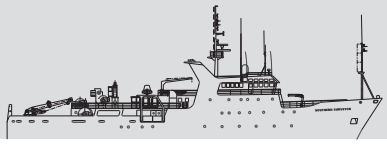


MARINE
NATIONAL FACILITY

2010 program

RV *Southern Surveyor*

voyageplan
ss2010_v09

Impact of the East Australian Current on water chemistry, bio-optical properties and coastal primary productivity in the NSW region.

Itinerary

Mobilise Sydney 0800, Thursday 14 October, 2010
Depart Sydney 1000, Friday 15 October, 2010
Arrive Sydney 1600, Sunday 31 October, 2010
Demobilise Sydney 0800, Monday 1 November, 2010

Principal Investigators

Dr. Martina Doblin (Chief Scientist) – University of Technology, Sydney
Plant Functional Biology and Climate Change Cluster, PO Box 123 Broadway, NSW 2007
Phone: (02) 9514 8307 **Mobile:** 0439 339 230
Fax: 02 9514 4079 **Email:** martina.doblin@uts.edu.au

Dr. Christel Hassler – University of Technology, Sydney
Plant Functional Biology and Climate Change Cluster, PO Box 123 Broadway, NSW 2007
Phone: (02) 9514 4159 **Mobile:** 0439 339 230
Fax: (02) 9514 4079 **Email:** christel.hassler@uts.edu.au

Dr Michael Ellwood – Research School of Earth Sciences
Australian National University, ACT 0200
Phone: +61 2 612 59967 **Email:** michael.ellwood@anu.edu.au **Fax:** +61 2 612 55544

CSIRO

Scientific Objectives

The East Australia Current is the single-most important factor affecting regional productivity along the eastern seaboard of Australia, yet we do not have a good measure of its strength, variability or a complete understanding of its biological impact. This voyage seeks to better understand the interaction of the EAC with the continental shelf in the area north and south of the EAC separation zone off NSW, an important region supporting almost 50% of Australians living near the coast. High-resolution data will be collected to characterise the relationship between physical oceanography, water chemistry (e.g. nutrient distribution and light availability) and primary and secondary productivities.

Phytoplankton are responsible for >40% of global photosynthesis and are the energetic 'base' of marine foodwebs (Falkowski and Raven 2007). Their productivity is generally determined by the provision of nutrients and light and the degree of herbivorous grazing. It is therefore critical to understand these inter-relationships in order to parameterise this complex and dynamic marine environment for biogeochemical and ecosystem models.

This project will use traditional as well as innovative techniques to assess productivity (14-C uptake and bio-optical and fluorescence-based estimates of production) as well as grazing losses. In addition, bio-optical biogeochemical quantities will be measured in-situ and provide much needed data for the wider NSW scientific community to improve remotely-sensed estimates of ocean colour (chlorophyll-a biomass). Shifts in the composition and function of bacterial communities will be assessed using metagenomic approaches and will be related to specific oceanographic features and phytoplankton community characteristics. Finally, nutrient and organic source (fulvic acid) enrichment experiments will provide insights about the role of nutrients and coastal inputs in controlling plankton biomass, diversity and activity at three contrasted sites chosen to represent the heterogeneity of this area (EAC, upwelling and inner shelf / coastal regions). These experiments will gather knowledge not only on phytoplankton but also bacteria, and processes affecting coloured dissolved organic matter (CDOM) composition and its bio-optical signature.

This project will yield data for an existing regional biogeochemical model by measuring key parameters (e.g. chlorophyll a to carbon ratio) and testing its prediction under perturbed conditions (i.e., nutrient enrichment). Model and remote sensing improvements are critical in this region, as it is predicted to be highly sensitive to climate change.

The overall scientific objective of this voyage is to provide a comprehensive description of the lower trophic level responses to EAC interactions on the NSW continental shelf, and establish linkages between the oceanography, nutrient and light climate and productivity. Specifically this project will:

1: Undertake CTD measurements of water structure and chemistry in a set of transects traversing the continental shelf and slope and evaluating the biogeochemical signature of the EAC;

2: Identify the inter-relationships between water masses, nutrients, bacteria and phytoplankton diversity and primary productivity in the transition zone of the EAC;

3: Study critical processes in contrasted oceanographic features (EAC, upwelling and coastal / inner shelf regions) such as the impact of macronutrients, organic sources (reflecting coastal inputs) and grazing on microbial diversity and productivity;

4: Measure key parameters required in remote sensing algorithms and ecosystem models (e.g., NPZD models (e.g., Moore et al., 2007; Baird et al., 2008) and:

(i) In particular, the Particulate Organic Carbon (POC) to Chlorophyll a (Chl a) ratio.

(ii) Characterize the underwater light field using optical/biogeochemical (bio-optical) measurements (particulate absorption, attenuation, backscattering, scattering, radiance, irradiance, diffuse attenuation, coloured dissolved organic matter (CDOM), Dissolved Organic Carbon (DOC), phytoplankton pigment composition using High Performance Liquid Chromatography, total suspended solids, particle size distribution).

Six cross-shelf transects will be undertaken along the NSW coast:

1) Diamond Head/EAC separation zone (~31.6°S);
2) Urunga (~30.5°S);
3) Evans River (~29.0°S).
4) Jervis Bay (~35.0 °S)
5) Hawesbury-Nepean River (~32.5°S);
6) Sydney (~33.6 °S)

Voyage Objectives

1) Deploy CTD rosette to obtain vertical profiles of bio-optical properties (including particulate backscatter, CDOM fluorescence, chl-a fluorescence), as well as photosynthetic rates and collect water samples for microbial, phytoplankton, and micro zooplankton assessment.

2) Undertake process studies, focusing on the EAC (nutrient poor), an upwelling zone (relatively nutrient-enriched) and inner shelf waters (intermediate) to understand the links between macro-nutrient availability, microbial diversity (bacteria and phytoplankton) and productivity of lower trophic levels.

3) Undertake perturbation experiments to assess parameters affecting the bio-optical signature of CDOM. Both biological transformation and photo-degradation will be investigated.

4) Undertake grazing experiments to determine the net phytoplankton production at process stations.

5) Deploy optical sensors in air and in the surface mixed layer of the ocean to measure optical properties and their variability.

6) Conduct above surface and in-water optical mesurments to calibrate and validate satellite remote sensing products such as chlorophyll and primary production.

7) Conduct deployments of 'in situ chemotaxis assay' at process stations.

8) Collect CTD, Optical Plankton Counter and Ecotriplet data whilst undertaking process studies to assess spatial variability in the region.

Voyage Track

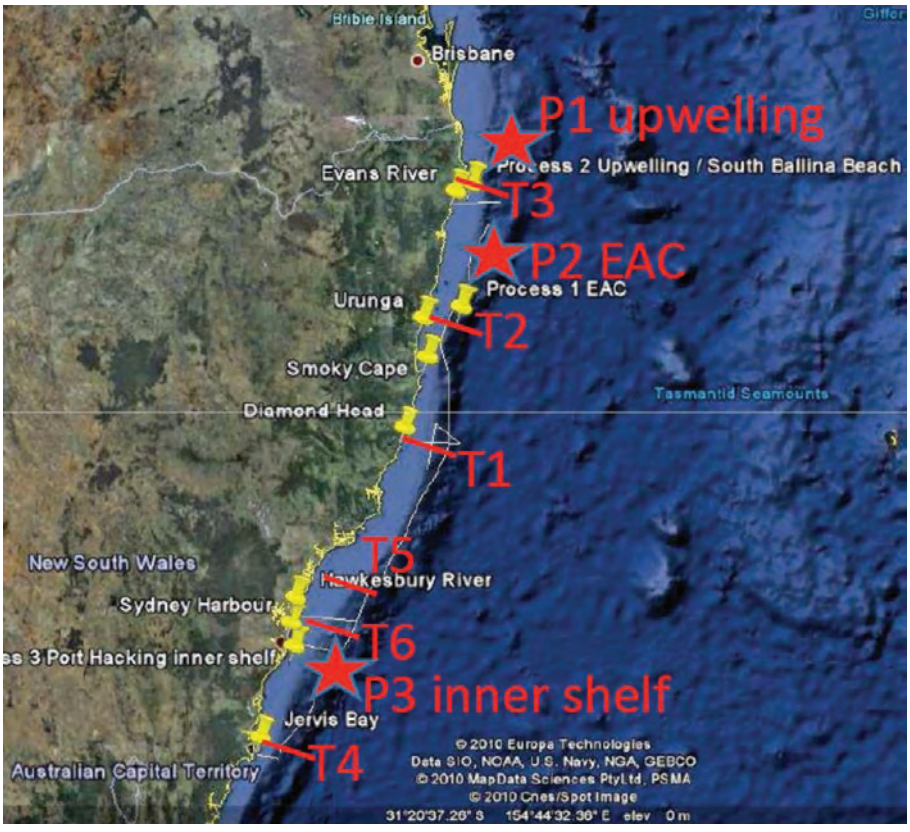


Figure 1: TransectsVoyage track for SS09/2010. Voyage track is indicated by a dotted line, and major transects (corresponding with Table 1) indicated.

Voyage Overview

The voyage will consist of a series of transects running perpendicular to the coast (Fig. 1) to capture the spatial gradients in physical, chemical and bio-optical properties across and along the shelf. It will also comprise 3-day process studies in three distinct water masses: (1) upwelling region; (2) EAC; and (3) inner shelf waters. During process studies, we will perform 3-day nutrient enrichment experiments using on-deck incubators and conduct short-term productivity (1-2 hour) and grazing (24 hour) experiments.

The ship will start at the southern end of the study region, transit northward and then drift southwards in the EAC towards the most southerly transect location. Drifting along in the EAC (up to 4 knots) will allow us to conduct a Lagrangian study of processes occurring in the EAC while the water is moving southward.

The final transect will start from offshore of Sydney and end in Sydney Harbour before the ship docks at 1400. This means productivity experiments will progress until 1800 and there will be a need to run nutrient analyses on samples collected as late as 1400.

Deck operations will take place mainly during daylight hours because light is central to measuring in-situ bio-optical properties as well as primary productivity. Each cloud-free day, CTDs and optical casts will be timed to coincide with satellite overpasses at approximately 0930 and 1330. A third deployment will also occur at 1530. Given the timing of the voyage, we expect there will be a moderate number of days that will be cloudy. On these days, only part of the full suite of bio-optical measurements will be carried out.

Because in-situ bio-optical properties are strongly affected by estuarine runoff, eddies and other oceanographic features, the voyage track needs to be flexible to give us the opportunity to capture weather events that generate strong gradients in bio-optical properties. This flexible sampling schedule will be developed and implemented in conjunction with the Voyage Manager and Master using input from daily remotely sensed SST, ocean colour and particulate backscatter images, as well as through consultation with voyage participants.

Time Estimates

Please see Appendix 1 (Excel spreadsheet) for a detailed list of operations.

14/10/2010

0800-1800 Mobilisation

15/10/2010

In port: Inductions and tour of the ship, get gear configured and ready to go

1400 Depart Sydney and move to Transect 1 while towing Seasoar / replacement. During this time do Toolboxes and remaining setup

16/10/2010

Commence CTD deployments along Transect 1 (offshore to inshore; Diamond Head)

Typical order of operations:

0600 CTD and Rosette and prime for next deployment
0700-0745 Breakfast
0745 CTD and Rosette
0915 CTD and Rosette water samples for optics
1000 Optical cast to coincide with satellite overpass
1030 Satlantic radiometer profile from the front(ship's bow side)
1100 CTD and Rosette
1130-1230 Lunch
1300 CTD and Rosette water samples for optics
1400 Optical cast to coincide with satellite overpass
1430 Satlantic radiometer profile from the front(ship's bow side)
1530 CTD and Rosette water samples for optics
1600 Optical cast
1630 Satlantic radiometer profile from the front(ship's bow side)
1700-1800 Dinner
1800 CTD and Rosette
1930 CTD and Rosette
2000 Finish CTD Transect 1

Transit northward to Transect 2

17/10/2010

0700 Commence CTD deployments along Transect 2 (inshore to offshore; Urunga)

2000 Finish CTD Transect 2

Transit to Transect 3 while towing Seasoar / replacement

18/10/2010

0700 Commence CTD deployments along Transect 3 (offshore to inshore; Evans Head)

2000 Finish CTD Transect 3

Transit to Process station1 while towing Seasoar / replacement

19/10/2010

0700 Commence Process station 1 (Upwelling)

Typical order of operations:

0615 CTD and Rosette for starting biological process incubations
0700-0745 Breakfast
0915 CTD and Rosette water samples for optics
1000 Optical cast to coincide with satellite overpass
1030 Satlantic radiometer profile from the front(ship's bow side)
1130-1230 Lunch
1200 Microbial cast - Can this be combined with 1300 cast - it will be tight here.
1300 CTD and Rosette water samples for optics
1400 Optical cast to coincide with satellite overpass
1430 Satlantic radiometer profile from the front(ship's bow side)
1530 CTD and Rosette water samples for optics
1600 Optical cast
1630 Satlantic radiometer profile from the front(ship's bow side)
1700-1800 Dinner
2000 CTD and Rosette
2400 CTD and Rosette

20/10/2010

Process station 1; characterise region using Nacelle

21/10/2010

Process station 1; characterise region using Nacelle

End process station

Transit to Process 2

22/10/2010

0700 Commence Process station 2 (EAC)

23/10/2010

Process station 2 (EAC)

24/10/2010

Start to drift southward in EAC

Surface bucket sampling at 1000 and 1400 for satellite matchup

CTD cast at each degree latitude

25/10/2010

Drifting southward in EAC

Surface bucket sampling at 1000 and 1400 for satellite matchup

CTD cast at each degree latitude

26/10/2010

Arrive transect 4; Jervis Bay

CTD transect

Transit northward to Process 3: Port Hacking

27/10/2010

Process station 3; inner shelf waters

28/10/2010

Process station 3; inner shelf waters

29/10/2010

Process station 3; inner shelf waters

Transit northward to Transect 5; Hawkesbury-Nepean

30/10/2010

Arrive transect 5; Hawkesbury-Nepean

Transit to final Transect 6 (offshore to inshore; Sydney)

31/10/2010

Commence CTD deployments along Transect 6 (offshore to inshore; Sydney)
0945 Optical cast to coincide with satellite overpass
1000 CTD and Rosette water samples for optics
1015 Satlantic radiometer profile from the front(ship's bow side)

1200 Sydney Heads CTD cast

1215 Surface bucket sampling for optics

1300 Sydney Harbour CTD cast

1215 Surface bucket sampling for optics

1400 Arrive

Southern Surveyor Equipment

1. Walk in freezer
2. Simrad EK500 sounder for biological research (12, 38 and 120 kHz)
3. Simrad EA500 sounder for bottom detection (12 kHz)
4. ADCP set for shallow water profiling (to 700 m) with bins set at
   0-20 m, 20-40, 40-60, 60-80, 80-100 etc until 680-700 m.
5. Controlled temperature lab/cool room – ambient water temperature at time of voyage
6. Hydrochemistry laboratory
7. Wet lab/CTD room
8. Fish lab
9. Fish sorting room
10. Flammables cabinet
11. CTD/Hydro winch (8 mm single core conducting cable)
12. Towed-body winch (12 mm 7 core conducting cable)
13. Nacelle – towed profiling CTD
14. Scintillation counter
15. Radio-isotope lab
16. Dark room
17. General purpose depth sensor (Sonardyne)
18. CTD (Seabird SBE 911 plus)
    – Rosette (24 bottles up to 10 litres)
    – 10 L Niskin bottles
    – Transmissometer
    – Profiling fluorometer
    – Light (PAR)
    – Dissolved oxygen
    – Eco triplet sensor
    – ADCP
19. Underway fluorometer
20. Milli-Q water supply

User Equipment

1. Bio-optics cage (see Fig. 2 below; 150 kg: fully autonomous with power and data logging):
   – ac-S: hyperspectral absorption(a) and attenuation(c) sensor
   – ac-9 plus: absorption and attenuation meter with filter
   – Hydroscat-6: backscattering instrument
   – Bb-9: backscattering instrument
   – LISST-100: Laser particle sizer
   – BBE: flurometer for blue-green algae
   – CTD: SBE
2. Fast-tracker fluorometer (to be attached to the CTD)
3. Laser Optical Plankton Counter (to be attached to ???? must be used while underway)
4. Satlantic underwater radiometer (to be deployed on a tether to drift away from ship; see Fig. 3)
5. MicroTOPS-II Sun Photometer (Handheld instrument)
6. Radiometers (to be attached on upper deck):

   Irradiance sensors(2) on the top most point of the ship

   Coupled radiance and irradiance sensors on the bow (see Fig. 2 below)
7. Wetlabs Ecotriplet (to be attached to the Seasoar or replacement; owned by UWA)
8. Chemotaxis unit to be deployed on the CTD rosette or independently using the CTD winch (see Fig. 3)
9. Photosynthetron (owned by CSIRO)
10. Vacuum pumps, filters for chlorophyll, stable isotopes, molecular analyses
11. Liquid Nitrogen dewers, filled
12. Formalin, alcohol, Lugols solution, glutaraldehyde, Sodium Azide, Phosphoric acid
13. Microscopes in Fish Lab and General Purpose Lab
14. Nally bins for deckboard incubations
15. Deck incubator from ANU (1 m x 1 m x 1 m)
16. Laminar flow hood
17. Satellite drifters (owned by DECCW) – may be available for the voyage

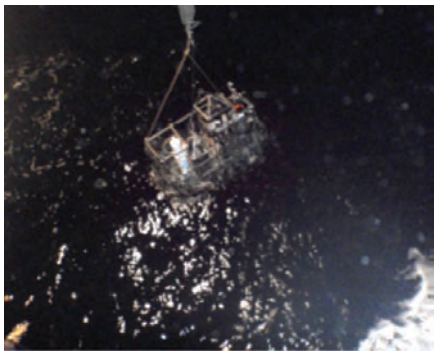
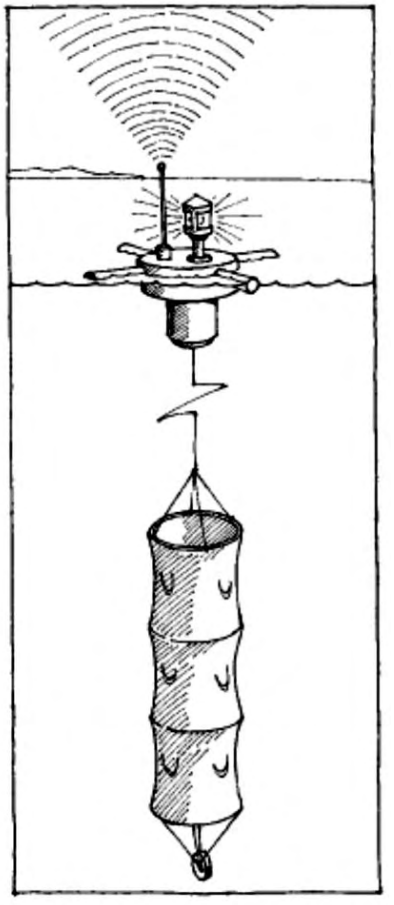


Figure 2: A) Coupled radiance and irradiance sensors on the bow; B, C, D) Bio-optics cage to be deployed from CTD winch.



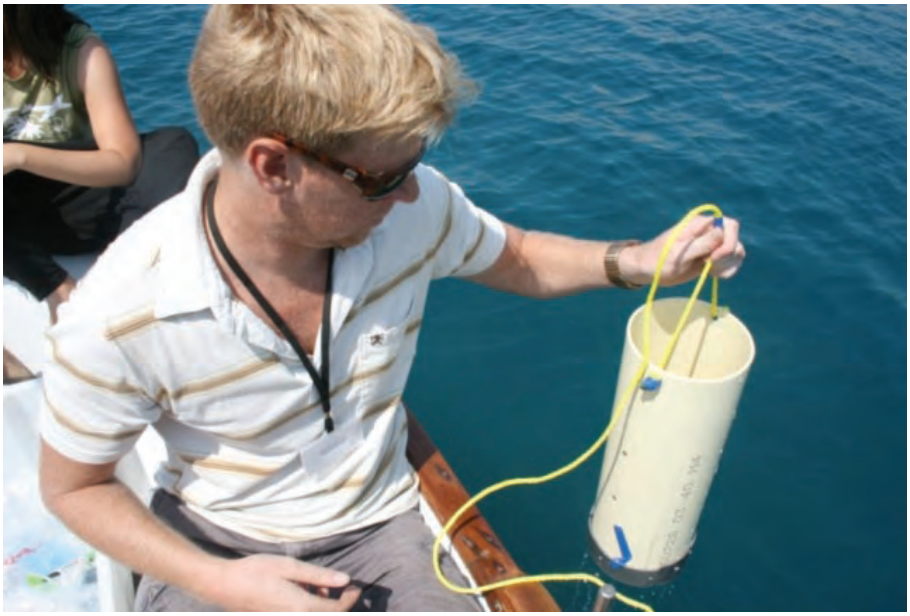


Figure 3: A) Hand-held hyperspectral radiometer to be hand-deployed off the bow; B and C) Chemotaxis unit to be deployed on the CTD Rosette or independently using the CTD winch; D) Fasttracka fluorometer to be deployed on the CTD Rosette (quick release for switching between profiling mode during transects and discrete mode during process stations); E) Schematic of satellite drifter owned by DECCW that may be deployed, depending on availability.

Special Requests

Our last transect into Sydney Harbour will begin on the final day of the voyage (Sunday 31 October). This means productivity experiments will progress until 1800 and there will be a need to run nutrient analyses on samples collected as late as 1400.

We have several pieces of kit that need to be mounted onto the CTD for deployment:

1) a Fast Repetition Rate Fluorometer that would ideally sit in a Niskin bottle position for easy attachment and detachment. This instrument is self-powered and self-logging.

2) an 'in situ chemotaxis assay' microbial sampling device. The device will be enclosed within a 40 cm x 15cm PVC pipe, which can either be attached to the CTD rosette or deployed independently by rope (up to crew?). The device will need to be submerged (5-10 m depth) for a period of 30 minutes.

We also have a Laser Optical Plankton Counter that we would like to deploy while underway. A preliminary conversation with Drew Mills indicated the Nacelle towed body (profiling CTD) would not be stable enough so we would like an alternative, if possible. It would be ideal if this platform could also carry an Ecotriplet sensor.

During the voyage, personnel will need access to the top deck to check on instruments measuring atmospheric properties.

We'd like pCO2 measurements made while underway and would like to request ammonia measurements.

Finally, we would like to drift southward in the EAC and would like to use a drogue to conduct Lagrangian-type sampling.

Our special requirements can be summarised as:
1. Sampling until just before arrival in Sydney;
2. Attachment of instruments to the CTD;
3. A way in which to deploy the Laser OPC together with Ecotriplet while underway;
4. Access to the top deck for atmospheric measurements;
5. Drogue with floating buoy for Lagrangian sampling.

Personnel List

Personnel all have experience at sea (with the possible exception of the postgrad student).

Scientific Staff	Affiliation	Duties (cabin)
1. Dr. Martina Doblin	UTS/SIMS	Chief Scientist
2. Dr Mark Baird	UTS/CMAR	Supporting Chief Scientist Shift leader A
3. Dr. Peter Davies	NSW DECCW	Supporting Scientist Shift leader B
4. Dr. Nagur Cherukuru	CLW	Supporting Scientist
5. Ms Janet Anstee	CLW	Supporting Scientist
6. Mr Jim Franklin	UTS	PhD Student
7. Dr Justin Seymour	UTS	PhD Student
8. Dr Mark Brown	UNSW	MPhil Student
9. Ms Katherina Petrou	UTS	PhD Student
10. Postgrad student	UTS	Supporting Scientist
11. Alicia Navidad	CMAR/MNF	Hydrochemistry Support
12. Don McKenzie	CMAR/MNF	Voyage Manager
13. Stephen Thomas	CMAR/MNF	Electronics Support
14. Hiski Kippo	CMAR/MNF	Computing Support
15. Peter Hughes	CMAR/MNF	Hydrochemistry Support

UTS – University of Technology Sydney; **SIMS** – Sydney institute of Marine Science; **MNF** – Marine National Facility; **CMAR** – CSIRO Marine and Atmospheric Research; **UNSW** – University of NSW; **CLW** – CSIRO Land and Water; **NSW DECCW** – NSW Department of Environment Climate Change and Water;

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.
Don McKenzie	ACM40524
Alicia Navidad	ACM40612
Stephen Thomas	ACM40504
Hiski Kippo	ACM40836
Peter Hughes	ACM41312

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

Dr. Martina Doblin
Chief Scientist

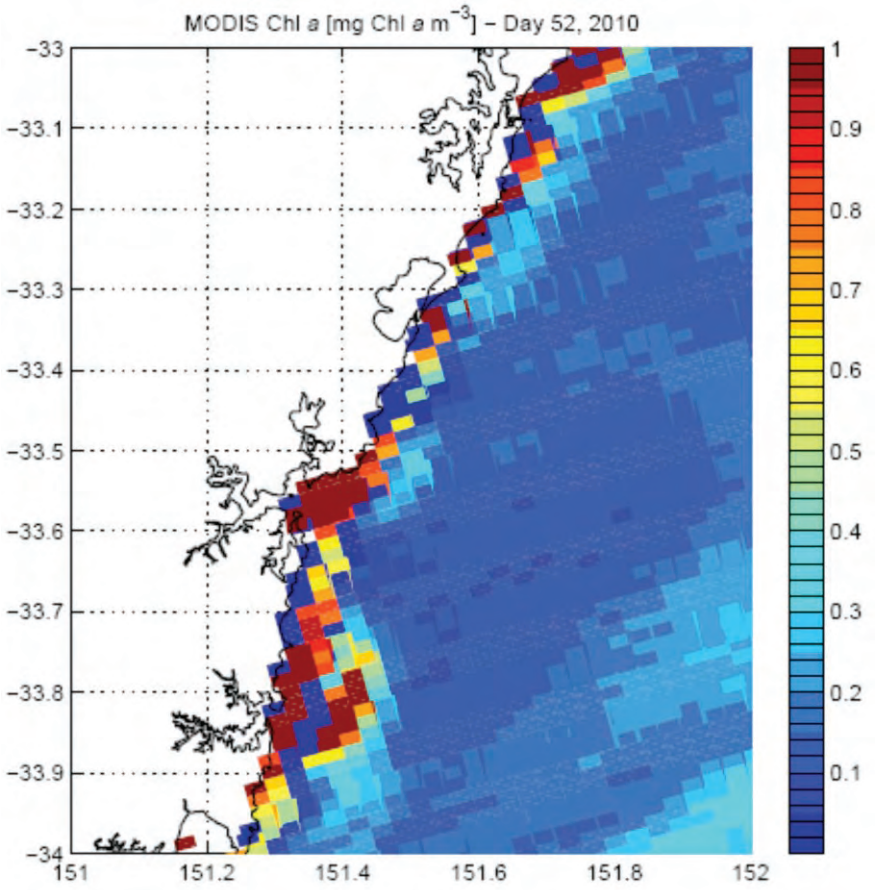


Figure 4: Distribution of surface chlorophyll-a (1 km pixel) after very heavy rains in February 2010 indicating the response of phytoplankton to land runoff.

Transect		# CTDs	Depths sampled	Nut samples	
1	Hawkesbury-Nepean	8	8	64	
2	Diamond Head	8	8	64	
3	Urunga	8	8	64	
4	Evans Head	8	8	64	
5	Jervis Bay	8	8	64	
6	Sydney	6	8	48	
				368	total for CTDs
		0,25,50,75,100,150,200, 300 for deep stations			
		0, 10, 25, 50 for shallow			
	EAC drift	8	4	32	for EAC drift
	Nut enrichments	10	3	30	90 for 3 enrichment experiments
		9 treatments in triplicate plus three T0 samples			
	Grazing experiments	16		16	48 for 3 grazing experiments
				538	**Grand total**