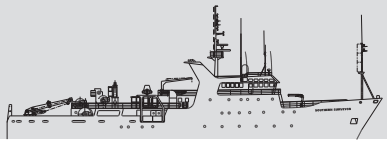

MARINE
NATIONAL FACILITY

2009 program

RV *Southern Surveyor*

voyageplan
SS05-2009

Salps, eddies and entrainment in the Stockton Bight

Returning to the eddy dynamics at the East Australian Current separation zone, to assess the effects of salps, eddy size and its source waters.

Itinerary

Mobilise Sydney 0900hrs, Friday 16 October, 2009
Depart Sydney 1600hrs, Friday 16 October, 2009
Arrive Sydney 0800hrs, Tuesday 27 October, 2009 and demobilise

Principal Investigators

Professor Iain Suthers (Chief Scientist) – University of New South Wales and Sydney Institute of Marine Science **Email:** I.Suthers@unsw.edu.au **Phone:** 0414 385 351

Dr Mark Baird – University of New South Wales and CMAR
Email: m.baird@unsw.edu.au **Phone:** 0416 631 657

Dr Jason Everett– University of New South Wales
Email: Jason.Everett@unsw.edu.au **Phone:** 0411 162 701

Dr Matthew Taylor – University of New South Wales
Email: Mattytaylor@unsw.edu.au **Email:** 0411 162 701

CSIRO

Scientific Objectives

The EAC is characterised from all boundary currents by the "mesoscale variability" – or eddies. Eddies of the East Australian Current entrain coastal water. Similar processes in the Kuroshio, California and Agulhas Currents are well documented for their importance to fisheries. We will compare ship-borne observations of species diversity and abundance; larval fish growth and zooplankton size frequency distributions within cold core eddies and compare these to the original coastal waters. We will assess whether eddies are plankton incubators and provide cross-shelf transport to coastal nursery areas.

Last year (SS10/2008) we successfully investigated the biological oceanography of salps and coastal cold-core eddies in the Stockton Bight (33S, 152E), and we wish to establish the persistence of our findings. Salps are large, fast-growing gelatinous zooplankton that graze on picoplankton and bacteria, and seem to displace the conventional crustacean zooplankton. Their dense blooms can significantly alter the food chain by removing phytoplankton but are also recorded in the guts of many fish. Described as the fastest growing animals on the planet, salps clearly have a major role in global carbon flux, but are essentially unstudied in the EAC since the work of Heron and others 20 years ago. By feeding on particles 1000 fold smaller than themselves, salps confound our biogeochemical models (Baird & Suthers 2007) and probably confound the biomass estimates of our optical plankton counter.

On SS05/2009 we will investigate eddies and entrainment processes off the central NSW coast, and thereby study the distributional ecology of salps. We will be conducting laboratory experiments with salps and krill in the Fish lab and the CT Room. We will deploy an IMOS Slocum glider ("Nemo-4") preceding the voyage, a Sea Glider ("Dory-1") during the voyage (just like an Argo float) and a third after the voyage (we may need to retrieve/re-deploy it during the voyage using the ship's inflatable). The gliders support a CTD and an 'Eco Puck' which records chlorophyll a, CDOM and backscatter. We need to characterise the response of the Eco-Puck to the local conditions on the Southern Surveyor's CTD and to see if this response is consistent between years. This voyage is supported by ARC grants to Suthers & Baird to investigate salp ecology and to Suthers & Oke to investigate eddies of the East Australian Current (EAC).

Our scientific aims are :

i) the biological oceanography of small (<50 km diameter, and possibly large) cyclonic eddies off the Stockton Bight in comparison to coastal waters, in conjunction with an IMOS Slocum Glider;

ii) the process of entrainment of coastal plankton into the EAC and eddies between 31ºS (Smoky Cape) and 35 ºS (Jervis Bay);

iii) the ecology and vertical distribution of salps and krill in shelf waters. The spatial pattern of sampling will take into consideration the synoptic and forecast oceanographic conditions from BlueLink;

iv) To conduct laboratory experiments with live plankton in the Fish Lab and in the CT Room;

v) To retrieve a Slocum Glider (using the work boat) and to launch a Sea Glider (similar to launching an ARGO float); and to use the CTD and EZ or Rectangular Midwater Trawl (RMT) net samples to help interpret the glider's optical sensors.

Voyage Objectives

During September and early October we will be examining MODIS image and BlueLink forecasts, searching for development of small 50 km diameter coastal eddies and possibly any similar eddies offshore. A week before and certainly 3 days before departure we will have a clear objective in mind. A Slocum Glider ("Nemo-4") will be deployed during the week of departure and we hope to sample around it. Another Slocum (Nemo-3") will be ready to be retrieved during the voyage (using the ship's work boat) and we wish to launch a Sea Glider ("Dory-1") through the A-frame.

Glider schedule:

- Launch Nemo-3 around 1st Oct. and retrieve during SS05/09 on ~20 Oct;
- Launch Nemo-4 around 15 Oct just before departure and retrieve after voyage in early Nov (or by Jason Middleton on way to Taupo);
- Launch Sea glider (Dory-1) from SS05/09 after Nemo-3 retrieved, and retrieve in late Jan by Christel and Martina's SS voyage;
- Launch Nemo5 in early Nov., after Nemo4

It is essential that the Sea Soar be ready to be deployed early in the voyage.

1) **Voyage track.** We intend to examine at least two (2) conspicuous eddies, south of the separation zone off Stockton Bight, however we may have to steam as far south as Jervis Bay (36°S) to find one. We will test whether a cyclonic eddy has greater zooplankton biomass or production and in larval fish growth in small cyclonic eddies (<50 km diameter, and if possible a large one ~100 km), in comparison to similar sampling in coastal waters.

   If no obvious eddies are apparent, we will examine the entrainment of coastal water question, from off Smoky Cape (31°S) to off Jervis Bay at approximately half degree intervals. At each latitude we will make a series of CTDs stations from 100 m to well into the EAC. We will also make RMT net tows at two stations – on the shelf and in the EAC.

2) **SeaSoar, ADCP and CTD.** We will make at least two SeaSoar and ADCP transects across each eddy. During the day, standard CTD profiles with the rosette sampler will also be used to overlay longer and deeper SeaSoar profiles with nutrients (nitrate, nitrite, ammonia, TRP, Si), which will be particularly intensive near the separation area.

   Our self-contained Wet-Labs Eco-triplet ("eco-puck") will be attached to the CTD and to the Sea Soar and EZ net. This is identical to that deployed on the gliders, and will wish to obtain chlorophyll and pigments to calibrate it, and to make quasi-synoptic plankton tows.

   As in SS10/2009, every CTD cast will be followed by two (2) 50 m casts with the N70 net (a 70 cm diameter vertical haul net). This is the same net used by CSIRO in 1939-1942 on the MV Warreen samples by Harold Thompson. We will occasionally make a 3rd cast with this net to capture live salps (and sometimes to 200 m for krill). We would prefer to use a small capstan winch on the aft side of the hydro frame for this tow.

3) EZ net (500 um mesh) trawls, and Rectangular Midwater Trawl. In the latter half of the voyage, we wish to examine vertical distribution of salps and krill. On at least two occasions when we are well off the shelf (in the day and night), we wish to tow the EZ net to as deep as 1000 m to sample krill.

We request that a strobe light be attached to the EZ and put in a housing with battery etc.

On the last day we will also make EZ net tows near the Sydney 140 m IMOS mooring, to provide zooplankton biomass data to calibrate the mooring's ADCP backscatter signal.

Using the coring winch we will make replicated oblique Rectangular Midwater Trawl tows (RMT, 0.75 x 1.5 m, 0.5 mm mesh pelagic trawl(fitted with Sonardyne), at 1.5 ms-1 will be made from the surface to the thermocline. Neuston net tows from the side of the vessel will be made at the same time.

Below decks, the 0.5 mm mesh net sample will be quickly sorted and 10 individuals of abundant larval taxa will be transferred to NUNC vials and frozen in liquid nitrogen until RNA:DNA analysis; the remainder will be placed in buffered formalin and transferred to 95% ethanol within 4 weeks for otoliths and age determination.

4) Plankton culturing experiments in the fish lab. During the voyage we wish to have tubs of seawater in the Fish Lab and also (for the first time!) make use of the CT Room. Temperature should be set at local SST-2 degr C (i.e. about 18 degr).

5) During the voyage we will probably have to retrieve a Slocum glider that was deployed 3 weeks earlier. For this we will require the vessel's satellite phone to communicate with Ben Hollings in Perth, and the work boat during optimal conditions. We will also launch a Sea Glider which can be simply done with the crew's help via the main gantry.

Voyage Track

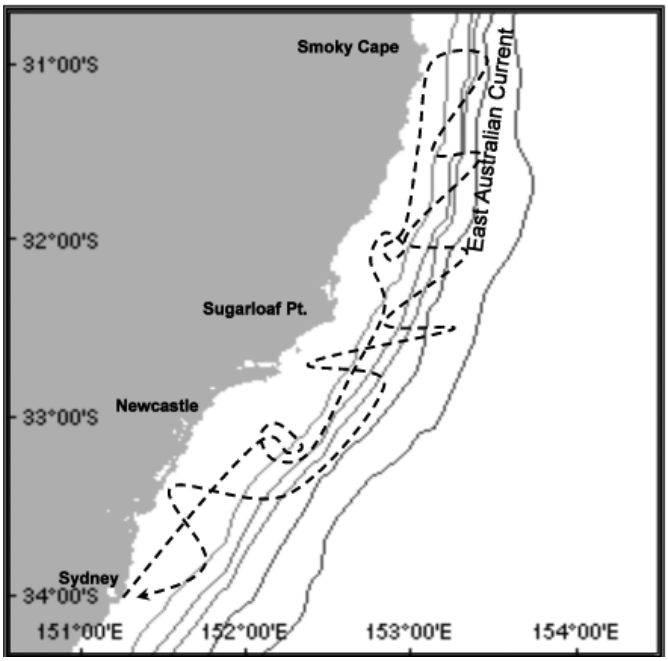

Fig. 1. Proposed voyage track (dashed) from Sydney to Sydney out to the separation off Smoky Cape. The actual voyage track will be apparent a week before departure. See back page for an idealised voyage track.

Scientific watches will be from 1400 – 0200 ("night"), and 0200-1400 ("day")

Friday 16 Oct. 2009

Induct new scientific crew. Muster drill after lunch.

Mobilise science party and depart at 16:00, arriving in region at around 21:00 (60 nautical miles).

Compare underway data with latest MODIS image and forecasts, Nemo-3 and Nemo-4 locations, and make ADCP transects in the region of interest.

When past the heads and after dinner we would like a CTD training/ toolbox and a test cast to 1000 m, and training by hydrochemist.

Toolbox for N70 net and capture of live plankton for initial experiments.

(nb first deployments of any gear will usually be done in daylight, either before or after lunch when both shifts are awake).

Continue ADCPs until after breakfast, steaming towards Nemo-3 or Nemo-4.

Sat. 17 Oct. 9 am – Sea Soar toolbox.

Commence 6 hour SeaSoar and ADCP Transect1 across eddy, followed by 10 CTD stations along return path (CTDs will typically be over the shelf, to near bottom (100 or 200 m) with 6-8 bottles per cast).

At end of SeaSoar, RMT net tool box and trial launch before CTD transects

Evening RMT and neuston tows.

Sun 18 Oct.

Reposition to new location and commence Sea Soar, and CTDs

15:00 Commence 8 hour SeaSoar and ADCP Transect2 across eddy, followed by 10 CTD stations along return path. RMT tows will occur at either end of transect.

Mon 19 Oct.

15:00 Commence 8 hour SeaSoar and ADCP Transect3 across eddy, followed by 10 CTD stations along return path. RMT tows will occur at either end of transect.

Tues 20 Oct. Repeat SeaSoar and CTD transects, RMT.

Wed. 21 Oct. Move to 2nd new eddy or feature and repeat SeaSoar and CTD transects, RMT

Thurs 22 Oct. Repeat SeaSoar and CTD transects, RMT.

Fri 23 Oct. Repeat SeaSoar and CTD transects, RMT

Sat. 24 Oct. Move to 3rd new eddy or feature.

Repeat SeaSoar (possibly CTD) transects, RMT.

Sun 25 Oct. Repeat SeaSoar (possibly CTD) transects, RMT. EZ net toolbox and then conduct first EZ net tows

Mon. 26 Oct. Complete EZ net tows in 1000 m, as well as near the SYD140 m mooring.

Tues 27 Oct. Dock in Sydney at 10:00

Southern Surveyor Equipment

– Underway data and ADCP

– CTD, fluorescence, 6 bottles for nutrients, DO, T, S
(possibly 12 if we need to filter water)

– EZ net and 500 um mesh nets (only 5 depth strata, ie 5 nets per tow, totalling 1 hour tow) with a strobe light attached to the frame to stun krill.

– SeaSoar and winch

– EA-500 (also have the EK-500 to compare with our salp biomass?)

– Fish lab and CT room for experiments

– Sonardyne on our RMT net.

– Work boat to possibly retrieve Slocum glider.

User Equipment

- Optical plankton Counter (to be attached to the Seasoar and EZ if <200 m) as per SS SS10/08
- Rectangular Midwater Trawl Net (+ spare) to be supplied by Iain Suthers, as per SS10/08, using coring wire winch with National Facilities' Sonardyne.
- Neuston net from forward boom.
- Vacuum pump, filters for chlorophyll, isotopes
- Liquid Nitrogen dewer, filled.
- Formalin, alcohol, jars, consumables
  Microscopes in Fish and GP lab and wetlab
  44 litre tanks (nally bins) with seawater

Special Requests

Only forward neuston net boom

Personnel List

Iain Suthers	Chief Scientist	A (14:00-02:00)	CS	UNSW (BEES)	0414 385 351
Matt Taylor	Krill Biology	A (14:00-02:00)	10/11	UNSW (BEES)	0410 558 653
Jason Everett	Salp Biology	B (02:00-14:00)	10/11	UNSW (BEES)	0411162701
Adrian Ferguson	Biology	A (14:00-02:00)	8/9	UNSW (BEES)	0410184117
Mark Baird	Oceanography	B (02:00-14:00)	8/9	UNSW (Maths)	0416 631 657
Helen Macdonald	Oceanography	A (14:00-02:00)	6/7	UNSW (Maths)	0415461132
Tegan Sime	Biology	B (02:00-14:00)	6/7	UNSW (BEES)	
Natasha Henshcke	Salp Biology	B (02:00-14:00)	4/5	UNSW (BEES)	0412934014
Ben Harris	Krill Biology	A (14:00-02:00)	4/5	UNSW (BEES)	0421545733
Kadija Oubelkheir	Phytoplankton	A (14:00-02:00)	2/3	UTS	
Martina Doblin	Phytoplankton	B (02:00-14:00)	2/3	UTS	0439339230
Kylie Pitt	Gelatinous Zoop.	B (02:00-14:00)	1	Griffith	
Lindsay Pender	MNF Voyage Manager/Computing Support		Cr/Sci 3	CMAR	
Alicia Navidad	MNF Hydrochemistry Support		Cr/Sci 2	CMAR	
Stephen Thomas	MNF Electronics Support		Cr/Sci 4	CMAR	

As per AMSA requirements for additional berths on Southern Surveyor, the following personnel are designated as System Support Technicians and are required to carry their original AMSA medical and AMSA Certificate of Safety Training on the voyage:

Name	**AMSA Certificate of Safety Training No.**
Lindsay Pender	AS02763
Alicia Navidad	AS04836
Stephen Thomas	AS02584

This voyage plan is in accordance with the directions of the Marine National Facility Steering Committee for the Research Vessel Southern Surveyor.

Iain Suthers
Chief Scientist

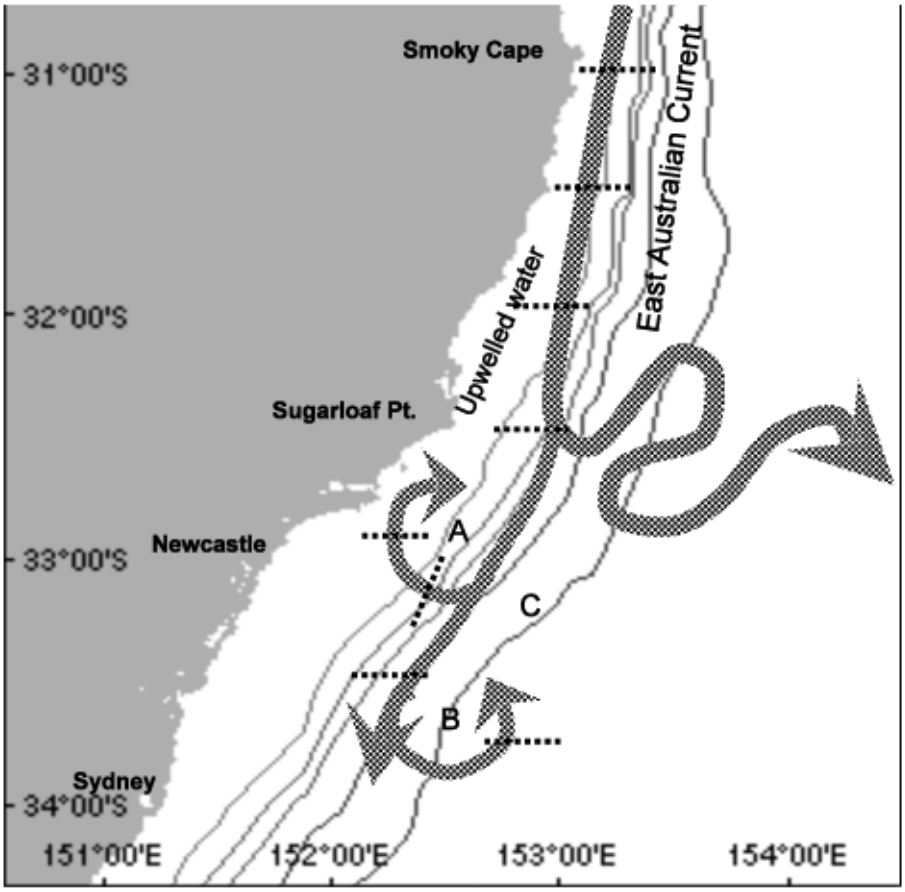

Figure 2: An idealised East Australian Current, and a possible voyage track for SS05/2009, showing SeaSoar and CTD stations (short, thick dotted lines crossing eddies). If no eddies are obvious we will conduct RMT tows and CTD at either end of these cross shelf transects. Two eddies are shown with A entraining coastally enriched water from off Port Stephens and a large anti-cyclonic eddy B entraining oceanic water. We hope to find smaller eddies (about half the size illustrated).

– Station C in ~1000 m water is where we will conduct EZ net tows for salps.

– A Slocum Glider will be simultaneously located in eddy A or B.

– After settling the science party, our priorities are to sample locations A, B and C.