

# Sydney Coastal Waters Chlorophyll 2009 Data report

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## Preamble

Samples of surface ocean water off shore of Sydney, Australia were collected and nourished with nutrients. The samples were exposed to natural sunlight and kept in a water bath. The variation of chlorophyll as detected by a fluorometer was recorded once per day.

The sea water collected was nourished in the manner reported by Harrison (2007). The measurement of fluorescence is reported in Appendix A. The temperature was near 20 degree C.

## Experiment 1

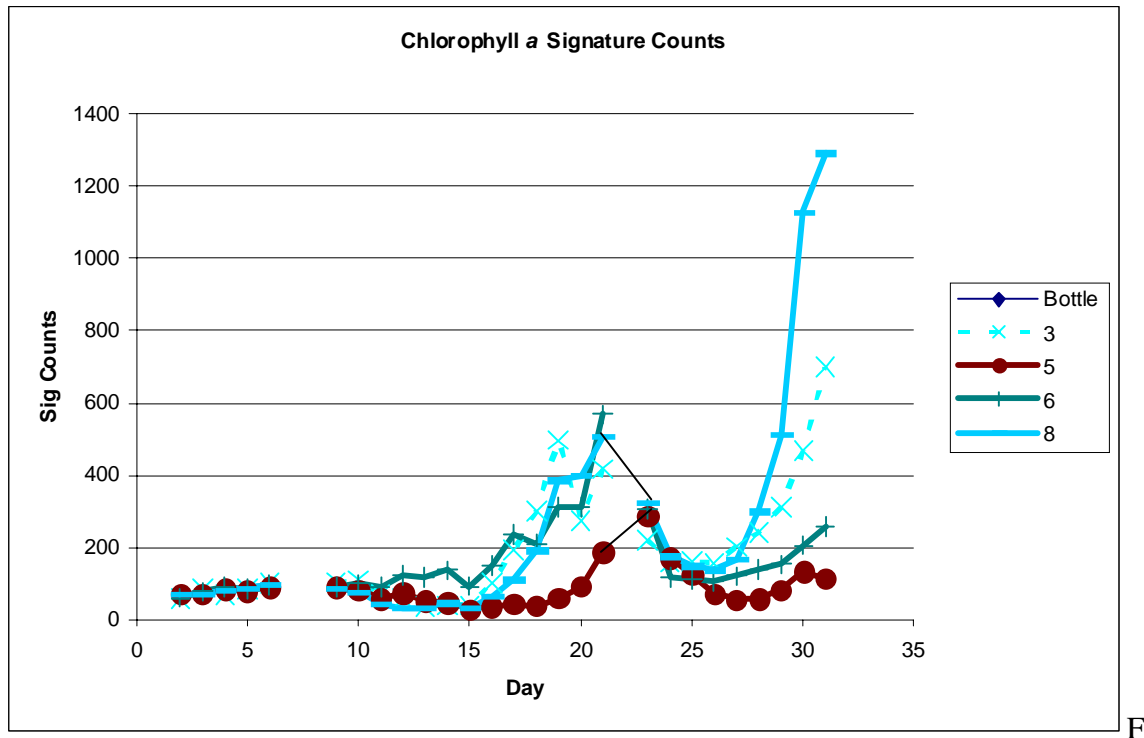


Fig 1: Experiment 1. Nourishment added on day 11. Sig Counts are proportional to chlorophyll concentration. No data was collected on day 7 and 8.

The first experiment involved 8 culture bottles all subjected to the same conditions to investigate the inherent variability of such experiments. Nourishment of 16µm N (as urea) and 1µm P (in the form of  $\text{KH}_2\text{PO}_4$ ) was added on day 11.

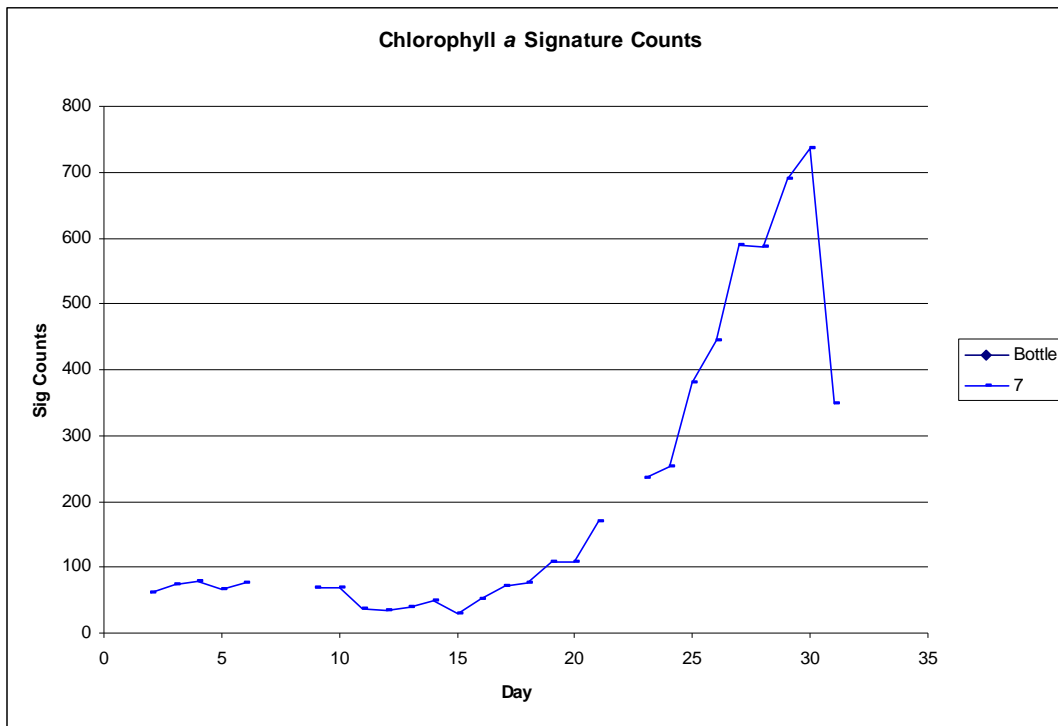


Fig 2: Experiment 1. Sig Counts can be converted to chlorophyll using Appendix A

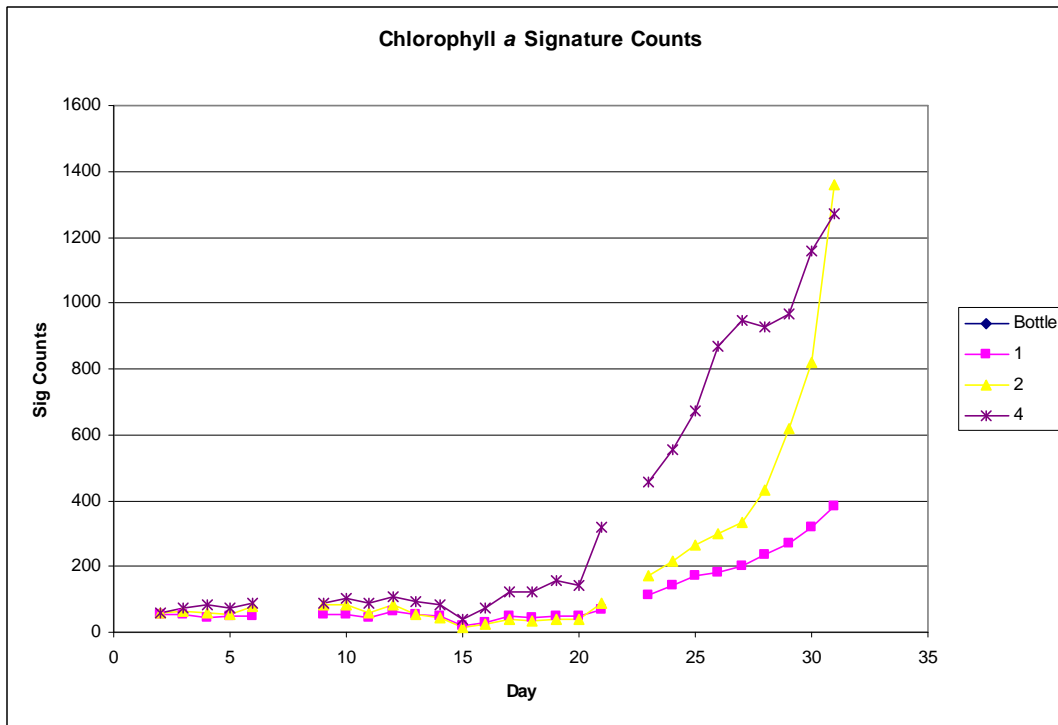


Fig 3 Experiment 1. Slow growing bottles. Sig Counts can be converted to chlorophyll using Appendix A.

The change in fluorescence with time after nourishment is presented in Figures 1, 2 and 3. Four bottles results, chosen to have peak fluorescence about 10 days from nutrient addition are shown in Fig 2. These bottles show evidence of regenerative primary production after another 10 days. The peak at 10 days after nourishment is unlikely to be macronutrient limitation as bottle 8 obtained higher fluorescence levels during regenerative production. The results may help in understanding the remineralisation time. Another bottle with maximum fluorescence after about 20 days from nutrient addition is shown in Fig 2. This pattern of growth and death is similar to that in Fig 6.1 of Jeffries et al (1997). Finally the remaining 3 bottle results from experiment 1 are shown in Fig 3.

### Experiment 2

The second experiment involved 2 control bottles and 3 bottles nourished by the addition of  $16\mu\text{M}$  N and  $1\mu\text{M}$  P (in the form of  $\text{KH}_2\text{PO}_4$ ) as in experiment 1. A further three bottles were subjected to twice the nutrient nourishment. Nourishment was added after 3 days. The average results are shown in Fig 4 and show faster rate of growth at higher nourishment levels.

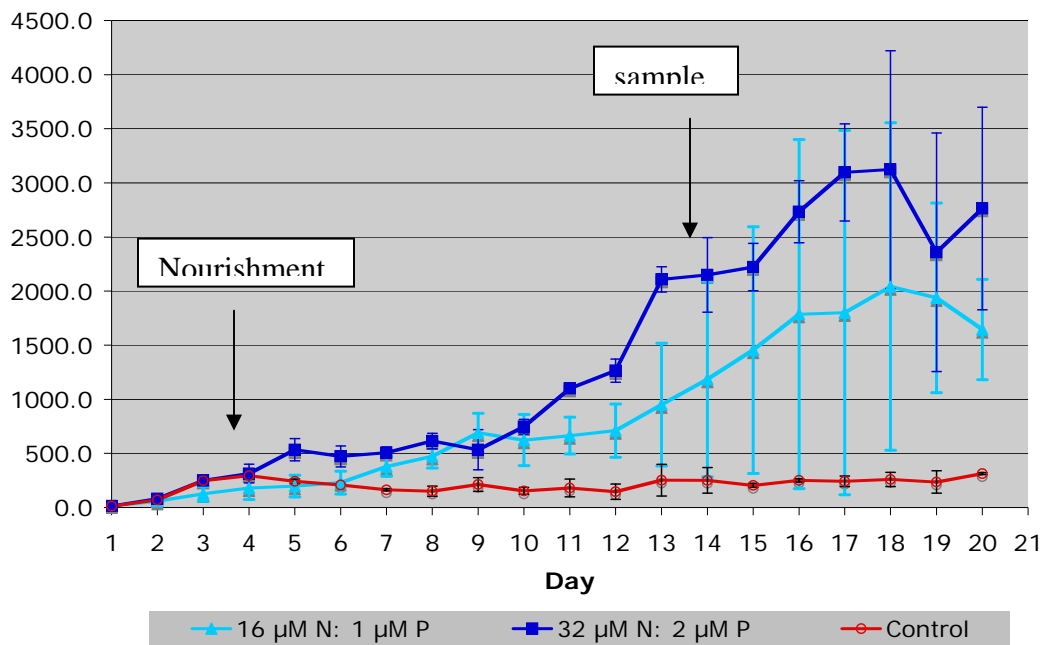


Fig 4: Experiment 2 showing the average of bottles treated similarly.

### Phytoplankton

The control and two nourished bottles in experiment 2 were examined for phytoplankton type 10 days after nourishment. The cells in the control were 60% dinoflagellate, while the strongly nourished sample was 67% dinoflagellate, but with 8 times as many cells. The weakly nourished

sample (16  $\mu$ M of N) had 50 times as many cells as the control, almost all cells were phaeocystis belonging to the Prymnesiophyceae class of plankton.

However the difference of fluorescence between the two levels of nourishment was not as dramatic as the cell number, suggesting the phaeocystis cells were small. Phaeocystis cells frequently dominate natural assemblages of phytoplankton.

### **References**

- Jeffries, S W, RFC Mantoura and S W Wright (1997) Phytoplankton pigments in oceanography: guidelines to modern methods, UNESCO publishing.
- Harrison, D P (2007) Ocean Nourishment® in the Philippines - Proof of Concept Report for the Sulu Sea, Earth Ocean & Space, Rep. 07-008.

## Appendix A

Instrument wet Labs

Sn: FLRT-782

Chlorophyll = (sig counts – dark counts)\* scale factor

Laboratory calibration values

Scale factor = .098 (micrograms/L, counts)

Dark counts = 84

Clear water offset in bottles shown on spread sheet and used instead of dark counts

Bottle washing

Exp 1 HNO<sub>3</sub>

Exp 2 HCl

Filter: 50 micron zooplankton filter

Bottle volume: 2 litres

Sample was allowed to sit in collection containers for more than 24 hours before decanting to culture bottles

Contamination: Care was taken to avoid contamination. The 10 day uniform chlorophyll concentration in all culture bottles in Exp 1 suggests contamination was adequately controlled.



Fig A1 Culture bottle, flurometer and computer.

# Appendix A

## Trial 1 - Chlorophyll a Signature Counts (after Clear Water Calibration)

notes	Date day	mon	tues	wed	thurs	fri	no measurements taken / containers not opened		no measurements taken / containers not opened		nutrient added					
		24/8/09	25/8/09	26/8/09	27/8/09	28/8/09	29/8/09	30/8/09	31/8/09	1/9/09	2/9/09	3/9/09	4/9/09	5/9/09	6/9/09	
CWO	Bottle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
	114	55.4	53	43.45	47.25	46.8			55.65	52.9	42.4	61.8	55.9	47.95	18.25	
	113	60.6	62.6	60.05	55.55	78.65			85	84.25	58.35	82.4	53.1	42.1	16.3	
	113	57.25	87.75	69.9	85	100.05			104.45	110.15	68.7	58.45	36.75	39.15	37.8	
	115	57.4	72.15	84.2	75.75	89			89.85	103.6	87.9	106.3	92.6	83.1	38.7	
	114	70.1	71.65	83.9	79.3	89.8			89.75	82.7	56.35	73.4	53.6	46.9	29.4	
	115	60.25	78.5	90.65	86.5	95.25			90	99.2	89.95	124.3	119.25	137.4	93.5	
	115	62.5	73.3	78.55	66.2	74.9			69.85	67.55	36.7	35	38.9	48.2	29.15	
	115	69.9	71.65	81.55	88.65	98.9			86.3	77.55	43.1	33.1	33.05	46.85	33.6	

cleaned F- meter	no measurements taken / containers not opened						no measurements taken / containers not opened											
	mon	tues	wed	thurs	fri	sat	sun	mon	tues	wed	thurs	fri	sat	sun	mon	tues		
7/9/09	8/9/09	9/9/09	10/9/09	11/9/09	12/9/09	13/9/09	14/9/09	15/9/09	16/9/09	17/9/09	18/9/09	19/9/09	20/9/09	21/9/09	22/9/09			
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
28.1	50.15	46.4	50.85	49.1	69.95		113.25	144.2	174.15	183.5	202.55	237.75	271.7	317.9	384.35			
26.8	39.85	33.8	41.85	40.2	89.55		174.95	214.6	268.2	302.6	333.15	432.1	621.2	820.9	1360.85			
101.45	194.65	299.85	497.75	274.9	417.6		220.75	157.15	161.85	157.1	202.6	242.05	311.4	466.7	701			
75.65	120.4	123.8	154.8	144.15	320.7		458.3	556.9	671.35	869.25	946.3	928.65	965.85	1157.85	1270.45			
35.4	44.75	38.65	60.75	91.35	187.35		288.65	171.55	124.85	73.15	55.5	57.95	82.6	133.25	113.5			
150.2	236.15	211.45	312.6	312.6	569.1		306.5	118	111.5	104.3	121	139.7	152.9	205.4	257.85			
50.8	71.65	76.8	108.55	107.45	169.25		235.7	251.55	381.35	444.2	588.85	586.8	690.25	735.1	347.7			
64.9	110.5	193.65	386.7	399.35	507.15		324.85	175.6	148.4	137.1	168.3	300.8	513.35	1129.4	1292.55			

## Appendix B

### Experiment 2 Results

#### Appendix B – Chlorophyll a signature counts (after clear water calibration)

day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<b>Bottle</b>	<b>16 <math>\mu</math>M N: 1 <math>\mu</math>M P</b>																			
<b>1</b>	9.7	30.1	53.0	58.6	87.2	123.9	275.6	349.6	503.8	361.2	505.5	722.0	1188.5	1289.8	1491.1	1526.2	1344.3	1522.4	1694.1	1296.4
<b>2</b>	15.2	63.8	139.7	224.1	224.2	230.7	419.4	518.4	702.1	686.8	645.7	459.6	303.4	236.2	298.5	319.8	394.6	858.7	1209.2	1464.6
<b>3</b>	19.4	79.5	187.9	258.6	283.4	335.7	440.9	552.5	865.0	820.7	843.3	950.3	1358.1	2031.3	2578.5	3515.1	3666.0	3746.2	2910.4	2172.2
mean	14.8	57.8	126.8	180.4	198.3	230.1	378.6	473.5	690.3	622.9	664.8	710.6	950.0	1185.8	1456.0	1787.0	1801.6	2042.4	1937.9	1644.4
std dev	4.9	25.3	68.4	106.9	100.6	105.9	89.9	108.7	180.9	236.3	169.7	245.5	566.4	902.0	1140.4	1613.5	1683.0	1512.4	876.4	464.8
relstdev	32.9%	43.7%	53.9%	59.3%	50.8%	46.0%	23.7%	22.9%	26.2%	37.9%	25.5%	34.6%	59.6%	76.1%	78.3%	90.3%	93.4%	74.0%	45.2%	28.3%
<b>Bottle</b>	<b>32 <math>\mu</math>M N: 2 <math>\mu</math>M P</b>																			
<b>4</b>	12.7	84.4	216.7	257.1	432.1	578.2	564.5	663.0	738.9	697.0	1065.5	1161.7	2166.6	1755.8	1969.9	2403.4	2585.1	1903.9	1160.4	1709.5
<b>5</b>	17.7	73.5	232.4	270.4	532.7	387.9	493.7	531.6	380.1	717.8	1143.2	1373.8	2187.1	2302.2	2353.2	2887.7	3414.5	3432.0	2584.3	3092.8
<b>6</b>	13.5	84.3	301.6	414.3	637.5	451.0	463.4	649.4	481.8	823.8	1090.9	1256.9	1974.3	2392.2	2344.8	2910.1	3292.6	4033.2	3331.3	3490.5
mean	14.6	80.7	250.2	313.9	534.1	472.3	507.2	614.7	533.6	746.2	1099.8	1264.1	2109.3	2150.0	2222.6	2733.7	3097.4	3123.0	2358.6	2764.3
std dev	2.7	6.2	45.2	87.2	102.7	96.9	51.9	72.3	184.9	68.0	39.6	106.3	117.4	344.4	218.9	286.3	447.8	1097.8	1102.9	934.9
relstdev	18.4%	7.7%	18.0%	27.8%	19.2%	20.5%	10.2%	11.8%	34.7%	9.1%	3.6%	8.4%	5.6%	16.0%	9.9%	10.5%	14.5%	35.2%	46.8%	33.8%
<b>Bottle</b>	<b>Control</b>																			
<b>7</b>	12.5	64.8	231.6	296.5	257.6	202.6	156.5	184.3	258.4	131.4	124.1	95.7	149.8	167.3	191.7	240.3	275.9	306.2	309.8	318.8
<b>8</b>	16.2	74.8	263.8	292.7	227.4	215.0	170.9	117.0	167.7	176.5	238.9	196.1	356.8	334.7	219.0	261.5	207.7	213.4	162.7	307.0
mean	14.3	69.8	247.7	294.6	242.5	208.8	163.7	150.6	213.0	153.9	181.5	145.9	253.3	251.0	205.3	250.9	241.8	259.8	236.3	312.9
std dev	2.6	7.1	22.7	2.7	21.4	8.8	10.2	47.6	64.2	31.9	81.2	71.0	146.3	118.3	19.3	15.0	48.2	65.6	104.0	8.3
relstdev	18.0%	10.1%	9.2%	0.9%	8.8%	4.2%	6.2%	31.6%	30.1%	20.7%	44.8%	48.7%	57.8%	47.1%	9.4%	6.0%	19.9%	25.3%	44.0%	2.7%