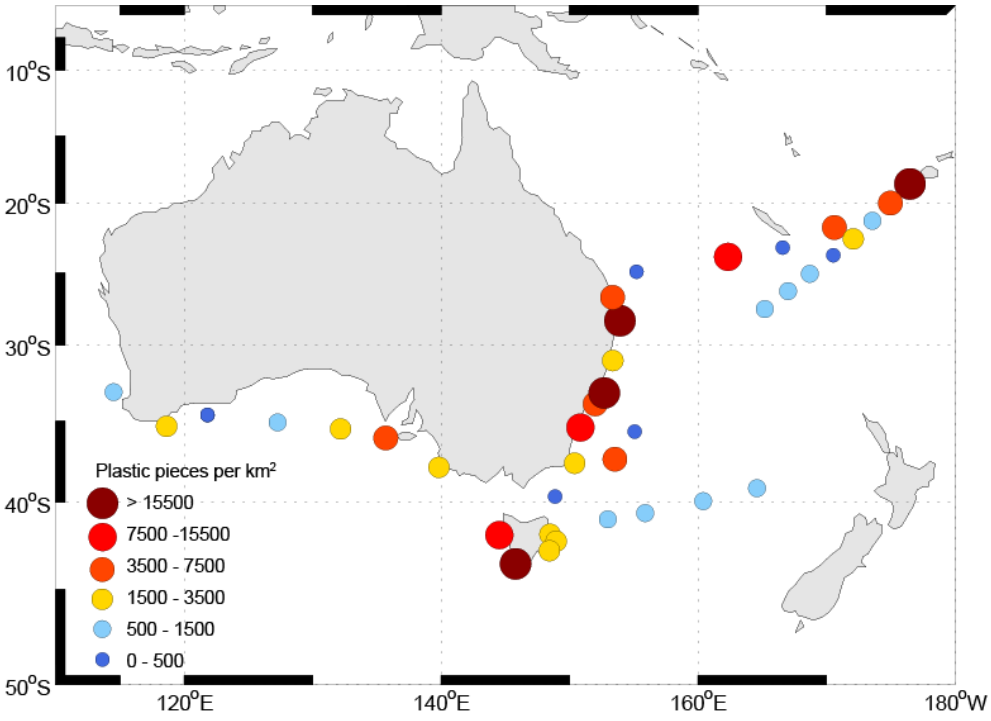


Figure 2. Marine plastic concentration in areas sampled during 2011-2012 Southern Surveyor transit voyages.

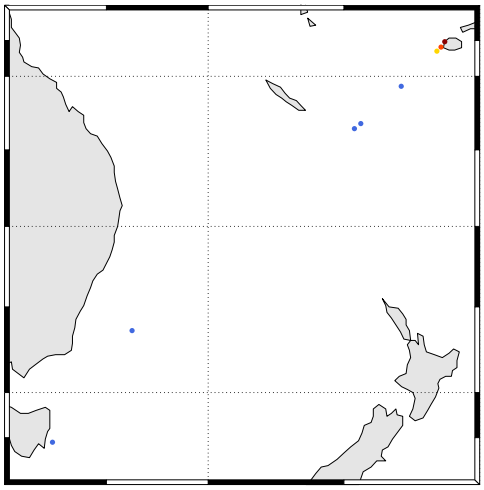


Figure 3. Locations where visual surveys were conducted during ss2012 _ t03. Brown dot indicates a location where 29 items were sighted (search time = 43 min), red bullet shows a place where 8 items were seen (search time = 40 min), yellow dot is where 4 items were registered (search time = 1 hour), and blue dots show locations where no debris was spotted.

Appendices

Appendix 1. Measurements of greenhouse gases in the marine atmosphere

Appendix 2. Transect measurements of plankton distribution in surface waters

Appendix 3. Phylogeny of Deep-sea crustaceans Asellota

Appendix 1 - Measurements of greenhouse gases in the marine atmosphere

Climate change is one of the most pressing global environmental issues of our time. It is driven by atmospheric change, and in particular by the large growth in greenhouse gases. There has been a great number of measurement campaigns focused on the Northern Hemisphere, however the data coverage in the Australasian region is sparse.

To characterize the sources and sinks of the major greenhouse gases in the Australasian region, continuous in situ measurements of the key greenhouse gases methane, carbon dioxide, nitrous oxide, as well as carbon monoxide and ozone were performed during ss2012 _ t03.

The data were collected by using (1) a fully automated Fourier Transform Spectrometer for CH4, CO2, N2O, del13C, CO and (2) a UV absorption instrument for O3. The time resolution was 5 min and 1 min, respectively.

The measurements performed on the ss2012 _ t03 transect from Lautoka to Hobart represent marine background conditions over the Pacific Ocean. The concentrations will be compared with continental influenced air masses, collected during the transit voyage from Hobart to Brisbane (ss2012 _ t01). This unique dataset will help constrain current models of the lower atmosphere, and hence improve our understanding of the processes contributing to the growth and variability of greenhouse gases in the atmosphere.

Appendix 2. Australian Continuous Plankton Recorder Survey

The Australian Continuous Plankton Recorder Survey is funded by the Integrated Marine Observing System (IMOS) and is run as a collaboration between CSIRO and the Australian Antarctic Division.

The survey collects phytoplankton and zooplankton samples from around the Australian coastline and the Southern Ocean using a Continuous Plankton Recorder (CPR), a torpedo shaped device approximately 1 m long and weighing 80 kg.

The recorder is towed behind the ship at about 10 metres depth with seawater and plankton entering through a small opening in the nose. Plankton are trapped between two layers of silk and preserved.

Data resulting from this process are used to: develop baselines relating to the biodiversity and distribution of plankton; document changes in response to climate change; provide indices for fisheries management; detect harmful algal blooms; and validate remote sensing and initialise and test ecosystem models.

For the ss2012 _ t03 transit voyage, the CPR was first deployed at 1210 (UTC) 15 June and then recovered at 0405 (UTC) 17 June 2012. Figure 2 shows the track coverage of the CPR from first deployment to final recovery.

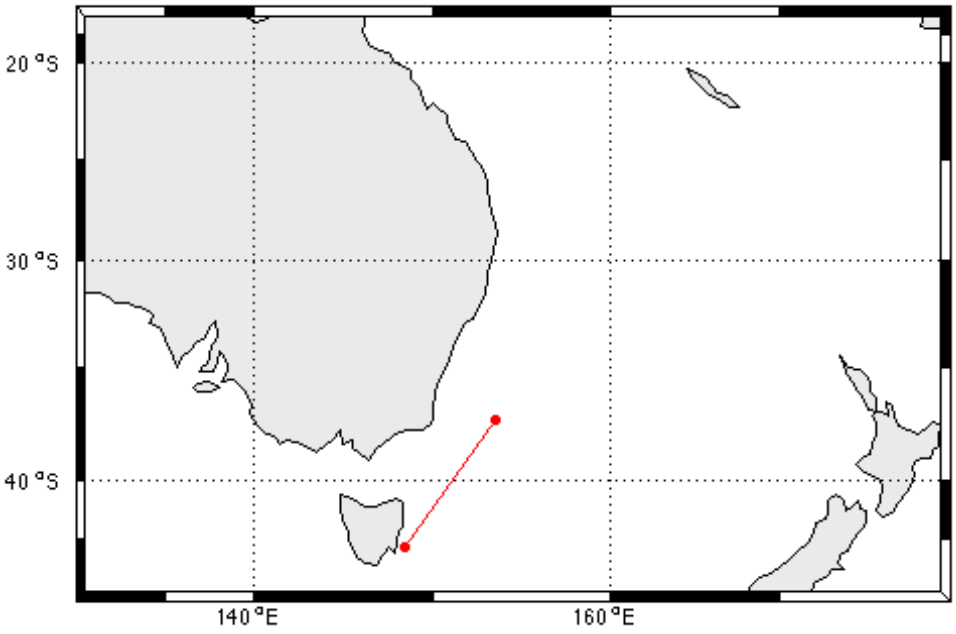


Figure 1. Continuous Plankton Recorder (CPR) tow track during ss2012 _ t03.

Appendix 3. Phylogeny of Deep-sea crustaceans Asellota

The Asellota crustaceans have a great diversity in both family and species number. This group of isopods is present in many basins in the world, but little is known about their evolution, including the processes that led to their current distribution. This project involves the use of molecular and morphological information to investigate the phylogeny and biogeography of the Asellota. Using molecular data will be used to find cryptic species that are difficult to identify using morphological data.

The majority of the samples from around the world are preserved in formalin, which makes it hard to study their genetics. The collection of fresh samples, like the ones collected during this voyage (42° 59.3'S, 148° 17.1'E) using a Smith-McIntyre mud-sampler (Figure 2), is giving PhD student Luana Lins the opportunity to conduct genetic analysis on this group. Understanding the phylogeny of this group should help to reveal general patterns and processes of evolution in the deep-sea fauna.

Figure 1. Example of a deep-sea crustacean Asellota. Specimens from Campos Basin, Brazil.

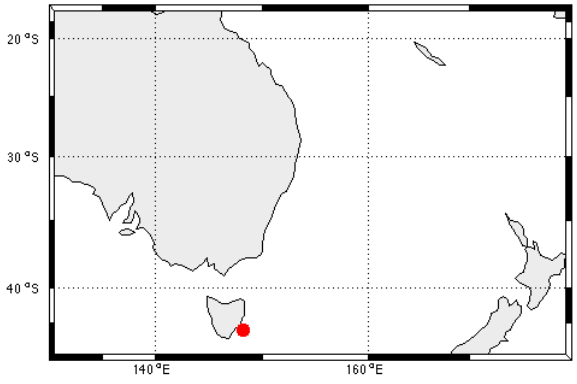


Figure 2. Mud samples location for ss2012 _ t03.

CSR/ROSCOP Parameter CodeS

Meteorology	
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

Physical Oceanography	
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

Chemical Oceanography	
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

Marine Contaminants/Pollution	
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

Marine Biology/Fisheries	
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

Marine Geology/Geophysics	
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements