ATSEA Cruise No. 2

"RV Solander"

2011

Acknowledgements

We gratefully acknowledge the fine crew of the R.V. Solander crew who made ATSEA cruise number 5355 so successful:

Chris Davis	Master
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Michael Walker	1st Mate
Jason Smith	2nd Mate
Ryan Doodson	Deckhand
Eddy Stevens	Chef
Kevin Ruby	Engineer

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SUMMARY

The second cruise of the ATSEA program was conducted from 30 June to 20 July 2011 aboard the AIMS vessel *R/V Solander*. The main objective of the expedition was to conduct detailed surveys of the benthos and the water-column within individual reefs of the Sahul Banks off northwestern Australia and along the entire southern coast of Timor Leste.

At the Sahul Banks, BRUVS and TowVID were used to map the benthos of the individual reefs as well as delimit fish abundance and species diversity. Many of the reefs showed high endemic biodiversity of both demersal fishes and benthic invertebrates. Over 10,000 still photos and over 75 hours of detailed videos were taken of these reefs and future analysis of this data will yield very detailed spatial maps of these highly diverse, rich habitats. Also, some surveys were made of the reefs fringing Jaco Island off the extreme eastern end of Timor Leste, similarly finding highly diverse reef biota and fringing reefal habitats.

Water-column casts at all of the stations revealed some evidence of upwelling of cold, nutrient-rich water into the reefs of the Sahul Banks, and, more significantly, extensive upwelling along the entire edge of the southern Timorese shelf. This cold water may account for fairly slow lows of benthic oxygen consumption; but high levels of chlorophyll suggest enhanced primary production as a result of these upwelling intrusions.

The seabed along the southern coast of Timor Leste is dominated by extensive deposits of mud, probably derived from enhanced erosion of land within southern river catchments. Rates of anaerobic respiration were very high, suggesting intense recycling of organic matter derived from both enhanced land runoff and phytoplankton production. These high rates of phytoplankton activity may help to explain why this area is a key migratory pathway for large pelagic such as tuna and for dolphins and whales.

LAPORAN PERJALANAN
"ATSEA (Arafura and Timor Sea Ecosystem Action) Cruise 2"
30 Juni - 20 Juli 2011
Oleh: Tim Indonesia (Awwaluddin, Agustin Rustam, Frederik Rijoly)
Timor Leste: Francisco X.L. Pereira, Fernando Da Silva

Penelitian *Oceanography and Biodiversity* telah dilakukan di perairan Laut Arafura dan Timor bagian Australia dan Timor Leste sejak tanggal 30 Juni sampai dengan 20 Jui 2011 dengan menggunakan kapal penelitian **RV. SOLANDER** milik **AIMS** (Australian Institute of Marine Science). Penelitian ini melibatkan peneliti dari tiga negara yang berbatasan, yaitu **Indonesia, Australia** dan **Timor Leste**. *Launching* RV Solander dilakukan pada tanggal 30 Juni 2011 di Darwin, Australia.

Tujuan penelitian ini adalah:

1. Melakukan kegiatan penyelidikan mengenai karakteristik geo-biologi dan geo-fisika Laut Arafura dan Timor
2. Melakukan kegiatan observasi mengenai keanekaragaman biologi dan komunitas bentik yang terdapat di daerah Laut Arafuru dan Timor dengan menggunakan metode *Towed-Video* dan BRUVs (*Baited Remote Underwater Video Station*) serta Panda (Tripod Kamera).

Ruang Lingkup Kegiatan

1. Geo-biologi dan Geo-fisika

- Pengambilan data beberapa parameter oseanografi seperti suhu, salinitas, kecerahan dan kelimpahan klorofil dilakukan dengan menggunakan CTD SEABIRD SBE 19 Plus. Data CTD langsung dianalisa di atas kapal dengan menggunakan software SEABIRD (*SeaTerm, SeaProc dan SeaSave);*
- Pada setiap stasiun CTD (kecuali di Pulau Jaco), juga dilakukan pengambilan sampel sedimen menggunakan Smith-McIntyre grab sebagai usaha untuk melihat kondisi lingkungan secara fisika, kimia dan biologi. Sampel sedimen diawetkan dan akan dikirimkan ke laboratorium untuk dianalisa lebih lanjut.
- Sebagian sampel sedimen digunakan untuk melakukan analisa *benthic respiration rate* dengan mengukur kandungan oksigen terlarut yang direkam setiap 10 menit selama 4 jam. Hasil pengukuran *benthic repiration rate* langsung dianalisa di atas kapal. ukan di atas kapal dan dilakukan juga pengambilan sampel air sisa respirasi setiap jam selama 4 jam untuk dianalisa kandungan nutrien dan karbon dioksida.

Assunto: Relatoriu *Badak konaba* Partisipasaun Timorense iha Cruise 2nd ATSEF-ATSEA International Pesquiza Cruise RV Solander.

A. Introdusaun

Forum Arafura Timor Seas (ATSEF) ne'ebe kompostu husi nasaun Indonesia, Australia no Timor-Leste halo peskiza iha area tasi Timor no Australia iha parte sul no norte. Komesa foti sampel husi tasi Australia to'o mai iha Tasi Timor nebe kompostu husi Distritus hat (Viqueque, Suai, Manufahi no Lospalos). Total sampel iha tasi Australia : 10 estasiun, no tasi Timor : 25 estasiun nebe inklui iha Distritu hat nebe iha leten. Aktividade Peskiza ida ne'e hala'o ba dala rua ona nebe Timor oan involve direitamente iha aktividade nebe refere. Primeiro Peskiza ho Ro'o Pesquiza Indonesia nian ho naran BARUNA JAYA VIII nebe involve mos Pesquisador sira husi nasaun tolu (3) nebe refere. TIMOR LESTE rasik involve Pesquizador nain hat (4). Aktividade ida ne'e hala'o durante loron sanulu resin tolu (13) nian laran nebe perkore Tasi Timor to'o Tasi Arafura. Segundu Pesquiza ho Ro'o Australia nian, RV. SOLANDER (AIMS nian) nebe involve mos Pesquizador husi nasaun tolu (3) nebe refere. Iha segundu Pesquiza ida ne'e Timor Leste rasik mos involve piskizador nain rua (2). Aktividade nebe refere hahu komesa husi tasi AUSTRALIA iha dia 30 de Junho to'o Tasi TIMOR- LESTE ate dia 18 de Julho de 2011.

B. *Objektivu Pesquiza*

Objektivu 2nd Cruise RV SOLANDER hanesan tuir mai ne'e :

1. Atu identifika no hatene Biodiversidade no organismus nebe moris iha tasi AUSTRALIA no TASI TIMOR iha parte Sul no Norte.
2. Atu identifika sedimentasaun, Biokimiku, DO, Temperatura, Salinidades no seluk-seluk tan.
3. Atu fo kapasitasaun ba expert Indonesia ho Timor oan sira atu nune'e iha futuru bele hala'o pesquiza mesak.

C. *Equipamentus*

Equipamentus nebe uja durante hala'o peskiza Internasional segundu (2nd) ATSEF-ATSEA mak hanesan tuir maine'e :

1. Towed Video Array
2. BRUVS
3. Grabs
4. Box Corer
5. CTD + Niskin Bottles
6. Panda

D. *Funsaun Equipamentus*

Funsaun equipamentus ida-ida mak hanesan iha okos`ne'e:

a. Towed Video Array, ne'e hanesan equipamentu ida nebe monta Camera Video ida husi oin atu hodi detekta Ikan , ahu ruin, Habitat tasi okos nebe ikan sira moris ba, husi ida ne'e ita bele haré no hatene especies ikan iha ahu ruin no bele haré mos katak hábitat iha tasi okos bele hatene katak hábitat iha área nebe refere kondisaun sei diak ka aat. Resultadu uja Towed Video bele hare kondisaun Habitat, ahu ruin, halimeda , spons no mos bele hatene mos especies saida mak moris iha área neba.

b. BRUVS, ne'e hanesan equipamentus nebe kompostu husi Frame Besi nebe ho total hamutuk ualu (8) nebe monta Camera rua-rua no sensor ida nebe monta iha iska nia kotuk. Equipamentu nebe refere hatun ba tasi laran hodi detekta populasaun ka Gerombolan ikan oin-oin nebe hadau ka haksesuk iska nebe hodi ita bele hatene katak ikan hirak sira ne'e jenis ka espesias saida.

c. GRABS ne'e hanesan equipamentus nebe kompostu husi Besi, nebe nian funsaun atu foti sedeimentasaun hanesan; Taho, Raihenek, Rubbles, Spons, Halimeda no seluk-seluk tan atu hodi haré, hatene Oxygen Terlarut (DO), CO_2 ho Nutriente nebe iha tasi okos.

d. BOXE CORER, ne'e mos equipamentu nebe kompostu husi Besi nebe nian funsaun atu foti sampel taho nian.

e. CTD SBE 19 + Niskin, ne'e equipamentus nebe kompostu husi Besi no Paralon atu detekta, haré no hatene Clean, Temperatura, Salinidade, Chlorofil namkari ka oin sa.

f. BANDA, ne'e equipamentu nebe monta Camera rua nebe nian funsaun hodi detekta no haré no foto kedas momento nebe hatun ba tasi Clean nebe tuir necesidades. Camera ne'e por volta 5 segundo nia rasik bele hasai foto Ahu ruin no ikan nebe moris iha ahu ruin laran. No mos ita haré no hatena katak ahu ruin ne'e kondisaun sei diak ka lae.

Ba ami nain rua nudar pesquizador husi TIMOR-LESTE ami orgullo no kontente tebes tamba ho oprtunidade nebe Governu Australia (AIMS) fasilita ami hodi tuir aktividade ne'e hodi hetan esprensia no lisaun ida nebe hanesan osan mean ba ami nain rua. Iha oportunidade ida ne'e lahalua ami hato'o Obrigado Barak ba Governu Australia no especial ba Mr. D. Alongi, Mr. Lindsay no Mr. Andrew, no Mr. Marcus nebe sai hanesan orador hodi facilita ami husi hahu pesquisa ne'e to'o remata.

Reported by

1. **FERNANDO DA SILVA**
2. **FRANCISCO XAVIER LUIS PEREIRA**

I. INTRODUCTION AND BACKGROUND

In Australasia, the Arafura and Timor Sea region is one of the major centers of tropical marine biodiversity, including fishery resources. The Arafura and Timor Seas also interact in a complex fashion with the atmosphere to be one of Asia's largest natural carbon sinks, well in excess of the normal rates of carbon sequestration in other parts of the world ocean. However, relatively little information and data are available for this region. The Arafura Sea has relatively shallow shelf that lies between Indonesia and northern Australia. It has approximately 1850 km (115 mile) of coastline with an average depth of 50 – 80 m (165 – 265 ft). The Timor Sea covers an area of 615,000 km^2 (235,000 mi^2) located between southeast of Timor Island and northwest of Australia. The Arafura and Timor Seas fit the definition of a semi-enclosed sea under Articles 122 and 123 of the United Nation Convention of the Law of the Sea.

The Arafura and Timor Seas are known to have high abundance of fisheries resources as well as rich biodiversity of marine invertebrates and plants. Management of these vast resources requires close cooperation between littoral nations bordering these seas, such as Australia, Indonesia, Timor Leste and Papua New Guinea. Realizing the uniqueness of the area and its importance to local communities, the Arafura and Timor Seas Expert Forum (referred to as ATSEF) was established with a clear objective to assist the stakeholders who depend upon the Arafura and Timor Seas in achieving the goals of sustainable development to support their livelihoods.

The gross annual production from commercial, artisanal and subsistence fisheries in the Arafura and Timor Seas region is very difficult to estimate, given existing gaps in data collection and analysis and the extremely high level of illegal, unregulated and unreported (IUU) fishing in the region, involving small and large fleets from several countries to the north of Indonesia. While a major threat is foreign fishing, there is also a substantial amount of Indonesian unregulated activity in Indonesian and Australian waters. In addition to unsustainable and IUU fishing, the Arafura and Timor Seas face significant threats from a number of other pressures including the potential for increased incidence of natural threats associated with climate change as well as rapidly expanding coastal populations, increasing urbanization, high levels of poverty and limited economic opportunities which can increase exploitative pressures on natural resources, degradation of coastal habitats, marine pollution from both land- and sea-based sources, and aquatic invasive species.

The threats facing the Arafura and Timor Seas region are transboundary in nature and can only be effectively addressed through multi-lateral cooperation between all four nations. The rationale for the GEF Full Scale Project (FSP) is therefore the need to work cooperatively to sustain the ATS shared living resources, conserve the biota of the seas and coasts, and improve sustainable socio-economic conditions and opportunities for coastal peoples. It is also based on the need for international assistance and catalytic financing, recognizing the significant development challenges and resource limitations facing Timor Leste, which is classified as both a Least Developed Country (LDC) and a Small Island Developing State (SIDS), as well as those challenges facing Indonesia and PNG, which is also designated as a SIDS. Through the Global Environment Facility (GEF) intervention, including the undertaking of a Trans-Boundary Diagnostic Analysis (TDA), development of a Strategic Action Programme (SAP), and implementation of innovative demonstration projects, the littoral nations will be greatly assisted to collaboratively understand and address the shared problems that cannot be solved by any one country.

To complete the TDA and SAP process, a number of approaches are being undertaken, including using research vessels to conduct oceanographic surveys of the area. The Arafura and Timor Seas are known to lack information with regard to a variety of oceanographic processes. As recommended in the framework report of Arafura and Timor Seas Ecosystem Action (ATSEA) during the Project Preparation Grant (PPG) stage, one key activity in developing a TDA of the ATS is to conduct surveys of these seas. This program involves scientists from the national and local stakeholders that are relevant to ATS.

Ocean exploration (referred to as ATSEA Cruise) is an interdisciplinary approach for assessing and investigating the physical, chemical, and biological characteristics of the ocean floor, the pelagic realm, and the diversity of life forms that inhabit the marine environment. Ocean exploration is intended to yield a body of knowledge that may result in immediate benefit or may inform research hypotheses that result in new scientific understanding in the future.

Objectives

The primary scientific objectives for the ATSEA Cruise 2 were to:

1) Conduct biological and geophysical oceanographic assessments of the ATS;
2) Benthic biodiversity assessments of blue-water habitats by BRUVS and Towed Video; and
3) Assist the IMOS Program in deploying instruments for measurement of the Indonesian Throughflow

II. MATERIALS AND METHODS

Personnel

Cruise	Dr Daniel M. Alongi
AIMS Scientific Personnel:	Dr Andrew Heyward, Mr Marcus Stowar, Mr Lindsay Trott
Indonesian ATSEF Scientists:	Mr Awwaluddin, Mr Frederik Rijoly, Ms Augustin Rustam
Timor Leste ATSEF Scientists:	Mr Fernando da Silva, Mr Francisco X.L. Pereira
Ship's crew:	Master: Chris Davis Engineers: Scott Davis, Kevin Ruby Mates: Mike Walker, Jason Smith Deckhand: Ryan Doodson Cook: Eddy Stevens

Time and Location

Depart Darwin, Australia, 30 June 2011

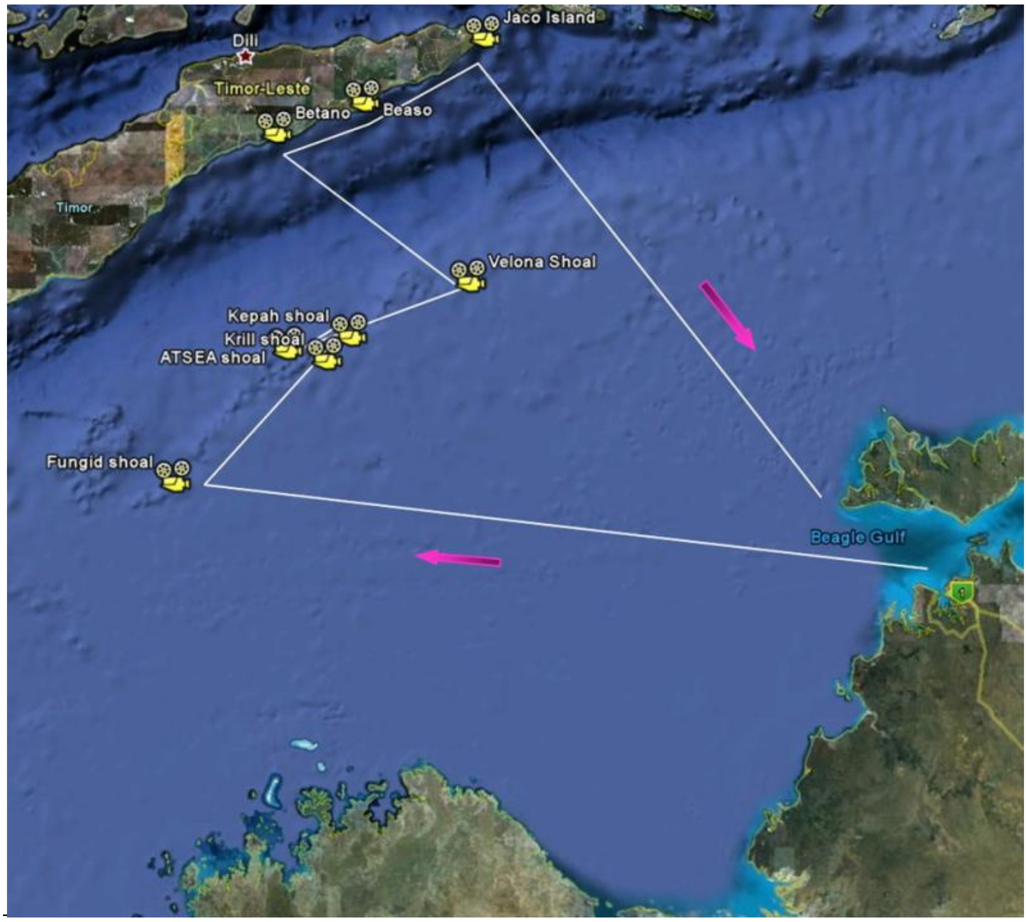


Figure 1. ATSEA Cruise 2 Track

Detailed Methods

See Appendix 1 for photos of selected sampling equipment

CTD: 32 stations were sampled based on their location with respect to ocean upwelling (Stn. 13, 23) or along a gradient from inshore (Stn. 14, 16,18) to near shore (Stn. 15, 17, 19) to offshore (Stn. 20, 21, 22) areas influenced by coastal runoff from rivers in Timor Leste. CTD used in the cruise was CTD SBE 19 Plus, and the CTD data were analysed by using SEABIRD® software.

NISKIN: A 5 L Niskin Bottle was used to collect samples approximately 1-2 meters above the bottom.

Grab: 28 stations; Marine sediment was taken by using a Smith-McIntyre grab. Samples were collected for C/N ratio, δ^{13} Cand δ^{15}N, Porosity, Sediment Grain size, Sediment Oxygen Respiration Rate, $\sum CO_2$ and Dissolved Nutrient Flux, and Sulfate Reduction Rate, Fe and Mn Redox State.

Sulfate reduction. Rates of sulfate reduction were measured from triplicate 2.7 cm diameter plastic cores taken to the depth of maximum penetration. The cores were capped at both ends. The samples were then incubated for 9 to 18 h, and then terminated by fixing sediments in 20% zinc acetate. Samples were then frozen until a 2-step distillation procedure was performed to determine the fraction of reduced radiolabel shunted into the acid-volatile sulfide (AVS) and chromium-reducible (CRS) sulfur pools.

Solute fluxes across the soil–water interface. Fluxes of $\sum CO_2$, NH_4^+, NO_2^- + NO^{3-},PO_4^{3-} across the sediment–water interface were measured in 3 opaque chambers (volume = 1 l; area = 63 cm2) and fluxes of O_2 were measured in 6 chambers over 4 h. Samples for solutes were taken hourly. The chambers were incubated in a seawater bath to maintain ambient seawater temperature. Each chamber had a propeller-electric motor unit and 2 sampling ports on opposite sides of the chamber. Dissolved oxygen was measured using an O_2 probe (TPS Model WP-82DO meters) placed into 1 sampling port; the other port was fitted with acid-washed Teflon tubing to draw off 10 ml samples for dissolved inorganic carbon ($\sum CO_2$) and other solutes. The solutes were filtered (0.45 µm Minisart filters) and kept cool and dark ($\sum CO_2$) or frozen (inorganic nutrients) until analysis. Concentrations of dissolved inorganic nutrients were determined using automated techniques. Dissolved Ca, Fe, and Mn were measured on a Varian ICP-mass spectrometer.

Net $\sum CO_2$, Fe, Mn, and NH4+ production in sediment incubations. Rates of net $\sum CO_2$, Fe, Mn, and NH_4^+ production in sediments were measured by incubating 2 sets of triplicate cores taken from a Smith McIntyre grab. One set of cores was sliced immediately at 2 cm intervals and porewater for measurement of Fe, Mn, and $\sum CO_2$ was collected by centrifugation. To the soil samples, 1 to 5 ml (depending on soil volume) of 1 M KCl was added and mixed into each sample. After 2 h, the samples were centrifuged to obtain porewater that was filtered (0.45µm) and placed into sterile plastic test tubes and frozen until measurement of total extractable NH4+. Soil from the other set of cores was mixed, with sub-samples placed in opaque glass bottles that were hermetically sealed and then incubated at *in situ* temperature for 6 d. After incubation, the samples were processed identically to the other set of cores. After filtration, concentrations of NH_4^+, $\sum CO_2$, Fe, and Mn were determined as described earlier. All samples are to be transported chilled or at room temperature for further analyses at AIMS Townsville. Sediment and pore water samples were not be treated with any preservatives.

Sediment Grain size and Nutrient concentrations. Marine sediment samples were taken by hand from the surface grabs. Samples were collected for measurements of particulate and dissolved nutrients, sediment particle size and rates of nutrient release from sediments. Samples will be used for analysis of sediment particle size by measuring percent sand, silt, and clay on a Malvern Mastersizer 2000 once the samples are returned to the Australian Institute of Marine Science. Two additional samples were taken for the estimation of porosity (water content) and C and N content. Samples in small plastic vials will be returned to AIMS, dried and ground to a fine powder for determination of total carbon and total nitrogen on a Perkin-Elmer 2400 CHNS/O Series II Analyzer and for total organic carbon on a Shimadzu TOC Analyzer with solid sampler. Other elements (P, S, Mn, Fe) will be determined after strong acid digestion on a Varian Liberty inductively-coupled atomic emission spectrometer. The entire sediment sample will be destroyed by this geochemical analysis.

Benthic Ecology and Biodiversity

Benthic ecology and biodiversity were observed by using **TowVid** (Towed Video is a video camera in an underwater housing mounted on a framework which is attached to the towing vessel via video cable. This device may show the characteristic of the sea bed and displaying it into a monitor computer for further analyses) and using **BRUVS** (Baited Remote Underwater Video Station is a twin underwater video camera system, deployable up to 100 metres by using natural lights. A case of baits is attached onto the device in order to attract the fishes and other biota to be recorded by the device).

The biological surveys used various camera configurations to provide a non-destructive sampling approach. Benthic habitats were sampled using cameras attached to a paravane platform towed behind the ship at 1-2 knots, within 1m of the seabed (Towvideo). A forward facing video camera provided live VGA video images to observers on the ship's aft deck, who immediately classified the dominant seabed substrata and macrobenthic communities. A series of transects were surveyed across the major plateau regions on each shoal, but did not extend down the steep sides beyond 60m depths. Data was collected in real-time using the AIMS Towvid software, which collates classification entries with GPS position and depth data provided from the RV Solander navigation instruments. Video was recorded to miniDV tape and all video and classification data archived onto digital media while at sea. A downward facing 10 megapixel camera and strobe system, also attached to the towed platform, obtained high resolution still photos every five seconds along each transect. These were archived after each tow for later laboratory analysis.

Demersal fish were surveyed using deployed stereo baited video systems (BRUVS) attached to lines and surface floats. At each shoal up to 24 BRUVS were deployed in groups of 8 across the central and rim areas of the plateau, with a minimum spacing of 300m. Each BRUV was baited with pilchards and fish arriving at each station were recorded to HD digital video for a minimum of one hour. Upon retrieval the video footage was archived onto digital media at sea for later laboratory analysis.

III. INITIAL RESULTS AND DISCUSSION

Table 1 lists all of the stations visited during the expedition, including a listing of the major research activities.

Table1. ATSEA Cruise 2 Stations

No.	Date	Station	Geographical Position		CTD	Niskin	Grab	TowVid	BRUVS
			Latitude	Longitude					
1	2/7/11	Fungid			✓	-	✓	✓	✓
2	3/7/11	KRL1			✓	-	✓	✓	✓
3	4/7/11	KRL2			✓	-	✓	✓	✓
4	4/7/11	BBS			✓	-	✓	✓	✓
5	5/7/11	BBS Day2			✓	-	✓	✓	✓
6	6/7/11	ATS1			✓	-	✓	✓	✓
7	6/7/11	ATS1-2			✓	-		✓	✓
8	7/7/11	KEP1			✓	-	✓	✓	✓
9	7/7/11	KEP1-B			✓			✓	✓
10	8/7/11	KEP2			✓	-	✓	✓	✓
11	10/7/11	TLS1			✓	-	✓		
12	10/7/11	TLS2			✓	-	✓		
13	11/7/11	TLS3			✓	-	✓		
14	11/7/11	TLS4			✓	-	✓		
15	12/7/11	TLS5			✓	-	✓		
16	12/7/11	TLS1-TLS5			-	✓			
17	12/7/11	TLS6			✓	✓	✓		
18	13/7/11	TLS7			✓	✓	✓		
19	13/7/11	TLS8			✓	✓	✓		
20	14/7/11	TLS9			✓	✓	✓		
21	14/7/11	TLS10			✓	✓	✓		
22	15/7/11	TLS11			✓	✓	✓		
23	15/7/11	TLS 12			✓	✓	✓		
24	15/7/11	TLS13			✓	✓	✓		
25	15/7/11	TLS 14			✓	✓	✓		
26	16/7/11	TLS15			✓	✓	✓		
27	16/7/11	TLS16			✓	✓	✓		
28	16/7/11	TLS17			✓	✓	✓		
29	16/7/11	TLS 18			✓	✓	✓		
30	16/7/11	TLS 19			✓	✓	✓		
31	16/7/11	TLS 20			✓	✓	✓		
32	17/7/11	JACO			-	-	-	✓	✓

a. Water-column processes

In total, there were 32 CTD stations (Table 1) where temperature, salinity, fluorescence (Chlorophyll), and PAR (Photosynthetic Active Radiation) were measured. The depths of the CTD stations were between 25-650 meters with the most shallow at Station KEP1 at Kepah Shoal and the deepest station at Station TLS12 in Timor Leste waters.

The waters overlying the reefs of the Big Bank Shoals (Figs. 3-7) show fairly oligotrophic conditions similar to other oceanic reefs but there is some indication of some cold water enchroachment in the near-bottom layers at some reefs such as at Fungid Reef (Fig.2); some reefs show enhanced phytoplankton biomass with increasing water depth, such as over Krill Reef (Fig. 3). These casts support evidence from earlier AIMS surveys that cold, nutrient-rich water intermittently intrudes onto this reef-rich outer edge of northern Australia's continental shelf.

The overlying water-column along the south coast of Timor Leste was characterised by coastal upwelling, probably induced by the Indonesian Throughflow. At most sites (Fig. 8-20), there were clear vertical profiles of sharp declines in temperature; initial nutrient analyses indicate high levels (> 10 μM) of nitrate. While the Indonesian Throughflow moves in a westerly direction south of Timor, there is a prevailing coastal countercurrent close to the coast that moves in an easterly direction, at least during the austral winter. The upwelling intrusions onto the southern Timorese shelf were mainly at the shelf edge as stations closer inshore (for example, at Sta. TLS 9, Fig. 12) did not show evidence of upwelling. However, nearly all stations did show high to very high levels of phytoplankton biomass suggesting enhancement of phytoplankton production from upwelling and from outwelling of nutrients and particulate matter from adjacent catchments.

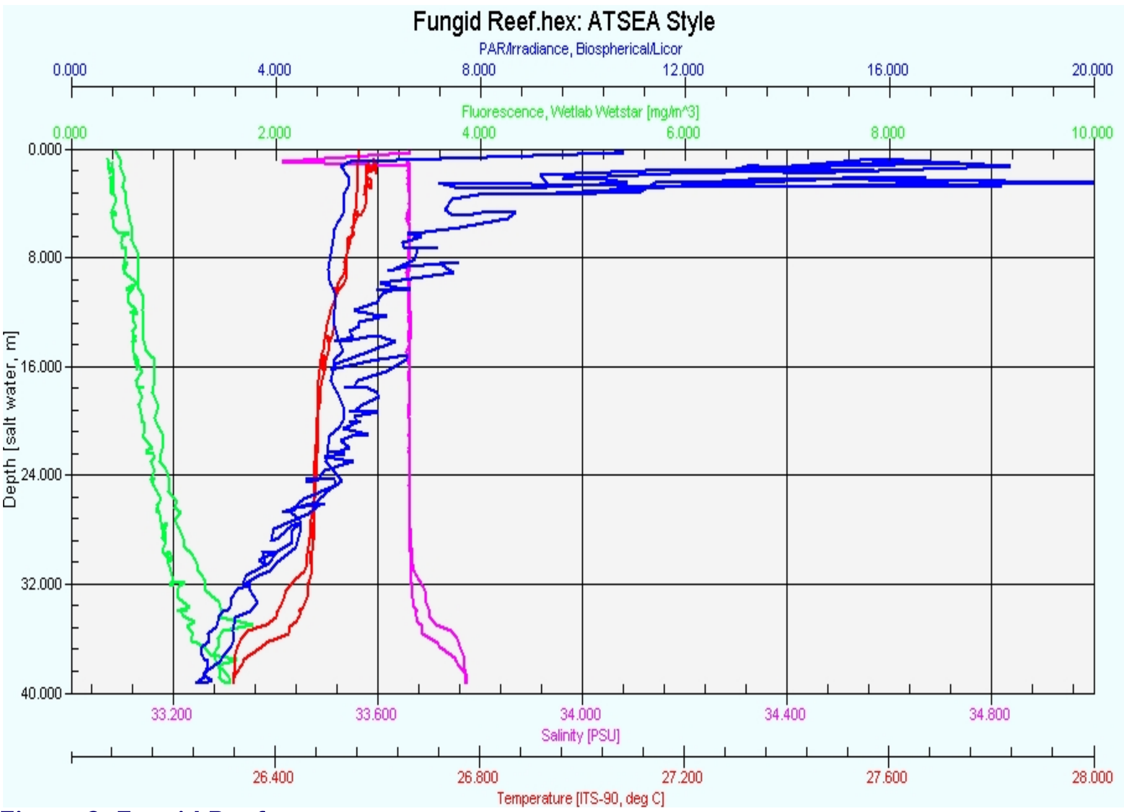


Figure 2. Fungid Reef

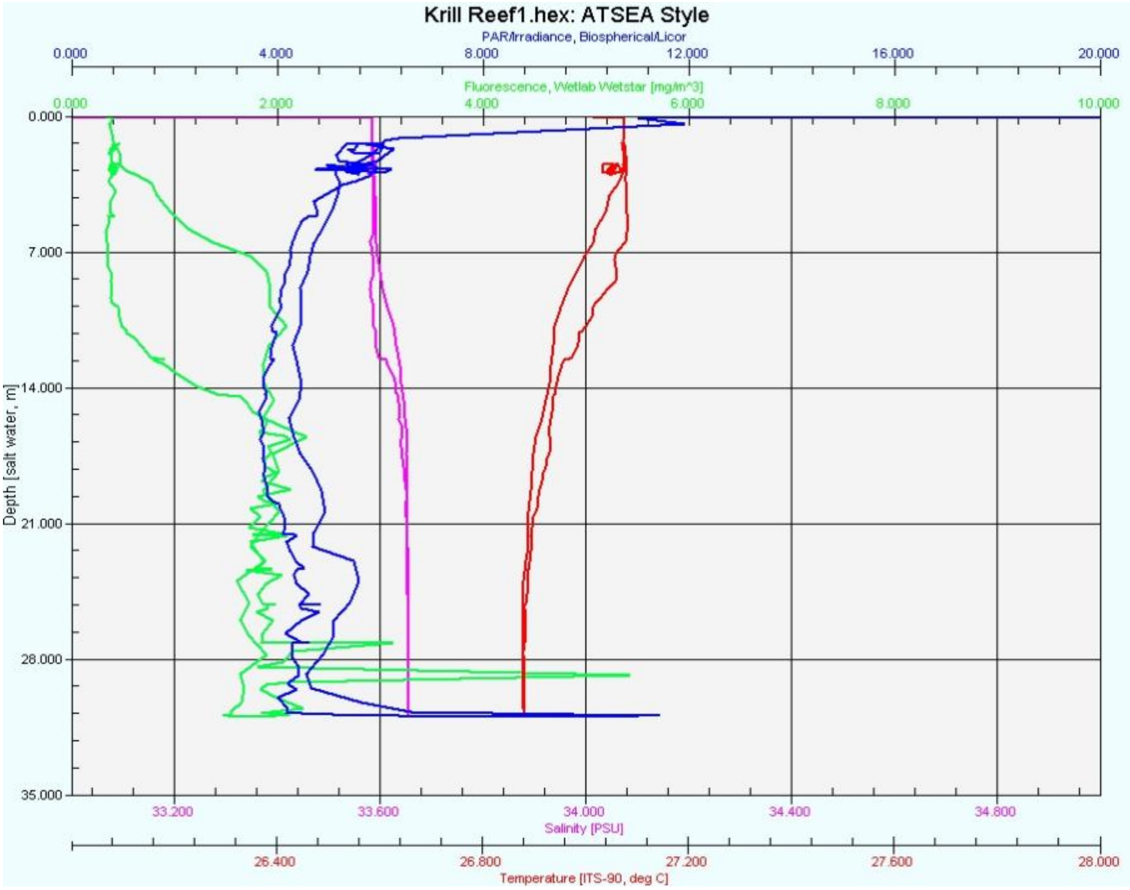


Figure 3 Krill Reef

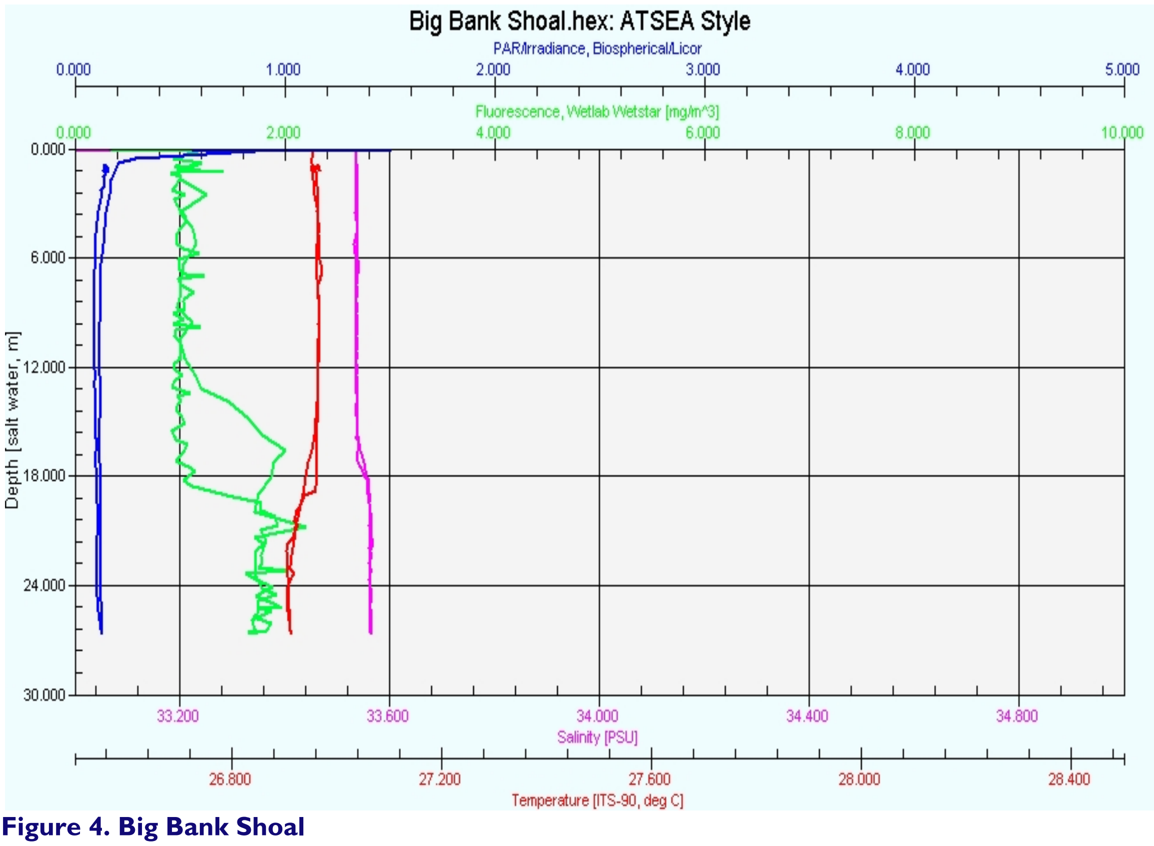


Figure 4. Big Bank Shoal

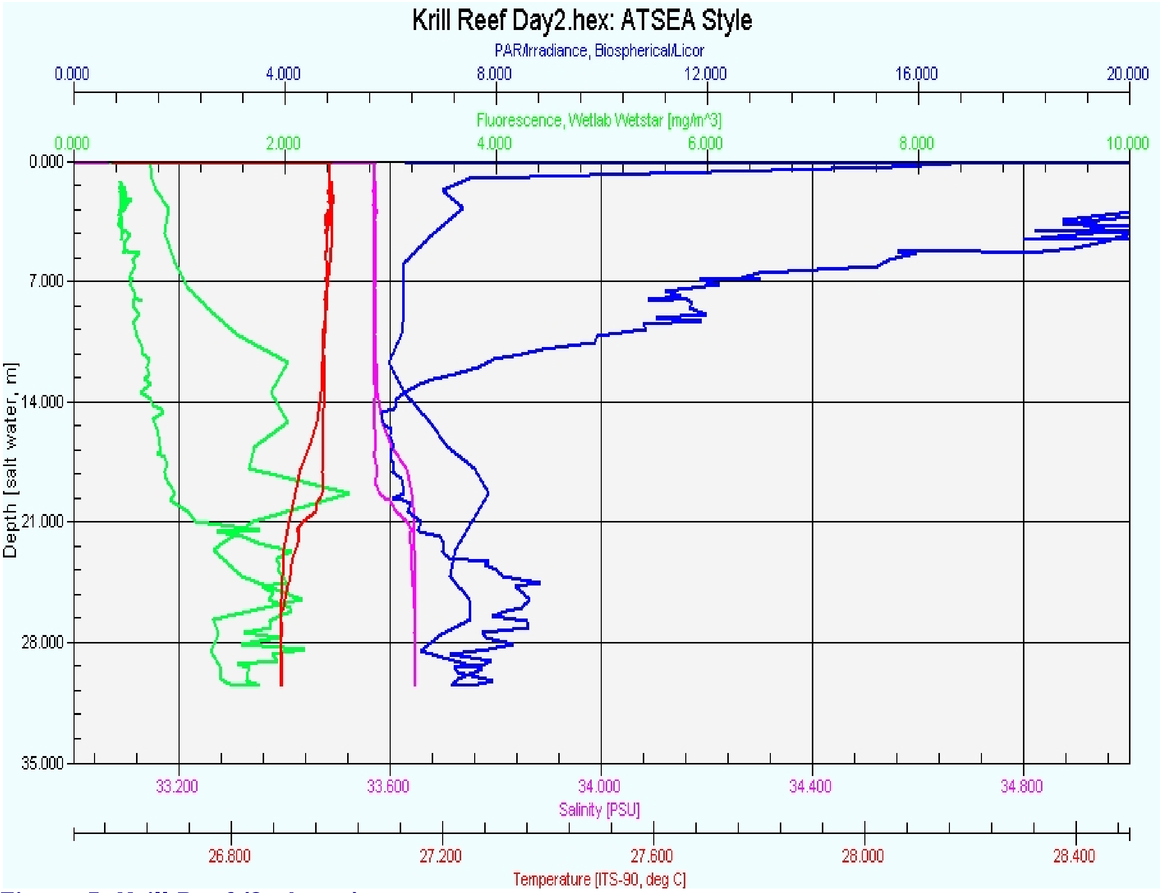


Figure 5. Krill Reef (2nd cast)

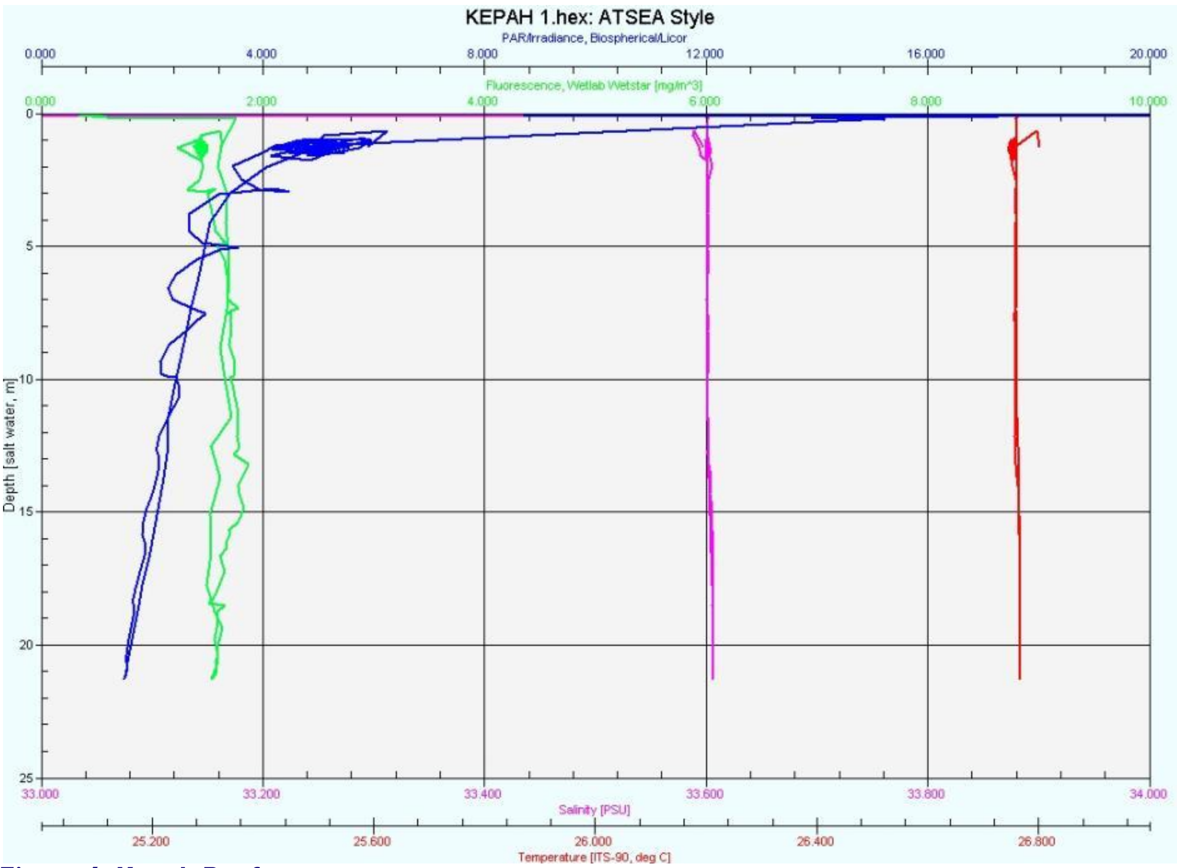


Figure 6. Kepah Reef

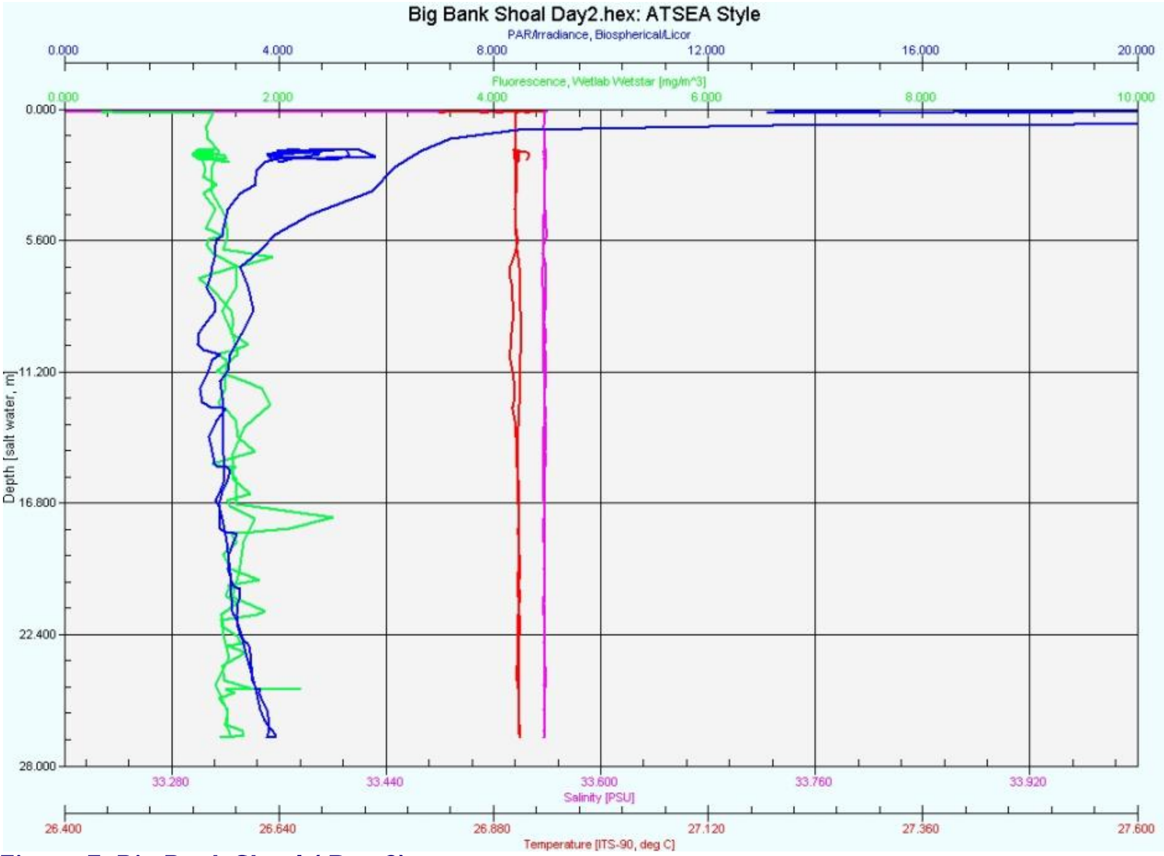
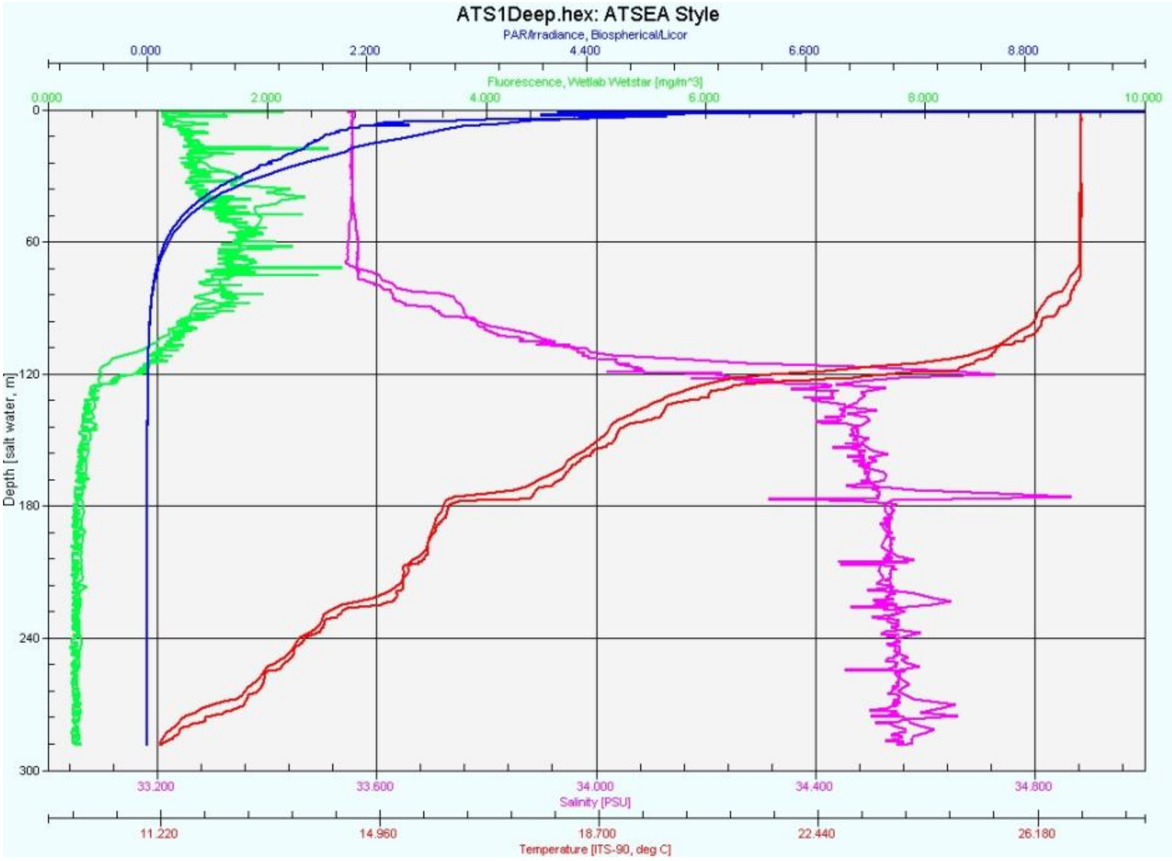


Figure 7. Big Bank Shoal (Day 2)



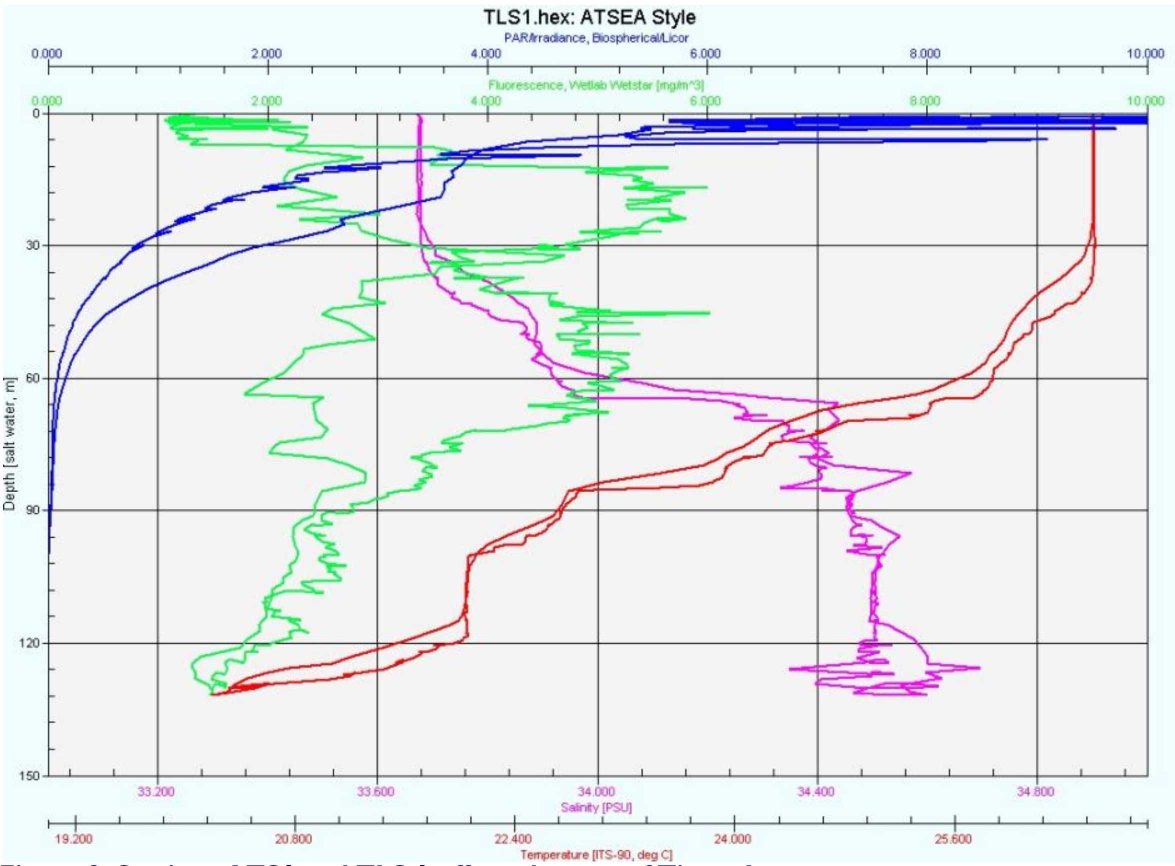
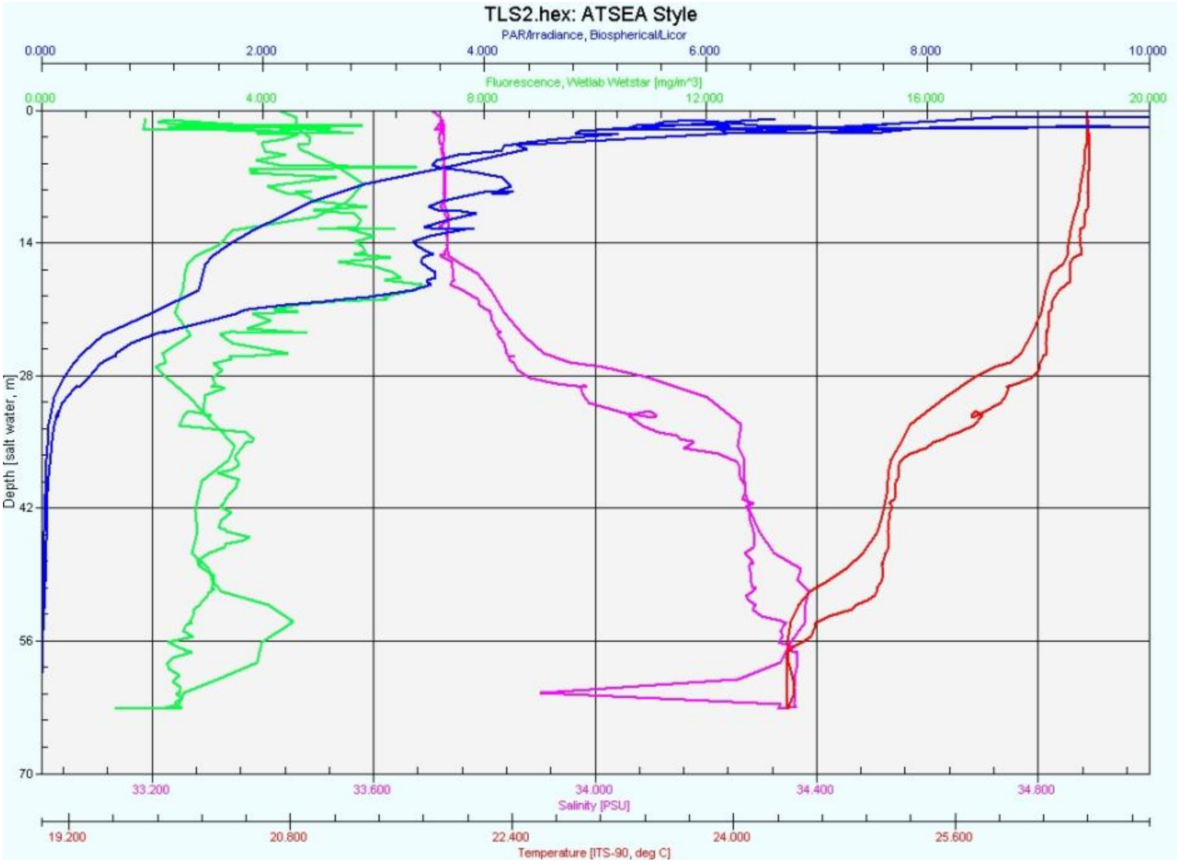


Figure 8. Stations ATS1 and TLS 1 off south coast of Timor Leste



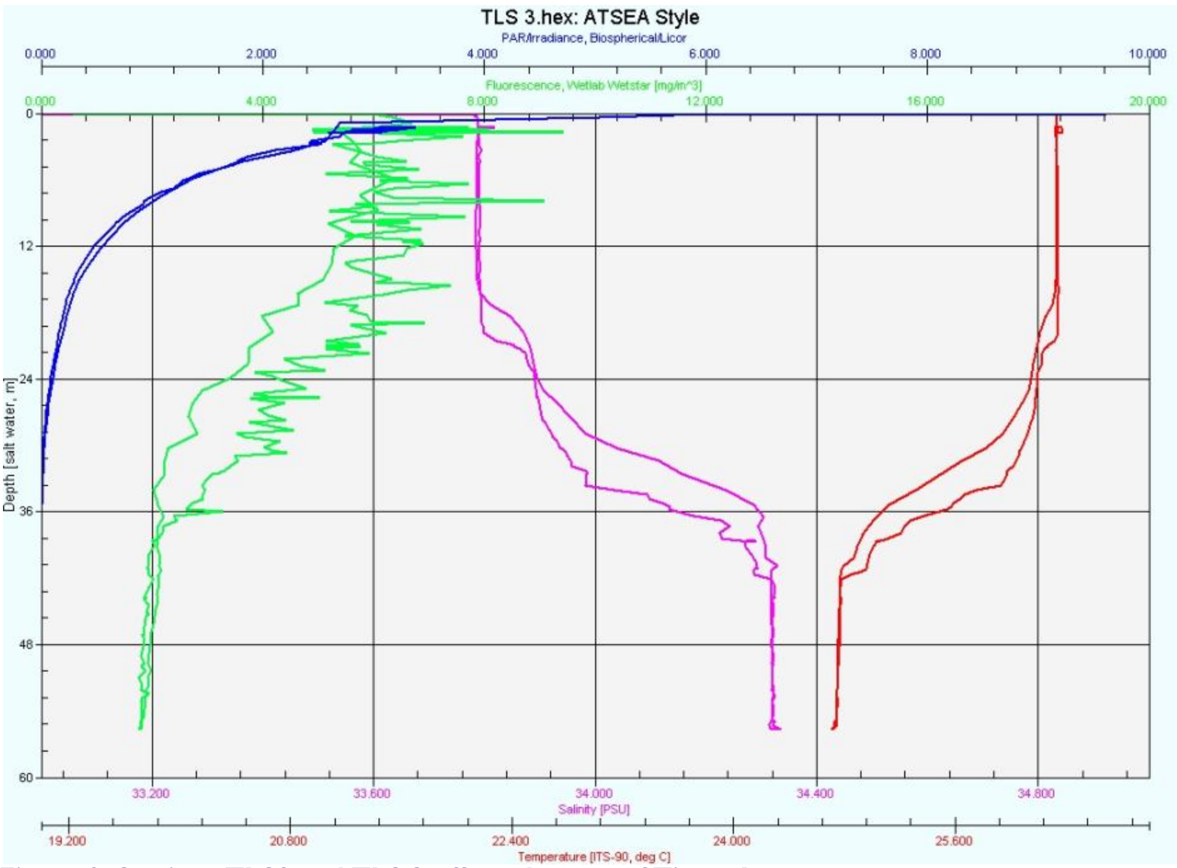


Figure 9. Stations TLS2 and TLS 3 off south coast of Timor Leste

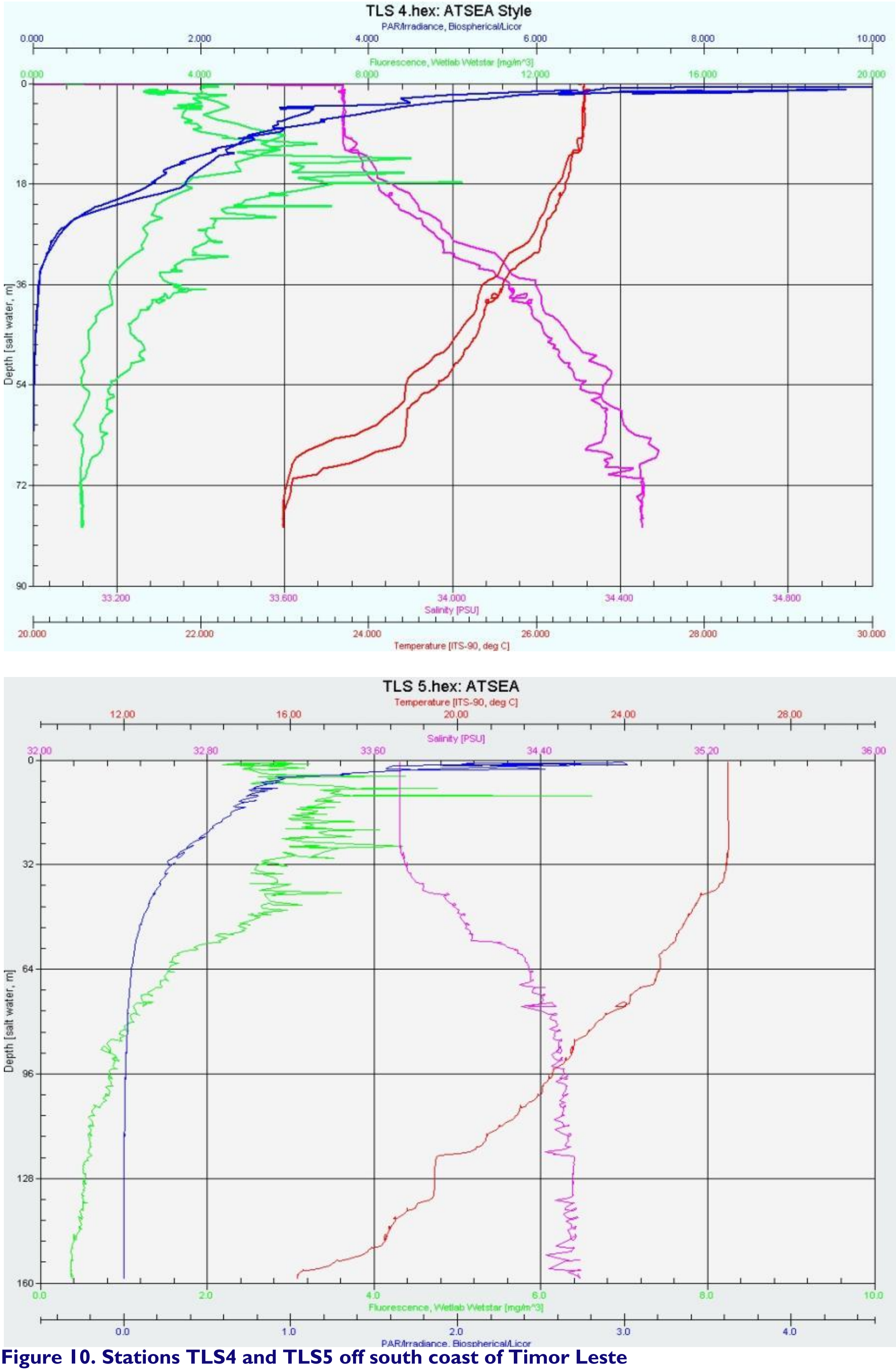
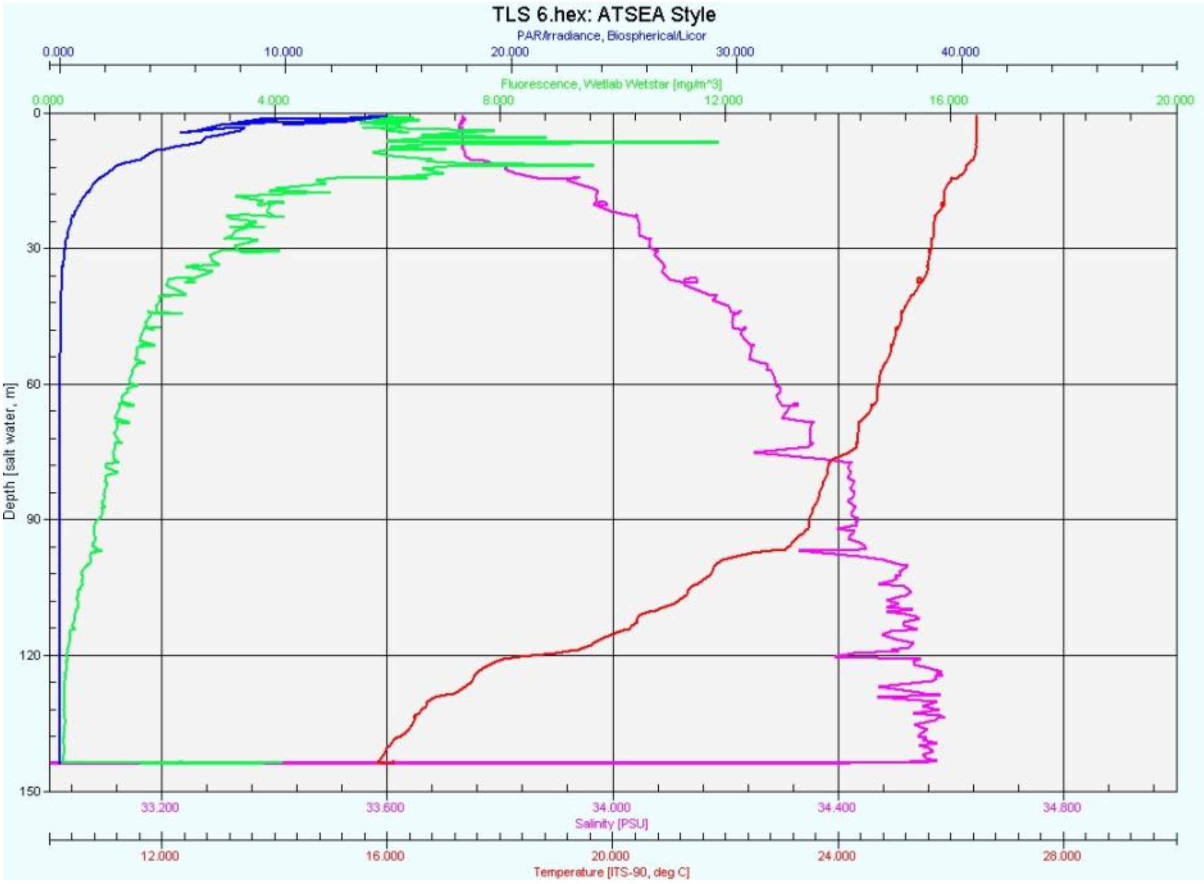


Figure 10. Stations TLS4 and TLS5 off south coast of Timor Leste



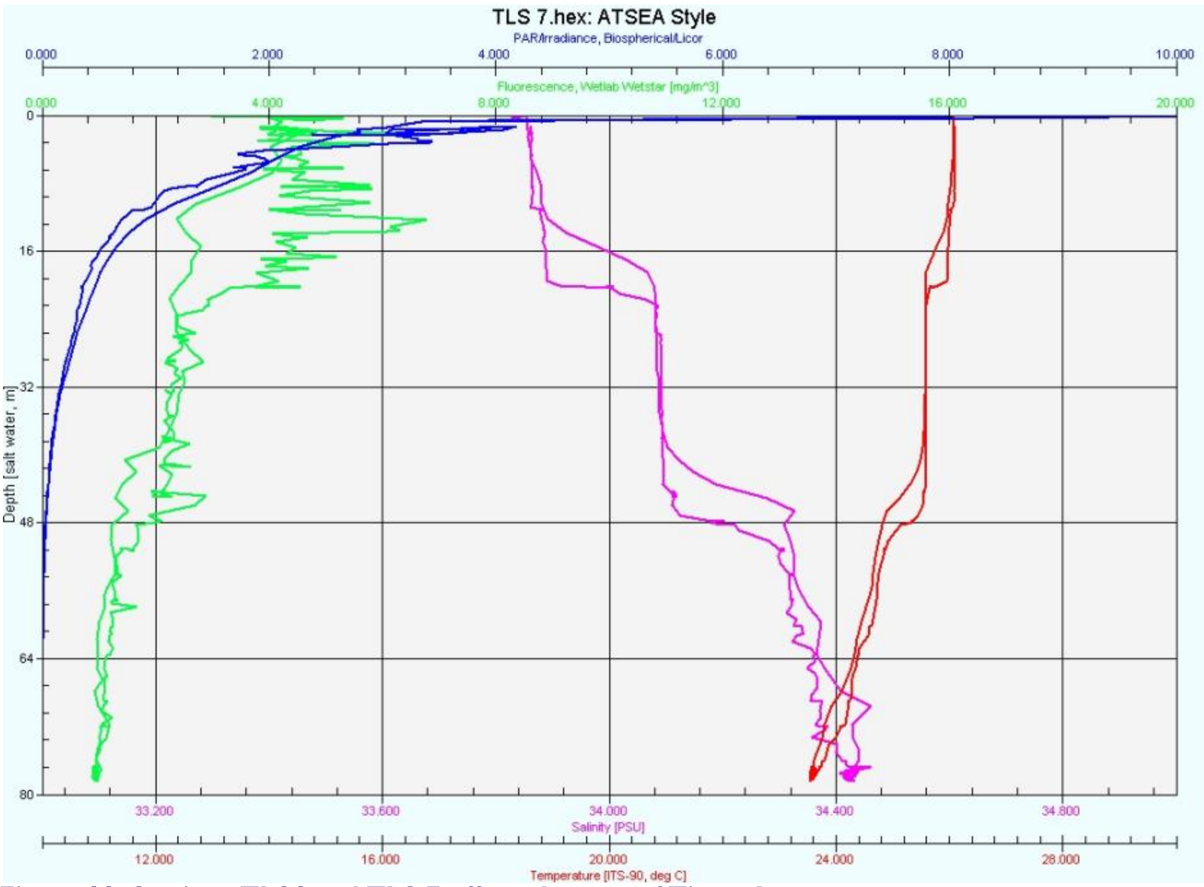


Figure 11. Stations TLS6 and TLS 7 off south coast of Timor Leste

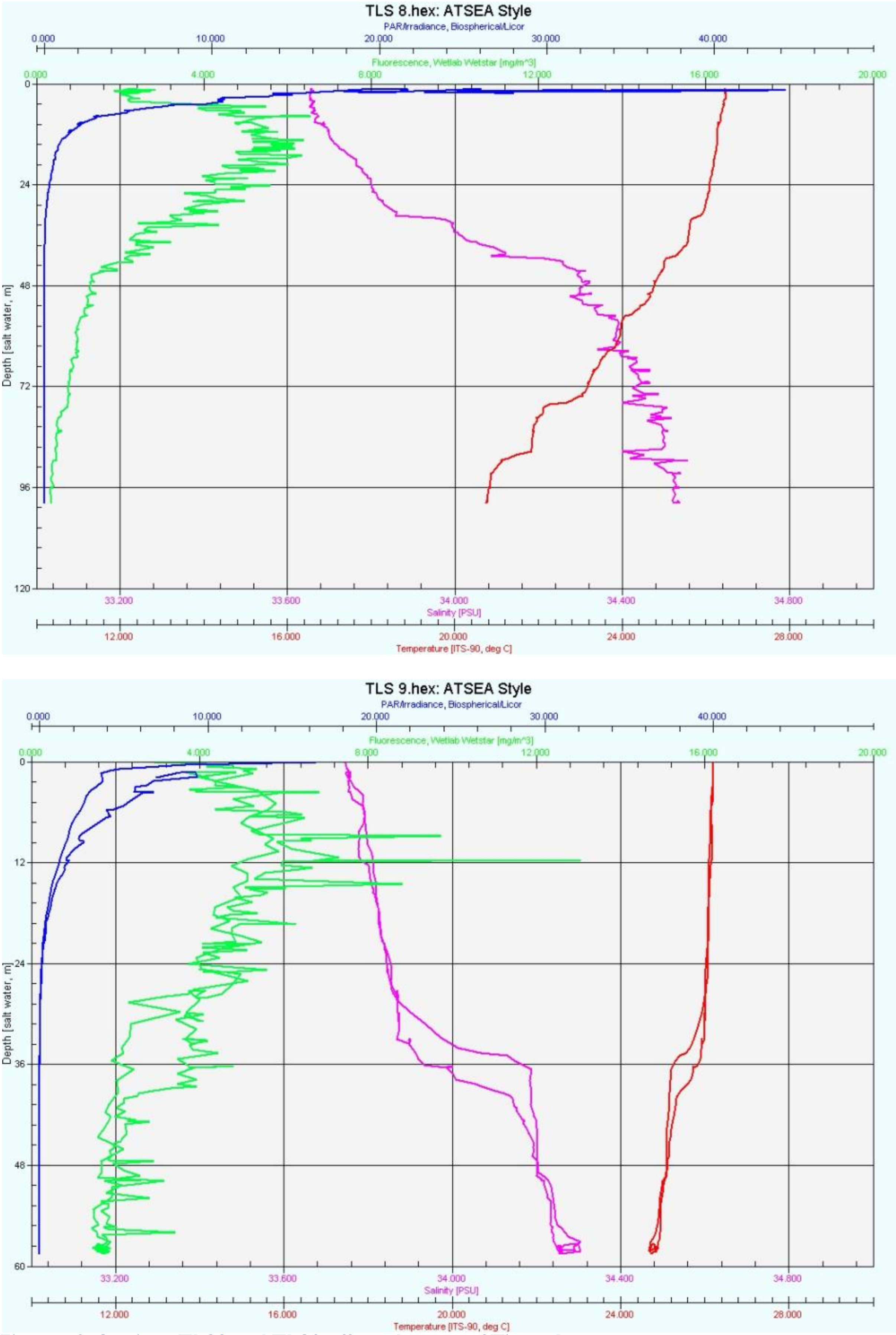
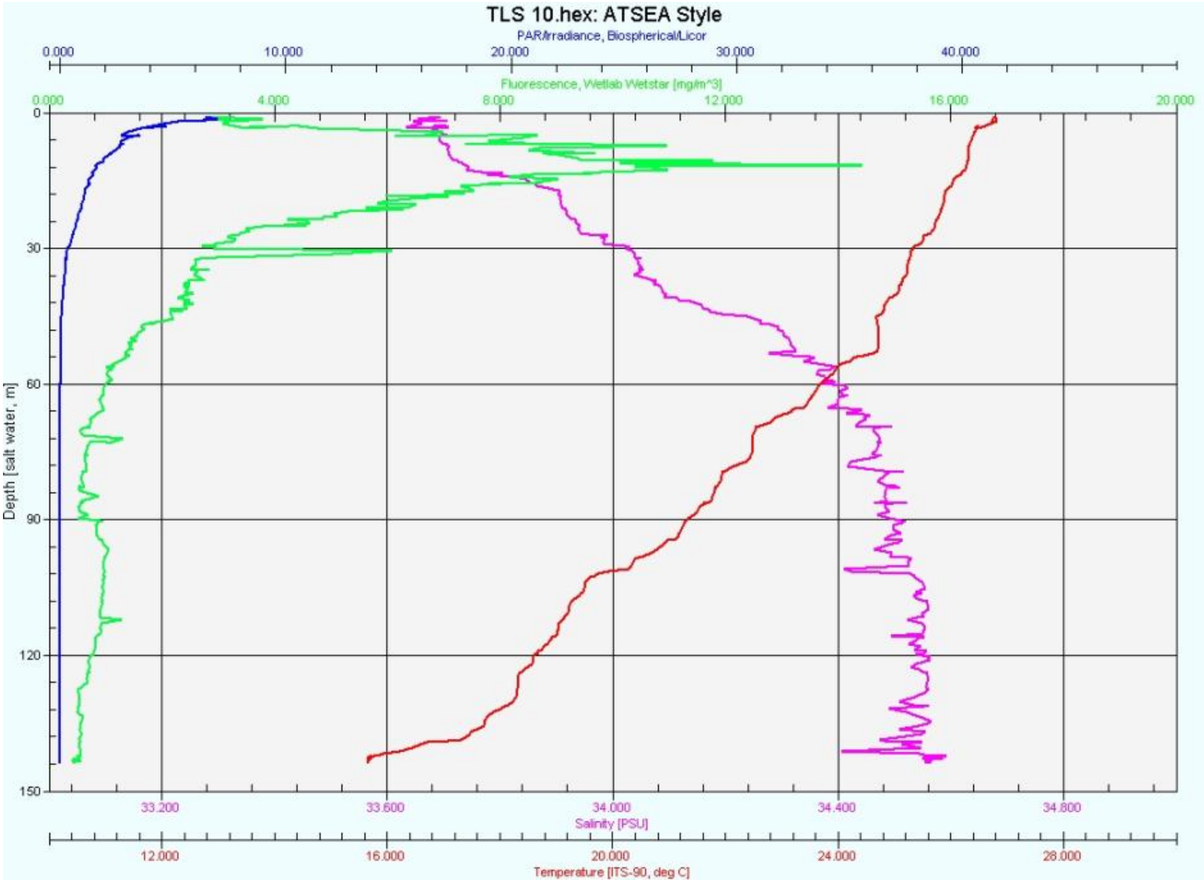


Figure 12. Stations TLS8 and TLS9 off south coast of Timor Leste



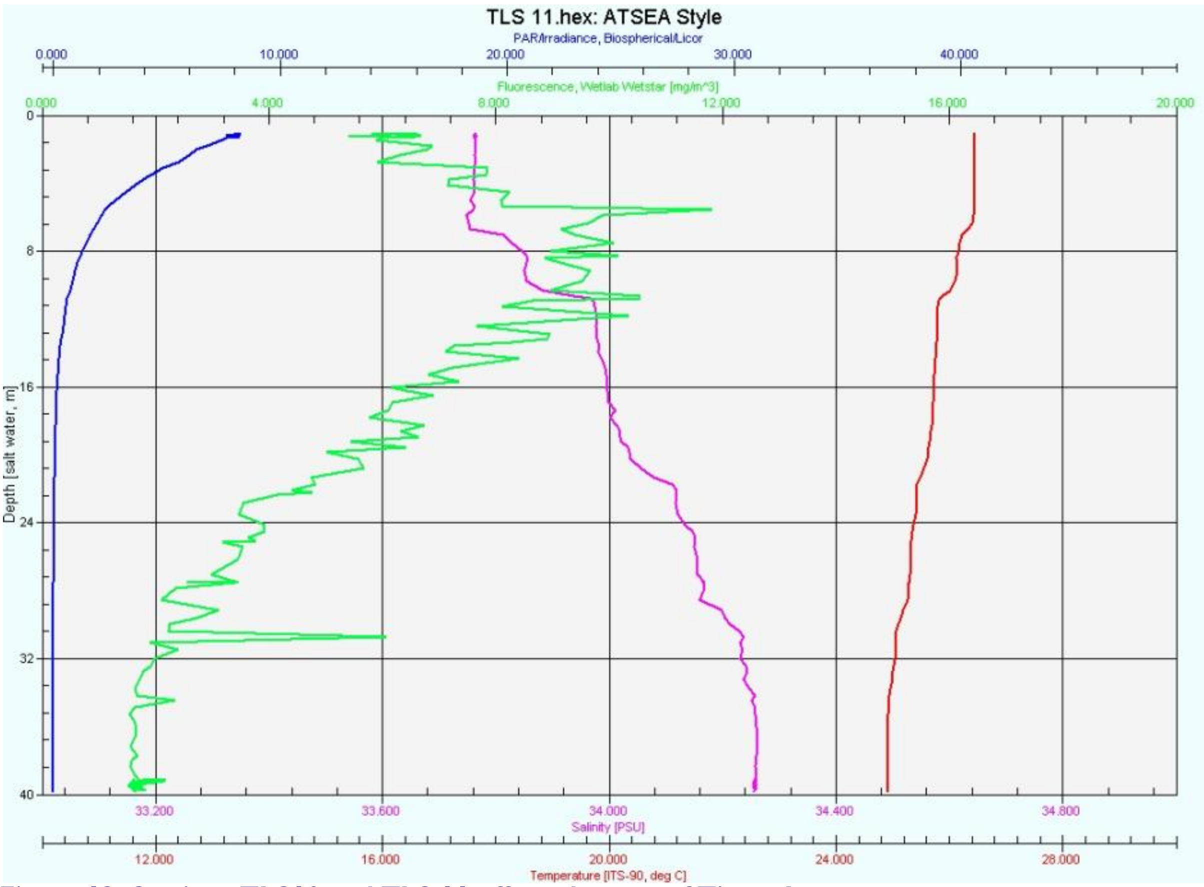
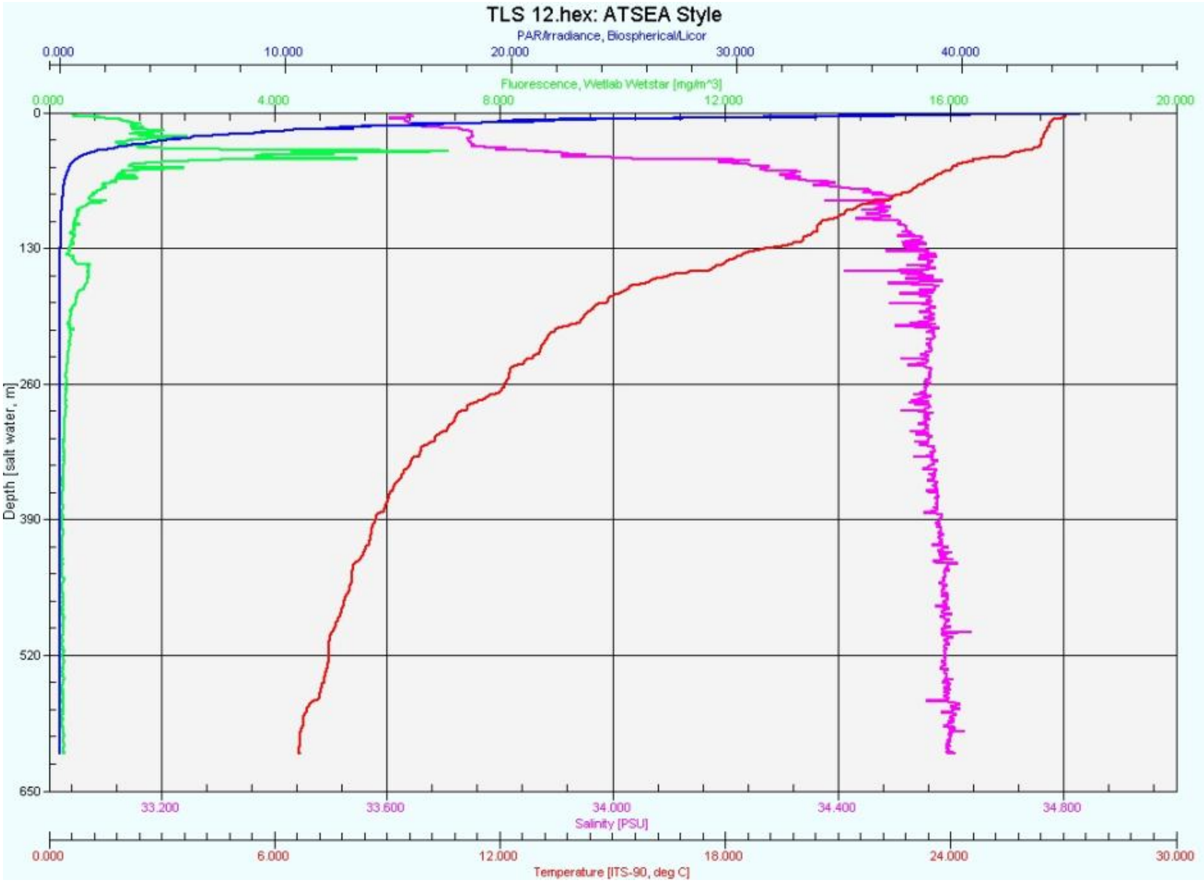


Figure 13. Stations TLS10 and TLS 11 off south coast of Timor Leste



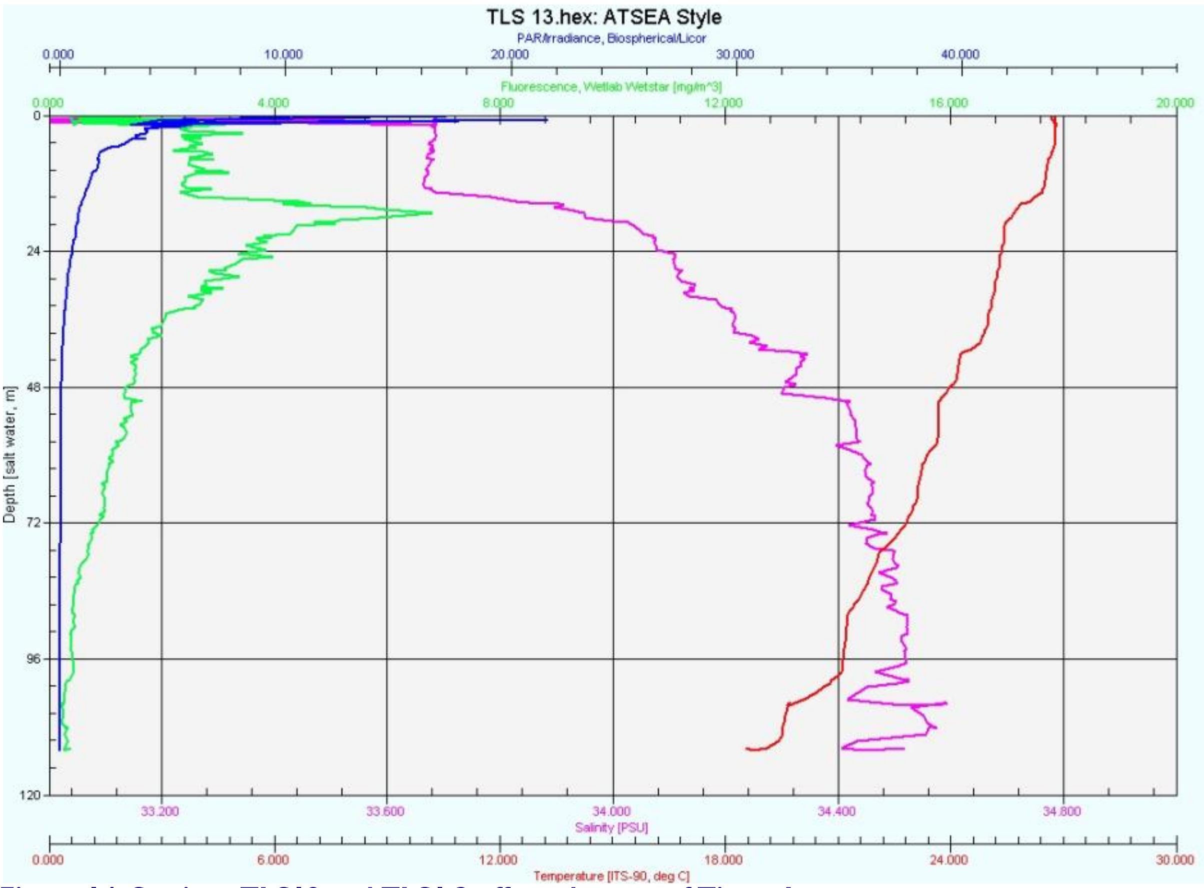
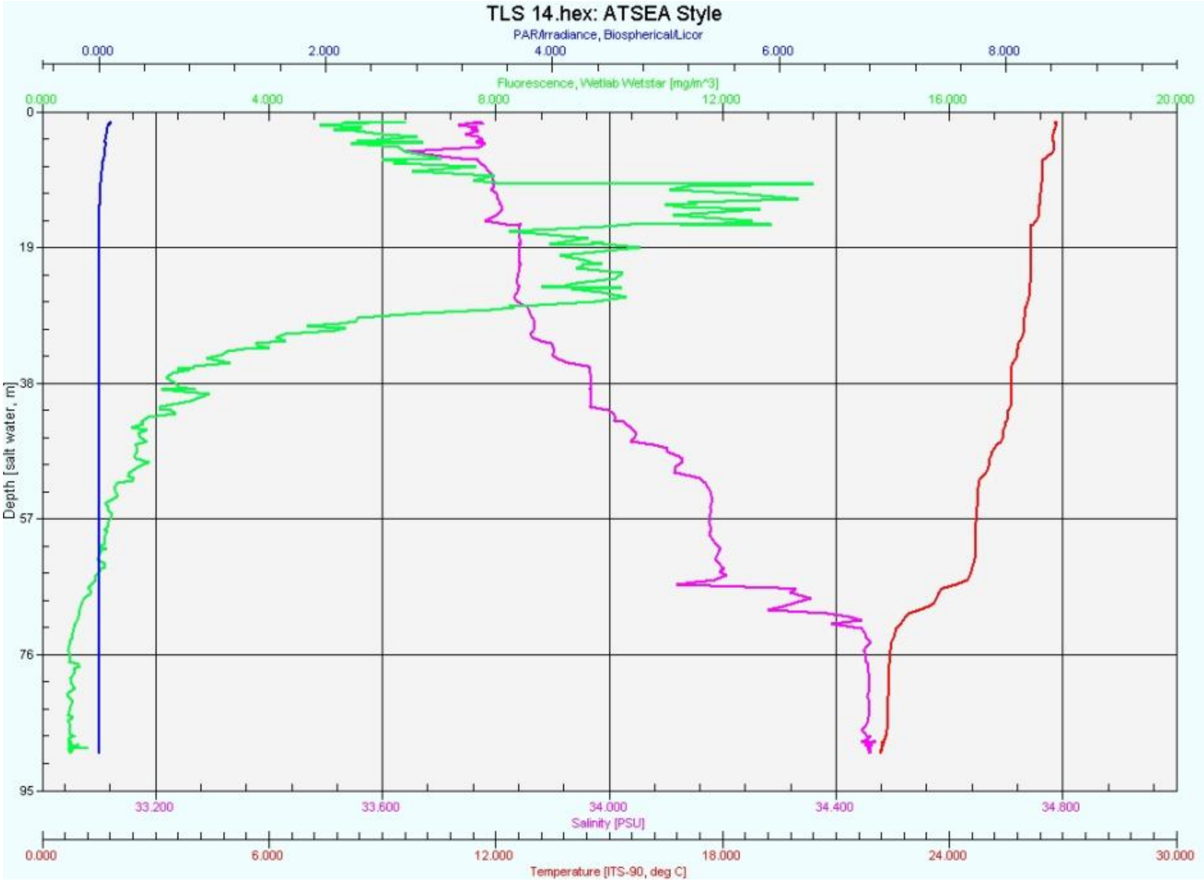


Figure 14. Stations TLS12 and TLS1 3 off south coast of Timor Leste



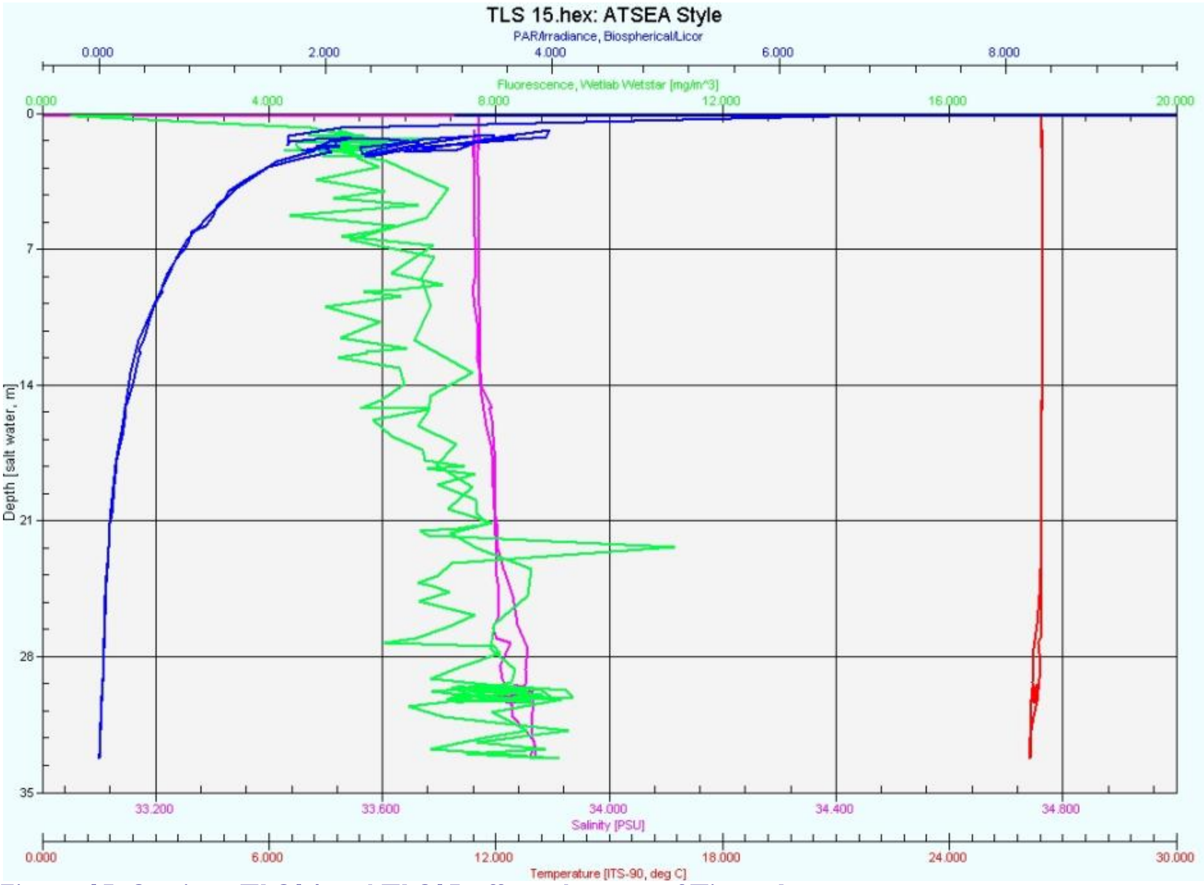
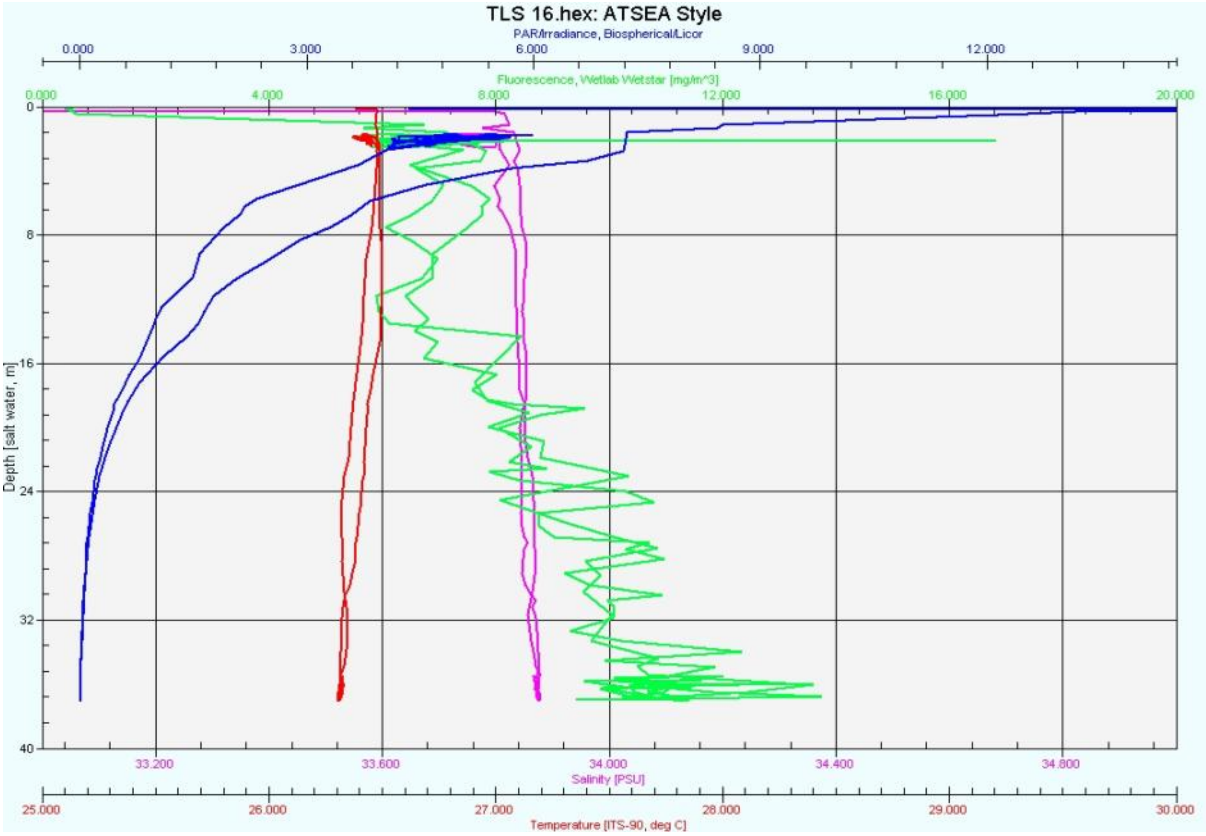


Figure 15. Stations TLS14 and TLS15 off south coast of Timor Leste



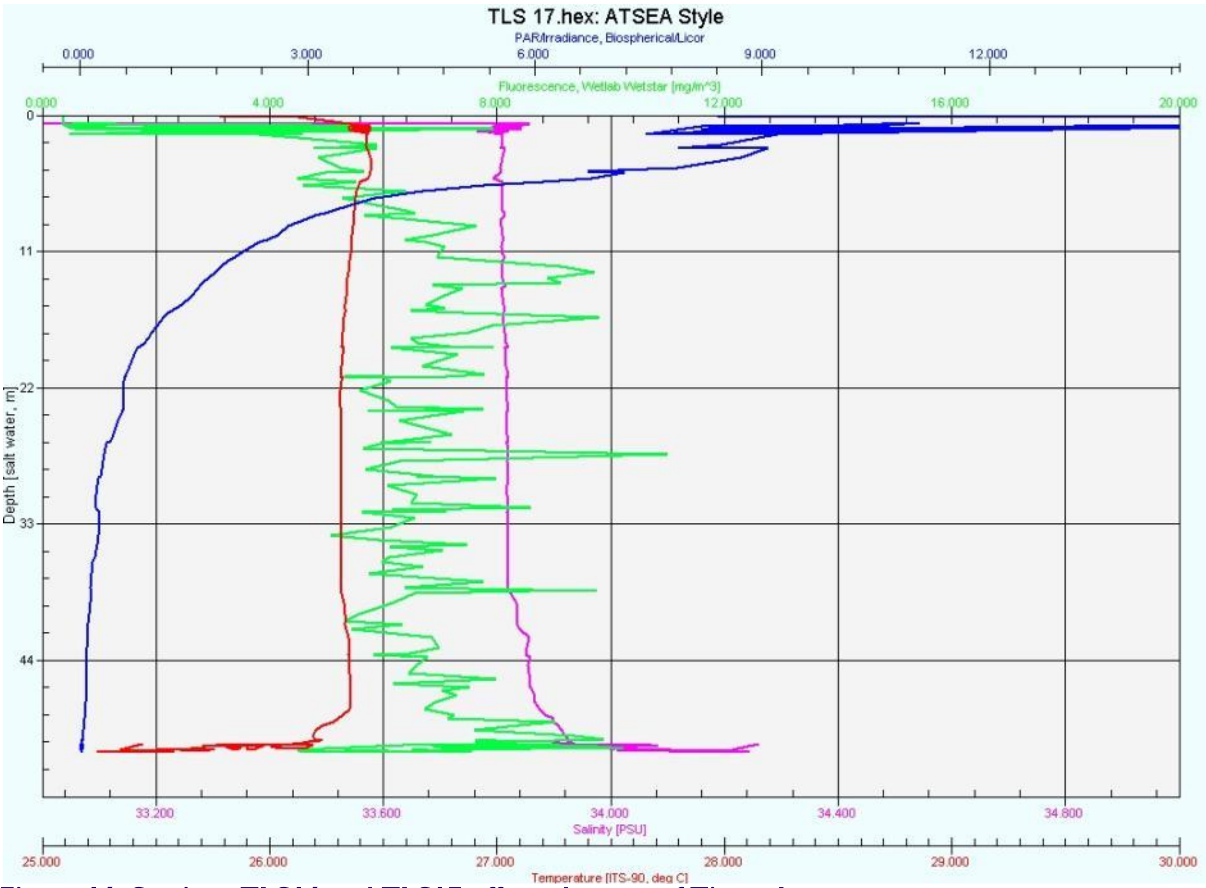
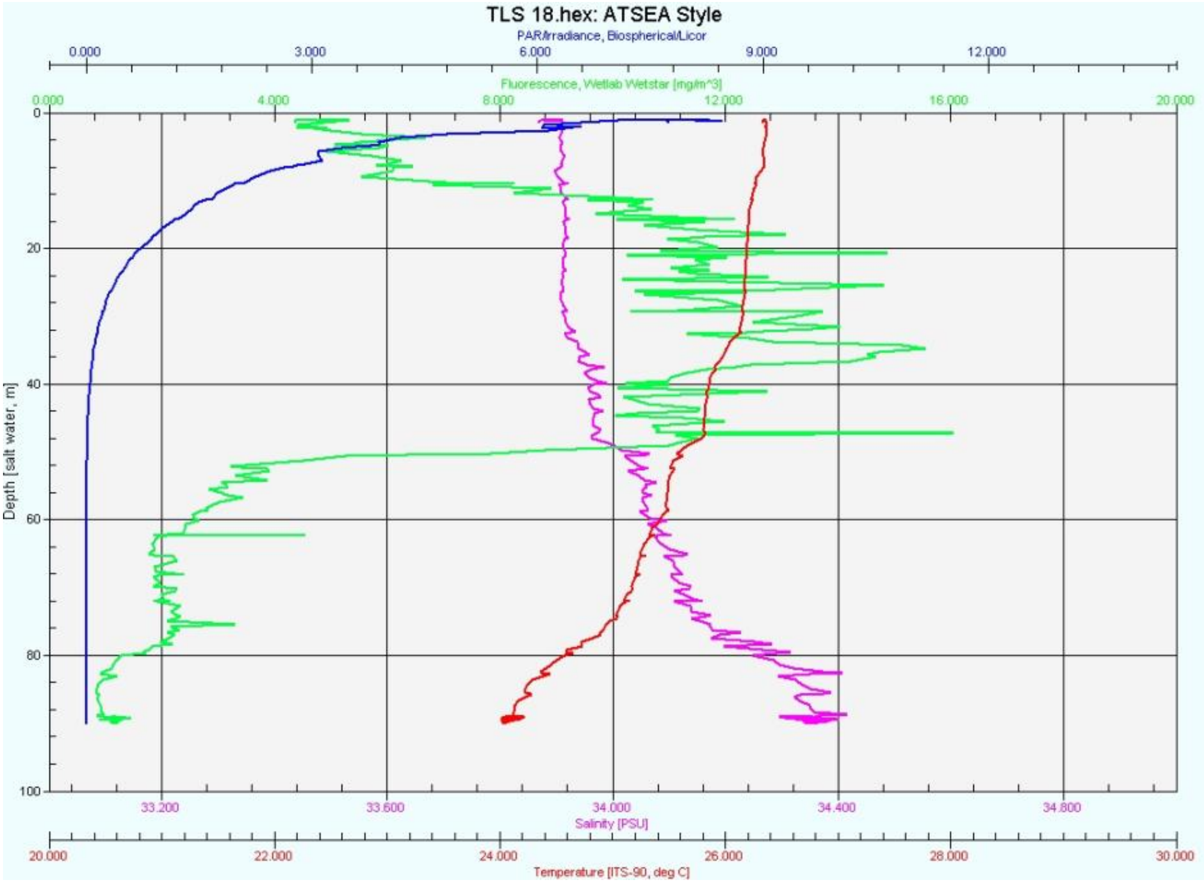


Figure 16. Stations TLS16 and TLS17 off south coast of Timor Leste



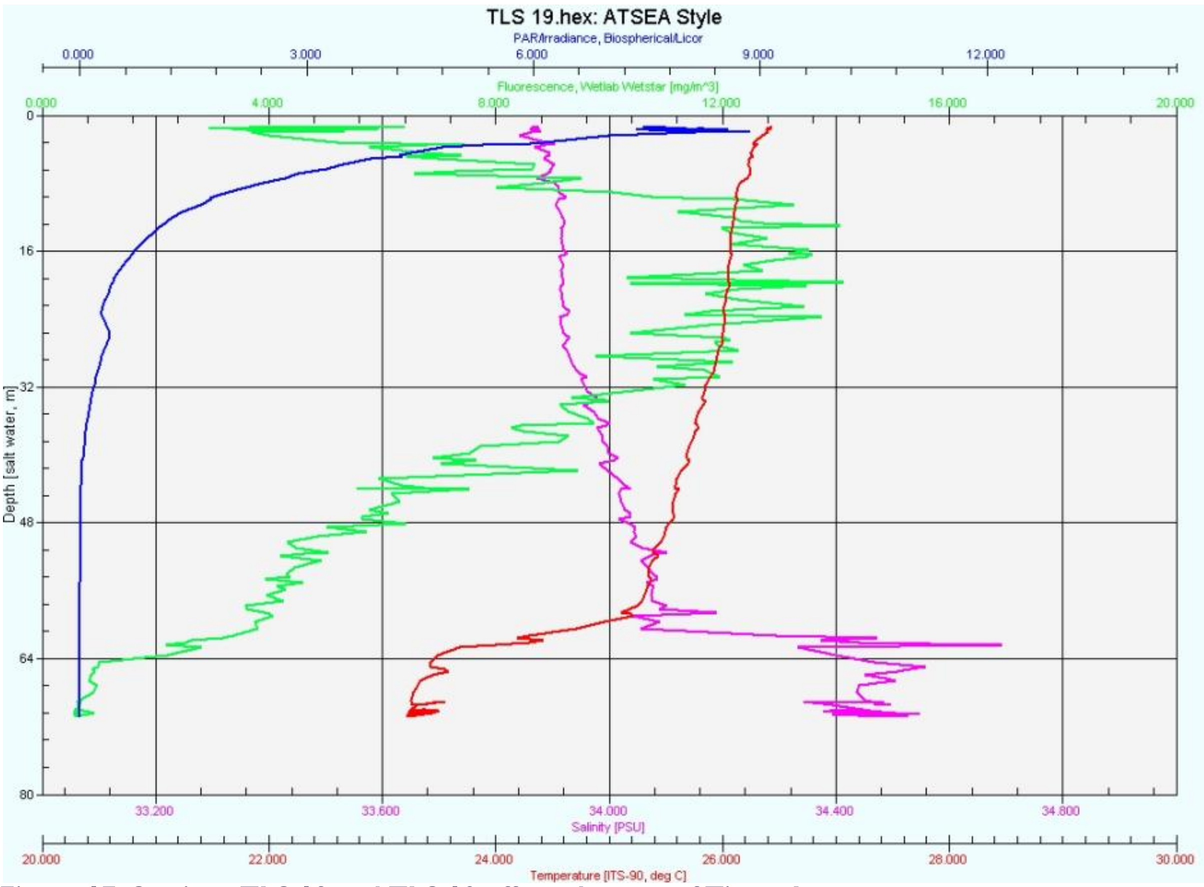
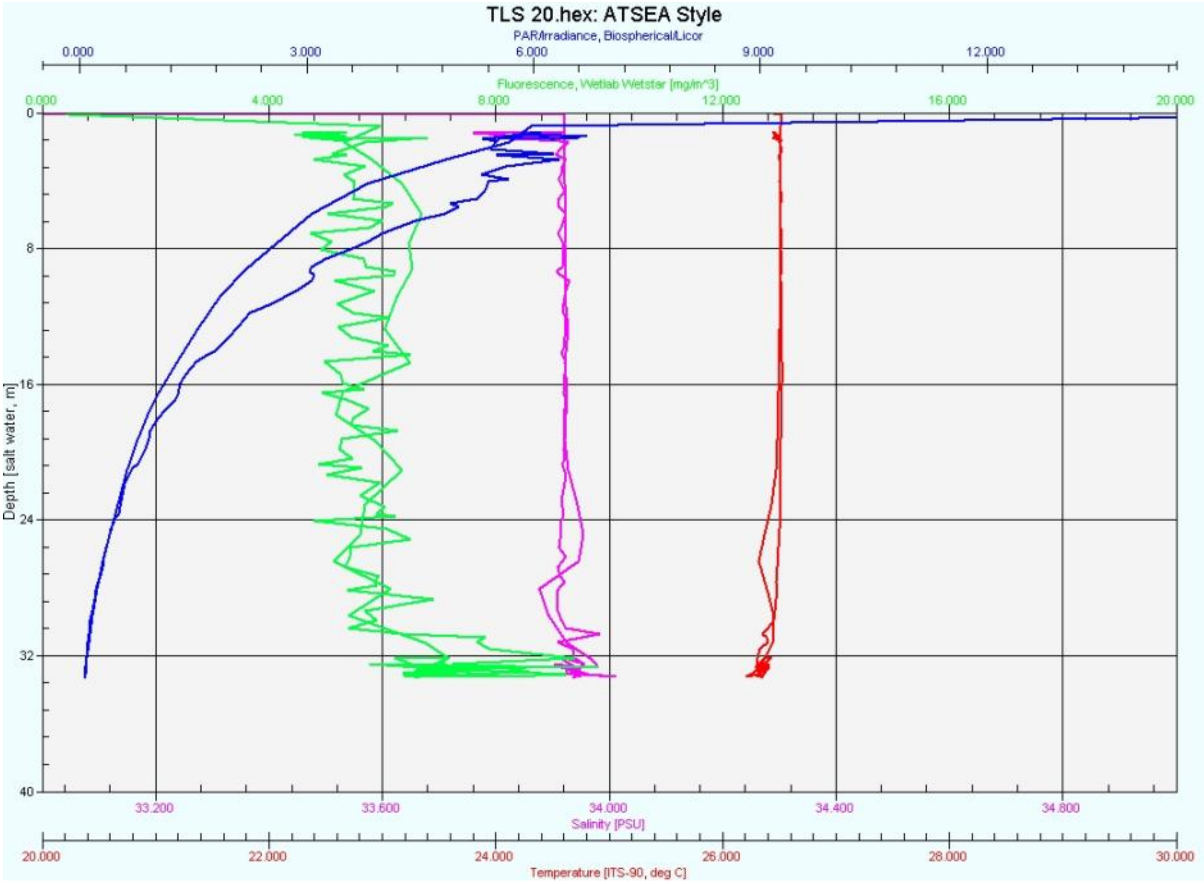


Figure 17. Stations TLS 18 and TLS 19 off south coast of Timor Leste



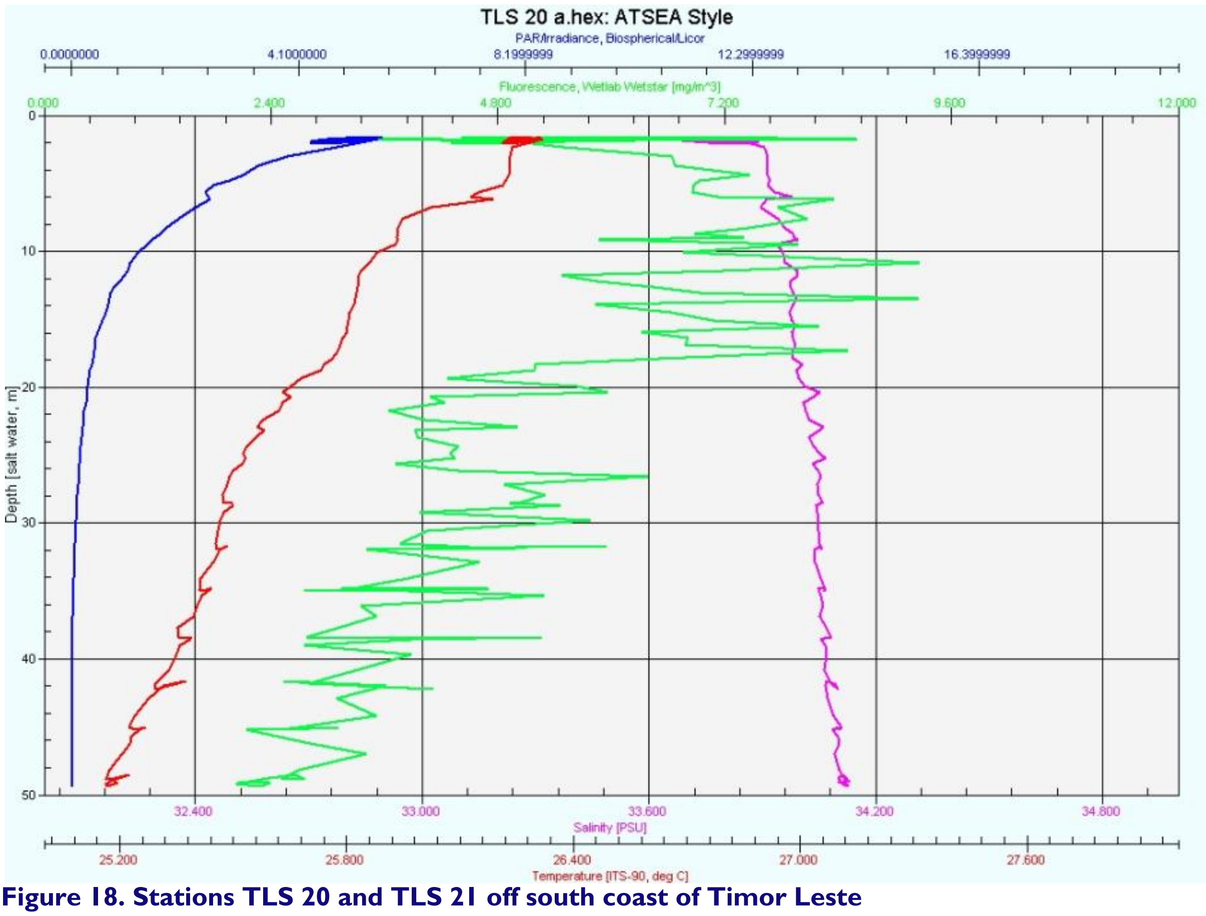
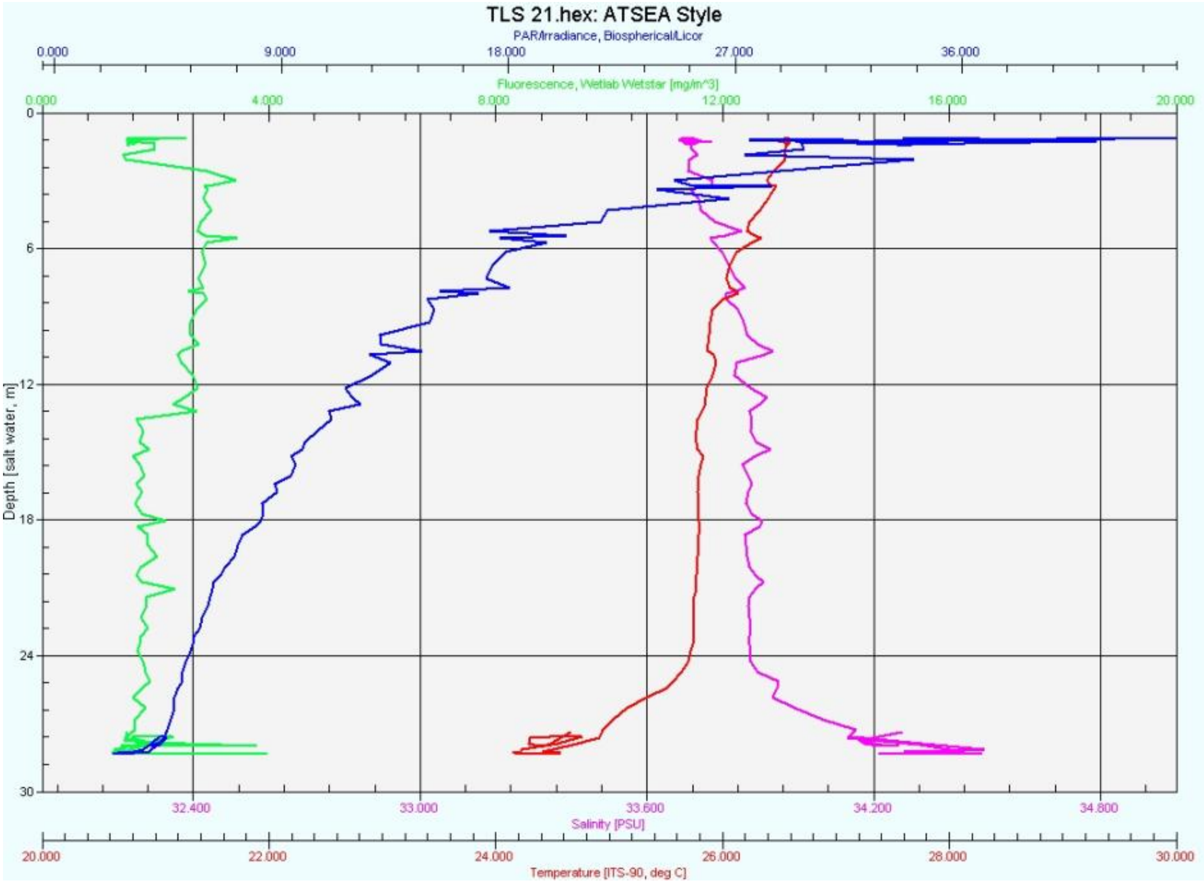


Figure 18. Stations TLS 20 and TLS 21 off south coast of Timor Leste



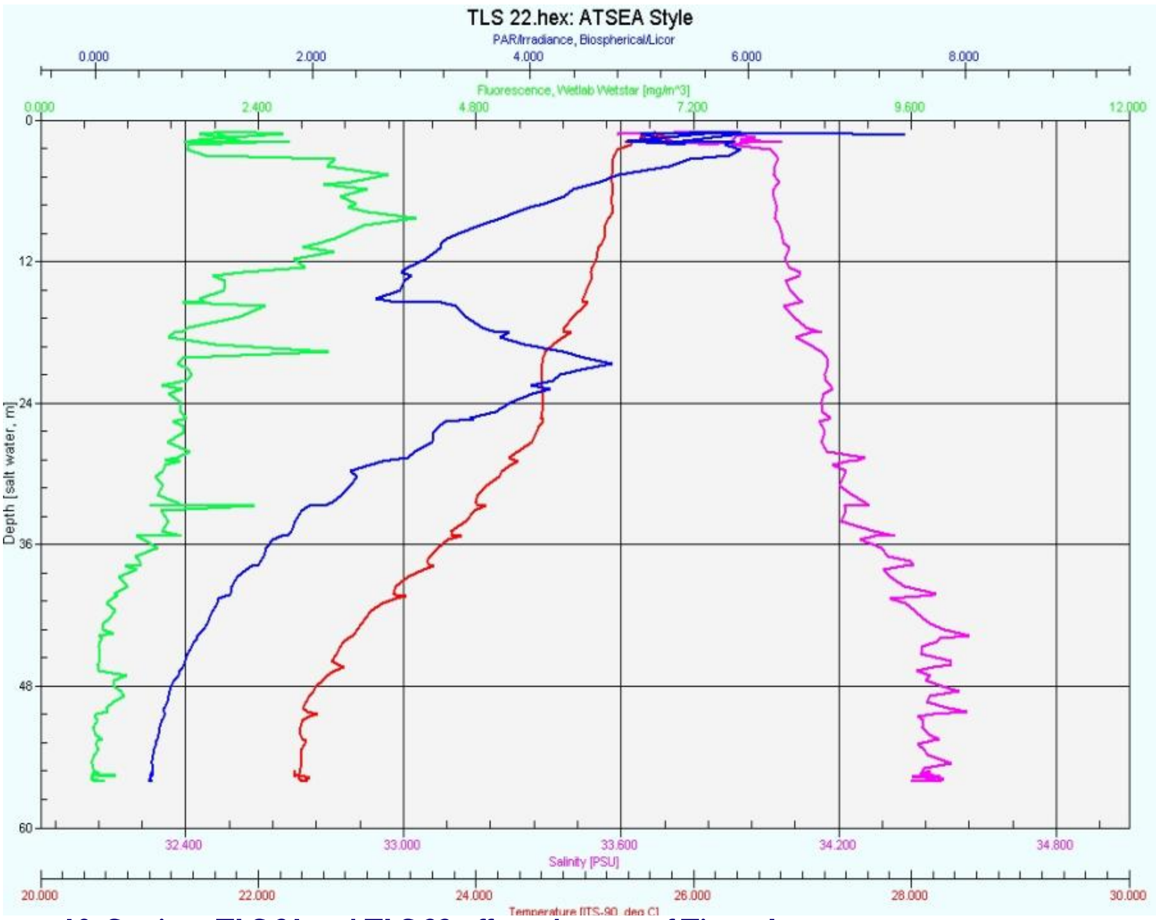
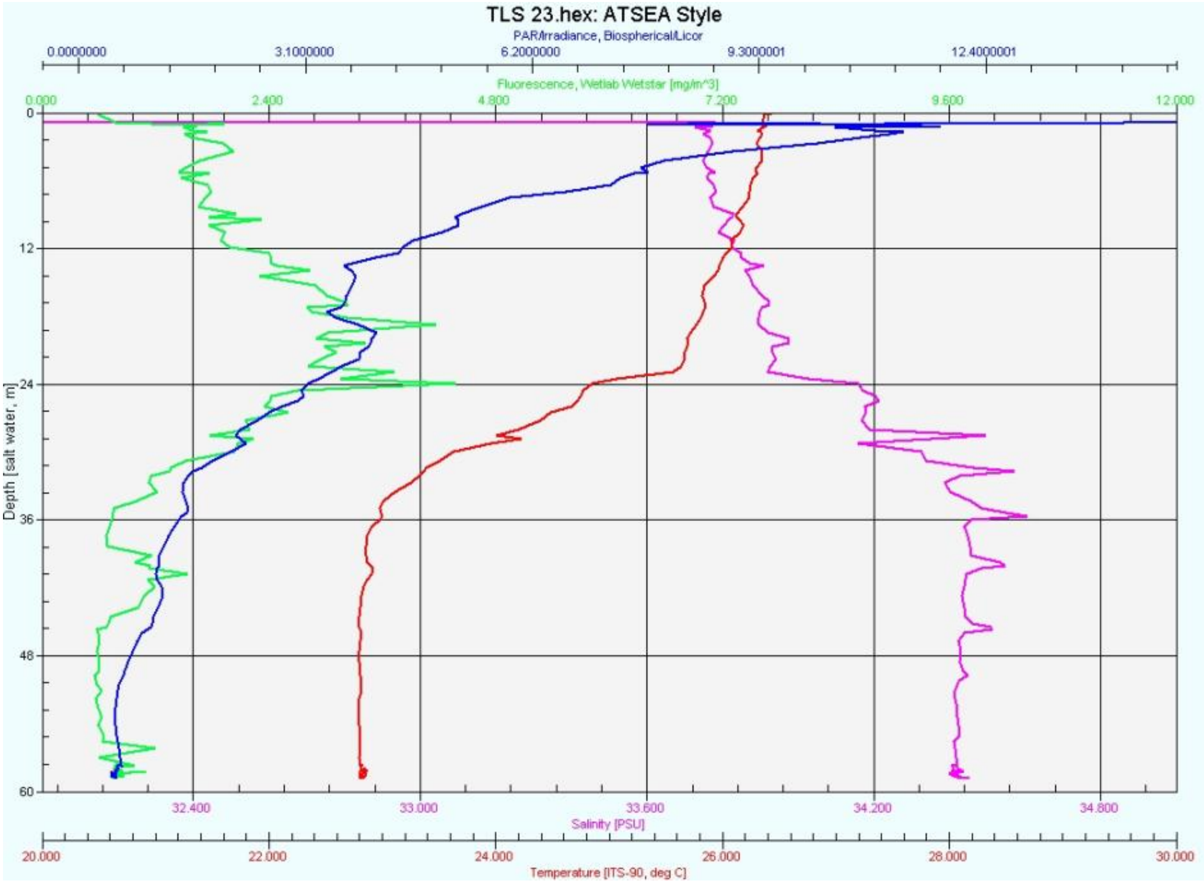


Figure 19. Stations TLS 21 and TLS 22 off south coast of Timor Leste



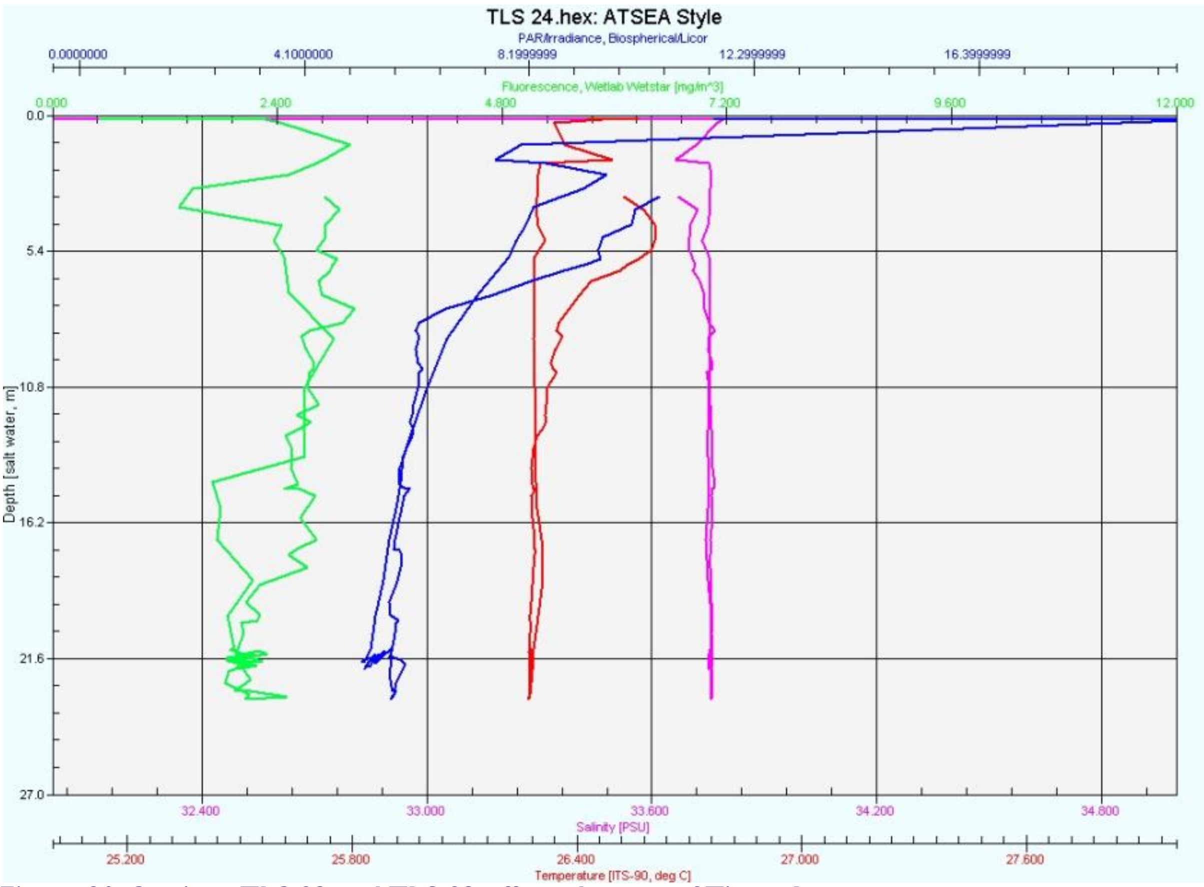


Figure 20. Stations TLS 23 and TLS 23 off south coast of Timor Leste

b. Soft Sediment processes

Benthic Respiration

Benthic respiration rates at various stations ranged from 12-98 mmol/m²/day and were higher on the reef sites with encrusting organisms compared to the sites with mud, clay or sand (Fig.21).

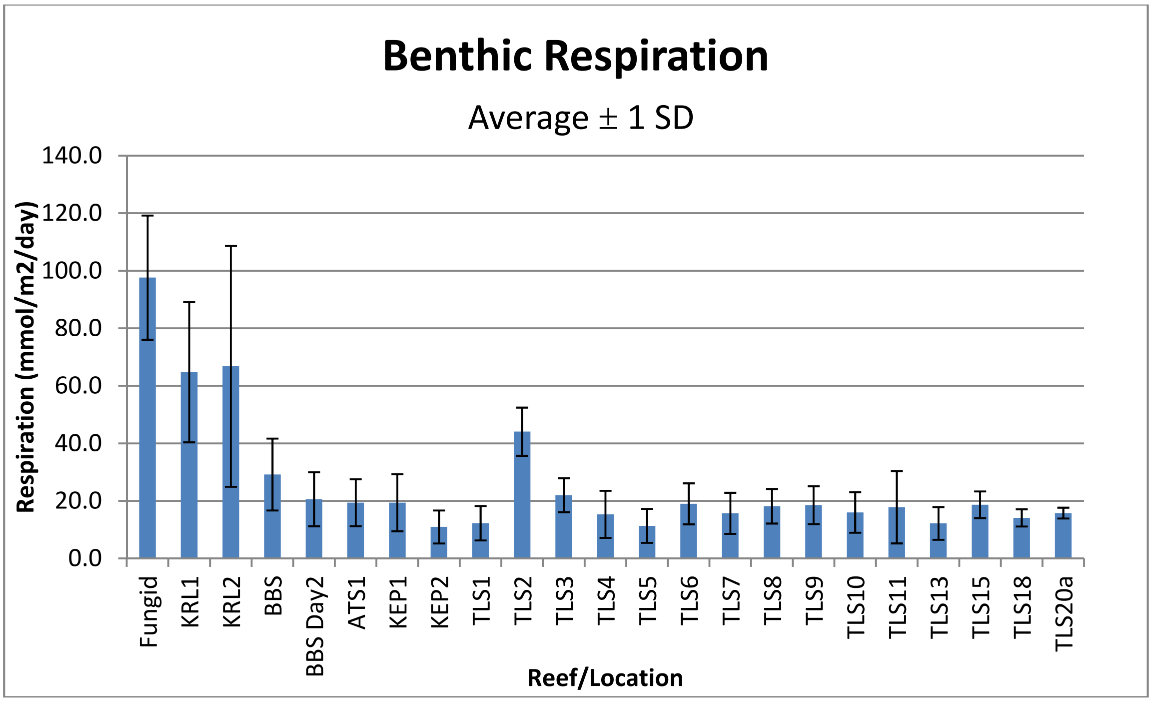


Figure 21. Rates of oxygen consumption (mmol O_2 m^{-2} d^{-1}) at each of the benthic stations.

Rates were greater at the Australian Reef sites than off the southern coast of Timor Leste.

Sediments at the reef sites were sandy, of low organic content and highly aerobic, explaining the rapid rates of benthic oxygen consumption. In contrast, most of the benthic stations off the south coast of Timor Leste were composed of fine silt and clay (mud). It is possible that the comparatively low rates of benthic respiration rates off Timor were the result of the comparatively cold water temperatures as the result of upwelling. However, rates of anaerobic processes, such as sulphate reduction were more rapid that rates of oxygen consumption, suggesting that there may be a significant amount of benthic-pelagic coupling, with most phytoplankton-derived carbon being consumed by sediment bacterial communities.

Measurement of other processes, such as stable isotope and sediment porewater chemistry, were completed successfully and await analytical processing.

c. Seabed biodiversity –submerged shoals & coastal sampling

Shoal Selection

Australia, Indonesia and Timor Leste share maritime jurisdictions in the middle of the Timor Sea (see Figure 22). Submerged shoals are a prominent feature of this area, with many of them located along the edge of the Australian continental shelf. These are carbonate banks rising from depths of 100-300m and culminating in plateaux lying 15-50m below present sea level. Preliminary research on similar shoals in Australia's EEZ has found that some support diverse tropical biota, including coral and fish species typical of coral reefs, but that there is high variability between shoals. This cruise provided an opportunity to extend biological surveys of the shoals into the shared central Timor Sea area. Four shoals were a primary focus, two in the joint jurisdictional areas between Australia and Indonesia and two in the JDPA area between Australia and Timor Leste. A fifth shoal, to the east, was visited briefly also, prior to the cruise continuing north to the coastal region of Timor Leste (see Fig 1).

Figure 22. Indicative maritime boundaries and locations of submerged shoals visited during the Cruise. The grey shading shows the Australia-Indonesia joint jurisdictional area. The light blue line bounds the JDPA area with Timor Leste. As none of the shoals have formal names on Australian charts, nominal field names were used.

Field Work completed

The plateaux regions of five submerged shoals were surveyed. The available navigation charts, e.g. Chart AUS 312, provided very limited and sometimes questionable information on fine scale bathymetry over each shoal. During the cruise interpolated bathymetric maps of each survey area were generated using the ship's single beam echosounder and navigation package (Maxsea). Waypoints were recorded for all sampling gear (see Appendix 2). Figures on the next pages show the Towvideo and BRUVS waypoints overlaid on the interpolated bathymetry, with sampling effort summarised in the table below.

Shoal name	Indicative plateau area <60m(km^2)	Common plateau depth (m)	Shallowest points (m)	Towvideo transects (n; length in m)	BRUVS (n)
Fungid	0.6	30-40	30	5; 4,816	8
Krill	1.8	30	<20	13; 13,403	24
Kepah	2.9	20-30	<20	10; 15,313	24
ATSEA	6.7	20-30	<20	12; 21,823	24
Velona	3.7	35-40m	35	2; 4,697	8

FUNGID SHOAL: The unnamed shoal is very small (<1km plateau diameter) and was given the cruise name Fungid Shoal due to the presence of an unusual assemblage of free-living mushroom corals (Fungiidae).The shoal plateau lies in approximately 30m of water and is slightly domed, with a gentle slope in all directions to 40m before deepening more rapidly to 60m then steeply beyond. Five cross plateau towvideo transects and 8 stereo BRUVS deployments were completed (see Fig. 23).

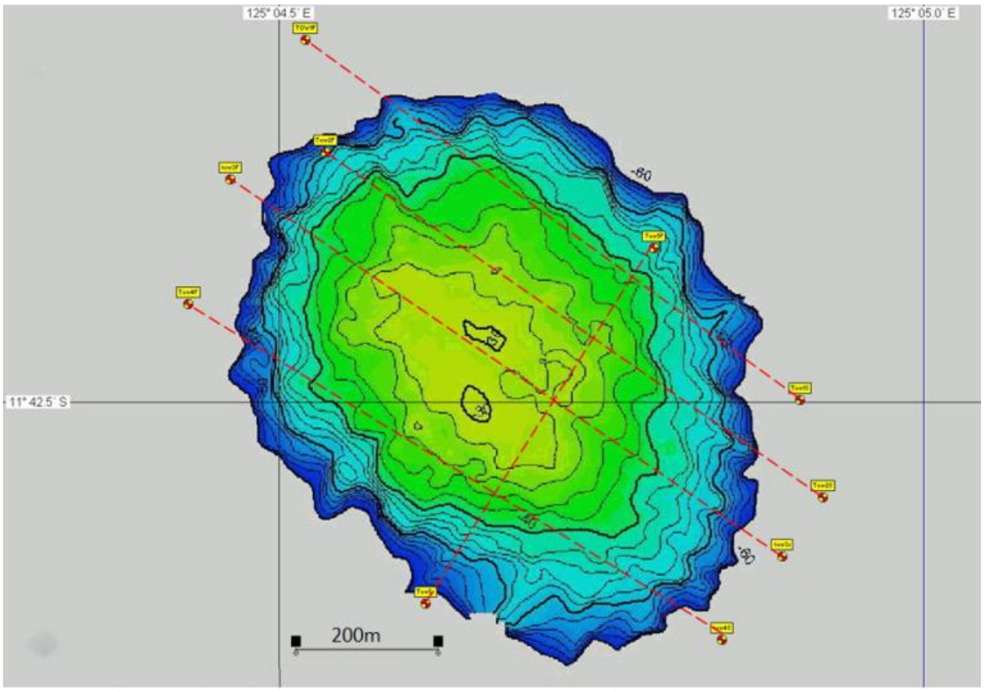


Figure 23. Fungid Shoal – towvideo transect nominal locations, between start and end waypoints, in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour.

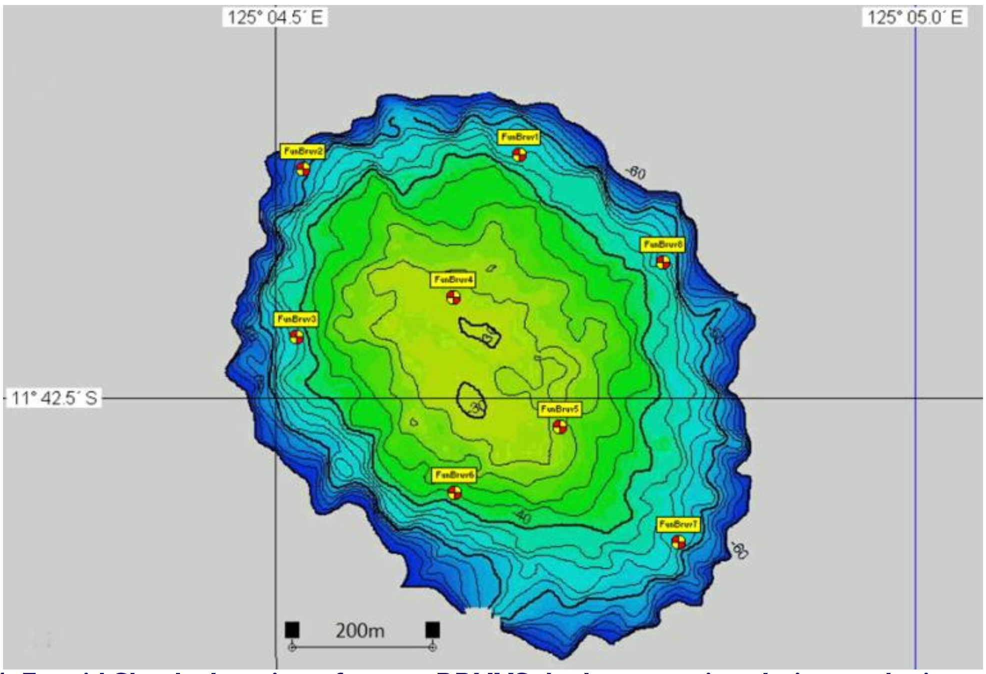


Figure 24. Fungid Shoal – location of stereo BRUVS deployments in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour. Green shaded areas 30-40m, blue 40-60m depths. The number of BRUVS used was constrained by the small size of the plateau area.

KRILL SHOAL : The plateau area supports diverse tropical reef life. The bathymetry indicates a slightly shallower region along the south-eastern rim region.

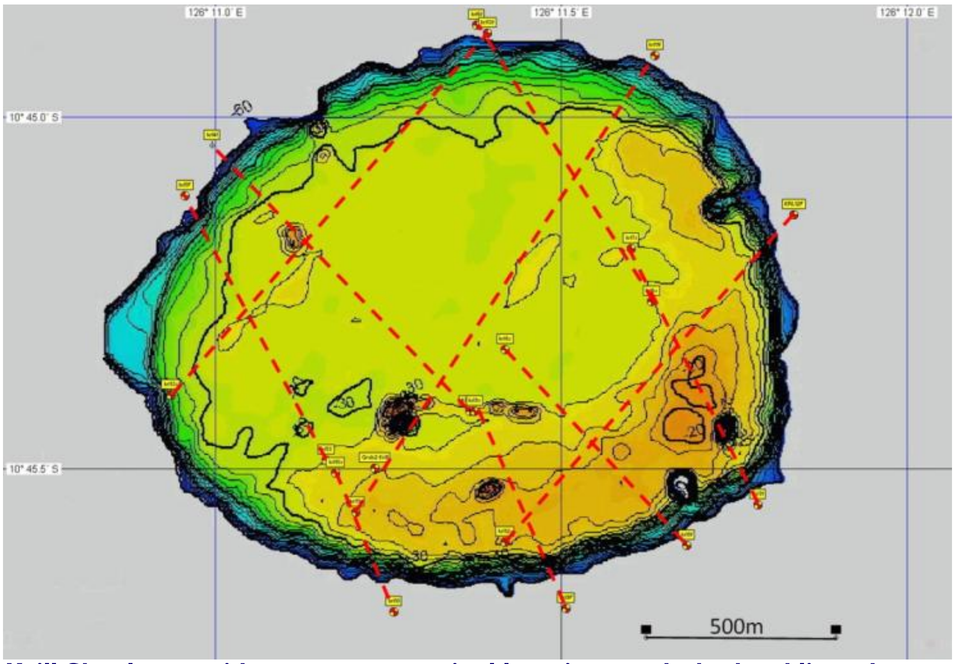


Figure 25. Krill Shoal – towvideo transect nominal locations as dashed red lines, between start and end waypoints, in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour.

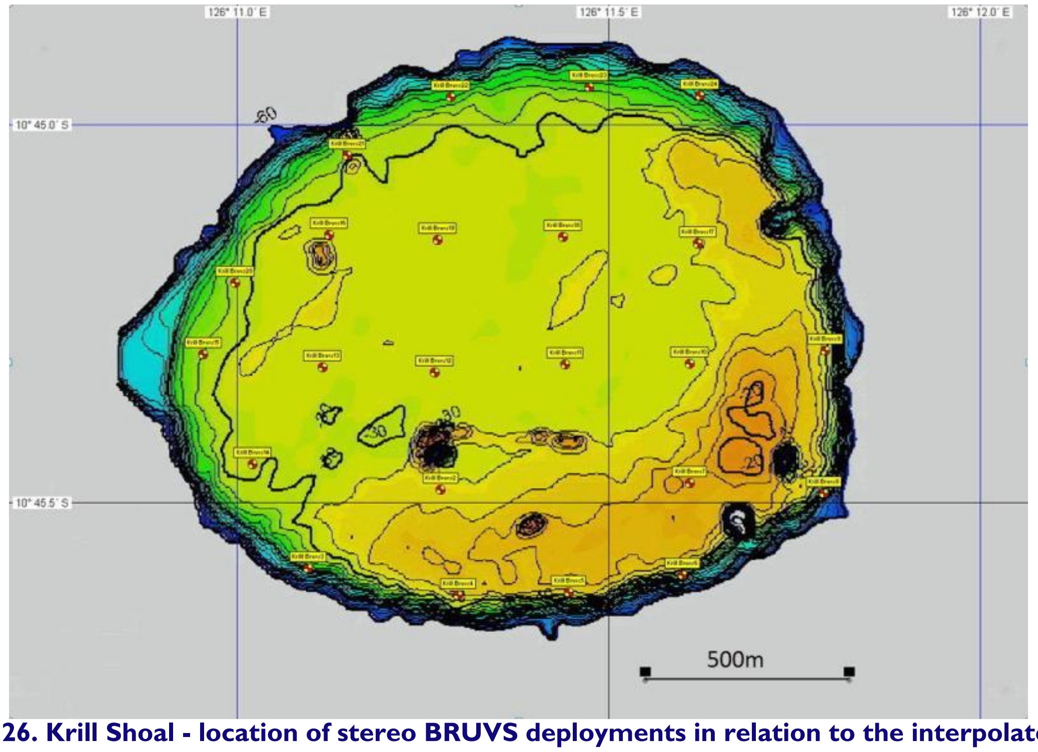


Figure 26. Krill Shoal - location of stereo BRUVS deployments in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour.

KEPAH SHOAL: Kepah Shoal is north east of Krill shoal. The shoal plateau is oval in shape, oriented N/NW-S/SE, with most of the plateau lying within the 30m contour. This shoal supported diverse habaits, including a mix of sand, rubble and consolidated coral outcrops. In places live coral abundance was high.

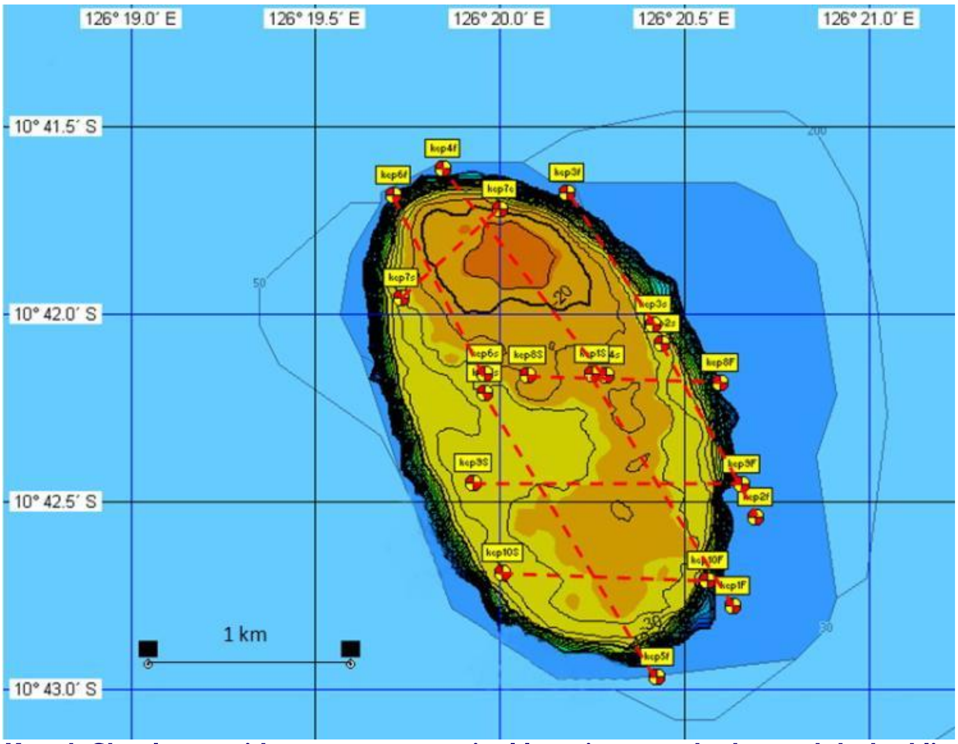


Figure 27. Kepah Shoal - towvideo transect nominal locations marked as red dashed lines, between start and end waypoints, in relation to the interpolated, acquired single-beam bathymetry of the shoal plateau down to the 60m depth contour. The acquired bathymetry is superimposed on the available chart bathymetry, revealing significant inconsistencies, with the shoal plateau smaller than the chart 30m contour (medium blue background) indicated.

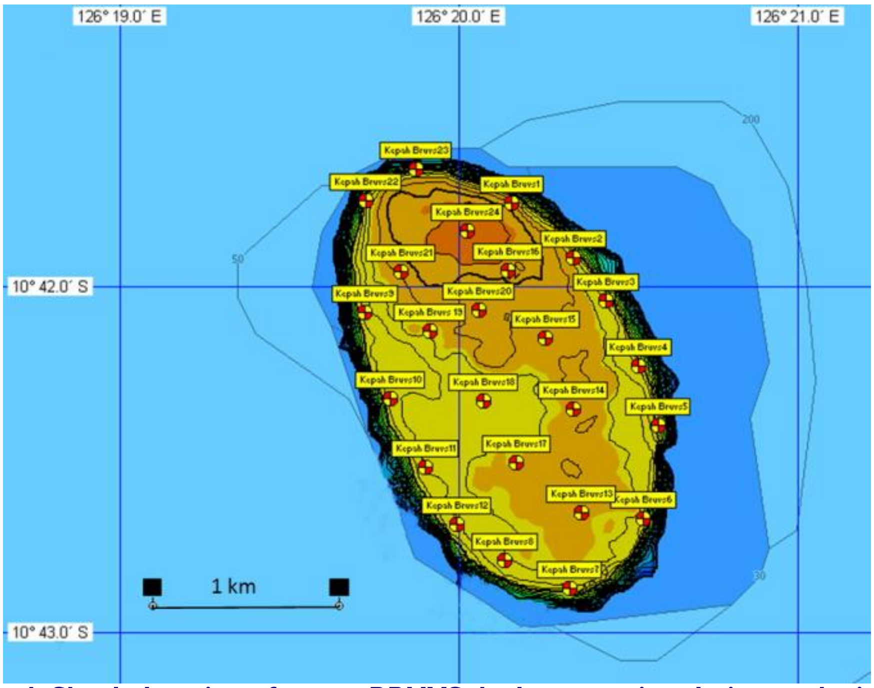


Figure 28. Kepah Shoal - location of stereo BRUVS deployments in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour.

ATSEA SHOAL .The largest of the shoals visited. As the shoal was not named on the relevant Australia navigation chart (AUS 312), we named it the ATSEA Shoal for the purposes of identification during the cruise.

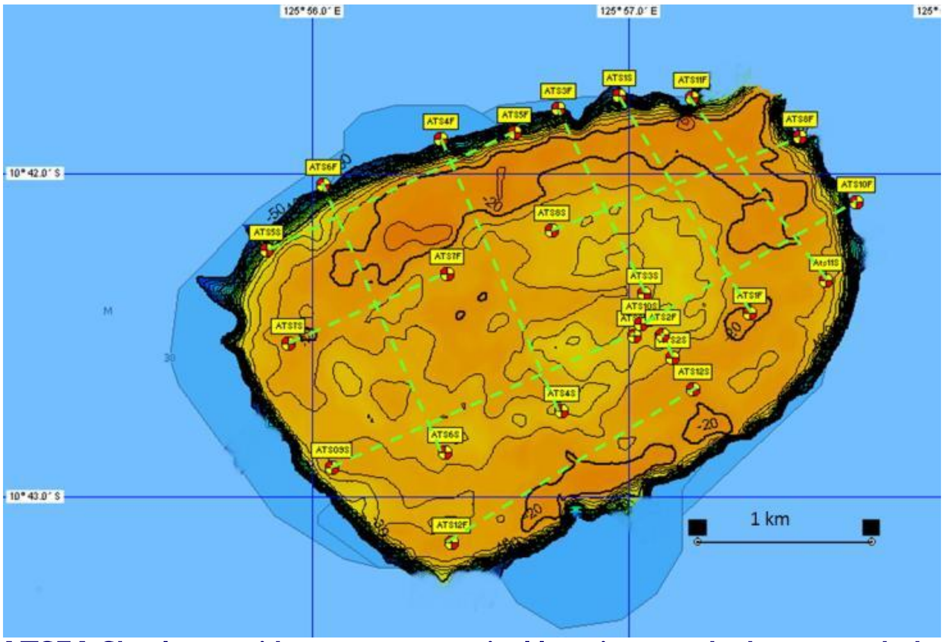


Figure 29. ATSEA Shoal – towvideo transect nominal locations marked as green dashed lines, between start and end waypoints, in relation to the interpolated, acquired single-beam bathymetry of the shoal plateau down to the 60m depth contour. The acquired bathymetry is superimposed on the available chart bathymetry, revealing significant inconsistencies.

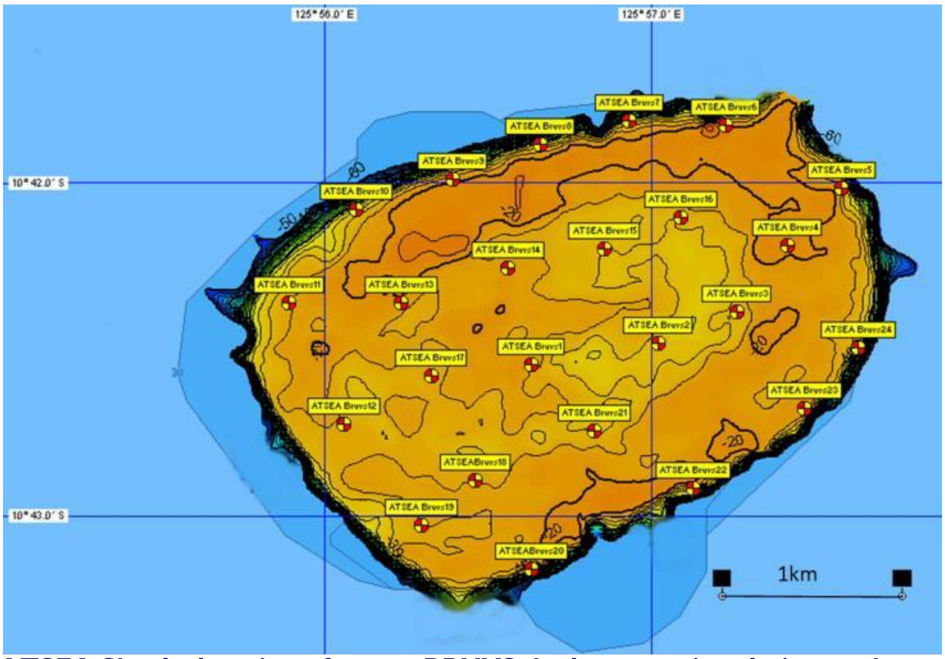


Figure 30. ATSEA Shoal – location of stereo BRUVS deployments in relation to the interpolated, single-beam mapped bathymetry of the shoal plateau down to the 60m depth contour. The majority of the shoal plateau was in 20-30m depths (mustard colour) with shallower regions < 20m (orange)around the north, east and southeast margins.

VELONA SHOAL: A more isolated shoal to the east of the others surveyed in the central area of the JDPA. Sampling was restricted to one day of effort prior to transit to coastal areas near Timor Leste.

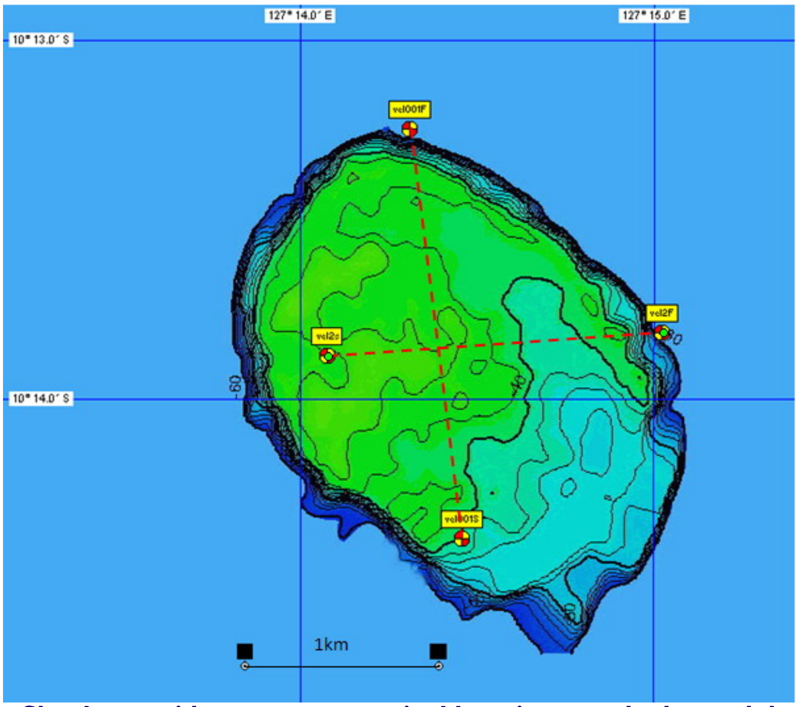


Figure 31. Velona Shoal - towvideo transect nominal locations marked as red dashed lines, between start and end waypoints, in relation to the interpolated, acquired single-beam bathymetry of the shoal plateau down to the 60m depth contour. The majority of the plateau lies in 35-40m depths (green), with a sloping southeast aspect and abrupt steepening beyond 60m (dark blue rim areas)

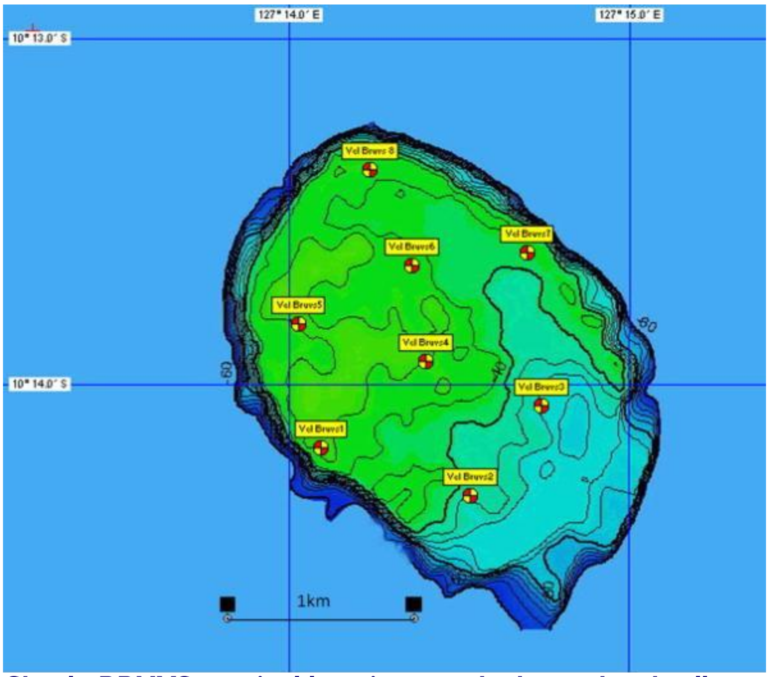


Figure 32. Velona Shoal - BRUVS nominal locations marked as red and yellow symbols, in relation to the interpolated, acquired single-beam bathymetry of the shoal plateau down to the 60m depth contour.

Coastal seabed biodiversity sampling

In the second half of the expedition, as the RV Solander sampled offshore sediments, a smaller ship's tender was used to simultaneously make initial assessments of benthic habitats along the south coast of Timor Leste. Three near shore areas (Betano, Breaso and Jaco Island (see Figs. 33-35), where shallow reef and surf could be seen, were sampled with a lightweight drop camera system deployed by hand from the RV Solander tender. Drop camera transects, usually 100-120m in length, were undertaken at all three locations. At Betano and Breaso, on the south Timor Leste coast, seawater clarity was low, precluding use of strobe illumination with the camera. Ambient light was sufficient for drop camera images and revealed patchy coral communities of low diversity and cover, although at least 5 coral families were represented. Water clarity improved around Jaco Island and the fringing reef supported moderate coral diversity and abundance, particularly in the 3-10m depth zone directly below the surf zone on the reef crest.

Location	Drop camera transects	Adjacent Towvideo Transects	Comments
Betano	3	Zero. Too turbid to image	Rocky points with patchy corals, filter feeders and some algae
Beco	4	Zero. Too turbid to image	Rocky points with patchy corals, filter feeders and some algae
Jaco Island	18	Six tows in adjacent deeper water 30-60m around Jaco Island.	Nearshore fringing reef with coral dominated fore-reef habitat in 3-10m depths and a rapid drop-off from 15m to 25-30m

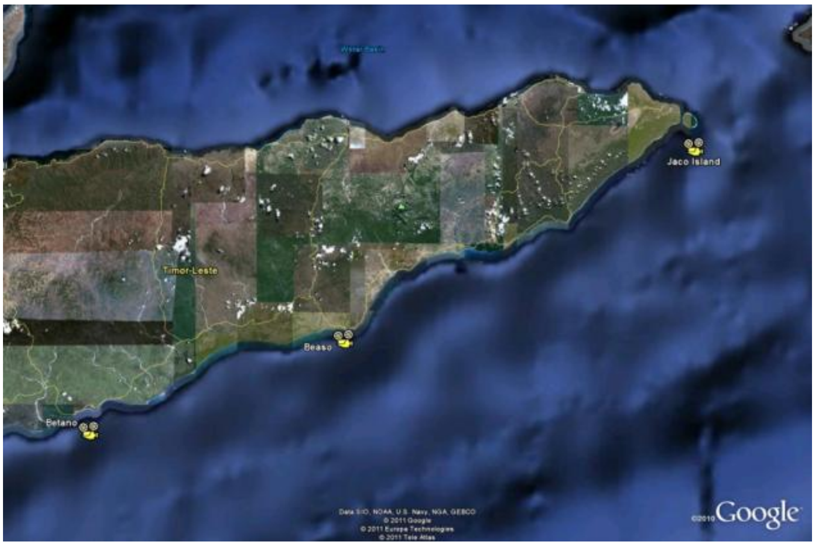
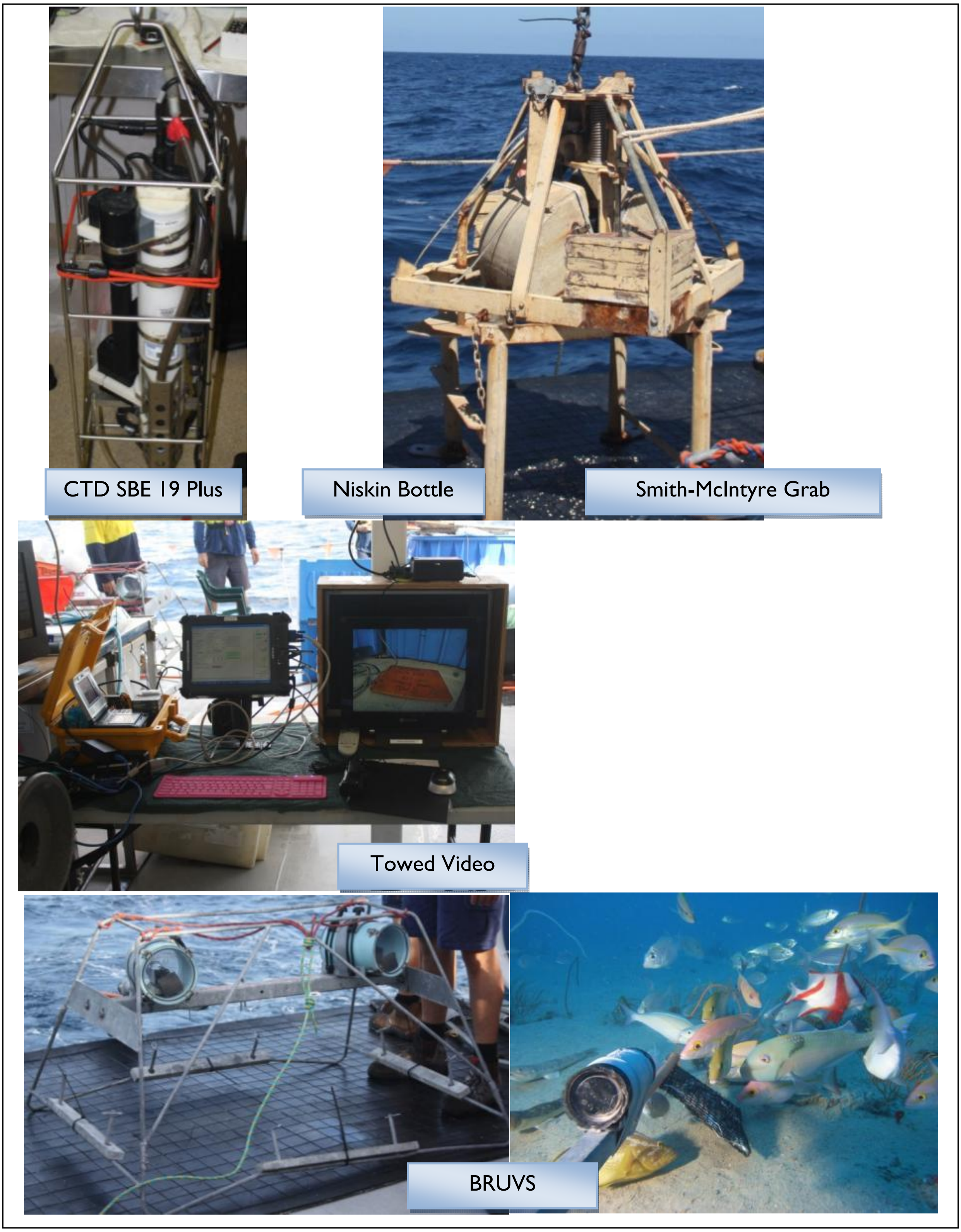


Figure 33. Coastal seabed biodiversity sampling was conducted near Betano, Beco and Jaco Island.

Figure 34. Towed video, BRUVS, water and CTD sampling sites adjacent to Jaco Island

Figure 35. Jaco Island fringing reef sampling locations using drop camera deployed from small boat.

Appendix 1. Instruments



Appendix 2. Waypoints of stations.

Gear	Date & Time	Latitude	Longitude	Depth	Comment
GRAB	02-Jul-11	-11.70646	125.078273	116.2	Waypoint obtained from wheelhouse plotter
CTD	02-Jul-11	-11.70628	125.078888	116	Waypoint obtained from wheelhouse plotter
GRAB	02-Jul-11	-11.707085	125.077125	117.5	Waypoint obtained from wheelhouse plotter
TOWVID	2/07/2011 8:31	-11.708356	125.081856	85.8	
TOWVID	2/07/2011 8:55	-11.7032275	125.074773	166.4	
TOWVID	2/07/2011 9:16	-11.708967	125.080733	51.5	Waypoint obtained from towvid
TOWVID	2/07/2011 9:38	-11.7050041	125.075478	62.1	
TOWVID	2/07/2011 10:19	-11.7102714	125.081315	77.9	
TOWVID	2/07/2011 10:45	-11.7056803	125.074554	71.2	
TOWVID	2/07/2011 10:57	-11.7112663	125.080616	77.5	
TOWVID	2/07/2011 11:22	-11.707117	125.073867	80.4	Waypoint obtained from towvid
BRUVS	2/07/2011 13:22	-11.7053568	125.078258	43.2	rig1
BRUVS	2/07/2011 13:26	-11.7053914	125.075482	50.1	rig2
BRUVS	2/07/2011 13:34	-11.7074203	125.075129	43.9	rig3
BRUVS	2/07/2011 13:37	-11.7069873	125.077279	32	rig4
BRUVS	2/07/2011 13:40	-11.7086528	125.078672	32.8	rig5
BRUVS	2/07/2011 13:44	-11.7095365	125.077416	38.2	rig6
BRUVS	2/07/2011 13:48	-11.710179	125.080152	46.1	rig7
BRUVS	2/07/2011 13:52	-11.7066899	125.080039	43.8	rig8
TOWVID	2/07/2011 15:41	-11.7108128	125.076919	60.6	
TOWVID	2/07/2011 15:57	-11.706526	125.079763	40.7	
TOWVID	3/07/2011 7:59	-10.7585589	126.194935	22.3	
TOWVID	3/07/2011 8:07	-10.760567	126.1937	68.1	Waypoint obtained from towvid
TOWVID	3/07/2011 8:17	-10.755416	126.190238	27.8	
TOWVID	3/07/2011 8:39	-10.7487504	126.185313	92.9	
TOWVID	3/07/2011 8:53	-10.7565843	126.189296	29	
TOWVID	3/07/2011 8:56	-10.7558	126.188683	29.4	Waypoint obtained from towvid
TOWVID	3/07/2011 9:31	-10.7575335	126.189653	28.1	
TOWVID	3/07/2011 9:57	-10.7506861	126.18326	90.1	
TOWVID	3/07/2011 10:08	-10.7581053	126.185969	28.5	
TOWVID	3/07/2011 10:27	-10.751967	126.182683	72.2	Waypoint obtained from towvid
TOWVID	3/07/2011 10:40	-10.7544617	126.193897	28.1	
TOWVID	3/07/2011 11:07	-10.7477805	126.189593	87.4	
CTD	3/07/2011 11:19	-10.7555542	126.19049	29	
GRAB	3/07/2011 11:29	-10.7568557	126.189453	29.2	
GRAB	3/07/2011 11:46	-10.7583033	126.187256	27.3	
TOWVID	3/07/2011 13:13	-10.7534436	126.193389	29.3	
TOWVID	3/07/2011 13:30	-10.7589536	126.196239	65.6	
TOWVID	3/07/2011 13:40	-10.7555191	126.19035	29.5	
TOWVID	3/07/2011 14:00	-10.7602263	126.194832	81.3	
TOWVID	3/07/2011 14:14	-10.7569305	126.18948	29.2	
TOWVID	3/07/2011 14:30	-10.7614962	126.191641	97.8	
TOWVID	3/07/2011 14:40	-10.7584775	126.186277	27.6	
TOWVID	3/07/2011 14:52	-10.7617321	126.187633	101.9	
TOWVID	3/07/2011 15:27	-10.7593504	126.186714	24.9	
TOWVID	3/07/2011 16:07	-10.7482595	126.194149	85	
TOWVID	3/07/2011 16:18	-10.7600944	126.190264	23.3	
TOWVID	3/07/2011 16:52	-10.7522329	126.197302	109.7	
TOWVID	3/07/2011 17:18	-10.7566686	126.182219	35.9	
TOWVID	3/07/2011 17:55	-10.7479851	126.189888	75.6	

Gear	Date & Time	Latitude	Longitude	Depth	Comment
GRAB	4/07/2011 6:07	-10.6807659	126.139491	25.7	
CTD	4/07/2011 6:07	-10.6808222	126.139566	25.8	
GRAB	4/07/2011 6:17	-10.6807563	126.139499	25.7	
BRUVS	4/07/2011 8:27	-10.7580219	126.190825	24.7	rig8
BRUVS	4/07/2011 8:30	-10.7580349	126.188094	27.2	rig7
BRUVS	4/07/2011 8:33	-10.7596167	126.185162	30.5	rig6
BRUVS	4/07/2011 8:36	-10.7603911	126.188106	25.4	rig5
BRUVS	4/07/2011 8:38	-10.7603053	126.190673	24	rig4
BRUVS	4/07/2011 8:41	-10.7599828	126.193195	31.8	rig3
BRUVS	4/07/2011 8:43	-10.7580235	126.193491	22.4	rig2
BRUVS	4/07/2011 8:46	-10.7580871	126.196356	32.5	rig1
BRUVS	4/07/2011 10:44	-10.7550574	126.196444	26.8	rig1
BRUVS	4/07/2011 10:47	-10.7552584	126.193577	28.1	rig2
BRUVS	4/07/2011 10:49	-10.7552983	126.19081	28.9	rig3
BRUVS	4/07/2011 10:52	-10.7554323	126.187854	28.7	rig4
BRUVS	4/07/2011 10:56	-10.755347	126.185311	29.4	rig5
BRUVS	4/07/2011 10:59	-10.7573978	126.183697	29.4	rig6
BRUVS	4/07/2011 11:03	-10.7553063	126.182579	31.6	rig7
BRUVS	4/07/2011 11:06	-10.7524984	126.185245	28.9	rig8
CTD	4/07/2011 11:14	-10.7572562	126.187761	29.1	
GRAB	4/07/2011 11:20	-10.7569515	126.188015	5	
GRAB	4/07/2011 11:28	-10.7573977	126.187994	5	
BRUVS	4/07/2011 13:45	-10.7525897	126.193577	28.5	rig8
BRUVS	4/07/2011 13:49	-10.7525052	126.190708	29.4	rig7
BRUVS	4/07/2011 13:51	-10.7525308	126.187928	29.6	rig6
BRUVS	4/07/2011 13:54	-10.7534706	126.183331	30.8	rig5
BRUVS	4/07/2011 13:58	-10.7507168	126.185721	33.1	rig4
BRUVS	4/07/2011 14:01	-10.7494528	126.18798	35.8	rig3
BRUVS	4/07/2011 14:04	-10.7491526	126.191122	36.2	rig2
BRUVS	4/07/2011 14:06	-10.7493545	126.193639	42.4	rig1
CTD	5/07/2011 7:07	-10.6865823	126.099748	25.1	
GRAB	5/07/2011 7:12	-10.6865989	126.098637	25.1	
GRAB	5/07/2011 7:18	-10.6869468	126.097244	25.6	
TOWVID	5/07/2011 9:36	-10.7071856	125.95633	19.1	
TOWVID	5/07/2011 10:12	-10.6959592	125.949485	70.9	
TOWVID	5/07/2011 10:23	-10.7094798	125.952294	23	
TOWVID	5/07/2011 10:26	-10.70825	125.951767	27.2	Comms stopped working
TOWVID	5/07/2011 10:49	-10.7060681	125.950783	22.9	
TOWVID	5/07/2011 11:28	-10.7095267	125.948608	73.3	
TOWVID	5/07/2011 11:36	-10.7121882	125.946404	24.9	
TOWVID	5/07/2011 12:19	-10.6980142	125.940059	124.2	
TOWVID	5/07/2011 13:26	-10.7038706	125.931024	33.9	
TOWVID	5/07/2011 14:02	-10.6978296	125.944057	43.6	
TOWVID	5/07/2011 14:14	-10.7146568	125.940342	22.5	
TOWVID	5/07/2011 14:53	-10.7004573	125.933938	82.9	
TOWVID	5/07/2011 15:05	-10.7085085	125.932264	21.8	
TOWVID	5/07/2011 15:29	-10.7051	125.940433	68.1	Comms stopped working
TOWVID	5/07/2011 16:02	-10.7029806	125.945861	24.1	
TOWVID	5/07/2011 16:39	-10.6981607	125.958844	70.5	
TOWVID	5/07/2011 17:00	-10.7151655	125.934424	21.5	
TOWVID	5/07/2011 17:47	-10.7083468	125.950223	24.5	
CTD	6/07/2011 7:18	-10.7080011	125.945572	22.2	
GRAB	6/07/2011 7:25	-10.7080971	125.94571	22.5	
GRAB	6/07/2011 7:33	-10.7079807	125.945742	22.4	
BRUVS	6/07/2011 8:13	-10.7080171	125.950289	24.4	rig2
BRUVS	6/07/2011 8:17	-10.7064395	125.954299	23.6	rig3

Gear	Date & Time	Latitude	Longitude	Depth	Comment
BRUVS	6/07/2011 8:20	-10.7032147	125.956834	19.5	rig4
BRUVS	6/07/2011 8:23	-10.7003131	125.959583	19.4	rig5
BRUVS	6/07/2011 8:27	-10.6971108	125.953906	19.5	rig6
BRUVS	6/07/2011 8:31	-10.6969239	125.949061	26.6	rig7
BRUVS	6/07/2011 8:34	-10.6980829	125.944193	25.4	rig8
CTD	6/07/2011 8:48	-10.7237495	125.949174	314.7	
BRUVS	6/07/2011 9:14	-10.7090818	125.94387	21.1	rig1
BRUVS	6/07/2011 10:32	-10.6997186	125.939966	20.2	rig8
BRUVS	6/07/2011 10:36	-10.7013178	125.935021	25.5	rig7
BRUVS	6/07/2011 10:39	-10.7059172	125.931571	22.3	rig6
BRUVS	6/07/2011 10:43	-10.711961	125.934293	22.1	rig5
BRUVS	6/07/2011 10:47	-10.7060353	125.937252	19.6	rig4
BRUVS	6/07/2011 10:51	-10.7042955	125.942661	21	rig3
BRUVS	6/07/2011 10:54	-10.7032855	125.947524	23.4	rig2
BRUVS	6/07/2011 10:57	-10.7017423	125.951483	24	rig1
BRUVS	6/07/2011 13:38	-10.7097159	125.938838	22.3	rig1
BRUVS	6/07/2011 13:42	-10.7147872	125.940972	22.3	rig2
BRUVS	6/07/2011 13:46	-10.7170569	125.938371	21.5	rig3
BRUVS	6/07/2011 13:50	-10.7193183	125.943857	21.9	rig4
BRUVS	6/07/2011 13:54	-10.7126701	125.947007	24	rig5
BRUVS	6/07/2011 13:58	-10.7152065	125.952043	20.2	rig6
BRUVS	6/07/2011 14:02	-10.7113668	125.957736	20.4	rig7
BRUVS	6/07/2011 14:04	-10.7082371	125.960491	24.2	rig8
TOWVID	6/07/2011 16:10	-10.7077752	125.950545	25.8	
TOWVID	6/07/2011 16:48	-10.701541	125.961877	72	
TOWVID	6/07/2011 16:59	-10.7058182	125.960483	21.9	
TOWVID	6/07/2011 17:27	-10.695844	125.953203	60.5	
TOWVID	6/07/2011 17:39	-10.7111272	125.953258	21.1	
TOWVID	6/07/2011 18:13	-10.719146	125.940453	19.9	
CTD	7/07/2011 7:48	-10.70165	126.336263	21	
GRAB	7/07/2011 7:53	-10.7016549	126.336352	20.5	
TOWVID	7/07/2011 8:18	-10.7025986	126.337467	21.3	
TOWVID	7/07/2011 8:53	-10.7129895	126.34393	140.8	
TOWVID	7/07/2011 9:07	-10.7013421	126.340647	24.5	
TOWVID	7/07/2011 9:28	-10.7088385	126.344769	129.3	
TOWVID	7/07/2011 9:39	-10.7002441	126.340149	24	
TOWVID	7/07/2011 10:03	-10.6945432	126.336317	78.9	
TOWVID	7/07/2011 10:13	-10.7026637	126.338093	21.2	
TOWVID	7/07/2011 10:40	-10.6934363	126.330627	86.2	
TOWVID	7/07/2011 10:49	-10.7034468	126.332656	23.6	
TOWVID	7/07/2011 11:34	-10.71605	126.340367	73.5	
CTD	7/07/2011 11:50	-10.7055758	126.335218	25.2	
TOWVID	7/07/2011 13:20	-10.7025741	126.332554	23.3	
TOWVID	7/07/2011 13:44	-10.694682	126.328556	71.1	
TOWVID	7/07/2011 13:55	-10.6993681	126.328788	25.6	
TOWVID	7/07/2011 14:17	-10.695283	126.334117	42.7	Lost Camera - snagged on reef. Waypoint from towvid
BRUVS	8/07/2011 8:29	-10.6958996	126.335854	21.3	rig8
BRUVS	8/07/2011 8:32	-10.6985014	126.338804	24.2	rig7
BRUVS	8/07/2011 8:34	-10.7005629	126.340474	25.8	rig6
BRUVS	8/07/2011 8:37	-10.7036992	126.342082	28.1	rig5
BRUVS	8/07/2011 8:40	-10.7065442	126.343199	28.9	rig4
BRUVS	8/07/2011 8:44	-10.7110429	126.342418	26.3	rig3
BRUVS	8/07/2011 8:48	-10.7145008	126.338879	25.1	rig2
BRUVS	8/07/2011 8:52	-10.7131505	126.335661	24.3	rig1
CTD	8/07/2011 9:07	-10.6946123	126.328946	61	

Gear	Date & Time	Latitude	Longitude	Depth	Comment
GRAB	8/07/2011 9:34	-10.6948626	126.328679	59	steep wall boat final depth 78m
GRAB	8/07/2011 9:49	-10.6944249	126.328794	71.1	
BRUVS	8/07/2011 11:29	-10.7011101	126.328711	26	rig1
BRUVS	8/07/2011 11:32	-10.7053461	126.329909	26.6	rig2
BRUVS	8/07/2011 11:35	-10.7085814	126.331652	25.6	rig3
BRUVS	8/07/2011 11:39	-10.7113828	126.333198	27.2	rig4
BRUVS	8/07/2011 11:44	-10.7109171	126.339207	22.1	rig5
BRUVS	8/07/2011 11:47	-10.7059713	126.338972	22.3	rig6
BRUVS	8/07/2011 11:49	-10.7025029	126.337578	22.3	rig7
BRUVS	8/07/2011 11:52	-10.6995945	126.335915	19.2	rig8
BRUVS	8/07/2011 14:18	-10.7083606	126.336206	24.2	rig8
BRUVS	8/07/2011 14:21	-10.7055718	126.334569	25.7	rig7
BRUVS	8/07/2011 14:24	-10.7021735	126.331972	23.5	rig6
BRUVS	8/07/2011 14:28	-10.7010954	126.334208	21.5	rig5
BRUVS	8/07/2011 14:31	-10.6992559	126.330577	21.1	rig4
BRUVS	8/07/2011 14:35	-10.6958835	126.328803	25.8	rig3
BRUVS	8/07/2011 14:38	-10.6942687	126.331123	34.1	rig2
BRUVS	8/07/2011 14:42	-10.6971655	126.333733	17.2	rig1
TOWVID	8/07/2011 16:44	-10.7026846	126.334772	21.7	
TOWVID	8/07/2011 17:06	-10.7030232	126.343077	51	
TOWVID	8/07/2011 17:22	-10.7074999	126.332022	25.9	
TOWVID	8/07/2011 17:51	-10.7076253	126.344389	80.5	
TOWVID	8/07/2011 18:01	-10.7115359	126.333308	27	
TOWVID	8/07/2011 18:22	-10.7118151	126.342641	29.1	
BRUVS	9/07/2011 11:00	-10.236349	127.234776	35.3	rig1
BRUVS	9/07/2011 11:06	-10.2386069	127.242147	38.3	rig2
BRUVS	9/07/2011 11:10	-10.2343898	127.245677	43.5	rig3
BRUVS	9/07/2011 11:13	-10.2322203	127.240123	36.3	rig4
BRUVS	9/07/2011 11:17	-10.2304141	127.23382	35.4	rig5
BRUVS	9/07/2011 11:22	-10.227665	127.239269	37.3	rig6
BRUVS	9/07/2011 11:28	-10.2270386	127.244985	38.2	rig7
BRUVS	9/07/2011 11:33	-10.2229824	127.237369	35.8	rig8
TOWVID	9/07/2011 14:26	-10.2399054	127.240949	39.4	
TOWVID	9/07/2011 15:13	-10.2206718	127.238469	72.4	
TOWVID	9/07/2011 15:33	-10.2312951	127.234609	35.6	
TOWVID	9/07/2011 16:07	-10.2302187	127.250491	71.4	
CTD	10/07/2011 7:40	-9.33623817	125.422887	133.6	
GRAB1	10/07/2011 8:36	-9.33511476	125.414668	128.4	
GRAB2	10/07/2011 8:53	-9.33517524	125.411476	128.4	
CTD	10/07/2011 14:37	-9.30147858	125.381543	61.1	
GRAB1	10/07/2011 14:47	-9.30144506	125.380299	58.4	
GRAB2	10/07/2011 14:58	-9.29993979	125.377101	51.4	
CTD	11/07/2011 7:33	-9.20565162	125.603102	55.9	
GRAB1	11/07/2011 7:42	-9.2055095	125.60196	55	
GRAB2	11/07/2011 7:54	-9.20613044	125.601035	55.6	
TOWVID	11/07/2011 8:15	-9.20901609	125.59647	63	
TOWVID	11/07/2011 8:26	-9.20977951	125.592202	57.2	
TOWVID	11/07/2011 8:35	-9.20299491	125.585448	34.8	
TOWVID	11/07/2011 8:53	-9.19912059	125.591683	34.6	
DROPCAM	11/07/2011 10:47	-9.15424	125.78356	6	Betano
DROPCAM	11/07/2011 11:00	-9.15487	125.78157	6	Betano
DROPCAM	11/07/2011 11:04	-9.15458	125.78442	7	Betano
DROPCAM	11/07/2011 11:18	-9.15502	125.78239	5	Betano
DROPCAM	11/07/2011 11:21	-9.15569	125.7861	5	Betano
DROPCAM	11/07/2011 11:35	-9.15629	125.78418	6	Betano
CTD	11/07/2011 14:08	-9.28141822	125.470928	79.2	

Gear	Date & Time	Latitude	Longitude	Depth	Comment
GRAB1	11/07/2011 14:20	-9.28118553	125.46822	73.5	
GRAB2	11/07/2011 14:38	-9.27968708	125.462345	62.9	
CTD	12/07/2011 8:07	-9.28576652	125.564841	156.3	
GRAB1	12/07/2011 8:28	-9.28444951	125.564419	156	
GRAB2	12/07/2011 8:44	-9.2844063	125.561571	153.5	
CTD&NISKIN	12/07/2011 13:35	-9.17492271	125.734848	148.8	
GRAB1	12/07/2011 13:52	-9.17386308	125.733265	104	
GRAB2	12/07/2011 14:10	-9.17447083	125.733678	118	
NISKIN	12/07/2011 15:21	-9.20349746	125.604599	50.8	
NISKIN	12/07/2011 16:01	-9.28537703	125.566328	150.5	
NISKIN	12/07/2011 16:45	-9.28032107	125.47343	80.1	
NISKIN	12/07/2011 17:22	-9.33569347	125.424982	132.5	
NISKIN	12/07/2011 17:49	-9.30232045	125.379611	60.8	
CTD&NISKIN	13/07/2011 7:47	-9.14869988	125.880298	81.1	
GRAB1	13/07/2011 7:58	-9.14914288	125.881992	90.2	
GRAB2	13/07/2011 8:17	-9.15037602	125.88614	113	
CTD&NISKIN	13/07/2011 13:36	-9.0704071	126.067916	106.4	
GRAB1	13/07/2011 13:45	-9.07006197	126.068718	110	
GRAB2	13/07/2011 14:03	-9.06942203	126.068454	104.7	
CTD&NISKIN	14/07/2011 7:41	-9.0045269	126.179476	59.3	
GRAB1	14/07/2011 7:50	-9.00406849	126.180898	57.8	
GRAB2	14/07/2011 8:37	-9.00441614	126.179188	59.8	
DROPCAM	14/07/2011 12:15	-8.95025	126.47491	4	Beaso
DROPCAM	14/07/2011 12:24	-8.95001	126.47357	2.5	Beaso
DROPCAM	14/07/2011 12:28	-8.95065	126.47671	8	Beaso
DROPCAM	14/07/2011 12:38	-8.9507	126.47535	8	Beaso
DROPCAM	14/07/2011 12:50	-8.95116	126.46441	6	Beaso
DROPCAM	14/07/2011 12:54	-8.95131	126.46404	5	Beaso
DROPCAM	14/07/2011 13:02	-8.95452	126.45508	4	Beaso
DROPCAM	14/07/2011 13:08	-8.95397	126.45369	7	Beaso
CTD&NISKIN	14/07/2011 15:06	-9.0376507	126.330431	148.8	
GRAB1	14/07/2011 15:20	-9.03662676	126.332725	149	
GRAB2	14/07/2011 15:36	-9.03635106	126.333981	143.7	
CTD&NISKIN	15/07/2011 7:43	-8.98668459	126.373829	39.8	
GRAB1	15/07/2011 7:50	-8.98669783	126.373962	39.6	
GRAB2	15/07/2011 8:00	-8.98671437	126.373987	39.7	
BOXCORE	15/07/2011 13:10	-9.15311499	126.189895	656.3	Unsuccessful
BOXCORE2	15/07/2011 13:48	-9.15180226	126.188948	642.4	Successful boxcore
CTD&NISKIN	15/07/2011 14:19	-9.1479714	126.195529	685.7	
CTD&NISKIN	15/07/2011 15:56	-9.02525273	126.412538	119	
GRAB1	15/07/2011 16:04	-9.02469184	126.41413	119.6	
GRAB2	15/07/2011 16:15	-9.02415716	126.416119	116.5	
CTD&NISKIN	15/07/2011 17:34	-8.88845473	126.565227	93.4	
GRAB1	15/07/2011 17:41	-8.88702716	126.56396	89	
CTD&NISKIN	16/07/2011 7:30	-8.8341429	126.588333	31.8	
GRAB1	16/07/2011 7:30	-8.8341999	126.588237	32.2	
CTD&NISKIN	16/07/2011 8:58	-8.784358	126.734275	39.7	
GRAB1	16/07/2011 9:05	-8.78397596	126.733132	38.6	
CTD&NISKIN	16/07/2011 10:11	-8.74577901	126.884885	55.1	
GRAB1	16/07/2011 10:16	-8.74532273	126.885151	52.3	
CTD&NISKIN	16/07/2011 10:56	-8.72666897	126.965733	93.3	
GRAB1	16/07/2011 11:03	-8.72549657	126.965499	90.8	
CTD&NISKIN	16/07/2011 11:51	-8.66894517	127.046873	78.7	
GRAB1	16/07/2011 11:57	-8.66867475	127.046116	72.9	
CTD&NISKIN	16/07/2011 13:10	-8.56202683	127.138929	32.8	
GRAB1	16/07/2011 13:14	-8.56152882	127.140128	47.2	

Gear	Date & Time	Latitude	Longitude	Depth	Comment
TOWVID	17/07/2011 8:54	-8.43702209	127.306197	16.8	
TOWVID	17/07/2011 9:04	-8.4318235	127.305558	21.8	
TOWVID	17/07/2011 9:06	-8.43055683	127.305475	22.5	
DROPCAM	17/07/2011 9:23	-8.44233	127.31515	6.5	Jaco Island
TOWVID	17/07/2011 9:28	-8.41865648	127.306138	26.3	
DROPCAM	17/07/2011 9:37	-8.44175	127.3144	7	Jaco Island
TOWVID	17/07/2011 9:39	-8.41897201	127.306363	24.4	
TOWVID	17/07/2011 10:07	-8.406317	127.30435	44.4	
TOWVID	17/07/2011 11:03	-8.41223194	127.30923	19.8	
DROPCAM	17/07/2011 11:10	-8.44062	127.31314	6	Jaco Island
DROPCAM	17/07/2011 11:21	-8.44005	127.31235	6.5	Jaco Island
DROPCAM	17/07/2011 11:25	-8.43953	127.3117	6	Jaco Island
DROPCAM	17/07/2011 11:36	-8.4389	127.31091	6	Jaco Island
DROPCAM	17/07/2011 11:44	-8.44257	127.31538	10	Jaco Island
TOWVID	17/07/2011 11:49	-8.4089477	127.324899	41.4	
DROPCAM	17/07/2011 11:52	-8.44254	127.31534	10	Jaco Island
DROPCAM	17/07/2011 11:57	-8.43918	127.31069	8	Jaco Island
DROPCAM	17/07/2011 12:05	-8.43968	127.31153	8	Jaco Island
TOWVID	17/07/2011 12:05	-8.40810003	127.326234	66.4	
DROPCAM	17/07/2011 12:11	-8.44057	127.31268	10	Jaco Island
DROPCAM	17/07/2011 12:20	-8.44109	127.31349	8	Jaco Island
DROPCAM	17/07/2011 12:24	-8.44197	127.31452	9.5	Jaco Island
DROPCAM	17/07/2011 12:27	-8.442	127.31473	9	Jaco Island
TOWVID	17/07/2011 12:29	-8.40510917	127.312465	57.3	
BRUVS	17/07/2011 13:41	-8.40464038	127.308888	35.2	rig8
BRUVS	17/07/2011 13:43	-8.40378887	127.310352	60	rig7
BRUVS	17/07/2011 13:46	-8.40459728	127.312672	62.3	rig6
BRUVS	17/07/2011 13:48	-8.40524119	127.314681	63.3	rig5
DROPCAM	17/07/2011 13:49	-8.40928	127.31799	5	Jaco Island
BRUVS	17/07/2011 13:50	-8.40542184	127.316348	63.9	rig4
BRUVS	17/07/2011 13:52	-8.40600811	127.318301	61.9	rig3
BRUVS	17/07/2011 13:53	-8.40626982	127.319998	62.8	rig2
DROPCAM	17/07/2011 13:56	-8.40836	127.3168	27	Jaco Island
BRUVS	17/07/2011 13:59	-8.40838826	127.325852	64.3	rig1
DROPCAM	17/07/2011 14:00	-8.40946	127.31785	4	Jaco Island
DROPCAM	17/07/2011 14:09	-8.40902	127.31684	14	Jaco Island
DROPCAM	17/07/2011 14:13	-8.4092	127.32099	6	Jaco Island
DROPCAM	17/07/2011 14:20	-8.40883	127.32008	8	Jaco Island
DROPCAM	17/07/2011 14:32	-8.41079	127.32584	7	Jaco Island
DROPCAM	17/07/2011 14:39	-8.41045	127.32488	6.6	Jaco Island
DROPCAM	17/07/2011 14:43	-8.41222	127.32877	6	Jaco Island
DROPCAM	17/07/2011 14:50	-8.41177	127.32786	6	Jaco Island
DROPCAM	17/07/2011 14:53	-8.41255	127.32991	10	Jaco Island
DROPCAM	17/07/2011 15:02	-8.41199	127.32914	12	Jaco Island
DROPCAM	17/07/2011 15:06	-8.41071	127.32653	10	Jaco Island
DROPCAM	17/07/2011 15:27	-8.4103	127.32563	11.5	Jaco Island
DROPCAM	17/07/2011 15:34	-8.40927	127.32265	10	Jaco Island
DROPCAM	17/07/2011 15:44	-8.40902	127.32164	10.5	Jaco Island
DROPCAM	17/07/2011 15:50	-8.4108	127.3267	11	Jaco Island
DROPCAM	17/07/2011 16:13	-8.41043	127.32582	10	Jaco Island
CTD&NISKIN	18/07/2011 8:17	-8.41177425	127.306058	26.7	
DROPCAM	18/07/2011 8:39	-8.446	127.33846	8	Jaco Island
DROPCAM	18/07/2011 8:48	-8.44537	127.33914	6	Jaco Island
DROPCAM	18/07/2011 8:52	-8.44496	127.3404	9	Jaco Island
DROPCAM	18/07/2011 8:59	-8.44541	127.33934	7	Jaco Island
DROPCAM	18/07/2011 9:04	-8.44471	127.34084	8	Jaco Island

Gear	Date & Time	Latitude	Longitude	Depth	Comment
DROPCAM	18/07/2011 9:13	-8.44501	127.33977	7	Jaco Island
DROPCAM	18/07/2011 9:17	-8.44571	127.33955	12	Jaco Island
CTD&NISKIN	18/07/2011 9:22	-8.44686074	127.317236	62.6	
DROPCAM	18/07/2011 9:23	-8.44604	127.3386	10	Jaco Island
DROPCAM	18/07/2011 9:26	-8.44691	127.3369	11	Jaco Island
DROPCAM	18/07/2011 9:35	-8.4472	127.336	8	Jaco Island
DROPCAM	18/07/2011 9:39	-8.44753	127.33521	10	Jaco Island
CTD&NISKIN	18/07/2011 9:41	-8.4396263	127.306613	56.7	
TOWVID	18/07/2011 9:51	-8.43813786	127.306025	20	
DROPCAM	18/07/2011 9:53	-8.44784	127.33439	10	Jaco Island
TOWVID	18/07/2011 10:24	-8.44847391	127.319661	69.6	
DROPCAM	18/07/2011 10:33	-8.44133	127.31283	25	Jaco Island
DROPCAM	18/07/2011 10:42	-8.44179	127.31367	18	Jaco Island
CTD&NISKIN	18/07/2011 10:46	-8.42640491	127.304723	23.9	
TOWVID	18/07/2011 11:14	-8.41797787	127.304836	28.7	
TOWVID	18/07/2011 11:23	-8.42132625	127.305319	25	
CTD	18/07/2011 13:03	-8.56345429	127.138358	53.1	
GRAB	18/07/2011 13:09	-8.56199962	127.139497	1.2	
DRIFTER	18/07/2011 15:04	-8.76405039	127.291791	1026	
DRIFTER	18/07/2011 19:04	-9.20564222	127.661557	3000	
DRIFTER	19/07/2011 3:05	-10.0996113	128.415411	74.1	
DRIFTER	19/07/2011 13:02	-11.1430719	129.300763	56.9	

Appendix 3: Photos

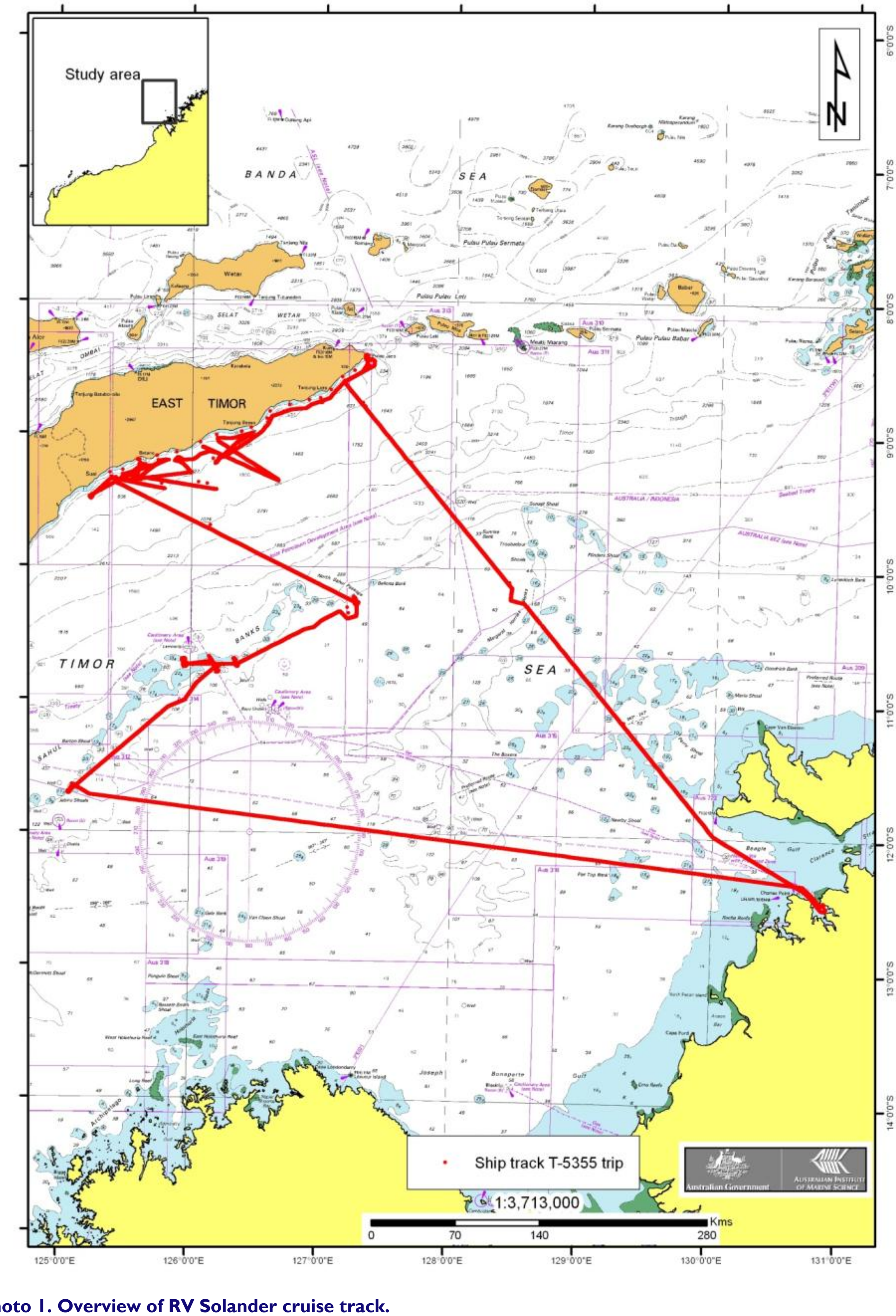


Photo 1. Overview of RV Solander cruise track.

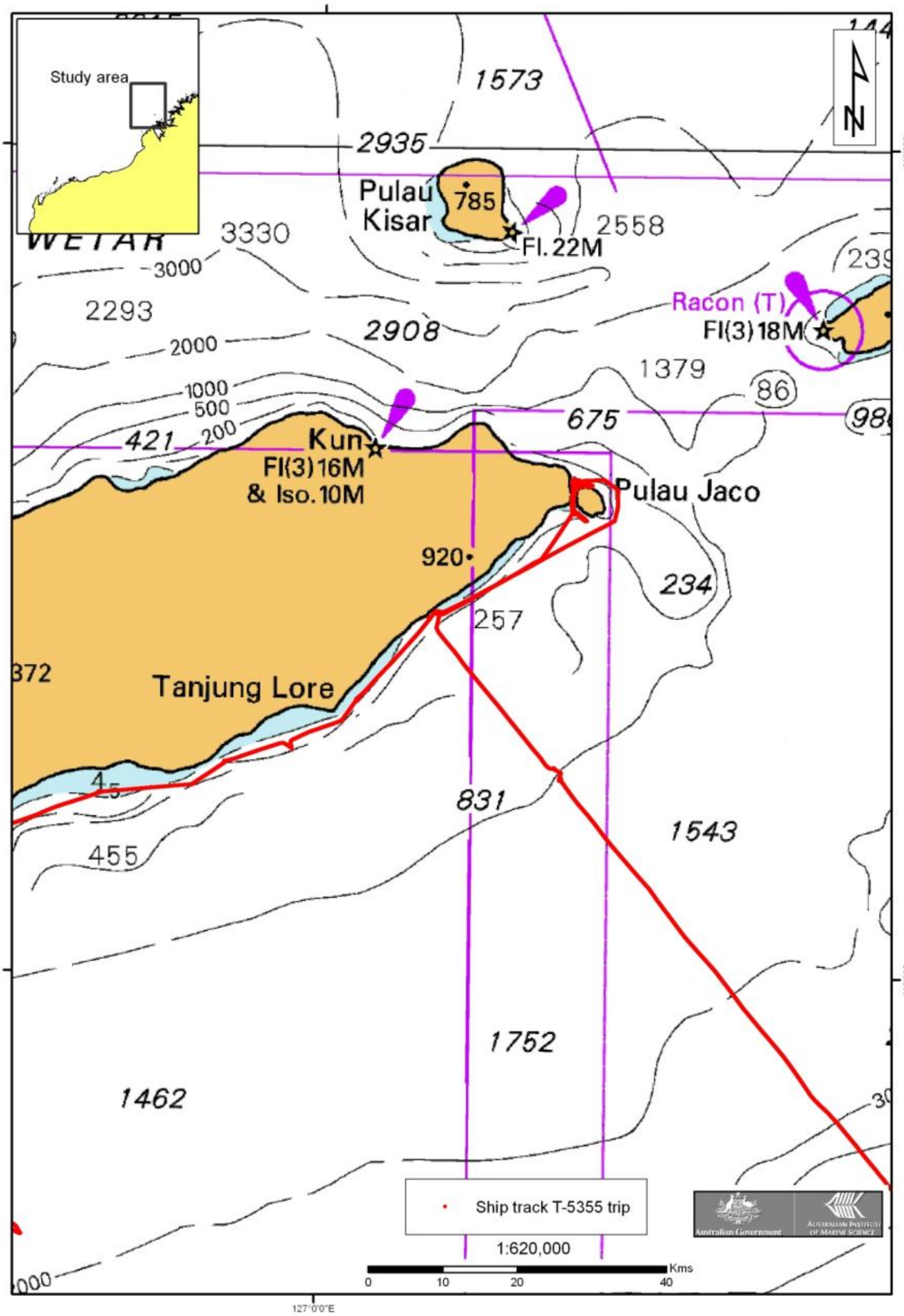


Photo 2 Closeup of RV Solander cruise track near Jaco Is..

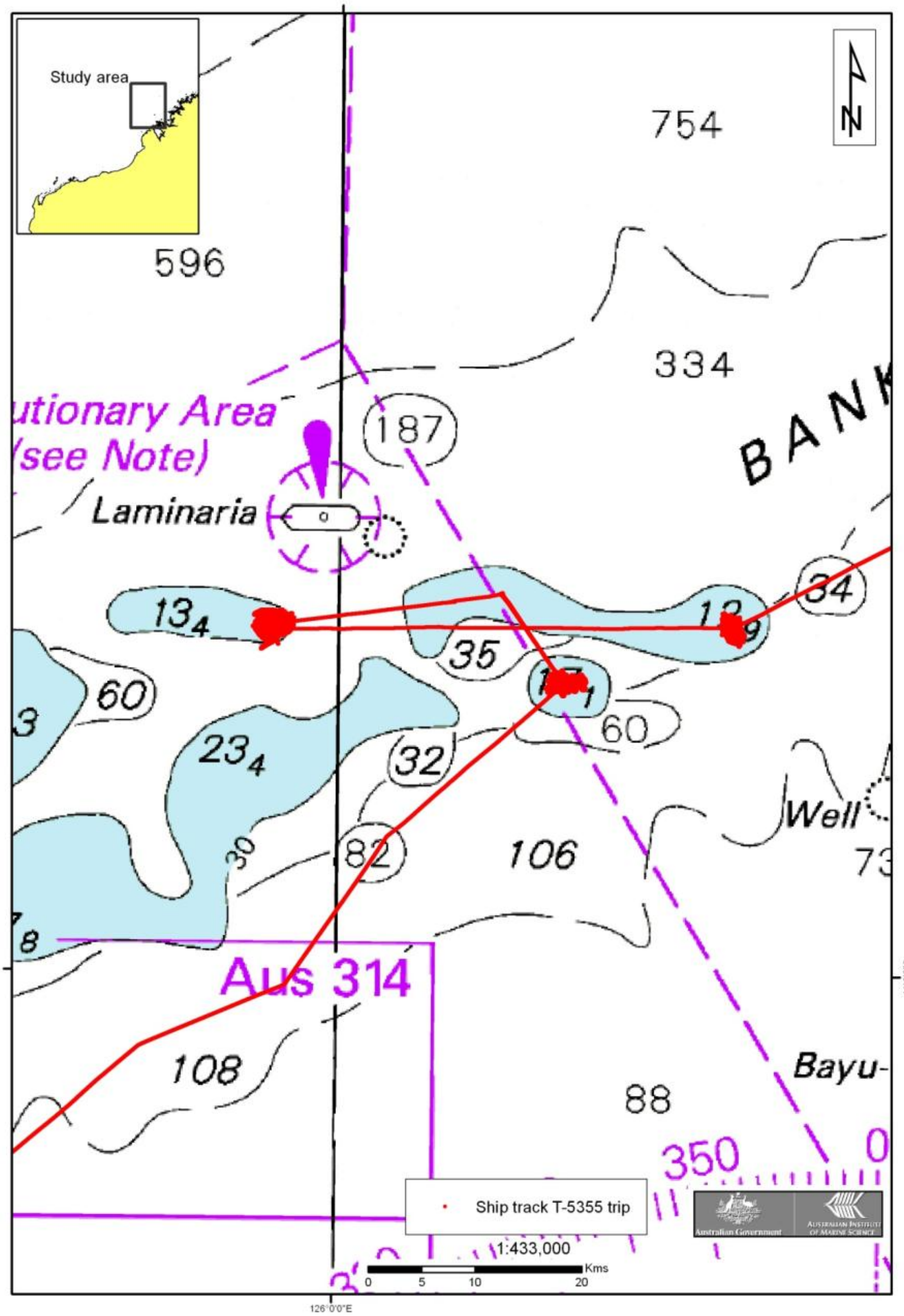


Photo 3 Closeup of RV Solander cruise track near Sahul Shoals reefs.

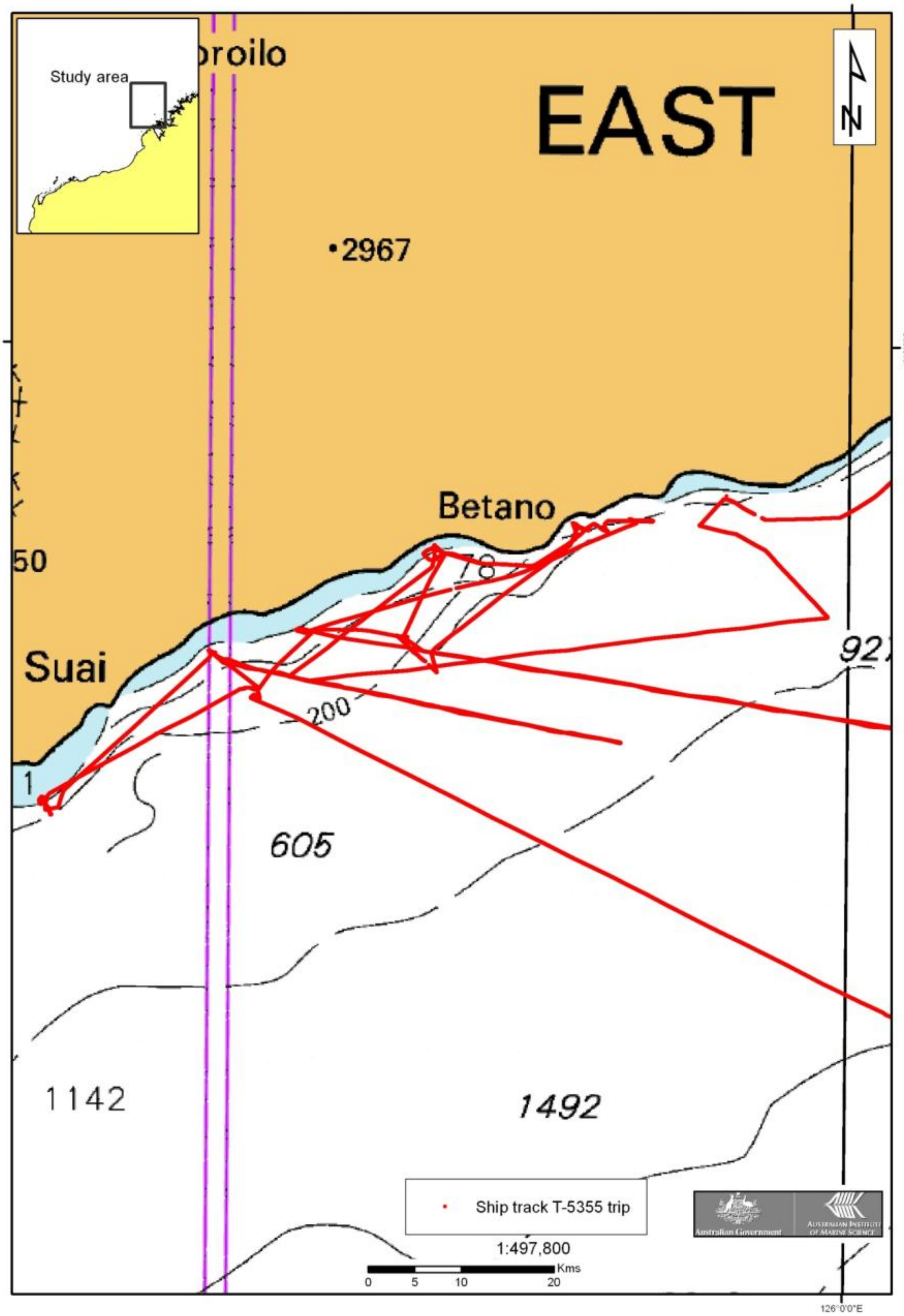


Photo 4 Closeup of RV Solander cruise track near S coast of Timor Leste.

Photo 5 Agaracid corals, Halimeda and planktivores on reef tops near Sahul Shoal

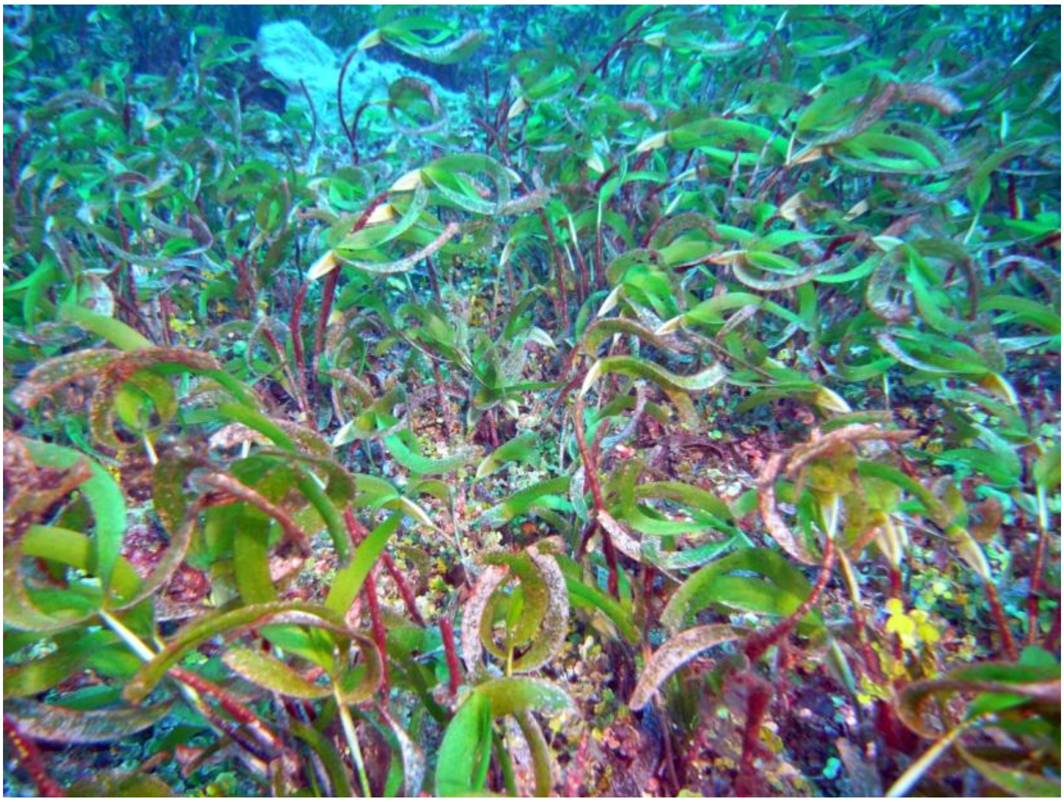


Photo 6 Thallasodendron ciliatum on Sahul Shoal reef top.

Photo 7 Example of Fungia corals at 40m on Sahul Shoals reef top.

Photo 8 Benthic nutrient flux experiments.

Photo 9 Benthic nutrient flux experiments.

Photo 10 Benthic nutrient flux experiments

Photo 11 Oxygen meters for benthic flux measurements.

Photo 12 Preparing the CTD for deployment.

Photo 13 Preparing the CTD for deployment.


Photo 14 Preparing the CTD for deployment.

Photo 15 Interrogating CTD data.

Photo 16 Interrogating CTD data.

Photo 17 Interrogating CTD data.

Photo 18 Plotting data.

Photo 19 Preparing nutrient tubes for samples.

Photo 20 Bouma box corer with sediment sample.

Photo 21 Smith MacIntyre Grab.

Photo 22 Stirrers on benthic flux chambers

Photo 23 Collecting mud from Smith Mac grab.

Photo 24 Eastern end of Timor Leste south coast.

Photo 25 Eastern end of Timor Leste south coast

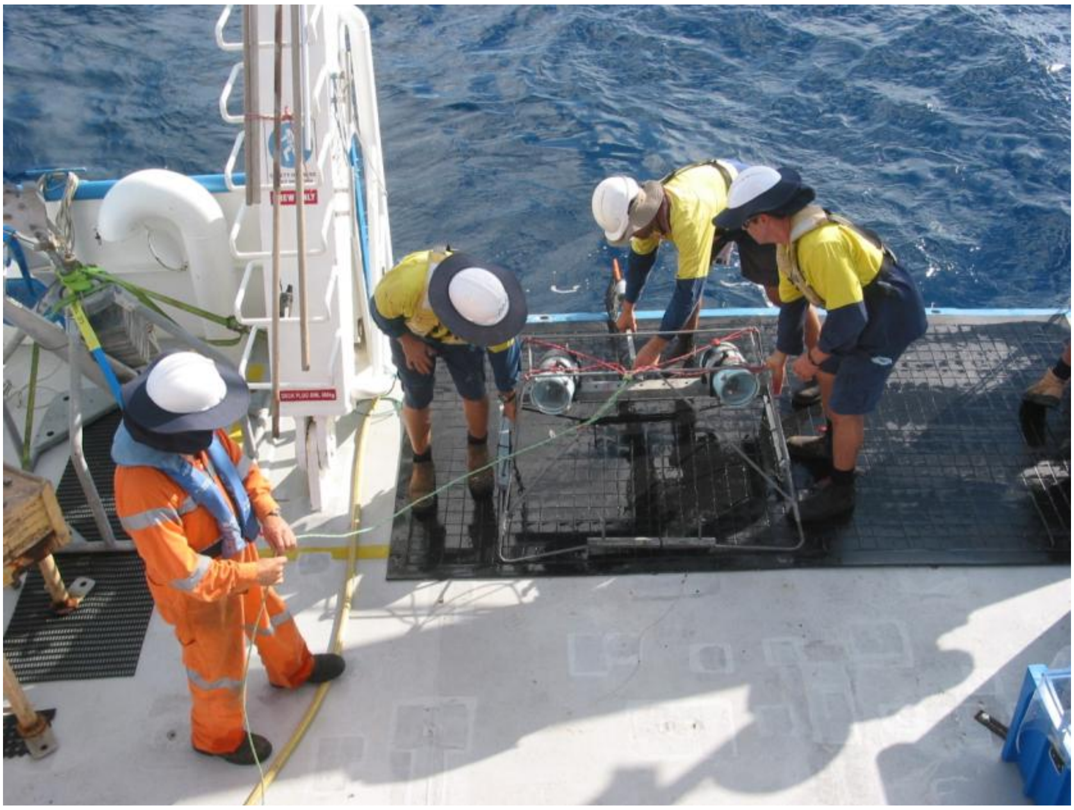


Photo 26 Deploying BRUVS

Photo 27 Deploying BRUVS.

Photo 28 BRUVS ready for deployment.

Photo 29 BRUVS ready for deployment

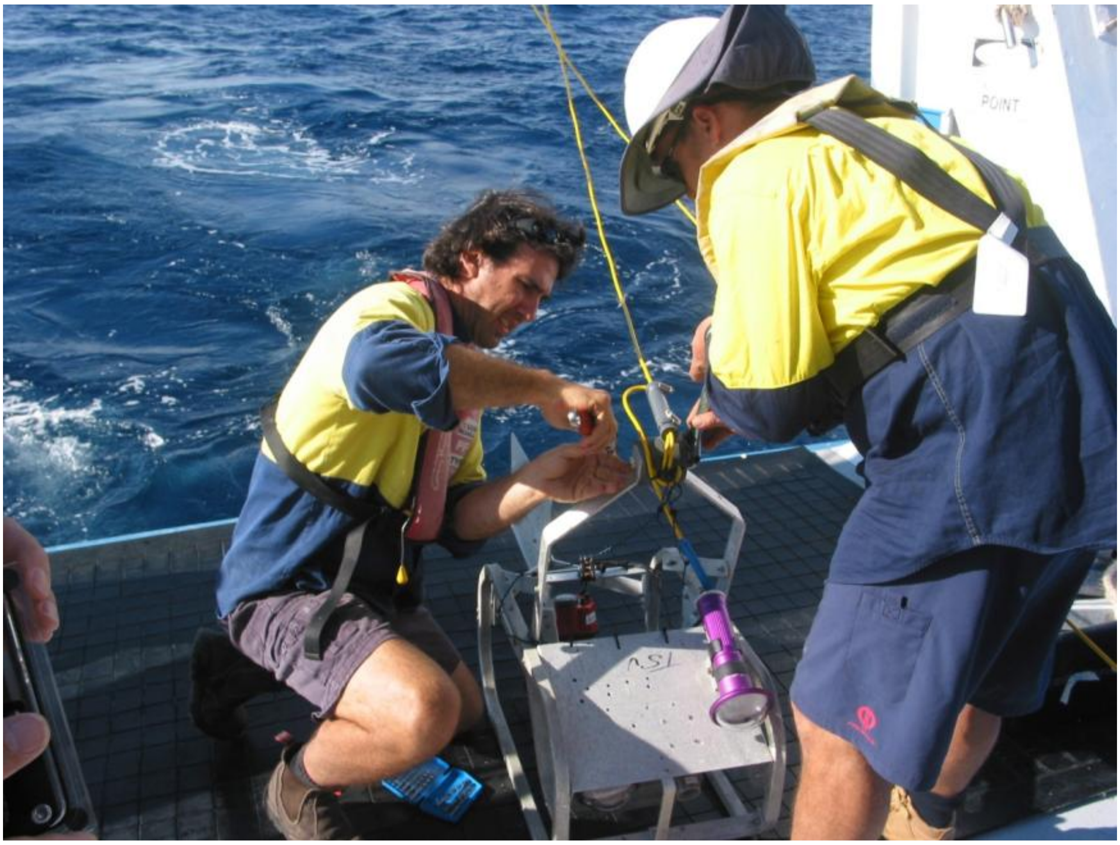


Photo 30 TowVid preparations for deployment.

Photo 31 Retrieving BRUVS.

Photo 32 Video cameras ready for loading into BRUVS

Photo 33 Waiting for BRUVS retrieval.

Photo 34 Watching surface readout from Towed Video.

Photo 35 Watching surface readout from Towed Video.

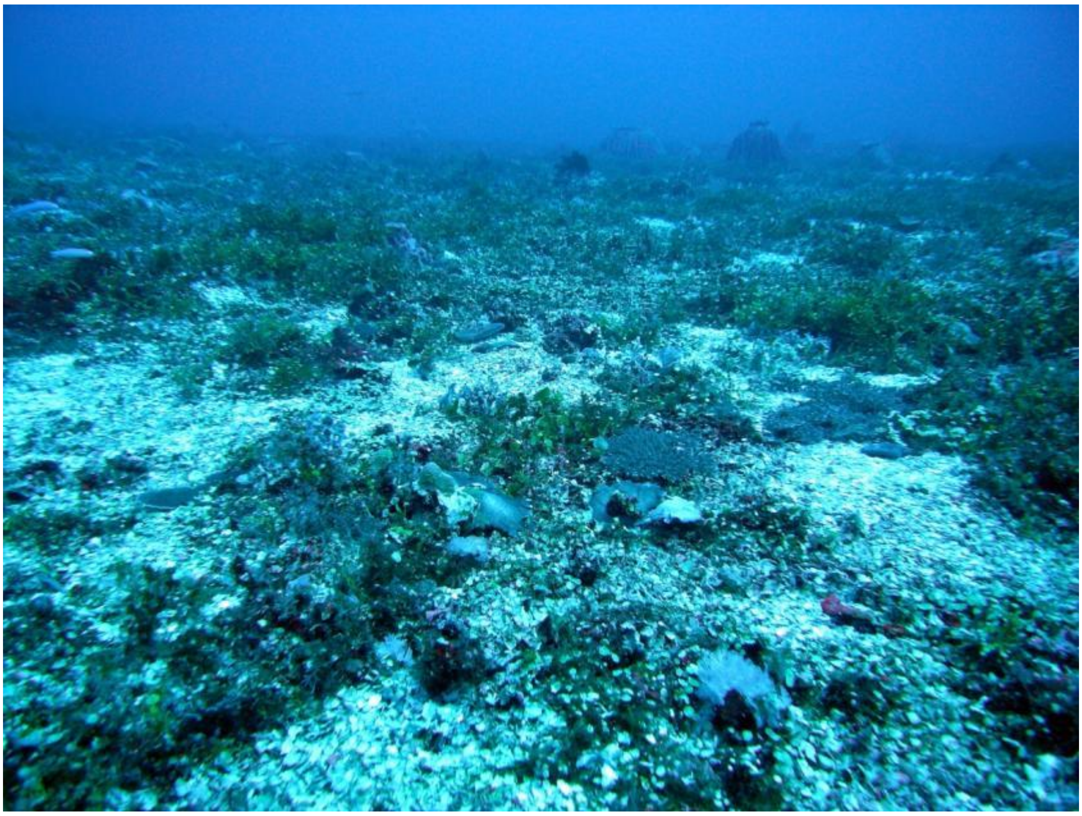


Photo 36 TowVid view of reef top in Sahul Shoals in 40m.

Photo 37 TowVid setup.

Photo 38 Preparing a replacement TowVid setup.

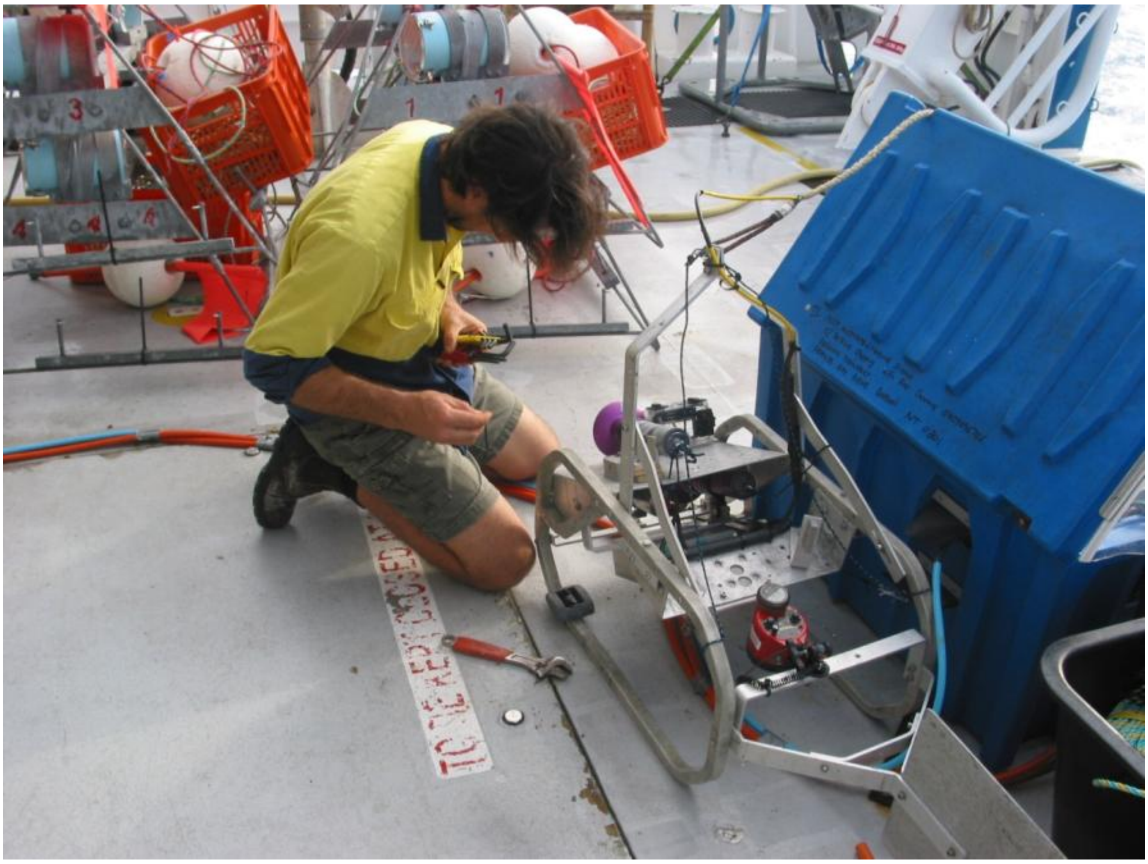


Photo 39 TowVid preparations.

Photo 40 TowVid repairs.

Photo 41 TowVid repairs.

Photo 42 Surface currents off Jaco Is in the ITF.

Photo 43 Undercut limestone cliffs on Jaco Is with Timor Leste behind.

Photo 44 Preparing for field sampling by zodiac.

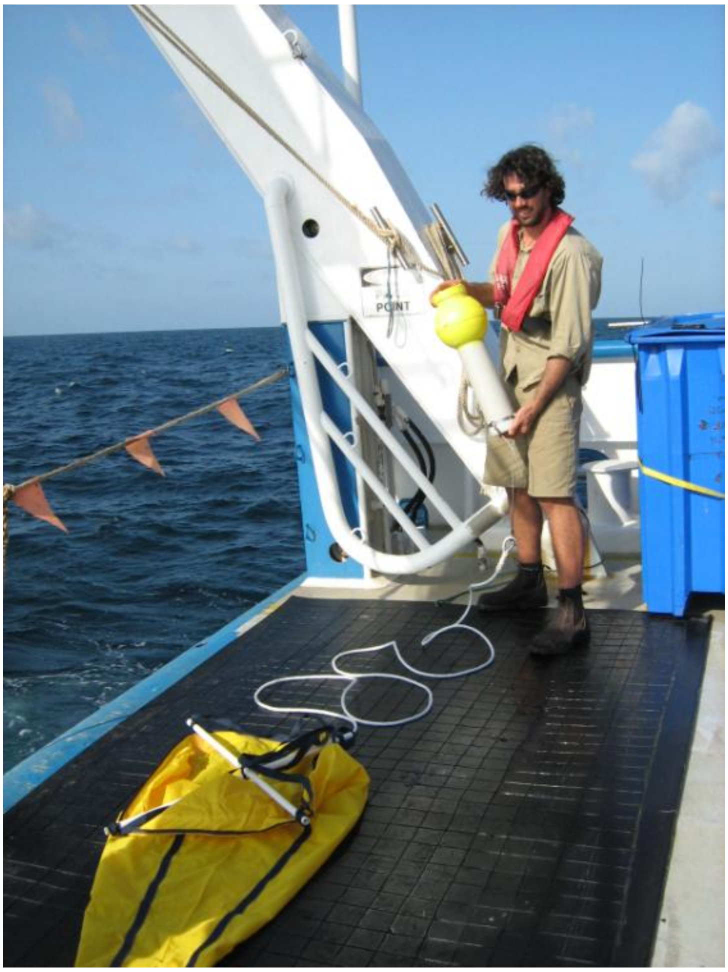


Photo 45 GPS Satellite drifters.

Photo 46 Pygmy sperm whale (?) off Timor Leste

Photo 47 Pygmy sperm whale (?) off Timor Leste