CROZET D300 CRUISE
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1) **Abundance and diversity of scavenging fish fauna – ROBIO**
2) **Fish Respirometry - FRESP**
3) **Demersal ichthyofaunal assessment using OTSB trawl at sites M5 and M6, Crozet Plateau. Contact: n.king@abdn.ac.uk.**

1) Abundance and diversity of scavenging fish fauna – ROBIO

The RObust BIOdiversity lander (ROBIO) is essentially a baited time-lapse camera system used to assess the abundance and diversity of scavenging fish fauna. Equipped with a 3 megapixel digital camera (Kongsberg OE-218) and flash-gun ROBIO can deployed for various durations on the seabed ranging from 2-48hrs. The photograph interval is pre-programmed prior to deployment and images are recorded to an internal 1GB compact flashcard. Deployment duration is generally dictated by bait longevity and photograph interval (and hence by flashcard and battery capacity). ROBIO is also equipped with a self-contained Aquadopp current meter (Nortek AS, Norway).
ROBIO can be deployed in several configurations but for studies during the CROZET programme it was deployed in suspended mode, with the instrument frame held 2m above the seabed attached to 100kg of ballast by a steel strop. Mackerel bait and a 1mx1m reference scale are attached to the ballast clump.

A summary of the ROBIO deployments completed at station M5 are shown in Table 1. No deployments were achieved at station M6 as the entire lander and mooring were lost after buoyancy spheres were destroyed by the ship's propeller during recovery of ROBIO 5.

Data collection was also affected at station M5 by a combination of a leaking battery cable (ROBIO 2 and 3) and by the lander becoming wedged against a large boulder that obscured the view of the bait and rendered the deployment unusable (ROBIO 4).

The photographs recovered from the first 4 deployments did clearly show large amounts of heterogeneously distributed phytodetritus patches on the seabed and a large amount of resuspended or sinking material in the water column. Species identified from photographs include *Corypahenoides armartus*, *Histiobranchus bathybius* and an unidentified Zoarcid (possibly *Pachycara* sp. based on trawl catches). Figure 4 shows some typical images recovered from ROBIO during the first 4 deployments.

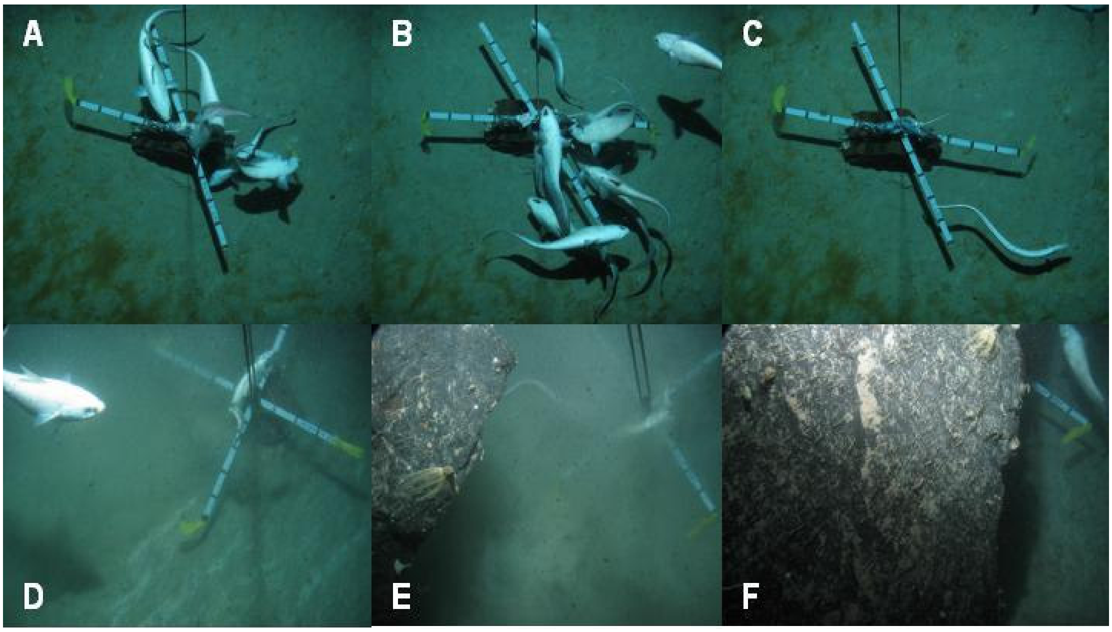

Figure 4. Example images from ROBIO deployments 1 (A-C) and 4 (D-F). Phytodetritus can clearly be seen aggregating on the seabed during deployment 1. Fish attracted to bait included *Coryphaenoides armartus* (A & B) and the deep-water eel *Histiobranchus bathybius* (C). Images D-F show the lander being dragged and becoming lodged against a large boulder. The reference cross is 1m x 1m, marked in 10cm intervals.

Data collected from the current meter attached to ROBIO indicated a significant rise in current velocities between deployments 1 and 2 and deployments 3 and 4 (Table 3).

ROBIO deployment	Minimum current velocity cm s^{-1}	Maximum current velocity cm s^{-1}	Mean current velocity cm s^{-1}
1	0.2	8.6	4.02 ±1.83
2	1.6	17.7	7.15 ±3.20
3	6.5	30.5	18.03 ±3.52
4	5.3	29.9	17.47± 4.60

Table 3. Near sea-bed (2mab) current velocities recorded from ROBIO lander.

A preliminary analysis of the photographs from deployment 1 was undertaken, primarily to determine the optimum time for closing the FRESP trap chamber.
527 images were viewed and the number of fish present in each frame was recorded. The first arrival time for fish at the bait was 25.5 minutes. A peak abundance of 10 fish in the frame occurred 6.5hrs into the deployment. There was no visible decline in fish arriving at the bait, with bait still being visible 13hrs into the deployment.

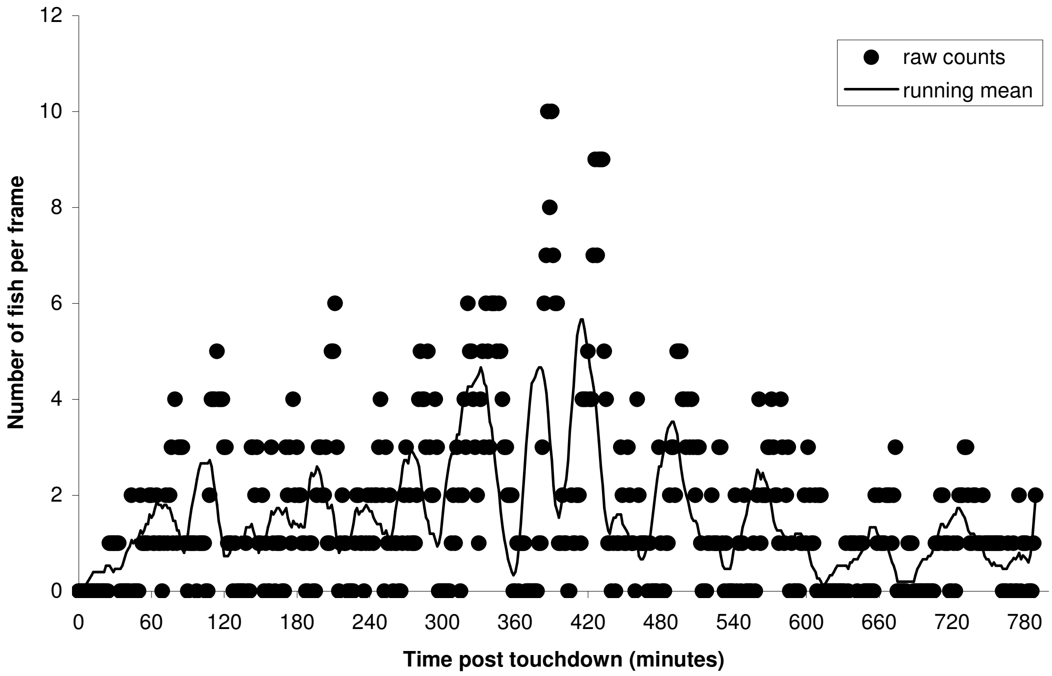

Figure 5. Fish arriving at ROBIO bait during deployment 1. Number of fish visible per frame plotted along with a 10 minute running mean of fish abundance.

2) Fish Respirometry - FRESP.

The FRESP lander deployed on this cruise had been modified from that used previously (Bailey et al., 2002; 2005) by the replacement of the polarographic oxygen electrode and pump system (SBE 23B and SBE 5 T, Sea-Bird Electronics Inc., USA) with an oxygen optode (O_2 optode 3930; Aanderaa Instruments, Norway). The O_2 measurements are logged via an RS232 link through a custom built TT8 controller to a flash card and recorded in text file format. The modified digital video recorder has been replaced with a custom built digital system recording a compressed MPEG format directly to a removable hard disk. In addition 2 banks of 3 high-power LEDs now provide the lighting source for the camera. The trap closing mechanism has been adapted by attaching the trap support lines to a small winch head that is attached to a stepper motor in a pressure housing. The O_2 measurement intervals, trap closure and camera start time/duration are pre-programmed with custom built text file command generator software and loaded onto the internal flash card. The controller is housed within a 6000m rated 6Al-4V titanium housing.

FRESP was deployed 3 times at each of stations M5 and M6 (see Table 1 for a summary). For each deployment the lander was baited with the carcasses of 3 large mackerel, retained in a mesh bag to prevent dispersal and rapid consumption by the scavenging fauna.
The lander was deployed with the following program.

```
000 00:00:00 STIRRERON
000 00:01:00 STIRREROFF
000 02:15:00 CAMERAON
000 02:25:00 CAMERAOFF
000 03:15:00 CAMERAON
000 03:20:00 CAMERAOFF
000 04:15:00 CAMERAON
000 04:20:00 CAMERAOFF
000 04:54:30 O2SENSORON 60
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000 04:55:00 CAMERAON
000 05:00:00 TRAP
000 05:01:00 STIRRERON
000 05:05:00 CAMERAOFF
000 06:00:00 CAMERAON
000 06:05:00 CAMERAOFF
000 07:00:00 CAMERAON
000 07:05:00 CAMERAOFF
000 08:00:00 CAMERAON
000 08:05:00 CAMERAOFF
000 09:00:00 CAMERAON
000 09:05:00 CAMERAOFF
000 10:00:00 CAMERAON
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000 11:00:00 CAMERAON
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000 13:05:00 CAMERAOFF
000 14:00:00 CAMERAON
000 14:05:00 CAMERAOFF
000 15:00:00 CAMERAON
000 15:05:00 CAMERAOFF
000 16:00:00 CAMERAON

When the FRESP is activated on deck prior to deployment the movement of the stirrer motor indicates that the program has been accepted and activated. The camera is then switched on for 4 short sequences prior to the trap being closed to observe fish arriving at the bait (see Figure 1). Based on fish arrival times and peak abundances, calculated from the ROBIO still images, the trap was closed 5hrs after the system was activated. Taking into account the descent time of the lander this was approximately 2.5hrs after reaching the seafloor. The camera then continues to film short sequences every hour (for the first 24hrs, then every 2hrs after) to monitor the behaviour of the trapped fish (see Figure 1).

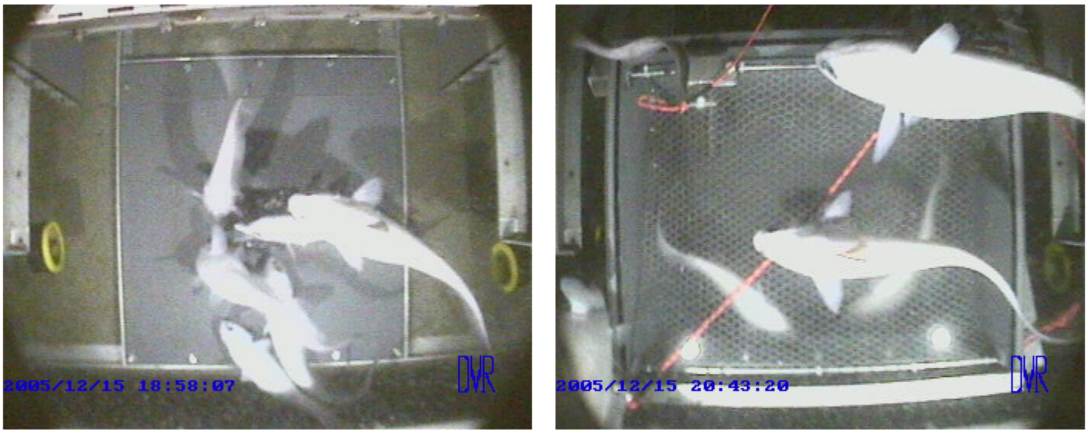

Figure 1. Still image grabs from FRESP video showing *C. armartus* attracted to bait and 2 specimens caught in the chamber following closure of the trap.

Although both the first 2 deployments were successful in trapping specimens of the abyssal grenadier, *Coryphaenoides armartus*, the O_2 data collection was compromised by firstly a defective gasket seal on the trap lid, then secondly by a fish becoming caught between the trap edge and baseplate, wedging it open for the duration of the deployment. Deployment 3 failed to trap any fish, although the O_2 data recorded by the optode indicated a good seal and provides a suitable control measure to account for any bacterial respiration associated with bait decay (see Figure 2). Deployment 4, at station M6, trapped 4 fish and an initial decline in O_2 concentration was recorded. However, after 13hrs the trap began to leak and the O_2 concentration rose, after viewing the video footage we believe that the trapped fish dislodged the lid seal when they pushed their way up over the mesh screen protecting the lid. Figure 2 shows the O_2 profile recorded and the associated consumption rates calculate from the data. The initial decline does appear to be a real reduction brought about by the respiring fish, and at some points on the video some the fish do appear to 'pass out' in the trap. Unfortunately, as so many fish were caught, and the fact that it was a multi-species assemblage, it is hard to attribute any species-specific rates in relation to the biomass of the fish. None of the four fish were recovered to the surface. Deployments 5 and 6 failed to trap any fish, but again the data from the optode sensor indicated that the trap seal was working effectively. Indeed deployment 6 did trap a large number of scavenging amphipods (min 40.6g wet weight, recovered at the surface) and a small reduction in O_2 concentration was recorded in the trap over the first 24hrs (see Figure 2).

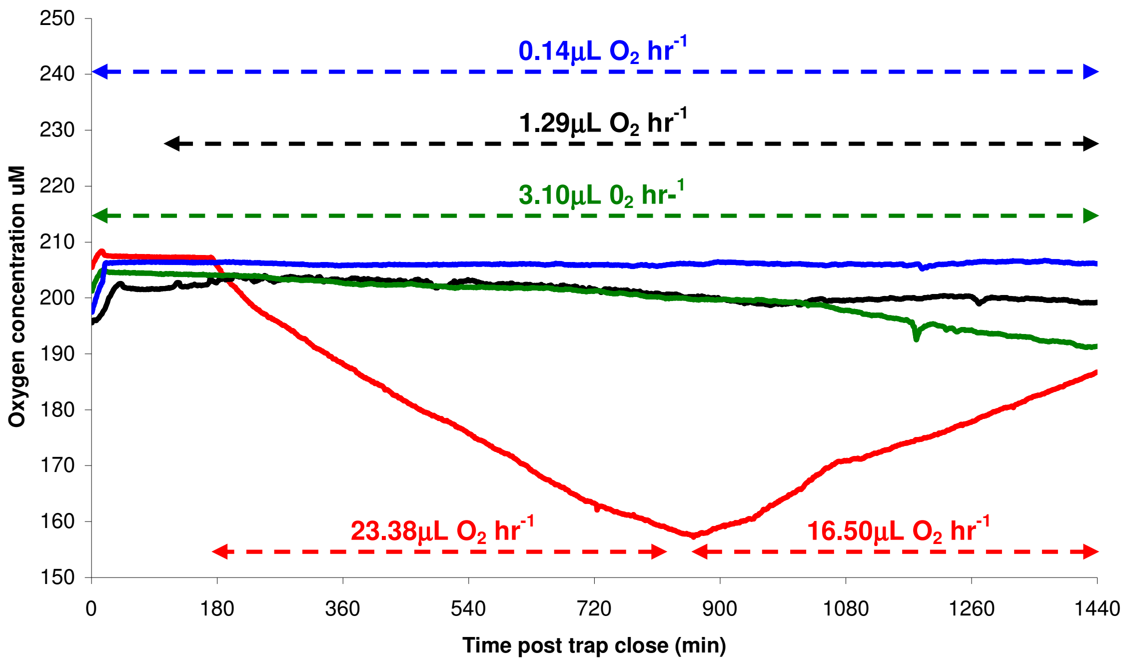

Figure 2. Oxygen profiles recorded from FRESP lander over 24hrs following closure of the respiration chamber trap. Associated rates of change in O_2 concentration indicated by dashed lines and are converted to micro litres of oxygen per hour. FRESP 3 = blue; FRESP 4 = red; FRESP 5 = black; FRESP 6 = green.

In addition to the collection of oxygen profile data, the video footage from the FRESP lander also underwent a preliminary analysis to record the number and size of fish arriving at the bait. The video sequences in the hours prior to the trap closing were viewed and the numbers of fish present at 1-minute intervals were recorded. Table 2 shows a summary of the mean number of fish arriving at the FRESP lander in the hours leading up to the trap falling.

Time before trap closes (hrs)	FRESP 1 M5	FRESP 2 M5	FRESP 3 M5	FRESP 4 M6	FRESP 5 M6	FRESP 6 M6
4	Water column	Water column	Water column	Water column	Water column	Water column
3	0.4	0.3	Water column	Water column	Water column	0
2	3.8	1.2	0.8	0.4	1.2	2.2
1	6.6	1.0	2.2	1.4	0.6	2.0
0	4.8	2.2	3.4	3.8	0	3.0

Table 2. Mean number of fish arriving at FRESP bait in the hours preceding trap closure. Means calculated from video sequences of 5-10mins in length recorded every hour.

The total lengths of all *C. armartus* arriving at the bait were also estimated using structures of known length on the lander (base-plate = 800x800mm). Fish present at the bait at 1-minute intervals were measured; those that were considered to be too high above the bait and base-plate reference were discounted from the length analysis. Based on the size distribution of *C. armartus* specimens caught in the OTSB trawl, the fish measured from the FRESP video were grouped into size classes of small, medium and large for comparison among deployments. The arbitrary size classes used were 0-40cm = SMALL; 41-60cm = MEDIUM, and 61cm+ = LARGE.

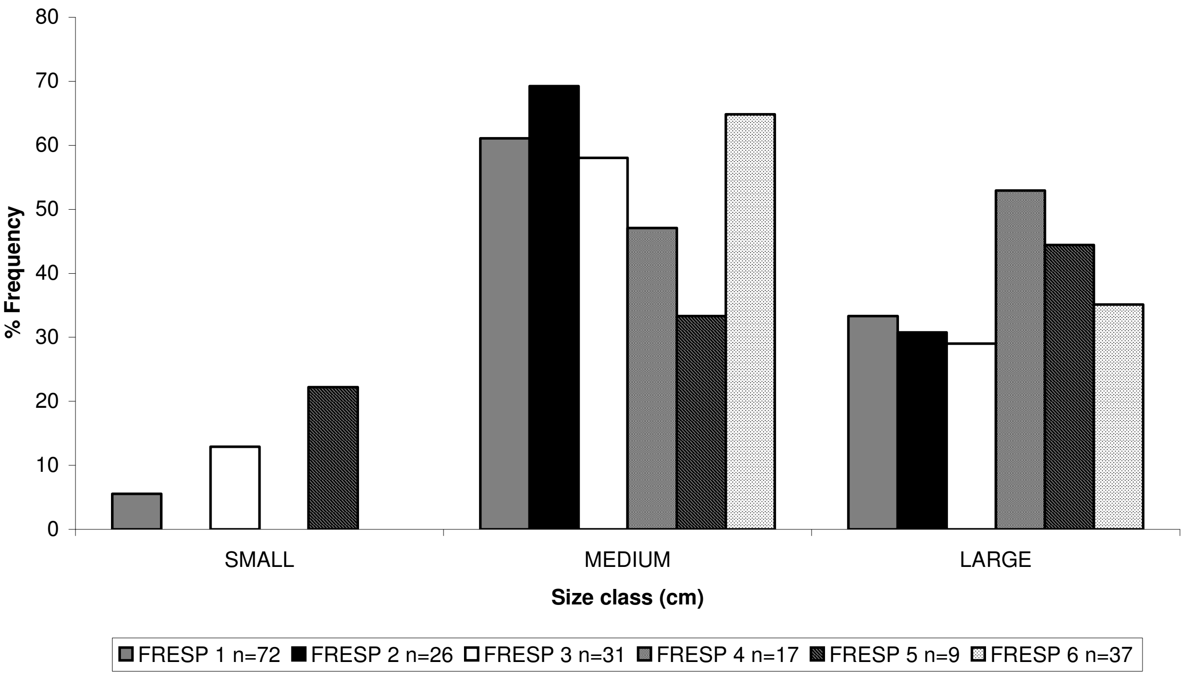

Figure 3. Percentage frequency histograms showing distribution of total body lengths for *C. armartus* arriving at FRESP bait.

With the exception of two deployments (FRESP 4 and 5) the fish arriving at the lander were largely those in the medium size class (~60-70% of the total fish observed). However, both these deployments attracted low numbers of fish (17 and 9 respectively). Small fish were only observed in 3 of the 6 deployments. Large fish contributed more to the observed assemblages at M6 compared to M5. Large fish were much more evident on the FRESP video when compared to their percentage contribution to the total trawl catches (~15-20% greater at both stations).

3) Demersal ichthyofaunal assessment using OTSB trawl at sites M5 and M6, Crozet Plateau.

Aims and objectives:

The aims and objectives were to assess the demersal ichthyofaunal biodiversity, abundance and biomass at a eutrophic site (M5), and oligotrophic site (M6) on the Crozet Plateau, and to determine any differences in biodiversity, abundance and biomass between the two regions. More specifically length/weight relationships and condition indices for the macrouridae will also be compared between the two sampling regions. Demersal fish specimen identification from trawls will also be used to verify fish imaged within ROBIO lander still images, and FRESP lander video.

Trawl processing:

Fish data were retrieved from 6 OTSB trawls (see station list for further details). Four trawls were conducted at M5, and only 2 trawls at M6 due to loss of the trawl net.

Both demersal and pelagic specimens within the trawl were identified to the lowest taxonomic level possible. Specimens that could not be identified to species level on board have been kept, and white muscle samples have been taken for phylogenetic analyses in most cases. All fish were given an individual number for tracing, and where possible total wet weight, total length, standard length, head length and pre-anal length were recorded. Only demersal fish are discussed here.

Further data was specifically taken for the macrouridae (rattails), which were sexed, stomach and liver weight recorded (when not regurgitated), and the stomach fullness and sexual maturity assessed.

Preliminary results:

Demersal fish species richness at both M5 and M6 were equal with 12 demersal fish species present in trawls (Table 1 & 2). Species composition is similar with the same major groups present, and the macrourids dominating the overall catch (Table 1 & 2). However large differences in total mean abundance (fish.hectare^{-2}) and biomass (kg.hectare^{-2}) between M5 and M6 are obvious. Total mean wet weight (kg.hectare^{-2}) is considerably lower at M6, as is abundance (fish.hectare^{-2}) compared with M5, but differences have not been determined statistically (Table 1 & 2; Fig. 1). Scavenging fish abundance is lower than expected from initial analyses of lander footage, with 1.3 fish.km^{-2} at M5, and 0.9 fish.km^{-2} at M6. Total fish biomass at both sites is also lower than expected at 0.375 kg.km^{-2}, and 0.199 kg.km^{-2}, at sites M5 and M6 respectively (Table 1 & 2).

When looking at trawl composition both sites display similar patterns, with the macrourids and *Bathypterois dubius* dominating trawl catches numerically, and the macrourids (particularly *Coryphaenoides (Nematonurus) armatus*) dominating the biomass (Figure 2).

Table 1. M5 demersal fish trawl summary. Taxa are listed in taxonomic order. Standard deviations are in parentheses.

	15773#8		15773#13		15773#23		15773#32		Mean	
	Abundance (fish.hectare^{-2})	Wet weight (kg.Hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.Hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.Hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.Hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.Hectare^{-2})
Bathypterois dubius	2	0.05	3	0.07	1	0.04	5	0.13	3 (1.77)	0.07 (0.04)
Histiobranchus bathybius	0	0.00	0	0.05	0	0.14	2	0.95	1 (0.96)	0.28 (0.45)
Coryphaenoides (N.) armatus	4	4.49	2	0.86	1	0.75	1	0.53	2 (1.82)	1.66 (0.06)
C. ferrieri	3	1.52	3	1.09	3	1.68	4	1.98	3 (1.62)	1.57 (1.89)
C. ferrieri juvenile	0	0.00	0	0.00	0	0.01	5	0.20	1 (0.60)	0.05 (0.37)
Coryphaenoides spp.	2	0.05	5	0.16	3	0.08	1	0.04	3 (2.29)	0.08 (0.10)
Zoarcidae (*Lycenchelys* sp.)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.07)	0.00 (0.00)
Zoarcidae (*Pachychara* sp.?)	0	0.00	0	0.00	0	0.01	0	0.10	0 (0.20)	0.03 (0.05)
Holocomycteronus brucei	0	0.00	0	0.00	0	0.04	0	0.00	0 (0.14)	0.01 (0.02)
Liparididae (*Careproctus* sp.?)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.20)	0.00 (0.00)
Liparididae (Unidentified sp. 1)	0	0.00	0	0.00	0	0.00	0	0.00	0 (0.11)	0.00 (0.00)
Liparididae (Unidentified sp. 2)	0	0.00	0	0.00	0	0.00	0	0.01	0 (0.11)	0.00 (0.00)
Total	11	6.12	13	2.24	10	2.74	18	3.93	13 (3.68)	3.75 (1.73)

Table 2. M6 demersal fish trawl summary. Taxa are listed in taxonomic order. Standard deviations are in parentheses.

	15775#4		15775#13		Mean	
	Abundance (fish.hectare^{-2})	Wet weight (kg.hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.hectare^{-2})	Abundance (fish.hectare^{-2})	Wet weight (kg.hectare^{-2})
Bathypterois dubius	2	0.11	2	0.07	2 (0.40)	0.09 (0.03)
Histiobranchus bathybius	0	0.00	0	0.20	0 (0.31)	0.10 (0.14)
C. (N) armatus	1	1.10	1	0.83	1 (0.05)	0.96 (0.19)
C. (N.) armatus juvenile?	0	0.00	0	0.00	0 (0.16)	0.00 (0.00)
C. ferrieri	2	0.65	1	0.50	1 (0.22)	0.58 (0.11)
Coryphaenoides spp.	4	0.13	2	0.09	3 (1.38)	0.11 (0.03)
Coryphaenoides spp. juvenile	0	0.00	0	0.00	0 (0.15)	0.00 (0.00)
Zoarcidae (*Lycenchelys antarctica*?)	0	0.00	0	0.00	0 (0.15)	0.00 (0.00)
Zoarcidae (*Pachycara* sp.)	0	0.00	0	0.00	0 (0.01)	0.00 (0.00)
Ophidiidae (*Apagesoma* sp.?)	0	0.00	0	0.25	0 (0.15)	0.12 (0.17)
Holcomycteronus brucei	0	0.01	0	0.05	0 (0.15)	0.03 (0.03)
Liparididae (*Paraliparis* sp.?)	0	0.00	0	0.00	0 (0.33)	0.00 (0.00)
Total	10	2.00	8	1.99	9 (1.63)	1.99 (0.01)

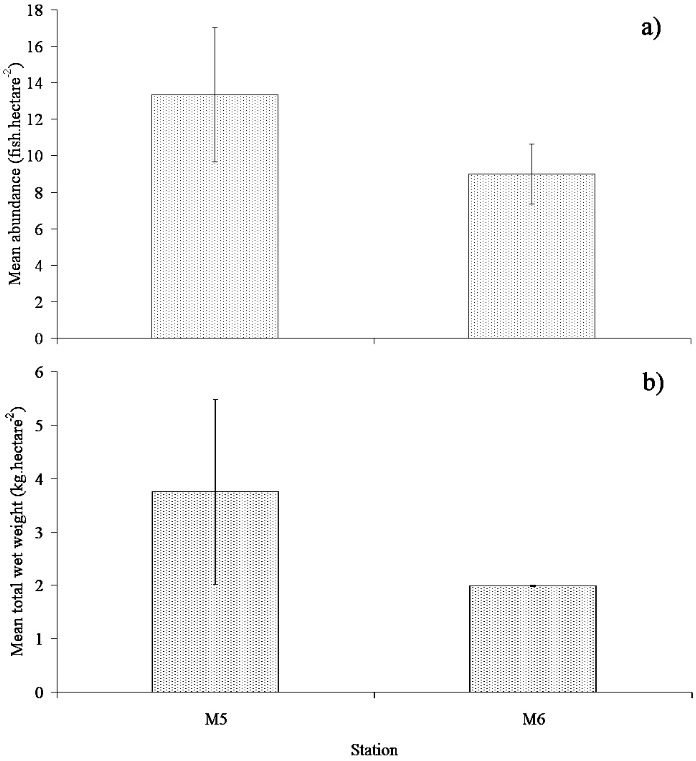

Figure 1. Demersal fish mean abundance and biomass. a) Mean abundance (fish.hectare^{-2}) at stations M5 and M6; b) mean wet weight (kg.hectare^{-2}) from stations M5 and M6. Solid t-bars indicate standard deviations.

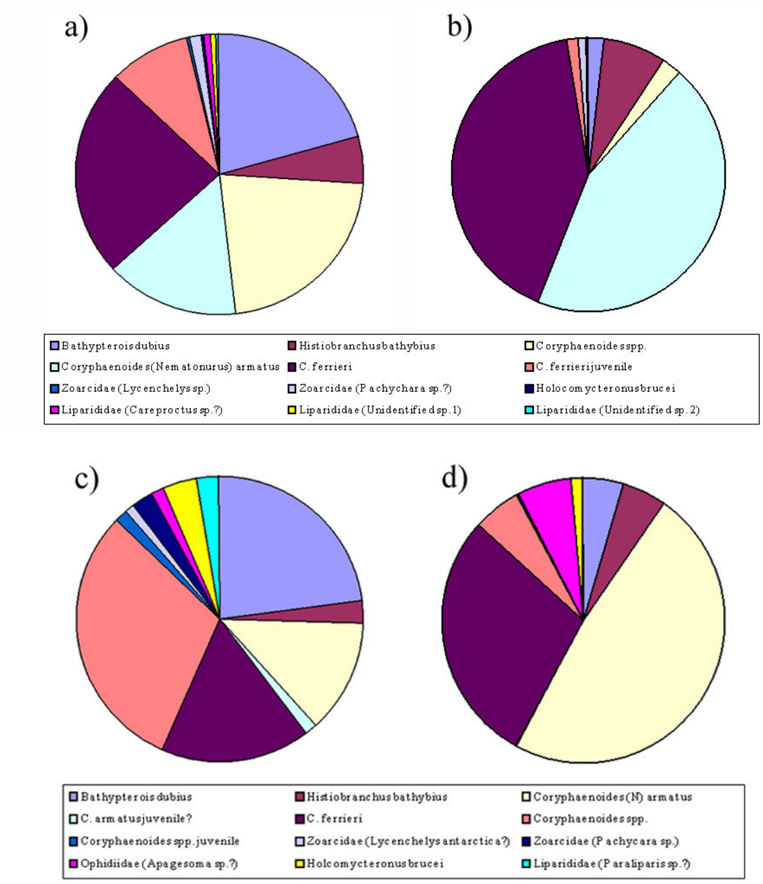

Figure 2. Comparison of demersal fish contributions to mean abundance (fish.hectare^{-2}) and mean wet weight (kg.hectare^{-2}) from trawl data at stations M5 and M6, Crozet Plateau; a) % contribution to mean abundance (fish.hectare^{-2}) station M5, b) % contribution to mean wet weight (kg.hectare^{-2}), station M5, c) % contribution to mean abundance (fish.hectare^{-2}), station M6, d) % contribution to mean wet weight (kg.hectare^{-2}), station M6.

Length-weight relationships between M5 and M6 were follow similar patterns in more than one taxonomic group (Fig. 3). Using liver weight vs. total wet weight also does not yield obvious differences between M5 and M6 for the *C. (N.) armatus* (Fig. 4).

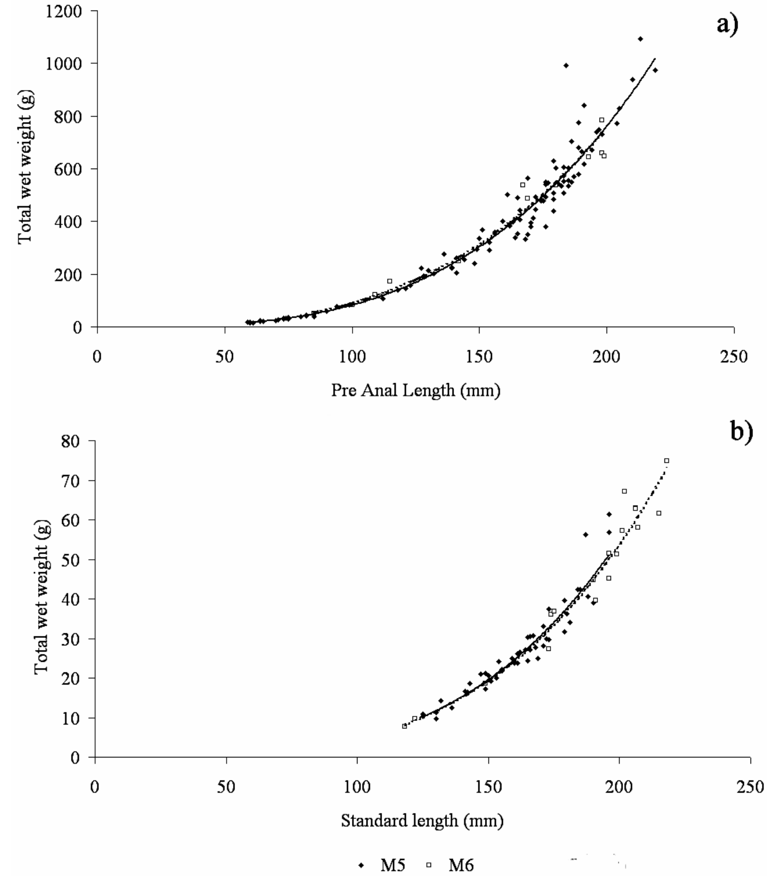

Figure 3. Length-weight relationships for *Coryphaenoides ferrieri* and *Bathypterois dubius* from station M5 and M6. a) *Coryphaenoides ferrieri*. Solid line indicates the length-weight relationship at M5 (Total weight (g)=$3x10^{-5}PAL^{3.1979}$, R^2 = 0.99, n = 106), dashed line indicates the relationship at M6 (Total weight (g) =$6x10^{-5}PAL^{3.0724}$, R^2 = 0.98, n = 24) and b) *Bathypterois dubius*. Solid line indicates the length-weight relationship at M5 (Total weight (g) = $3x10^{-7}SL^{3.5827}$, R^2 = 0.95, n = 63), dashed line indicates the relationship at M6 (Total weight (g) = $3x10^{-7}SL^{3.5637}$, R^2 = 0.98, n = 18). PAL = Pre anal length (mm), SL = standard length (mm).

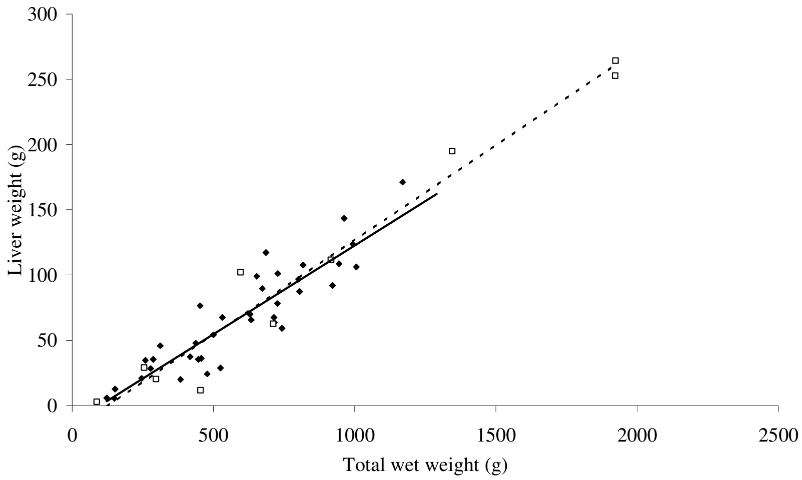

Figure 4. Liver weight (g) vs. total wet weight (g) for *Coryphaenoides (N.) armatus* from station M5 (closed diamonds) and M6 (open squares). The solid line indicates the linear relationship for site M5 (Liver weight (g) = 0.136WW – 13.42, R^2 = 0.83, n = 39), the dashed line indicates the relationship for site M6 (Liver weight (g) = 0.1457WW – 18.801, R^2 = 0.96, n = 10). WW = total wet weight (g).

From previous lander deployments approximate swimming speeds of *C. (N.) armatus* are known to be 0.05-0.077 $m.s^{-1}$, suggesting that it would take approximately 2 months to swim the 160 nm from M6 to M5. The prevailing current direction is from M6 to M5, and this combined with the current lack of notable difference in the length vs total weight and liver weight vs. total weight leads us to believe that the rattail fishes are transient between the oligotrophic M6 and the eutrophic M5, and do not consider the sharp productivity gradient a barrier to migration.

Analysis:

Analysis of the OTSB trawl data will consist of a) statistical determination of differences in biodiversity, biomass and abundance between M5 and M6, b) length-weight relationships of all demersal fish taxa for both M5 and M6 where sufficient data is available, and the appropriate statistics to determine if there are differences in the relationships between sites, c) official identification of difficult specimens by taxonomists.

Specifically for the macrouridae length frequency analysis will be conducted to determine age classes, and analysis of condition using the liver weight as a proxy for health (Fig. 4). Stomach analyses can also be used to determine differences in stomach fullness between M5 and M6, and where available stomach contents can be used to supplement information on trophic ecology. All data analyses should be conducted in time to be presented at the Deep-Sea Symposium, Southampton, July 2006.

White muscle samples were taken from all specimens of *C. (N.) armatus* (N=50) for use as an out-group for a study on the population genetic structure of specimens from the Mid-Atlantic Ridge, North Atlantic Ocean. Tissue samples were also taken from *C. (N.) armatus* and *C. ferrieri* for Elaine Fitzcharles at the British Antarctic Survey, Cambridge, for use as an out-group in a stock population survey specific to the Southern Ocean. Several samples were also taken from *C. (N.) armatus*, *C. ferrieri* and *Cynomacrurus piriei* for a phylogenetic study being conducted by David Johnston at the Natural History Museum, London.