RV *Investigator* Voyage Plan

Voyage #:	**IN2019_V05**
Voyage title:	Integrated Marine Observing System: monitoring of East Australian Current property transports at 27° S
Mobilisation:	Brisbane Thursday 05 – Sunday 08 September 2019
Depart:	Brisbane 0800 Monday 09 September 2019
Return:	Brisbane 1200 Sunday 29 September 2019
Demobilisation:	Brisbane Monday 30 September 2019
Voyage Manager:	Linda Gaskell MNF Operations Officer
Chief Scientist:	Dr Bernadette Sloyan
Affiliation:	CSIRO
Principal Investigators:	Prof Iain Suthers
Project name:	Dynamics of larval fish diversity for ocean observing off North Stradbroke Island
Affiliation:	University of NSW

Scientific objectives

The East Australian Current (EAC) is a complex and highly energetic western boundary system of the South Pacific Ocean off eastern Australia. It closes the South Pacific subtropical gyre, transporting heat, salt and plankton southward and onto the continental shelf. Off Brisbane (27°S) the EAC is north of the high eddy variability region, approaches its maximum strength and is relatively uniform and coherent. The mooring array is located near the existing long-term XBT transect and satellite altimetry ground tracks. The aim of this observing system is to capture the mean and time-varying flow of the EAC.

This EAC mooring array is a component of IMOS. These observations will provide an intensive reference set of measurements of the EAC over a sustained period for improved understanding of the relationship of EAC with the basin-scale South Pacific gyre. The mooring array will provide a physical context for the impact of the EAC on upwelling and coastal marine ecosystems; on cross-shelf flows such as frontal eddies; and on the validation and interpretation of the EAC system in numerous climate and ocean models.

Voyage objectives

This voyage will recover and re-deploy an array of six full-depth current meter and property (temperature, salinity and pressure) moorings from the continental slope to the abyssal waters off Brisbane (27°S). The observing system is designed to capture the mean and time-varying flow of the EAC. In order to resolve interannual and decadal signals we aim to maintain multi-year deployments of the array.

We will undertake biological and oceanographic sampling, using CTDs, Triaxus tows, bongo nets, SADCP, to characterise the shelf waters off the Stradbroke NRS, and to sample dynamic, ephemeral frontal eddies flowing down from Fraser Island and shelf – boundary exchanges. These observations will enable us to discover the spatial and temporal variability of shelf water and plankton around the Stradbroke Island National Reference Station (NRS) mooring.

The EAC array data is essential to utilise of the IMOS-Coffs moorings and the High Frequency (HF) radar to observe and model cross-shelf flows in upwelling and frontal eddy formation. Both these processes have a fundamental impact on ocean colour (i.e. phytoplankton) and therefore far-reaching effects on annual fisheries productivity and coastal shark interactions along the northern and central NSW coasts.

We will undertake CTD/0_2 and numerous Triaxus and ship ADCP sections across the EAC mooring line and across the shelf-EAC. These surveys will include bongo net tows, Triaxus/SADCP lines in the area between 28°S and 26°S. These operations will occur in between the mooring operations and at the completion of the mooring operations. We will deploy a number of floats (lagrangian SVP drifters, Argo and BCG-Argo) during the voyage.

We will use the 24-bottle rosette with the lowered ADCPs (150 kHz and 300 kHz) attached. We will collect salinity and oxygen samples for calibration of the CTD salinity and oxygen sensors, and nutrient (silicate, phosphate and nitrate) and carbon samples.

The following specific objectives will be completed:

1. Recover and deploy moorings at appropriate locations
2. CTD/rosette stations at each mooring location, with LADCP
3. Calibration CTD cast of recovered Seabird 37 and 39 instruments
4. Triaxus and Ship ADCP sections along the mooring line
5. SADCP/Triaxus across the shelf, slope and into the EAC frontal region.
6. Bongo net tows along the EAC mooring line, and as part of the shelf-slope survey to study the significance of re-circulation features;
7. Bongo nets, CTD and bio-acoustic sampling surrounding the Stradbroke NRS site including opportunistic sampling of frontal eddies; and
8. Deploy various Argo (core and BGC) floats during the voyage
9. Test the CSIRO XBT auto-launcher

Please note: BCG-Argo float deployments will not take place during this voyage due to delays in the delivery of the Argo floats

	EAC_500 (M1)	**EAC_2000 (M2)**	**EAC_3200 (M3)**	**EAC_4200 (M4)**	**EAC_4700 (M5)**	**EAC_4800 (M6)**
Longitude	153.8996 (153° 53.979'E)	153.999 (153° 59.967' E)	154.1301 (154° 7.805' E)	154.2972 (154 ° 17.832' E)	154.6487 (154 ° 38.921' E)	155.2968 (155 ° 17.827' E)
Latitude	-27.3261 (27 ° 19.568' S)	-27.3129 (27 ° 18.778' S)	-27.2841 (27 ° 17.048' S)	-27.2397 (27 ° 14.387' S)	-27.2064 (27 ° 12.385' S)	-27.1009 (27 ° 6.467' S)
Depth	540	1908	3161	4292-10	4779	4790

Table 1. Location of moorings to be recovered.

	EAC_500 (M1)	**EAC_2000 (M2)**	**EAC_3200 (M3)**	**EAC_4200 (M4)**	**EAC_4700 (M5)**	**EAC_4800 (M6)**
Longitude	153.8993 (153° 53.958'E)	154.0026 (154 ° 0.156' E)	154.1356 (154 ° 8.136' E)	154.2971 (154 ° 17.8260' E)	154.6471 (154 ° 38.826' E)	155.2993 (155 ° 17.958' E)
Latitude	-27.327 (27 ° 19.620' S)	-27.3157 (27 ° 18.942' S)	-27.2853 (27 ° 17.118' S)	-27.2498 (27 ° 14.988' S)	-27.2086 (27 ° 12.516' S)	-27.102 (27 ° 6.120' S)
MNF Swath Depth (m) - correction	541	1887	3187-30	4266-10	4777-10	4791-10
Build depth	**541**	**1887**	**3157**	**4256**	**4767**	**4781**

Table 2. Location of moorings to be deployed.

	Latitude	Longitude
In-shore	-27.33 (27° 19.8' S)	153.8 (153° 48' E)
Off-shore	-27.10 (27° 6'S)	155.35 (155° 21' E)

Table 3. On-shore and off-shore locations of SADCP/Triaxus line along the mooring line

	Latitude	Longitude
North Stradbroke	-27.34 (27° 20.5' S)	153.56 (153° 33.73' E)

Table 4. Location of North Stradbroke Island IMOS mooring site

	Latitude	Longitude
Southwest limit	-28.0 (28° 0'S)	153.75 (153° 45'E)
Southeast limit	-27.9 (27° 54'S)	154.25 (154° 15'E)
Northeast limit	-26.5 (26° 30'S)	154.75 (154° 15'E)
Northwest limit	-26.0 (26° 0'S)	153.50 (153° 30'E)

Table 5. Approximate area of shelf-EAC SADCP/Triaxus survey

Operational Risk Management

- Mooring deployment and recovery

  The planned operations with moorings have been identified as potentially high-risk work and will therefore trigger MNF procedures for potentially high-risk operations including toolbox meeting before each operation, operational summary meeting immediately following each operation.

  Moorings will include a rehearsal of high-risk activities and will carry out all moorings operations in alignment with the Moorings Procedure.

- CTD operations

  Support staff and ASP crew involved in the CTD operations have completed risk assessments of this work and will be signing onto deck Job Safety Analysis and Safe Work Instructions, specific for this task.

- Triaxus tows (Tow speed 6-8 knots)

  Due to the level of risk associated of towing the Triaxus (Lines under tension), main deck access will be restricted during periods of Triaxus towing. As a result, Triaxus operations have been scheduled between 1800 – 0700 on days when mooring team will be working on the back deck. Main deck exclusion zones will be demarked to allow for auxiliary mooring operations (i.e. Cleaning/ maintenance) as required, during Triaxus towing periods.

- Bongo Net Tows (Tow speed 3 knots to 40 m depth, 10 minutes each)

  The MNF's 60 or 70 cm diameter bongo net with the 20 kg net depressor will be deployed over the stern through the ship's A Frame as is current SWI required practice. Sampling will usually be at night (19:00 to 01:00, with 2-3 replicates per site; before steaming 1 h to next site. Winds >25 knots can make deployment difficult and may have to be cancelled for the evening.

- Biological Sampling (Chemical usage)

  Formalin and 95% ethanol will be dispensed in the Preservation room fume hood, with gloves and glasses. Samples will be preserved and double bagged, kept in black drums for ease of shipment.

- Argo float deployments (deployment speed 1-2 knots)
  At the desired location or at the completion of a CTD station core Argo floats will be deployed in their cardboard disposable boxes from the fantail and BGC-Argo floats will be deployed using the A-frame, synthetic rope and sea catch release.

Please note: BGC-Argo float deployments will not take place during this voyage due to delays in the delivery of the Argo floats

Risk	Activities impacted	Contingency management
Mooring deployment and recovery	MNF procedures for potentially high-risk operations including toolbox meeting before each operation, operational summary meeting immediately following each operation. Moorings will include a rehearsal of high-risk activities and will carry out all moorings operations in alignment with the Moorings Procedure.	Clear and open communication to be maintained during the voyage
Mooring instrument cleaning	Potential risk of stings and cuts from biology growth on instruments	Use gloves and plastic cleaning implements when handling fouled instruments
CTD Operations	Support staff and ASP crew involved in the CTD operations have completed risk assessments of this work and will be signing onto deck Job Safety Analysis and Safe Work Instructions, specific for this task.	Clear and open communication to be maintained during the voyage. Science party to adhere to instructions of MNF personnel
Triaxus Tows	Triaxus operations have been scheduled between 1800 – 0700, on completion of daily moorings operations, in addition, main deck exclusion zones will be demarked to allow for auxiliary mooring operations (i.e. Cleaning/	Clear and open communication to be maintained during the voyage. Science party to adhere to instructions of MNF personnel

Risk	Activities impacted	Contingency management
	maintenance) as required, during Triaxus towing periods.	
Bongo Net Tows	Support staff and ASP crew involved in the bongo net operations have completed risk assessments of this work and will be signing onto deck Job Safety Analysis and Safe Work Instructions, specific for this task.	Clear and open communication to be maintained during the voyage. Science party to adhere to instructions of MNF personnel
Chemical spills	One 20 L container of formalin will be secured (tied down) in the fume hood, and usually a sheep-drench gun used to dispense 60 mL per 1.2 L jar. Some sorting of preserved samples will occur in the wet lab; waste cubes will be brought to retain 5% formalin waste	Discussion and JSA with MNF safety officer before voyage. Post MSDS forms and follow UNSW Safe-Sys documentation.
Argo (Core) floats	ASP crew will deploy Argo floats following instructions provided by scientific personnel (Bec Cowley)	Clear and open communication to be maintained during the voyage. Science party to adhere to instructions of MNF and ASP personnel
BGC Argo float	ASP crew will deploy BGC Argo floats following instructions provided by scientific personnel.	Clear and open communication to be maintained during the voyage. Science party to adhere to instructions of MNF and ASP personnel

Overall activity plan including details for first 24 hours of voyage

The general plan is a staged recovery and redeployment of the six EAC moorings along the mooring deployment line. We will undertake a CTD station prior to the recovery of a mooring and after a mooring deployment and a few additional stations (approximately 20-25 CTDs). Therefore, with the bongo net sampling we will undertake at approximately 40-45 CTD stations on the voyage. We will also complete several Triaxus and ship ADCP sections along the mooring line during the voyage and complete a closed box survey once mooring operations have been completed.

First 24 hours

Steam from Brisbane to pilot station and then steam directly to the location of the first mooring operation, EAC_4800 recovery site (M6_R). During the transit to the mooring recovery site we will undertake a rehearsal of mooring operations (for example anchor and syntactic sphere movements and lifts), undertake CTD toolbox and a test CTD cast in water depth greater than 2000m. After the CTD training, science personnel will be trained in water sampling procedures by Hydrochemistry staff. We will also continue to setup the deck, mooring gear and instruments. We will undertake a CTD station at the location of EAC_4800 recover site (M6_R) prior to beginning our first mooring recovery operation.

Voyage track example

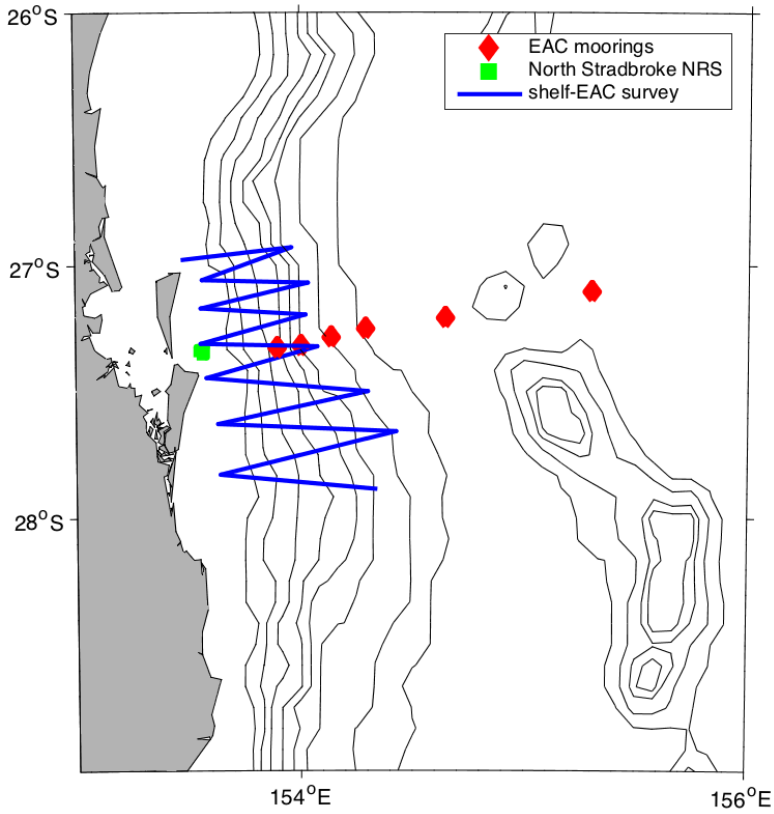

Figure 1: Voyage track including location of moorings, CTD stations, SADCP/Triaxus line along mooring array, and Triaxus/SADCP survey along the shelf- EAC boundary (blue).

Waypoints and stations

List of major operations; mooring operations (recover (_R) and deploy (_D)), full depth CTD stations, ship ADCP/Triaxus line, and shelf-slope survey. The time given is the time for each operation. Please refer to Table 3 (Time Estimates) for actual planned daily schedule as mooring operations will be conducted between the hours of 0600 and 1700hrs.

Transit times are based on a steaming speed of 10 knots, Triaxus/SADCP lines are based on tow speed of 6-8 knots. Triaxus/SADCP and SADCP sections will be undertaken between mooring operations, and Triaxus operations will be between 1800-0600 hours to ensure no one is working below the live tow-wire.

Bongo net tows will usually occur after sunset to 0200, and usually start within 1 hour steam from the vessel's location at ~1600. Between 0200-0600 will be either CTD, Triaxus or re-position vessel for morning's mooring activities.

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming/ CTD/ mooring time (hrs.)	Total time (hrs.)
Brisbane	-27.48	153.13	0	0	0	0
Caloundra	-26.8	153.5	45.3	45.3	6	6
Transit EAC_4800 recovery site (M6_R)	-27.101	155.296	97.4	152.7	9.7	15.7
CTD @ EAC_4800 (M6_R)	-27.101	155.296	0	152.7	3.9	19.6
Recover EAC_4800 (M6_R)	-27.101	155.296	0	152.7	8.0	27.6
Transit EAC_4700 recovery site (M5_R)	-27.206	154.648	35.4	188.1	3.5	31.5
CTD @ EAC_4700 (M5_R), bongo net tows	-27.206	154.648	0	188.1	3.9	35.4
CTD and bongo net tows- enroute to EAC_4200 (M4_R)			10	198	1.2	36.6
Transit EAC_4200 recovery site (M4_R)	-27.239	154.297	18.8	216.8	1.9	38.5
CTD @ EAC_4200 recovery site (M4_R)	-27.239	154.297	0		1.9	40.4
Transit CTD station	-27.158	154.939	36.2	253	4.0	44.4
CTD @ location	-27.158	154.939	0		3.5	47.9
Bongo net tows, calibration CTD of mooring instruments			10	263	3.0	50.9

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming/ CTD/ mooring time (hrs.)	Total time (hrs.)
During transit to EAC_4800 (M6_D)						
Transit EAC_4800 deploy site (M6_D)	-27.102	155.299	17.7	280.7	2.0	52.9
Deploy EAC_4800 (M6_D)	-27.102	155.299	0		10.0	62.9
CTD @ EAC_4800 (M6_D). Bongo net tows	-27.102	155.299	0		3.9	66.8
Transit EAC_4700 (M5_R)	-27.206	154.648	35.4	316.1	3.5	70.3
Recovery EAC_4700 (M5_R)	-27.206	154.648	0		8.0	78.3
Transit to offshore beginning of SADCP line and begin SACP line. Bongo net tows after dusk and CTD casts	-27.10	155.35	38.4	354.5	5.7	84.0
End SADCP line	-27.33	153.8	83.8	438.3	10.5	94.5
Transit to EAC_4700 (M5_D) deployment site. During transit CTDs, Bongo net tows, calibration CTD of recovered mooring instruments	-27.209	154.647	39.6	477.9	10.7	105.2
Deploy EAC_4700 (M5_D)	-27.209	154.647	0		10.0	115.2
CTD @ EAC_4700 (M5_D). Bongo net tows and additional CTDs	-27.209	154.647	0		10.9	126.1
Transit to EAC_4200 (M4_R)	-27.239	154.297	18.8	496.7	2.0	128.1
Recover EAC_4200 (M4_R)	-27.239	154.291	0		8.0	136.1
Transit to offshore beginning of Triaxus/SADCP line	-27.10	155.35	54.2	550.9	2.8	138.9

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming/ CTD/ mooring time (hrs.)	Total time (hrs.)
and begin Triaxus/SACP line						
End Triaxus/SADCP line and recover Triaxus	-27.33	153.8	83.8	634.7	10.5	149.4
Transit to EAC_500 (M1_R) recovery site	-27.329	153.898	3	637.7	0.5	149.9
CTD @ EAC_500 (M1_R)	-27.329	153.898	0		1.4	151.3
Transit to EAC_2000 (M2_R) recovery site	-27.318	154.001	5.5	643.2	0.7	152
CTD @ EAC_2000 (M2_R)	-27.318	154.001	0		2.2	154.2
Transit to EAC_3200 (M3_R) recovery site.	-27.283	-154.137	7.3	650.5	0.8	155
CTD @ EAC_3200 (M3_R). During transit calibration CTD of recovered mooring instruments	-27.283	-154.137	0		10	165
Transit North Stradbroke Island (NSB) IMOS mooring site. Undertake Bongo net tows during transit	-27.34	153.56	16.5	667	5.0	172
Bongo net tows and cross-shelf Triaxus/SADCP sections in vicinity of (NSB)	-27.34	153.56			10.0	182
Begin Triaxus/SADCP line to EAC_4200 (M4_D)	-27.34	155.56			0	
End Triaxus/SADCP line	-27.249	154.297	67.5	734.5	12	194
Deploy EAC_4200 (M4_D)	-27.249	154.297	0		10	204
CTD @ EAC_4200	-27.249	154.297	0		4	208
Transit to EAC_3200 (M3_R) recovery	-27.283	-154.137	8.9	743.4	10	218

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming/ CTD/ mooring time (hrs.)	Total time (hrs.)
site. Bongo net twos and CTDs						
Recover EAC_3200 (M3_R)	-27.283	-154.137	0		7.0	225
Transit to off-shore edge of SADCP line and begin SADCP transect	-27.10	155.35	63.1	806.5	7	232
End SADCP transect	-27.33	153.8	83.8	890.3	11	243
SADCP sections across shelf or shelf eddy. Calibration CTD of recovered mooring instruments					10.0	253
Transit to EAC_3200 (M3_D) deployment site	-27.285	154.136	15.8	906.1	4	257
Deploy EAC_3200 (M3_D)	-27.285	154.136	0		8.0	265
CTD @ EAC_3200 (M3_D)	-27.285	154.136	0		3.0	268
Transit EAC_2000 (M2_R) recovery site	-27.318	154.001	7.3	913.4	1	269
Recover EAC_2000 (M2_R)	-27.318	154.001	0		6.0	275
Transit to EAC_500 (M1_R) recovery site	-27.329	153.898	5.5	918.9	1	276
Recover EAC_500 (M1_R)	-27.329	153.898	0		3.0	279
Transit to in-shore edge of Triaxus/SADCP line and begin Triaxus/SADCP transect	-27.33	153.8	3	921.9	1	280
End Triaxus/SADCP transect	-27.10	155.35	83.8	1005.7	11	291
Transit to EAC_2000 (M2_D) deployment location. During transit calibration	-27.316	154.002	75.3	1081	10	301

	Decimal Latitude	Decimal Longitude	Distance (nm)	Total Distance (nm)	Steaming/ CTD/ mooring time (hrs.)	Total time (hrs.)
CTD of recovered mooring instruments						
Deploy EAC_2000 (M2_D)	-27.316	154.002	0		6.0	307
CTD@ EAC_2000 (M2_D)	-27.316	154.002	0		2	309
Transit to EAC_500 (M1_D) deployment site	-27.327	153.899	5.5	1086.5	1	310
Deploy EAC_500 (M1_D)	-27.327	153.899	0		3.0	313
CTD @ EAC_500 (M1_D). Bongo net tows, CTD and Triaxus tows.	-27.327	153.899	0		2	315
Transit to southwest corner limit of the shelf-EAC Triaxus/SADCP survey region	-28.0	-153.74	41.3	1126.3	4	319
Undertake shelf-EAC survey. Actual way points will be determined just prior to the voyage and updated during the voyage based on position of EAC front and eddies in the regions	Exact survey positions to be determined during the voyage	Exact survey positions to be determined during the voyage	404	1530.3	Approx. 50 hours	369
End shelf-EAC survey						
Transit to Pilot station at Caloundra	-26.8	153.5	20	1550.3	2	371
Transit Brisbane	-27.48	153.13	45.3	1595.6	4	375

CTD Configuration

	Please select:
Fundamentals:	
• Which CTD rosette to be used for this voyage (24 Niskin bottles or 36):	24
• Likely total number of casts:	50 (20 full depth, 30 to 1000m)
• Likely maximum depth of deepest cast:	5000 m
• Lowered ADCP required:	yes
Instrumentation (maximum 6 auxiliary channels in addition to 2x DO):	
• 2x pumped Temperature, Conductivity, Dissolved Oxygen circuits:	(Standard)
• Altimeter (required if operating anywhere near the sea floor):	yes
• PAR Sensor (Bio spherical QCP-2300):	yes
• Transmissometer (Wet labs C-Star 25cm):	yes
• Fluorometer – Chlorophyll-a (Chelsea Aquatracka III – 430/685nm):	no
• Fluorometer – CDOM (Wet labs FLCDOM – 370/460nm)	Yes, if configuration allows, but lower priority than User supplied FLBB sensor
• Nephelometer (Seapoint Turbidity Meter)	yes
• User supplied Wetlabs FLBB 6000m rated sensor (Trull)	yes
Hydrochemistry Analyses:	
• Salinity	yes
• Dissolved Oxygen	yes
• Nutrients: Nitrate	yes
• Nutrients: Phosphate	yes
• Nutrients: Silicate	yes
• Nutrients: Nitrite	yes
• Nutrients: Ammonia (special request after discussion with hydrochemistry)	

The science party will also undertake carbon sampling from several CTD stations. This will include:

1. up to 24 pairs of DIC/Alkalinity samples
   12 depths in the top 2000m from 2 casts; 2 L total per depth including rinses
2. up to 12 pairs of pigment/POM samples
   6 depths in top 150m from 2 CTD casts or 3 depths from 4 casts, depending on bottle spacing and biomass profiles; 4-8 L per depth depending on biomass abundance

Time estimates

The following time estimates are based on a steaming speed of 11 knots.

<table>
<tr><th>Date</th><th>Time</th><th>Activity</th></tr>
<tr><td>05 Sept</td><td>0800-1700</td><td>Transport EAC mooring equipment for ship yard. The specific working order for the mobilisation day for crane lifts is:
<table>
<tr><td>Task/Equipment</td><td>Weight</td><td>Number of lifts</td><td>Estimated Time (min)</td></tr>
<tr><td>Load Mooring weights x 18</td><td>1.5 T</td><td>18</td><td>120</td></tr>
<tr><td>Load Pallets of SBE37s x 2</td><td>425 kg</td><td>2</td><td>60</td></tr>
<tr><td>Land shipping container</td><td>3.5T</td><td>1</td><td>25</td></tr>
<tr><td>Landing open half height container x 2</td><td>4.5T</td><td>2</td><td>60</td></tr>
<tr><td>Land shipping container</td><td>2.4T</td><td>1</td><td>25</td></tr>
<tr><td>Land anchor container on ship deck</td><td>8.5T</td><td>1</td><td>25</td></tr>
<tr><td>Load Syntatic floatation sphere with current meters installed x 9</td><td>550 kg</td><td>9</td><td>100</td></tr>
<tr><td>Load Syntatic floatation sphere x 2</td><td>450 kg</td><td>4</td><td>60</td></tr>
<tr><td>Load cube rack</td><td>600 kg</td><td>1</td><td>25</td></tr>
<tr><td>Load pallet of releases</td><td>600 kg</td><td>1</td><td>25</td></tr>
<tr><td>Load spoolers x 3</td><td>200 kg</td><td>3</td><td>45</td></tr>
<tr><td>Load Pallet of spools x 3</td><td>350 kg</td><td>3</td><td>45</td></tr>
<tr><td></td><td></td><td>Total time (hrs)</td><td>Approx. 10 hours</td></tr>
</table>
Full containers will be loaded onto the vessel. Syntactic spheres will be loaded onto the deck and moved to storage positions. We will also hand carry on a number of instrument boxes. Instrument will be secured on tables in the dirty wet lab and sheltered science area.</td></tr>
</table>

		Science crew will unload, store and secure equipment. Set up back deck and store gear in dirty wet lab. Test all instrument setups.
07-08 September	0800-1700	Complete any final lifts. Test mooring winch is in working order. If required, reorganise back deck. Secure all gear.
09 September (Day 1)	0800 1400 1400-	Depart Brisbane Offload pilot at Caloundra and begin transit EAC_4800 (M6_R). During transit undertake a rehearsal of mooring operations and test CTD (water depth >2000 m) and deck rehearsal.
10 September (Day 2)	0300 0700 0730 1600 2000-2400	Arrive at EAC_4800 (M6_R) recovery site and begin CTD at mooring site Complete the CTD station and hold the mooring toolbox in preparation for mooring recovery Begin mooring recovery operation (M6_R) Complete mooring recovery operations. Clean back deck and instruments. Begin transit to EAC_4700 (M5_R) recovery site Conduct bongo net toolbox during steam to EAC_4700 (M5_R) Arrive EAC_4700 (M5_R) recovery site and begin CTD,
11 September (Day 3)	0200 0200-0400 0500 0900	Complete CTD at EAC_4700 (M5_R). Begin transit to EAC_4200 (M4_R) recovery site. Undertake 3 bongo net tows 10 minutes each at completion of CTD. Then 1 h steam and CTD; followed by 3 bongo net tows. Steam to EAC_4200 (M5_R) site Arrive EAC_4200 (M4_R). Begin CTD at EAC_4200 (M4_R) recovery site. End CTD 3 at EAC_4200 (M4_R) recovery site. Begin transit to CTD (-27.158, 154.939, mid-point between M6 and M5) Arrive CTD station. Begin CTD

	1300	End CTD; 2 stations of 3 bongo net tows each.
	1500	Calibration CTD of EAC_4800 recovered SBE 37 and 39 instruments
	1700	Transit to EAC_4800 (M6_D) deployment site
	2100	Arrive EAC_4800 (M6_D) deployment site. Assess weather and current condition and plan vessel setup for mooring operations.
	2300	During the day the mooring and deck crew will spool-off the recovered EAC_4800 mooring lines and spool-on the EAC_4800 deployment line. They will clean and prepare deck for next mooring operation. The science team will begin to download data and clean instruments. Recovered cleaned instruments will be packed and stored.
12 September (Day 4)	0700	Mooring toolbox meeting
	0800	Begin to Deploy EAC_4800 (M6_D)
	1800	Complete mooring deployment operation. Triangulate mooring position and begin CTD followed by 3 bongo net tows
	2200	Complete CTD. Transit to EAC_4700 (M5_R) recovery site.
13 September (Day 5)	0700	Mooring recovery toolbox meeting
	0800	Begin recovery of EAC_4700 (M5_R)
	1600	Complete recovery of EAC_4700 (M5_R). Begin transit to offshore location of Triaxus/SADCP line. When: after dusk complete CTD cast and bongo net tows.
	2000	Arrive offshore locations, deploy Triaxus and begin Triaxus/SADCP line
14 September (Day 6)	0800	End Triaxus/SADCP line. Recover Triaxus. Begin transit to EAC_4700 (M5_D) deployment location
	0900-2400	CTDs, bongo nets, biological samplings as we transit to EAC_4700 (M5_D). Calibration of CTD EAC_4700 recovered SBE 37 and 39 instruments During the day the mooring and deck crew will spool-off the recovered EAC_4700 mooring lines and spool-on the EAC_4700 deployment line. They will clean and prepare deck for next mooring operation. The science team will begin to download data

		and clean instruments. Recovered cleaned instruments will be packed and stored.
15 September (Day 7)	0400 0600 0800 1600 - 2400	Arrive EAC_4700 (M5_D) deployment location. Assess weather and current conditions and plan vessel setup for mooring operations. Mooring deployment toolbox meeting Begin deployment of EAC_4700 (M5_D) Complete mooring deployment operation. Triangulate mooring position and begin CTD; followed by 3 bongo net tows (**or preceded** by 3 bongo net tows, then CTD, then another 3 if time permits). Transit to EAC_4200 (M4_R) recovery site.
16 September (Day 8)	0400 0700 0730 1600 1600 2100 - 2400	Arrive EAC_4200 (M4_R) recovery site Mooring toolbox meeting Recovery EAC_4200 (M4_R) Complete recovery of mooring Transit to offshore edge of mooring SADCP section. Bongo net sampling during transit Deploy Triaxus at offshore edge and begin tow to inshore edge
17 September (Day 9)	0900 1000-1800 1800 – 2400	Complete Triaxus section CTDs at EAC_0500, EAC_2000 and EAC_3200 recovery sites. Calibration of CTD EAC_4200 recovered SBE 37 and 39 instruments During the day the mooring and deck crew will spool-off the recovered EAC_4200 mooring lines and spool-on the EAC_4200 deployment line. They will clean and prepare deck for next mooring operation. The science team will begin to download data and clean instruments. Recovered cleaned instruments will be packed and stored.

		Undertake Bongo net tows on transit to the Stradbroke NRS. Undertake cross-shelf survey with Triaxus/SADCP.
18 September (Day 10)	0700 0800-1800 1800-2400	End Triaxus/SADCP shelf survey. Recover Triaxus. CTD stations and biological sampling surrounding the Stradbroke NRS Continue to clean and prepare deck for next mooring operation. The science team will begin to download data and clean instruments. Recovered cleaned instruments will be packed and stored. Triaxus/SADCP from Stradbroke NRS to EAC_4200 (M4_D) mooring site
19 September (Day 11)	0400 0700 0800 1600 1800 - 2400	Arrive EAC_4200 (M4_D). Assess weather and current conditions and plan vessel setup for mooring operations. Mooring deployment toolbox meeting Begin deployment of EAC_4200 (M4_D) Complete mooring deployment operation. Triangulate mooring position. Move to EAC_3200 (M3_R) recovery location. Bongo nets and CTD overnight
20 September (Day 12)	0400 0600 0700 1600 1800-2400	Arrive EAC_3200 (EAC3_R) recovery location. Assess weather and current conditions and plan vessel setup for mooring operations. Mooring recovery toolbox Begin recovery of mooring Complete mooring recovery. Transit to off-shore edge SADCP line. Begin Triaxus tow
21 September (Day 13)	0700	End Triaxus/SADCP line.

	0800-1800	SADCP sections along the shelf front or shelf eddy. Calibration of CTD EAC_3200 recovered SBE 37 and 39 instruments During the day the mooring and deck crew will spool-off the recovered EAC_3200 mooring lines and spool-on the EAC_3200 deployment line. They will clean and prepare deck for next mooring operation. The science team will begin to download data and clean instruments. Recovered cleaned instruments will be packed and stored.
	1800-2400	Bongo net, Triaxus survey shelf front/shelf eddy
22 September (Day 14)	0400	Arrive EAC_3200 (M3_D) deployment location. Assess weather and current conditions and plan vessel setup for mooring operations.
	0600	Mooring deployment toolbox meeting
	0700	Begin deployment of EAC_3200 (M3_D)
	1600-2400	Complete mooring deployment operation. Triangulate mooring position and begin CTD. Transit to EAC_2000 (EAC2_R) location
23 September (Day 15)	0400	Arrive EAC_2000 (EAC2_R) recovery location. Assess weather and current conditions and plan vessel setup for mooring operations.
	0600	Mooring recovery toolbox
	0700	Begin recovery of mooring
	1300	Complete mooring recovery operation. Move to EAC_500 (EAC1_R) recovery location.
	1400	Begin recovery of EAC_500 (EAC1_R)
	1800	Complete mooring recovery. Transit to in-shore end of Triaxus/SADCP along mooring line
	1830-2400	Deploy Triaxus and begin Triaxus/SADCP line along the EAC mooring line
24 September (Day 16)	0800	End Triaxus/SADCP line. Recover Triaxus. Begin transit to EAC_2000 (M2_D) deployment location. Calibration of CTD EAC_2000 and EAC_0500 recovered SBE 37 and 39 instruments
	1800	Arrive EAC_2000 (EAC2_D) deploy site

		During the day the mooring and deck crew will spool-off the recovered EAC_2000 and EAC_500 mooring lines and spool-on the EAC_2000 and EAC_500 deployment line. They will clean and prepare deck for next mooring operation. The science team will begin to download data and clean instruments. Recovered cleaned instruments will be packed and stored.
	1800 - 2400	Calibration of CTD EAC_2000 and EAC_0500 recovered SBE 37 and 39 instruments. Bongo net, Triaxus across in regional of Stradbroke NRS and shelf-EAC front, respectively.
25 September (Day 17)	0400	Arrive EAC_2000 (EAC2_D) deployment location. Assess weather and current conditions and plan vessel setup for mooring operations.
	0600	Mooring deployment toolbox
	0700	Begin deployment of mooring
	1400	Complete mooring deployment operation. Triangulate mooring position and complete CTD.
	1600	Bongo net, Triaxus/SADCP sections across the shelf-slope edge or shelf eddy.
26 September (Day 18)	0500	Arrive EAC_500 (EAC1_D) deployment location. Assess weather and current conditions and plan vessel setup for mooring operations.
	0700	Mooring deployment toolbox
	0800	Begin deployment of mooring
	1400	Complete mooring deployment operation. Triangulate mooring position and complete CTD 13. Transit to southern limit of the shelf-slope Triaxus/SADCP/bongo net survey
	1800	Undertake bongo net trawls Triaxus/SADCP along shelf
27 September (Day 19)	0700 2400	Working between 28°S and 26°S complete an along-flow survey, of the shelf-EAC front survey. This will include CTDs, Triaxus and bongo nets.
28 September (Day 20)	1100	Complete shelf survey

	1200-	SADCP section along the mooring line beginning at the inshore location (-27.33, 153.8) to offshore (-27.10, 155.35) or as far along line as possible given time available.
29 September (Day 21)	0600 1200 1300-1700	Arrive pilot station, pick up pilot, begin transit to Brisbane Arrive Brisbane Complete packing of gear, and begin off-loading
30 September	0800-1600	Off-load containers from vessel to trucks. Hand carry gear off ship. Transport containers to storage yard.

** The 4 core Argo and 2 BGC-Argo floats will be deployed at the desired location or at the completion of a CTD station in water greater than 2000 m. The exact deployment location will be determined during the voyage based on position of the EAC. Prior to the start of a CTD station we will notify the MNF and ASP of the intention to deploy a float.

*** The autonomous XBT system, developed by CSIRO, will be tested during a transit between mooring operations.

Piggy-back projects

Professor Iain Suthers - UNSW

To biologically characterise the shelf waters off the Stradbroke NRS, and to sample dynamic, ephemeral frontal eddies flowing down from Fraser Island to better document the spatial and temporal variability of shelf water around the Stradbroke Island NRS mooring, in view of the new SIMS-RAAP post-doc and the IMOS larval fish project.

The EAC array data of course will be essential to our use of the IMOS-Coffs Harbour moorings and radar and frontal eddy formation.

Argo Australia

Core Argo Floats Dr Peter Oke – CSIRO

The international Argo program is the largest coordinated effort to monitor the subsurface oceans (http://www.argo.ucsd.edu/About_Argo.html). Argo is a highly regarded, international program that measures the changing ocean temperature (heat content) and salinity with profiling floats distributed throughout the ocean. Since its inception Australia has been one of the leading partners in the program, deploying and maintaining about 10% of the global array.

Argo Australia is a joint project between CSIRO's Oceans and Atmosphere, the Bureau of Meteorology, the Australian Antarctic Program Partnership (AAPP), Australia's Integrated Marine Observing System (IMOS) and the Royal Australian Navy. CSIRO manages procurement, deployment and data processing and distribution of all Australian floats in collaboration with our domestic and international partners.

We will use this voyage to deploy 4 floats in the Tasman Sea at these approximate locations:

ARGO FLOAT No.	Latitude	Longitude
1069	27° 30’ S	155° 30’ E
1063	27° 30’ S	156° 00’ E
1056	27° 00’ S	156° 00’ E
1073	26° 50’ S	156° 00’ E
1072	26° 45’ S	156° 00’ E

BGC-Argo Floats Dr Tom Trull – CSIRO

Biogeochemical-Argo is the extension of the Argo array of profiling floats to include floats that are equipped with biogeochemical sensors for pH, oxygen, nitrate, chlorophyll, suspended particles, and downwelling irradiance. Newly developed sensors now allow profiling floats to also observe biogeochemical properties with sufficient accuracy for climate studies. This extension of Argo will enable an observing system that can determine the seasonal to decadal-scale variability in biological productivity, the supply of essential plant nutrients from deepwaters to the sunlit surface layer, ocean acidification, hypoxia, and ocean uptake of CO2. Biogeochemical-Argo will drive a transformative shift in our ability to observe and predict the effects of climate change on ocean metabolism, carbon uptake, and living marine resource management.

The Australian contribution to global Biogeochemical-Argo is coordinated through the Australia-India Strategic Research Fund (AISRF) Indian Ocean Bio-Argo project and the IMOS Argo-Australia facility.

We will use this voyage to deploy 2 floats in the Tasman Sea.

Please note: BCG-Argo float deployments will not take place during this voyage due to delays in the delivery of the Argo floats

Permits

DoE & AFMA permits for biological sampling:

1. DoE permit #: AU-COM2019-457 Access to Biological Resources in a Commonwealth Area for Non-Commercial Purposes (copy with Master).
2. AFMA permit #: 1004298 Scientific Permit (copy with Master)

As operational location is greater than 3nm offshore (QLD waters) it isn’t a concern for QLD fisheries management and therefore IN2019_V05 will not need a QLD general fishery permit.

Signature

Your name	Bernadette Sloyan
Title	Chief Scientist
Date:	07/08/2019

List of additional figures and documents

Appendix A

Scientific equipment and facilities provided by the Marine National Facility

Some equipment items on the list may not be available at the time of sailing. Applicants will be notified directly of any changes. Indicate what equipment and facilities you require from the Marine National Facility by placing an **X** in the relevant box.

(i) Standard laboratories and facilities

Name	Essential	Desirable	Notes/Comments
Aerosol Sampling Lab			
Air Chemistry Lab			
Preservation Lab	x		
Constant Temperature Lab	x		• Please indicate the required setpoint temperature (at coastal SST)
Underway Seawater Analysis Laboratory			
GP Wet Lab (Dirty)	x		
GP Wet Lab (Clean)	x		
GP Dry Lab (Clean)	x		
Sheltered Science Area	x		
Observation deck 07 level			
Walk in Freezer			
Blast Freezer			
Ultra-Low Temperature Freezer (-80^{0}C) X2			
Walk in Cool Room	x		
Salt water ice machine	x		

(ii) Specialised laboratory and facilities *(may require additional support)*

Name	Essential	Desirable	Notes/Comments
Modular Radiation Laboratory			
Modular Trace Metal Laboratory (TM1-blue)			
Modular Trace Metal Laboratory (TM2-white)			• Cannot be over stacked
Trace metal rosette and bottles			• 10-foot container
Modular Hazchem Locker			
Deck incubators			
Stabilised Platform Container			
Clothing container			• The use of this container will be identified by MNF

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
CTD - Seabird 911 with 36 Bottle Rosette			
CTD - Seabird 911 with 24 Bottle Rosette	X		
Lowered ADCP	X		
Sonardyne USBL System			
Milli-Q System	X		
Laboratory Incubators			
Heavy Duty Electronic Balance (80kg)			
Medium Duty Electronic Balance (15kg/5g resolution)			
Light Duty Electronic Balance (3kg/1g resolution)			
Surface Net (mouth area 1m^2)			• Please specify 500-micron, mesh please
Bongo Net (not instrumented) ring diameter 485mm 0.018m^2	X		• 500-micron mesh only
Smith Mac grab			

(iii) Standard laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments
Dissecting Microscopes (x4)	x		• Please specify number required (all 4 please)

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
TRIAXUS – Underway Profiling CTD	X		Triaxus is a pilotable towed vehicle capable of carrying a variety of instrumentation. Constant depth towing or undulating profiles (e.g. cyclic depth pattern from 10m to 200m) are possible. Towing speed depends on the tow profile, instrumentation payload and prevailing conditions. Typically, undulations from the surface to 200m are possible at 8knt, with slower speeds for deeper profiles and faster for constant-depth towing. Maximum achievable depth typically 300m Usual instrumentation: SBE9plus (pressure sensor and communication hub) and dual pumped temperature/conductivity/dissolved oxygen circuits. Usual auxiliary instrumentation includes an ECO-Triplet (Chl, CDOM, backscatter), transmissometer, PAR sensor, and Laser Optical Plankton Counter.
Desired towing profile:	0-300 m or deeper		0-300 m at 6-8 knots
Additional instrumentation: (Please supply, make and model and datasheets. Also, a contact person for discussion on integration.			
Continuous Plankton Recorder (CPR)			
Deep towed camera			
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			

(iv) Specialised laboratory and sampling equipment

Name	Essential	Desirable	Notes/Comments *(These items may require additional MNF support staff)*
XBT System			• 2 per day provided
Trace Metal Rosette and bottles			
Sherman epibenthic sled			
Trace- metal in-situ pumps (x6)			• See non-MNF owned section below for additional 2 units
Rock Dredges			
EZ Net (maximum of 10 nets for depth stratified sampling. Mouth area of 1m^2)			• Please specify 335 micron, 500 microns, or 1,000 micron mesh – Not needed
Rock saw			• Requires trained science personnel
Portable pot hauler			
Beam Trawl			
Pelagic trawl system (net, doors)			• Contact MNF to discuss net and mesh dimensions
Demersal trawl system (net, doors)			• Contact MNF to discuss net and mesh dimensions
MIDOC (multiple opening/closing codend system for pelagic trawl)			
Stern Ramp (please select exposed *OR* installed)	**Ramp Exposed**	**Deck covers installed**	
Trawl monitoring instrumentation (ITI) (2,000m depth limit)			
Radiosonde Receiver System			

(v) Equipment and sampling gear requiring external support *(may require additional support from applicants)*

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with your Voyage Operations Manager as required. Additional staff may be required for these activities.
Seismic compressors			
Seismic acquisition system			

(vi) Underway systems

Acoustic Underway Systems

Name	Essential	Desirable	Notes/Comments
75kHz ADCP	x		
150kHz ADCP	x		
Multi Beam echo sounder EM122 12kHz (100m to full ocean depth)	x		
Multi Beam echo sounder EM710 70-100kHz (0-1000m approx.)			
Sub-Bottom Profiler SBP120			
Scientific Echo Sounders EK60 (6 bands, 18kHz-333kHz)	x		Turned on when working near the North Stradbroke Island NRS. Turned off when making ship ADCP/Triaxus sections and survey and during mooring work
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)			
Omnidirectional Echo Sounder SH90			
Gravity Meter			

Atmospheric Underway Sensors

Name	Essential	Desirable	Notes/Comments
Nephelometer			
Multi Angle Absorption Photometer (MAAP)			
Scanning Mobility Particle Sizer (SMPS)			
Radon detector			
Ozone detector			
Condensation Particle Counter (CPC)			
Picarro spectrometer (analysis of CO_2/CH_4/H_2O)			
Aerodyne spectrometer (analysis of N_2O/CO/H_2O)			
Cloud Condensation Nuclei (CCN)			
Polarimetric Weather Radar			

Underway Seawater Systems and Instrumentation

Name	Essential	Desirable	Notes/Comments
Thermosalinograph	x		
Fluorometer	x		
Optode	x		
pCO2	x		

Seawater systems

Name	Essential	Desirable	Notes/Comments
Trace metal clean seawater supply			
Scientific clean seawater supplied to laboaratories	x		
Raw seawater available on deck and in laboratories.			

Non MNF Owned Equipment which may be accessed

Name	Essential	Desirable	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Additional staff may be required for these activities.
D & N Francis winch			• 13mm electro-optical cable
Box Corer			
UTAS In-Situ Pumps (x2)			
EM2040			• Shallow water multibeam echosounder system

Special Requests – MNF Scientific Equipment and Facilities

Describe any special requirements here.

Do you have video conferencing / data communication requirements?

Appendix B

User equipment and facilities to be provided by the Chief Scientist

List the equipment that will be brought on board under the Lead Principal Investigator/Principal Investigator responsible for the item.

The Voyage Operations Manager will advise if a RV *Investigator* Application form will be required for your nominated equipment. A deck layout will be developed from the information provided here and in the RVI Voyage Specific Equipment Installation Form.

See Manifest of User Supplied Equipment

Owner	**Item name**	**Supporting information (weight, dimensions, location on board)**	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***(MNF use Only Y/N)***

Owner	**Item name**	**Supporting information (weight, dimensions, location on board)**	Please give this careful consideration, as there is no guarantee that these resources will be available unless specifically requested. Liaise with Voyage Operations Manager as required. Do you require any equipment to be fitted to the vessel? What services (e.g. electricity, water) are required to support the equipment? Are there any special procedures to be followed with the new equipment, radiation work, lasers, small boat work or diving? Do you need to test any equipment or procedures before sailing or under controlled conditions? These activities will require separate approvals.	**RV *Investigator* Equipment Application form required?** ***(MNF use Only Y/N)***

Special Requests – User Equipment

Describe any special requirements here.