CE13001 OSMOSIS Seaglider turnaround cruise Jan 2013

R/V Celtic Explorer 5th to 11th Jan 2013.

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Seagliders

The plan for OSMOSIS is to deploy ocean gliders in pairs for a period of a full year. Each glider deployment will last for four months. Careful monitoring and planning will be required to maintain sufficient battery power throughout the four months. Initial estimates seem to show that the 10V science battery will most likely be the limiting factor. Cruise CE13001 was on board the R/V Celtic Explorer. The plan was to depart from Galway, Ireland on 5th January 2013 and steam to the Porcupine Abyssal Plain (PAP) monitoring station, collecting a Meteorological buoy, which had become detached from it's mooring, before arriving at the PAP site to recover Seagliders SG533 and SG566, deploy two gliders from SG510, SG502 and SG579 and take measurements for dissolved Oxygen, Chlorophyll a and Nutrients to calibrate the sensors on the Seagliders.

Deployment Timeline – see below for more details.

5th Jan 2013 Arrived on ship
Set up Oxygen titration system and Chlorophyll filtration rig
Set up Chlorophyll extraction apparatus and Turner 'Trilogy' Fluorometer.

Self tests and assembly of SG510 and SG579

6th Jan 2013 Continued assembly and self tests of SG579

7th Jan 2013 Continued self tests on SG510 and SG579

Notes from 8pm Toolbox meeting

ETA 05:00 08/01/2013 PAP site

1.	Deploy SG510 and SG579	estimate 3 hours
2.	Deep CTD to 4800m for Marine Institute	estimate 5 hours
3.	Shallow CTD to 1000m for OSMOSIS calibrations	estimate 1 hour
4.	Recover SG533 and SG566	estimate 4 hours
5.	Steam to SAMS Seaglider SG156	estimate 20 hours
6.	Recovery of SAMS seaglider SG156	estimate 2 hours
7.	CTD to 1000m at SAMS recovery site No samples	estimate 1 hour
8.	Steam to Castletown bere	estimate 20 hours
9.	Unload equipment	

R/V Celtic Explorer anticipated arrival time 05:00 Friday 11th Jan 2013
R/V Celtic Explorer anticipated departure time 17:00 Friday 11th Jan 2013

8th Jan 2013 **Deployment and Recovery day.**

05:50 SG510 Deployed using 'Crane and smugglers knot' technique Serious problems encountered on deployment resulting in a snapped antennae and un-tethered Seaglider. See SG510 deployment notes

06:50 SG510 Recovered

08:20 SG579 Deployed using 'hand lowered over drop-side' technique

09:52 **CTD CE13001/01**
CTD to 1000m for Seaglider sensor calibration

Position of CTD 48° 41.48N
16° 10.18W
Maximum depth of CTD 1000m

Depth (m)	Niskin No's	Oxygen sample bottle no's	Chlorophyll sample bottle no's	nutrient sample bottle no's
880	1,2	1,2	1,2	222, 221
840	3	3,4	3	227
700	4,5	5,6	4,5	220, 225
550	6,7	7,8	6,7	226, 223
350	8,9	9,10	8,9	228, 231
220	10,11	11,12	10	232
140	12,13	32,35	11	229
100	14	31,33	12	230
70	15	36,34	13	240
60	16	37,38	14	247
50	17,18	40,42	15	248
30	19,20	39,41	16	241
20	21	51,50	17	233
10	22,23	49,52	18	234

Sampling finished at 12:22

13:00 SG502 Deployed using 'hand lowered over drop-side'

13:35 SG533 Recovered

16:50 SG566 Recovered

17:10 **CTD CE13001/03**
CTD to 4826m for Marine Institute, Galway

Position of CTD 48° 43.32N
16° 11.44W
Maximum depth of CTD 4826m

Depth (m)	Niskin No's	Oxygen sample bottle no's	Chlorophyll sample bottle no's	nutrient sample bottle no's
4826	1,2			236
4500	3,4	44,43,45		238
4000	5,6			235
3500	7,8	48,46,68		243
3000	9,10	77,67,69		245
2500	11,12			239
2000	13,14	47,57,59		246
1500	15,16			242
1000	17	71,19,22	2	237
500	18	20,23,24	3	249
200	19	58,56,72	4	244
100	20	25,55,60	5	250
50	21		6	251

9th Jan 2013

19:40 SG156 recovered

19:50 CTD to 1000m for SAMS sensor calibration

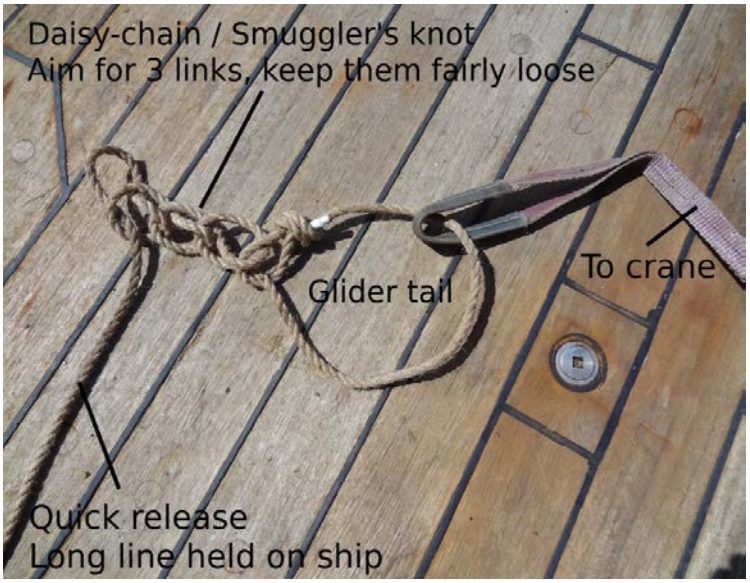
20:00 Begin steam to Castletown bere, Ireland

11th Jan 2013

02:00 Dock in Castletown Bere, Ireland

Deployment and Recovery techniques and problems

Initial problems were encountered with the deployment and recovery techniques. SG510 was the first seaglider to be deployed and the favoured deployment technique was utilising the crane and rope together with a smugglers knot



Upon deployment the rope twisted around the antenna of the seaglider, probably due to the heavy swell and movement of the ship. The tension on the ‘quick release long-line’ (again through twisting) caused the smugglers knot to become un-tied, at the same time as the antenna snapped through tension caused by the ships rolling. This quickly turned into a very risky situation. We now had an un-tethered seaglider in a heavy swell, in total darkness with no communication (as the antenna had snapped and the ARGOS tag was submersed in water). A constant visual contact was required in order not to lose the Seaglider. The ‘man overboard’ technique was employed, with ship’s crew both on the bridge and deck pointing to the location of the seaglider so as not to lose sight, but even so, the glider disappeared from view on three occasions, circum-navigating the ship four times before eventually being recovered 1 hour after its initial deployment.

The recovery pole was used for the recovery of SG510. The pole was initially set up using the plastic block with the recovery rope ‘looped through’. Problems were encountered with this technique as there was nothing to hold the noose open. The eventual technique to recover the Seaglider was by coiling the rope around the Seagliders’ tail end until the rope had coiled around 7-8 times. This gave enough hold to be able to drag the Seaglider out of the water, but also meant that the Seaglider wasn’t ever securely attached to the line. Although successful on this occasion, it was felt that this technique was somewhat haphazard and a refined technique was required for future recoveries.

The Seaglider recovery pole also suffered some damage during this recovery. The plastic block holding the loop was broken and the final 30cm of the pole was snapped. The Seaglider pole was modified to aid easier recoveries and details of this can be found in the ‘Recovery Technique’ section below.

SG510 took a heavy knock to its CTD sail upon recovery, which knocked the sensor out of alignment and this, together with the snapped antenna made redeployment risky, because of the threat of a leak in the pupae through the CT sensor bulk-head fitting. It was decided not to redeploy SG510, but instead deploy the spare Seaglider SG502.

The ‘Drop-side hand lowered technique’ for Seaglider deployment.

After discussions with the ship's crew, it was decided to employ an alternative technique for future deployments; a technique which became known as the ‘drop-side hand lowered technique. This involved no knots, but a long length of rope looped twice around the aft end of the Seaglider, below the tail-fin and then hand-lowered into the sea keeping hold of both lengths of rope, through the drop-side, where the CTD rosette is normally deployed and recovered.

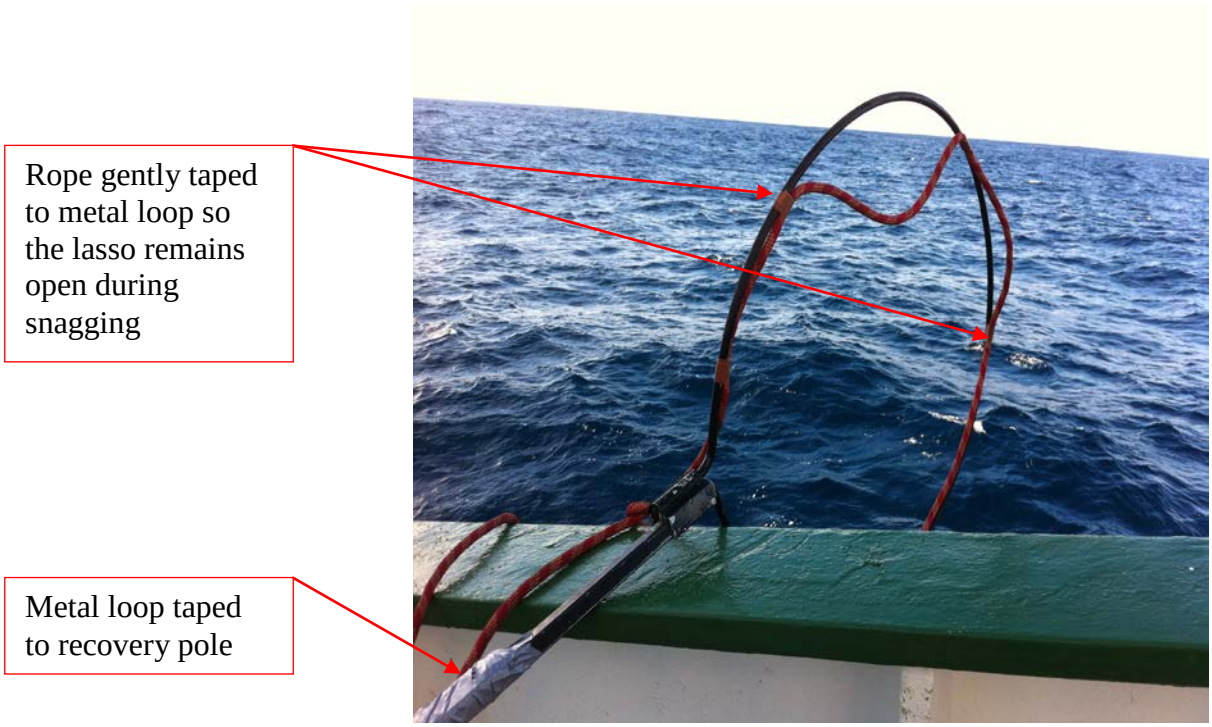
Hold on to both lengths of rope until the deployment team are happy to deploy the seaglider. To deploy, cast one end of rope into ocean and pull loop through until completely detached

One and a half loops around Seaglider tail, below tailfin allows control of seaglider and is easily detached upon release

Once the seaglider has been gently lowered into the sea and the deployment team are happy with the way the seaglider is sitting in the water, one length of rope is cast into the sea and the other length of rope is pulled to release the loop around the tail-fin. The seaglider is now un-tethered and the ship can move away to allow the seaglider to begin its first dive. This technique seemed to work very well, with 2-3 people lowering the seaglider over the side. Each member had adequate protection in the form of self inflating life jackets, personal distress radio beacons, and a fall arrest line in the event of falling overboard. This technique has the advantage of having two 'lead' ropes which can be manipulated to avoid twisting of the line. The deployment team also has greater control of the seaglider as the rope is being controlled by the deployment team as opposed to the ships' winch. Any twists in the rope can simply be untwisted by the team. This technique was employed for the rest of the campaign for the deployment of the further two Seagliders.

Recovery Technique

The seaglider recovery pole was modified so that a large metal loop was attached to one end of the pole. A rope was gently taped to the metal loop so that the noose was held open. The loop was then positioned over the antenna and tail-fin before the rope is hauled to break away from the metal loop and attach around the lifting point on the seaglider. The seaglider can then be lifted onboard the ship either by means of the ship's crane or hand-hauled by 2-3 members of the ships crew.



This recovery method was successful with all three recoveries (SG566, SG533 and SG156) and there was no identifiable damage to any of the seagliders during recovery.
Upon return to UEA, the seaglider recovery pole will be modified to incorporate a lightweight loop and fixing points to hold the rope (and the loop open)

Chlorophyll Analysis

Chlorophyll samples were taken from two stations around the Seaglider deployment/recovery area (see above). All of the Seagliders were recovered and deployment in the same area it was decided that 1-2 stations would be adequate for all calibrations.
The chlorophyll samples were taken by rinsing a polyethylene bottle 3 times and filling. The samples were then stored at 11° C in the dark, until they were filtered.
A known quantity of sample was measured using a measuring cylinder and filtered through a GF/F filter paper. The filter paper was placed in 6ml 90% Acetone and stored at 4° C for 20-24 hours to allow the chlorophyll extraction to take place. The extract was analysed on a 'Turner Trilogy' Fluorometer using the 'un-acidified' chlorophyll method. The Fluorometer was calibrated using a solid chlorophyll standard. The Fluorometer and chlorophyll standard will be sent back to the manufacturer post cruise for recalibration.

Nutrient Analysis

Nutrient samples were taken from the two stations around the Seaglider deployment/recovery area. These samples were frozen immediately and transported back to the University of East Anglia whilst remaining frozen. These samples will be analysed post cruise for their nutrient concentrations.

Oxygen Analysis

Oxygen samples were taken from two stations around the Seaglider deployment/recovery area. Samples were taken by inverting the glass bottle and rinsing it for 30-40 seconds with seawater from the same Niskin bottle as sampled. Once rinsed, the bottle was gently reoriented and completely filled with an amount of water 2-3 times the bottle volume. The excess of water was left to overflow, and the bottle was checked for the absence of bubbles. 1.00 cm^3 of 3.0 mol dm^{-3} Manganese Chloride Tetrahydrate ($MnCl_2$) and 1.00 cm^3 4.0 mol dm^{-3} Sodium Iodide/ 8.0 mol dm^{-3} Sodium Hydroxide (NaOH/NaI) was added to fix the oxygen. Bottles were subsequently sealed with the corresponding stopper and vigorously shaken to mix the reagent with the sample. The Shaking was repeated after 20-30 min and then the bottles were left for 1 day to let the precipitate settle at the bottom. 24 hours later, the stopper was removed and 1.00 cm^3 of 5.0 mol dm^{-3} Sulphuric acid (H_2SO_4) was added to the sample together with a magnetic stir bar. The titration was performed with 0.20 mol dm^{-3} Sodium thiosulfate pentahydrate ($Na_2S_2O_3$. 5H2O) after most of the precipitate has dissolved, liberating iodine until the equivalence point was reached.
Burettes were flushed before each titration to get rid of the bubbles for at least 10 minutes (40 minutes when first unpacked).

Sodium thiosulfate standardization was performed three times during the cruise. In this case MilliQ water was poured into an iodine flask with a magnetic stirring bar. Then reagents were added in the order of 1.000 cm^3 of "standard" 23.36 mol dm^{-3} Potassium Iodide (KIO_3) solution by Dosimat, 1.00 cm^3 of H_2SO_4 5 mol dm^{-1}, 1.00 cm^3 of the NaOH/NaI and 1.00 cm^3 of $MnCl_2$. Flasks were then filled to the neck with MilliQ. Solution was titrated to the equivalence point with $Na_2S_2O_3$ and final volume of titrant added was recorded.

Blank determination was performed three times during the cruise. MilliQ water was poured into an iodine flask, together with a magnetic stirring bar. 1.000 cm^3 of "blank" KIO_3 solution (by pipette), 1.00 cm^3 of H_2SO_4 5 mol dm^{-1}, 1.00 cm^3 of the NaOH/NaI and 1.00 cm^3 of $MnCl_2$ was then added. The Flask was filled to the neck with MilliQ water. The Solution was titrated to the equivalence point with $Na_2S_2O_3$ and final volume of titrant added was recorded. An additional 1.000 cm^3 of "blank" KIO_3 was pipetted in the solution and the titration was repeated. Blank volume was measured as the difference between the first and second $Na_2S_2O_3$ titrant volume.