Potential impacts of the MARS Cable on the seabed and benthic faunal assemblages

J.P. Barry, L. Kuhnz, K. Buck, C. Lovera, P.J. Whaling
Monterey Bay Aquarium Research Institute

SUMMARY

A geological and biological sampling program to assess the condition of the MARS cable and its potential effects on seabed geology and biology was performed in late 2007-2008. The sampling program was designed to;

- Observe the condition of the cable or cable trench along the cable route (52 km),
- Assess the potential impacts of the MARS cable on geological characteristics and biological assemblages on a local scale (0-100m from cable) and a regional scale (km), using ROV video transects and sediment samples.

The major conclusion of the study is that the MARS cable has had little detectable impact on seabed geomorphology, sediment conditions, or biological assemblages. Specific conclusions include the following:

- Over most of its length, the cable remains buried, with little evidence of change since installation
    - The burial trench remains intact along deeper areas of the cable route,
    - Sediment is slowly filling the cable trench
- No detectable changes in sediment characteristics (mean grain size, or percent organic carbon) can be attributed to the MARS cable
- Local variation in benthic megafaunal communities within 50-100 m of the MARS cable is minor or undetectable.
    - The abundances of most animals observed did not differ between the area over the cable route and 50 m away
    - Longnose skates *(Raja rhina*) were significantly more abundant along sections where the MARS cable is suspended over topography (~300 m depth), and are likely to respond to electromagnetic fields generated by the cable.
- The MARS cable has little or no detectable effect on the distribution and abundance of macrofaunal and megafaunal assemblages on a regional scale (e.g. kilometers).
    - Megafauna and macrofauna compared before and after cable installation among 3 control stations and 1 cable station at each of 3 depth zones (Shelf - <200 m, Neck – 200-500 m, Slope - >500 m) indicated very few potential changes in benthic biological patterns due to the MARS cable.
    - Natural spatial and temporal variation in the abundance and distribution of benthic macrofauna and megafauna appears to be greater than any detectable effects of the MARS cable.

INTRODUCTION

The Monterey Accelerated Research System (MARS) is an undersea cable from the Monterey Bay Aquarium Research Institute (MBARI) to a science 'node' at a depth of 891 m on the continental slope just outside Monterey Bay, California. The system provides power and high data bandwidth for science instruments connected to the node via thin 'extension' cables deployed on the seabed by remotely operated vehicles (ROVs). MARS is one of a few cabled ocean observing systems that enable continuous, long-term science capabilities for ocean science with real-time communication, control, and data capture from offshore subsea sensor systems.

The main MARS cable was installed in March 2007 from the cable-laying ship *Global Sentinel*. It stretches 52 km from shore to the science node, which is positioned in 891 m depth roughly 35 km from shore. The cable was buried (jetted into the sediment) during installation though most of its length, though although this was not possible just below the continental shelf break (200 – 400 m depth) where carbonate and bedrock outcrops prevent complete burial of the cable. The MARS science node was installed and powered briefly in February, 2008, but failed due to subsea connector corrosion. The failed parts were recovered, repaired, and reinstalled in November 2008. MARS has been fully operational since that time.

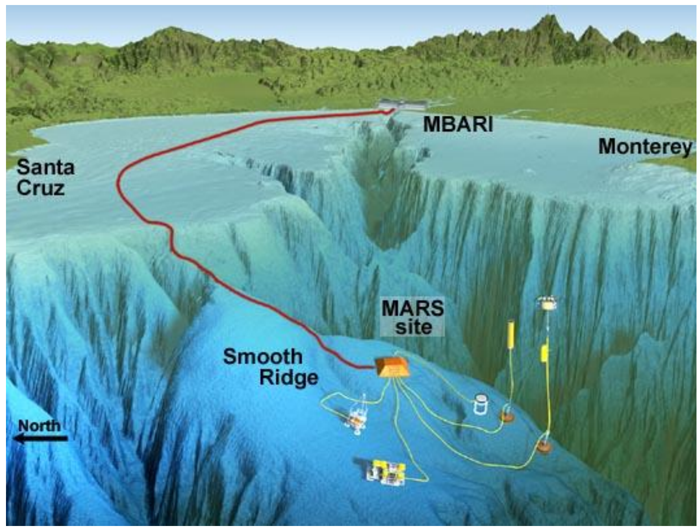

Figure 1. View of the MARS cable, node, and potential science instruments over exaggerated bathymetry of Monterey Bay, Monterey Canyon, and the continental slope. The science node is indicated as "MARS site".

Prior to MARS cable installation, an environmental impact report was prepared, including characterization of seabed biological communities along the cable route and initial sampling for future environmental impact assessment. This survey included characterization of the megafaunal animals (organisms identifiable in video recordings) and macrofaunal organisms (worms, crustaceans, etc., captured from sieved sediment samples) along the cable route. Subsequent to MARS cable installation, an environmental impact assessment is required at ~18 month intervals, including observations of the condition of the cable and potential effects on biological communities. In this report, we present the results of environmental impact assessment surveys performed prior to cable installation and following cable installation in January 2008.

METHODS

Cable Condition Survey

The position and condition of the cable was assessed by a 'fly-over' survey of the cable and cable route using the ROV *Ventana*. The ROV was flown over the cable or cable route approximately 1-3 m over the seabed, using a cable-sensing system attached to the ROV to determine accurately the position of the cable over the buried portion of the cable route.

Annotations of video observations included the superficial condition of the seabed, damage to the seabed related to cable installation, and whether the cable was still buried, the condition of the burial trench (i.e. exposed, filled with mud, etc.), and if not buried, if it is lying on the seabed or suspended due to 'bridging' between seabed objects.

Seabed Observations and Sediment Sampling

Observations of the seabed and sample collection were performed using the *ROV Ventana*, supported by the *RV Pt. Lobos.* The main camera on the ROV Ventana is a High Definition Insite Zues Plus, mounted on a 3-axis pan and tilt capable of +/- 45^o of tilt. Two manipulator arms and a sample drawer provide space and manipulation capabilities for sediment sampling. All available recorded video was annotated using MBARI's computer annotation system, Video Information Capture with Knowledge Inferencing (VICKI).

Video Transects

Quantitative estimates of the densities of seabed organisms and objects were obtained from the analysis of video transects. For each video transects, the ROV camera was tilted toward the seabed and zoomed to provide a 1-1.5 m wide swath visible at the base of the image frame. Each transect was run at ~0.1-0.2 ms^{-1} over a distance of 100 m. Paired lasers (~33 cm apart) provided a reference scale for estimating the spatial dimensions of the video image. Voucher specimens were collected as needed for additional taxonomic study.

Video transects were annotated using the VICKI annotation system in a quantitative manner to provide estimates of the density (# m^{-2}) of identifiable objects and organisms. Taxonomic identification of all megafauna was performed to the lowest practical taxonomic level. Because identification of organisms from video can be difficult, we were conservative in assignment of taxonomic names. All objects within a 1-1.5 m wide swath (width determined repeatedly during each transect using the paired laser system) were annotated (counted) along the length of the transect. To avoid bias in counts of the number of organisms due to field of view distortion, animals in the upper third of the image were not counted. Thus only those organisms passing through a 1-1.5 m wide swath in the lower 2/3 of the image were used for counts. The density of objects and organisms over a single transects was used a sample unit for further analyses.

Sediment Samples

Samples of seabed sediments for faunal and geologic characteristics were collected using 7.5 cm diameter tube cores, which penetrated the sediment to a depth of ~20 cm. The top 5 cm of these core samples were washed gently through a 0.3 mm sieve using cold seawater.

All organisms collected were relaxed using a 7% solution of magnesium chloride (MgCl2), then preserved in a 4% formaldehyde (10% formalin) solution for several days. Samples were then rinsed with de-ionized water and stored in 70% ethanol for subsequent sorting and identification under a dissecting microscope.

Biological Communities

Local Effects of Cable Installation

Are there detectable differences in the abundances of animals living directly on or over the cable path compared to nearby areas not on the cable path? This was evaluated using video transects at stations positioned at 5 km intervals along the entire cable route, comprising 10 cable stations (Figure 2). At each station, a 100 m long video transect was run over the cable route (cable treatment), and a second 100 m long transect (control treatment) was performed parallel to the cable, but 50 m away from it. For each transect, all identifiable organisms were identified and counted. Data from cable and control treatments were then compared to assess differences in megafaunal assemblages potentially caused by the cable.

Regional Effects of Cable Installation

Geological and biological impacts potentially associated with the installation and presence of the MARS cable were investigated at three depths selected within the 3 major habitat types or "cable zones" occupied by the cable (Figure 2). These include; 1) the continental shelf (Shelf), 2)

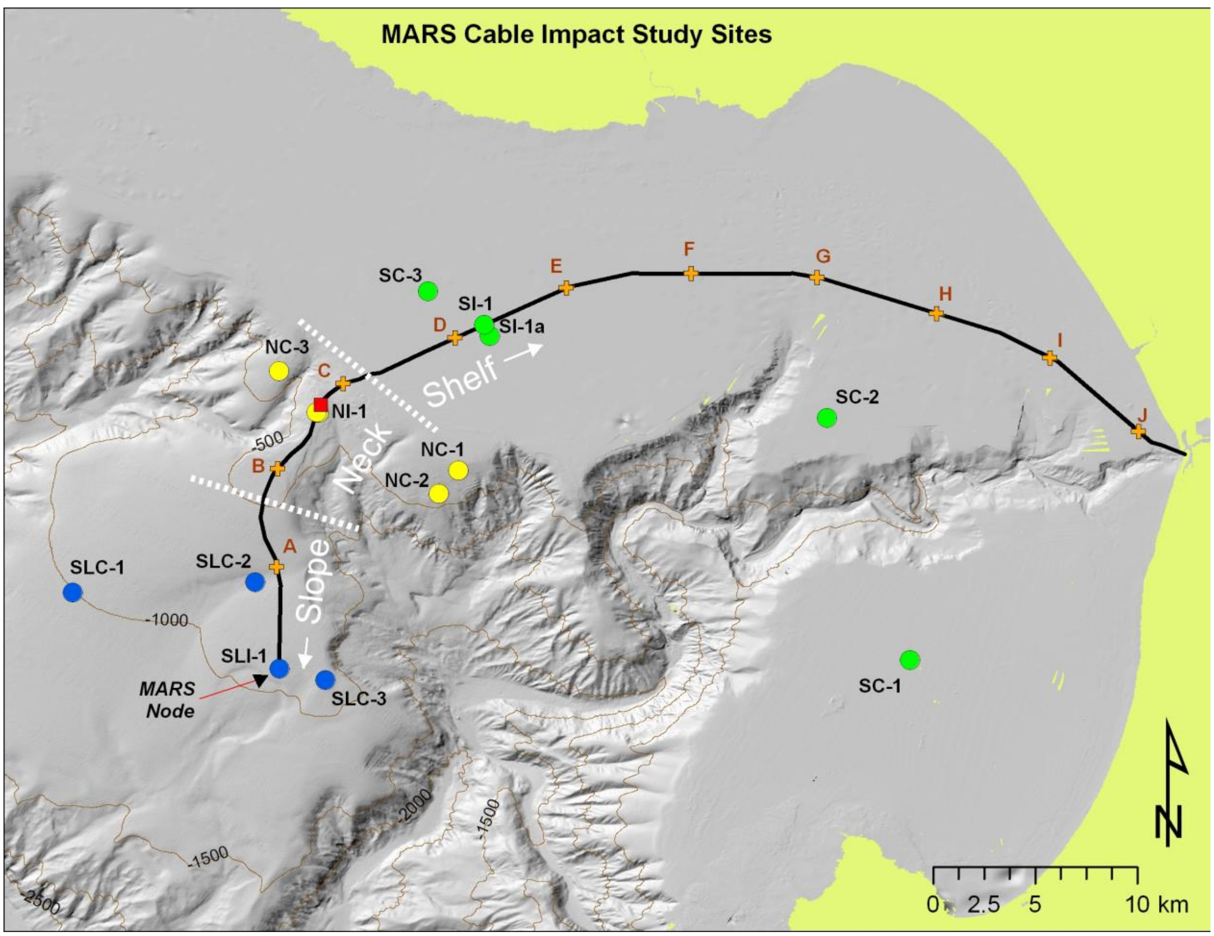

Figure 2. Map of MARS cable (black line) environmental studies sites. Colored circles represent regional sites for impact studies at Shelf (green), Neck (yellow), and Slope (blue) depths. Red box indicates location for Skate transects. Brown plus symbols (A-J) indicate transect locations for localized megafaunal studies.

the continental shelf break and upper slope (Neck), and 3) the continental slope region near the MARS benthic node (Slope). These depths represent the principal habitat types along the cable path. Within each cable zone (depth), a single 'cable' site was selected over the cable route, and 3 control sites were selected in the region, each ranging from 1-16 km from the cable route.

Each sampling site was considered as a ~200 m diameter circular area within which 3 replicate 100 m long ROV video transects were performed (Figure 3). All animals, as well as rocks, debris, and other items, were identified to the lowest possible taxon, and counted. In addition, replicate sediment cores (7.5 cm diameter) were collected (Figure 4) along video transects to characterize macrofauna (n= 6 cores per site) and sediment characteristics (n=3 per site; %C, %N, stable C and N isotopes, grain size composition).

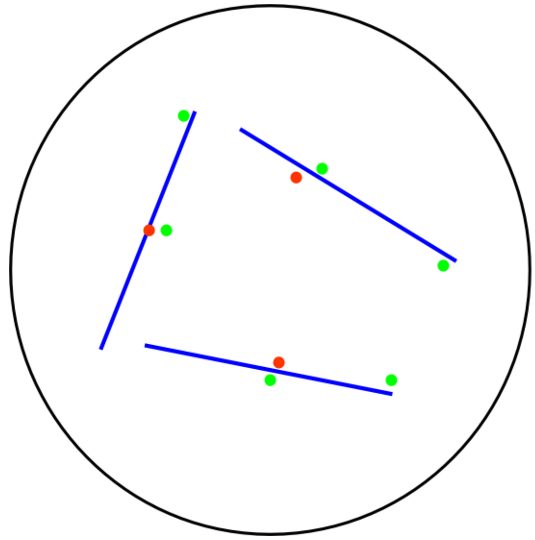

Figure 3. Sampling protocol for cable and control sites at each depth. Circle – 200 m diameter site. Blue lines – 100 m long video transects. Green circles – sediment core samples for macrofaunal assemblage characterization. Brown circles – sediment cores for tracer measurements.

Skate and Ray Abundance at Neck Cable Zone

Early observations of apparent aggregations of some species of elasmobranches (skates and rays) may aggregate near the cable, particularly near suspended sections of the cable. To test the hypothesis that these species (and perhaps others) are more (or less) abundance near suspended portions of the MARS cable, 3 replicate ROV video transects (100 m long) were performed along suspended or exposed portions of the cable in the Neck cable zone, and compared to 3 similar control transects performed ~100 – 200 m from the cable-transects. Counts of all identifiable megafauna were made along each transect.

Analytical Methods

Detection of differences in geologic and biologic parameters between cable and control sites with data available for both before and after cable installation were made using a BACI (Before-After, Control-Impact) analytical design (Oaten et al. 1986; Underwood et al. 1994; Hewitt et al. 2001). Using this design, individual 2-factor (Period (before, after), Treatment (cable, control)) comparisons were performed using permutation statistics available with *PRIMER-6* and *PERMANOVA+* (v.1.03; www.primer-e.com). This design was used for both multivariate and univariate data sets of biological or geological parameters. In most cases, raw counts of abundance (# 100 m^{-2}, megafauna; # m^{-2}

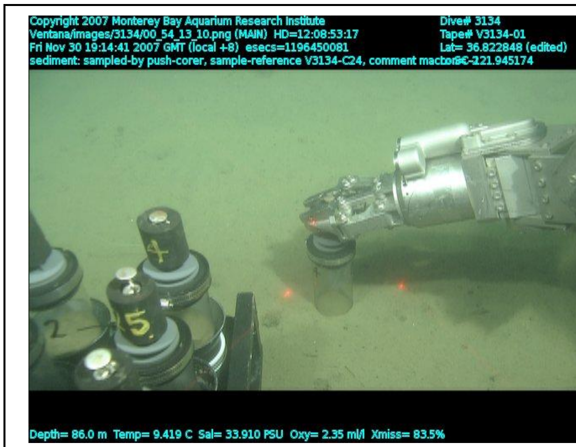

Figure 4. Collection of sediment core.

macrofauna) were transformed (4th root) prior to analysis to increase homogeneity of variances among groups and to reduce the influence of very abundant species. Similarity matrices for Permanova analyses were calculated using Bray-Curtis overlap for multivariate tests and Euclidean Distance for univariate tests. Monte Carlo P-values (Anderson and Robinson 2003) were used to assess statistical significance.

Univariate tests were run for sediment characteristics (mean grain size and % organic carbon), with no transformation of raw data and Euclidean Distance as an overlap measure.

Faunal assemblage data were analyzed on a level of individual species and major faunal groups (e.g. Classes) for both multivariate and univariate tests. For multivariate tests, all species or all major groups were analyzed together. For univariate tests, only the most abundant species (~>1% of total faunal abundance) or major groups (~>3% of total faunal abundance) were analyzed.

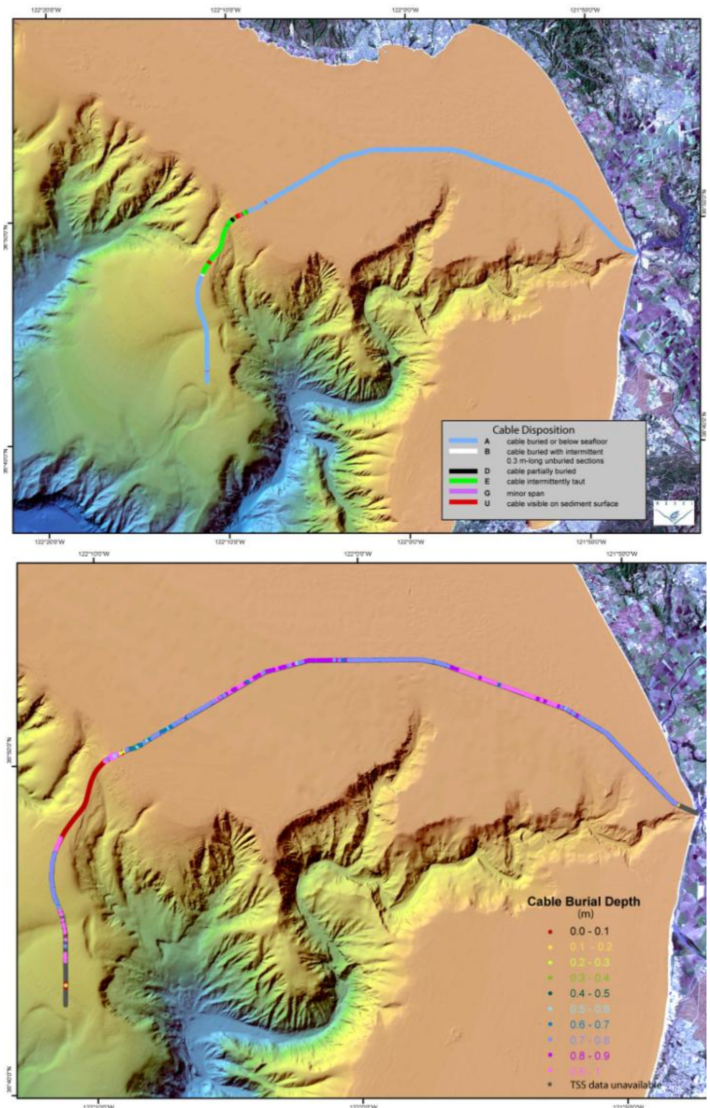

Figure 5. Exposure and depth of burial of the MARS cable after installation. Upper map – buried versus exposed condition of cable. Note exposure in Neck Cable zone. Lower panel – depth of burial of cable. These observations were made during the 2007 survey.

Because of the large number of individual tests run, the likelihood of a type 1 error increases, and α (the likelihood of type 1 error) is often adjusted downward from 0.05 to a lower proportion based on the number of tests performed (Cabin and Mitchell 2000). Unfortunately, decreasing the likelihood of type 1 errors also increases the likelihood of type II errors (accepting a false null hypothesis). Thus, the use of such adjustments is questionable (Perneger 1998; Cabin and Mitchell 2000), and we have not used them in analyses of cable impact data.

RESULTS & DISCUSSION

ROV Dive Series

A total of 16 days of ROV dives using the *R/V Pt. Lobos* and the *ROV Ventana* were used to complete the MARS cable environmental studies from November 30, 2007 to April 1, 2008

(Appendix 1). Three additional sea days were cancelled or postponed due to weather. Observations, including ROV surveys & transects, and sediment collections (tube cores) were completed during these cruises. In addition to surveying the entire length (~57 km) of the cable route, the field and analysis team completed 62 quantitative video transects, and collected & analyzed 114 sediment cores (72 for macrofaunal analyses, 36 for sediment characteristics, 6 spare cores).

Condition of Cable

Inspection of the cable and underlying seabed indicated that there was little change in the position of the cable 18 months after installation. Survey observations verified that the cable is still buried from 0-1 m beneath the surface of the seabed, as measured during the first post-installation survey (March-June 2007) (Figure 5). No evidence of trawling impact was observed. Nor was any

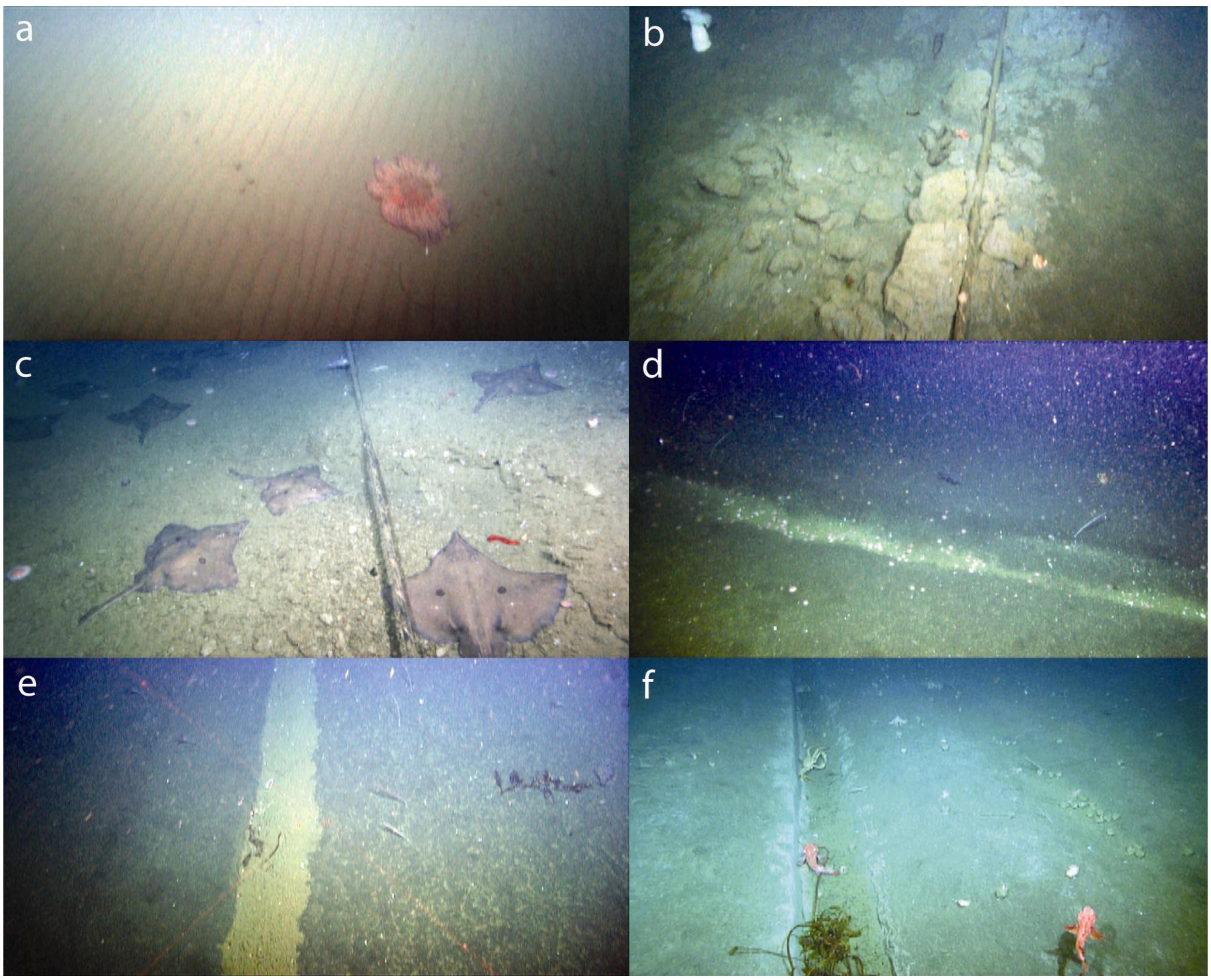

Figure 6. Images of the seabed along the cable route. A. Sand ripples at 31 m depth, cable not visible. B. Cable on seabed at 115 m. C. Skate (*Raja rhina*) aggregation at 303 m depth. D. Cable trench at 82 m. E. Cable trench sediment infilling at 653 m. F. Cable trench at 826 m.

change apparent along the exposed or suspended portions of the cable (Figure 6), which during the post-installation survey were largely confined to the Neck depths (Figure 4). There is no new evidence of strumming or other movement of the cable. The cable remains buried with no trace of habitat disturbance in shallow sandy areas (Figure 6a), which comprise roughly 50 percent of the cable route. In many other areas, habitat disturbance is less evident compared with the previous survey and the burial trench is filling in with time (Figure 6e), as indicated by the accumulation of soft, light-colored sediment in the trench.

Sediment Characteristics

The grain size and percentage carbon content of sediments varied significantly between treatments and sites for all 3 cable depth zones. However, because no "Before" data were available, any effects of the cable on sediment grain size could be inferred only from comparisons among impact and control sites after installation of the cable.

Sediment Grain Size

Mean sediment grain size varied among Cable Depth Zones from 20 to 143 µm, with the coarsest sediments at Neck stations (mean = 82.4 µm) and similar sized, but finer mean sizes (44, 49 µm) at Shelf and Slope depths.

Grain size at the shelf control sites were significantly smaller than at the impact site ($p<0.001$) (Figure 7), which might be expected in association with the installation of the cable. But because grain size also varied significantly between sites, irrespective of treatment (e.g. SC-1 < SC-2, SC-3; $p<0.05$), it is possible that the difference among stations is due to natural variability rather than any effects of the cable.

This pattern of significant variation between treatments and among control sites was also observed at Neck and Slope depths (Figure 7). Within the Neck cable depth zone, Control sites differed significantly from Cable sites overall ($p<0.05$), but variation among control sites was also significant ($p<0.01$). In contrast to Shelf depths, grain size at the Neck cable zone was much finer at the Cable site than the Control sites. It remains difficult to determine definitively the effects of the cable on grain size.

Intersite variation in grain size observed at shallower depth also occurred at the Slope depth sites. Together, these results suggest strongly that variation in mean sediment grain size varies greatly among stations both within and between depths. Although

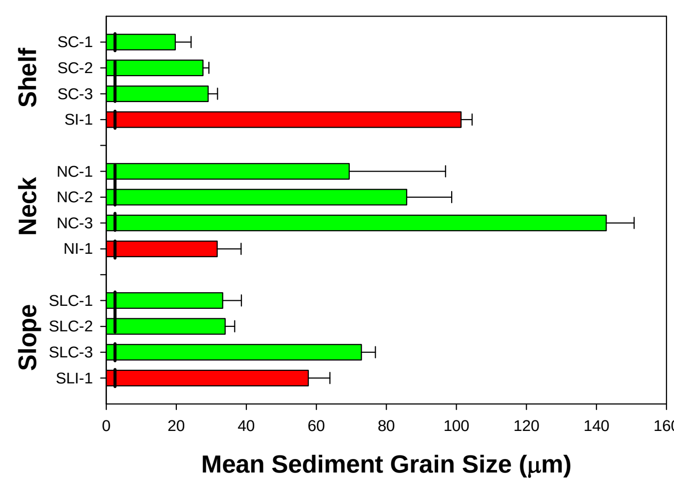

Figure 7. Mean sediment grain size (+/- SD) at control and cable stations for 3 cable depth zones. Note the high variation between treatments and stations for each depth. Black bars at bottom of graph indicate significant variation between groups for each depth (overlapping bars are not significantly different in grain size).

significant variation in grain size was detected between control and cable stations, it is not possible to determine if this difference is due to the effects of the cable or simply to naturally high station to station variation.

Sediment Percent Carbon Content

The mean organic carbon content of sediments ranged among sites from 0.39 to 1.11 percent (Figure 8), with the more organic-rich sediments generally found in the finer grain sizes (R^2 = 0.28, p<0.06). Analysis of the percentage carbon content of sediments at control and cable sites for each cable depth zone indicated marginally significant variation in carbon content between cable and control stations at the Neck depth (p<0.05), but no significant variation between treatments at the Shelf (p>0.6) and Slope (p>0.3) depths. Variation among stations within each depth was often significant. These results indicate that there was little variation in the carbon content of sediments related to the installation of the cable.

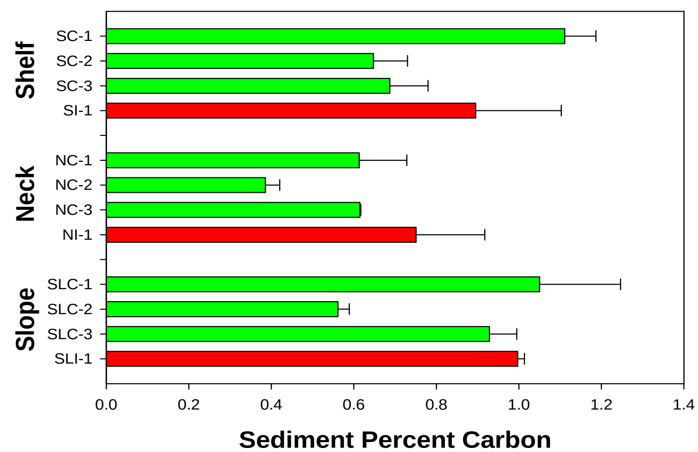

Figure 8. Mean percent organic carbon in surficial sediments for control and cable sites at three Cable Depth Zones. Comparisons of Cable versus Control sites within each depth were nonsignificant (Shelf, p>0.6, Slope (p>0.3) and marginally significant at the Neck depth (p<0.05).

Biological Characteristics

Megafaunal Assemblage

The seabed megafaunal assemblage along the cable route included 116 species (or unidentified species) observed in 94 ROV video transects (Appendix 2). The overall average density of megafauna averaged 148 individuals / 100 m^2). By phyla or major taxonomic groups, Echinoderms were the most abundance phylum comprising just over 37 percent of the total megafaunal abundance, particularly sea stars (Asteroidea), urchins (Echinoidea), and sea cucumbers (Holothuroidea) (Table 1). Cnidarians ranked second among phyla with 31 percent of the total abundance, represented mainly by sea pens (Pennatulacea) and anemones (Actinaria). Fishes (Chordata) were the third most abundance phylum with nearly 10 percent of the total abundance.

The top 7 ranking megafaunal species accounted for nearly 60 percent of the total abundance. Three common taxa (Figure 9a-c.) comprised 32 percent of the total megafauna. *Funiculina* sp., a common sea pen at slope depths near 500 – 1000 m was the most abundant species (17.3 ind. 100 m^{-2}), with 11.6 percent of the total megafaunal abundance. The common sea star *Rathbunaster californicus* ranked second with 11.4 percent of the total. *Allocentrotus, fragilis,* a common urchin at upper slope depths, ranked third, with 9 percent.

Table 1. Summary of megafaunal abundance by phyla and major groups. Abundance is listed as a mean (# 100 m^{-2}), standard deviation (SD), and percent of total abundance (%).

Phylum / Major Group	Mean	SD	%
Echinodermata	**55.90**	**110.95**	**37.65**
Asteroidea	23.28	50.41	15.68
Echinoidea	13.42	40.40	9.04
Holothuroidea	11.82	54.50	7.96
Ophiuroidea	7.27	33.82	4.90
Crinoidea	0.10	0.43	0.07
Cnidaria	**47.13**	**67.11**	**31.74**
Pennatulacea	33.37	56.36	22.47
Actiniaria	11.25	19.76	7.58
Ceriantharia	1.97	2.89	1.33
Gorgonacea	0.23	1.27	0.16
Corallimorphidae	0.17	0.86	0.11
Alcyonacea	0.07	0.36	0.05
Anthozoa	0.03	0.18	0.02
Hydromedusae	0.02	0.15	0.01
Cnidaria (unid.)	0.01	0.10	0.01
Vertebrata	**14.05**	**15.40**	**9.46**
Myxinidae	0.17	0.56	0.11
Rajiformes	1.58	10.76	1.07
Chimaeridae	0.18	0.91	0.12
Scyliorhinidae	0.11	0.48	0.07
Scorpaenidae	5.31	12.23	3.58
Pleuronectiformes	3.44	4.50	2.32
Zoarcidae	1.36	3.09	0.91
Osteichthyes	0.76	3.18	0.51
Agonidae	0.30	0.80	0.20
Merlucciidae	0.25	1.47	0.17
Macrouridae	0.13	0.78	0.09
Stichaeidae	0.11	0.50	0.07
Liparidae	0.08	0.48	0.05
Zaniolepididae	0.07	0.39	0.05
Moridae	0.06	0.32	0.04
Ophidiidae	0.04	0.26	0.03
Anoplopomatidae	0.04	0.25	0.03
Hexagrammidae	0.01	0.12	0.01
Osmeridae	0.01	0.11	0.01
Alepocephalidae	0.01	0.10	0.01
Embiotocidae	0.01	0.10	0.01
Torpedinidae	0.01	0.10	0.01

Phylum / Major Group	Mean	SD	%
Detritus	**13.04**	**18.44**	**8.78**
Phyllospadix	12.63	18.12	8.51
Laminariales	0.41	0.89	0.28
Annelida (Polychaeta)	**7.56**	**38.78**	**5.09**
Mollusca	**6.90**	**14.45**	**4.65**
Gastropoda	6.72	14.51	4.53
Cephalopoda	0.19	0.68	0.12
Arthropoda	**2.02**	**5.73**	**1.36**
Decapoda	1.11	2.55	0.75
Caridea	0.68	4.17	0.46
Anomura	0.23	1.05	0.15
Porifera	**1.75**	**5.54**	**1.18**
Brachipoda	**0.06**	**0.62**	**0.04**
Echiura	**0.03**	**0.18**	**0.02**
Urochordata	**0.02**	**0.14**	**0.01**
Grand Total	**148.47**		

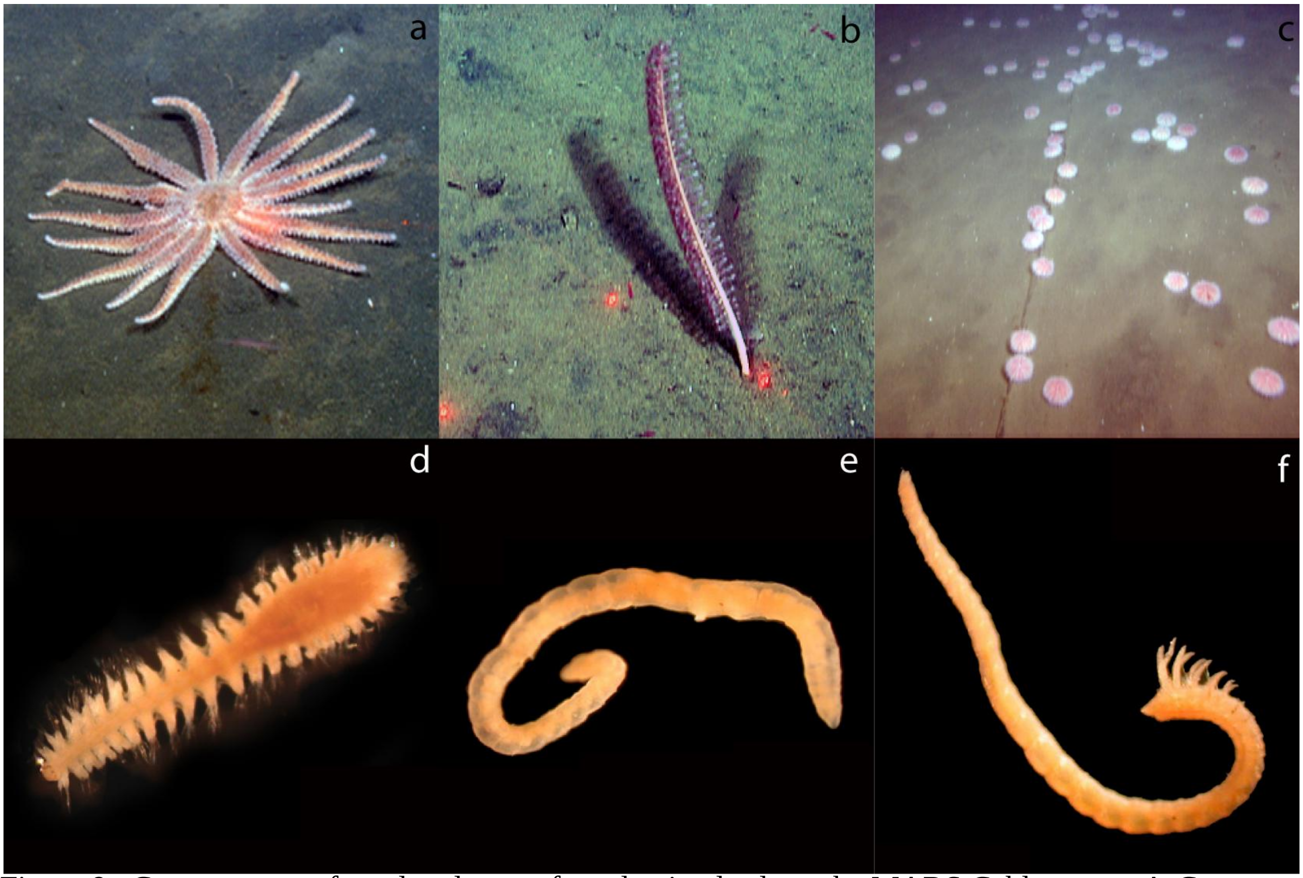

Figure 9. Common megafaunal and macrofaunal animals along the MARS Cable route. A-C: Megafauna: A. *Rathbunaster californicus* (sea star). B. *Funiculina* sp. (sea pen). C. *Allocentrotus fragilis*, (urchin). D-F: Macrofauna: D. *Cossura* sp. (polychaete E. Oligochaeta. F. Prionospio sp. These taxa are some of the most abundant organisms observed in video (megafauna) or collected in sediment cores (macrofauna).

Macrofaunal Assemblage

The macrofaunal assemblage along the MARS cable route was diverse (280 taxa identified), but was dominated greatly by annelid worms (53 % of total macrofaunal abundance), especially polychaetes (Table 2). Arthropoda, mainly amphipods were second in abundance with 35 % of total abundance). Molluscs (mostly bivalves) comprised nearly 8 percent of the total. Other groups were minor elements of the fauna.

On a species level, several polychaete annelids were abundant. Polychaetes included *Mediomastus* sp. (9.5% of total macrofaunal abundance), *Nepthys* sp. (3.8 %), *Prionospio* sp. (3.3 %) and *Cossura* sp. (2.2 %), as well as several unidentified species (9.4 %) (Figure 9d-f). Oligochaeta were not identified to species, but together comprised 4% of the total macrofaunal assemblage.

Local Effects of Cable Installation

Little variation in the megafaunal assemblage was detected between video transects directly over the cable route and parallel transects 50 m from the cable (Figure 10). Multivariate tests comparing cable and control treatments for all species or all groups were non-significant ($p>0.95$). Likewise, univariate tests evaluating the abundance of faunal groups or individual species indicated no significant variation in the megafaunal assemblage from directly over the cable to 50 m away. Thus, local variation in the megafaunal assemblage very near the cable was largely undetectable.

One important exception to this pattern was observed near 300 m depth in the Neck Zone, where the cable is occasionally suspended between rocks for short distances. At these locations, the density of longnose skates (*Raja rhina*) was anomalously high (Figure 6c). The density or *R. rhina* was 42 per 100 m^2 over the cable, but only 0.3 per 100 m^2 at nearby control areas ($p<0.027$), representing an increase by a factor of 126. A number of marine fishes, especially elasmobranchs are known to sense electromagnetic fields using electroreceptors as a method of prey detection (Bullock 1982). The suspended MARS cable very likely produced a weak electromagnetic field as local ocean currents flow through the Earth's magnetic field and around the cable (Sanford, 1971). This is possible even though the cable was not energized during the 2008 video survey. This electric field is apparently

Table 2. Mean density of macrofaunal taxa, by major groups over all samples. Density is listed as number per core (45.4 cm^2). % indicates the percentage of the taxon of the total macrofaunal abundance.

Phylum	**Major Group**	**Mean (#/core)**	**SE**	**%**
Annelida		**24.893**	**1.994**	**52.597**
	Polychaeta	22.884	1.844	48.352
	Oligochaeta	2.009	0.427	4.245
Arthropoda		**16.397**	**1.790**	**34.644**
	Amphipoda	10.611	1.413	22.420
	Tanaidacea	1.934	0.438	4.086
	Isopoda	1.364	0.208	2.882
	Ostracoda	1.291	0.239	2.727
	Cumacea	1.098	0.158	2.320
	Mysida	0.095	0.037	0.200
	Decapoda	0.004	0.003	0.008
	Pycnogonida	0.001	0.001	0.002
Mollusca		**3.766**	**0.369**	**7.958**
	Bivalvia	2.803	0.280	5.923
	Scaphopoda	0.536	0.095	1.133
	Gastropoda	0.273	0.063	0.577
	Aplacophora	0.138	0.046	0.291
	Polyplacophora	0.016	0.010	0.033
Nemertea		**1.150**	**0.189**	**2.430**
Echinodermata		**0.942**	**0.122**	**1.991**
	Ophiuroidea	0.909	0.121	1.921
	Echinoidea	0.021	0.012	0.045
	Holothuroidea	0.012	0.009	0.025
Cnidaria		**0.109**	**0.036**	**0.231**
	Actiniaria	**0.109**	**0.036**	**0.231**
Sipuncula		**0.027**	**0.014**	**0.058**
Echiura		**0.017**	**0.012**	**0.036**
Enteropneusta		**0.017**	**0.012**	**0.036**
Platyhelminthes		**0.009**	**0.009**	**0.018**
Total		**47.329**		

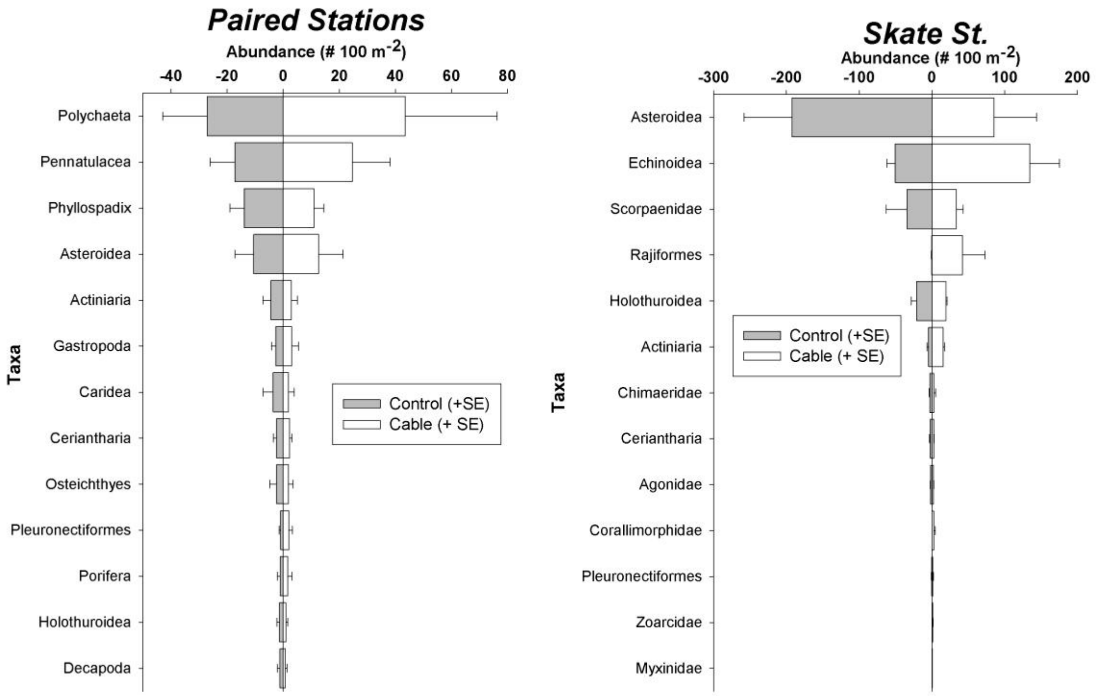

Figure 10. Variation in abundance of megafaunal groups along the cable route. Paired stations (left chart) show little variation in mean densities of megafauna over 10 stations along the cable. Right chart – variation in megafaunal groups at 3 stations at Neck depths (~500 m) where the cable is suspended slightly above the bottom. Note the higher abundance of Rajiformes (Skates) over the cable compared to 50 m away. Cable = directly over the cable route. Control = 50 m from the cable.

detectable by *R. rhina*, which aggregated near the cable. Electric fields from seabed cables including telecommunications cables and power distribution cables (e.g. coastal windfarms) are expected to have ecological effects due to their effects on the behavior of various species capable of electroreception (Gill 2005). It is likely that the response of longnose skates and perhaps other species may respond to the MARS cable after it is energized and operational.

Regional Cable Impacts- Megafauna

The installation and presence of the MARS cable appears to have very mild to benign effects on the structure of the macrofaunal and megafaunal assemblages on the scale of kilometers, based on the results of megafaunal and macrofaunal samples at cable and control sites before and after cable installation. Using both multivariate and univariate analyses, few statistically significant differences in the densities of megafauna or macrofauna were detected in relation to the installation of the cable.

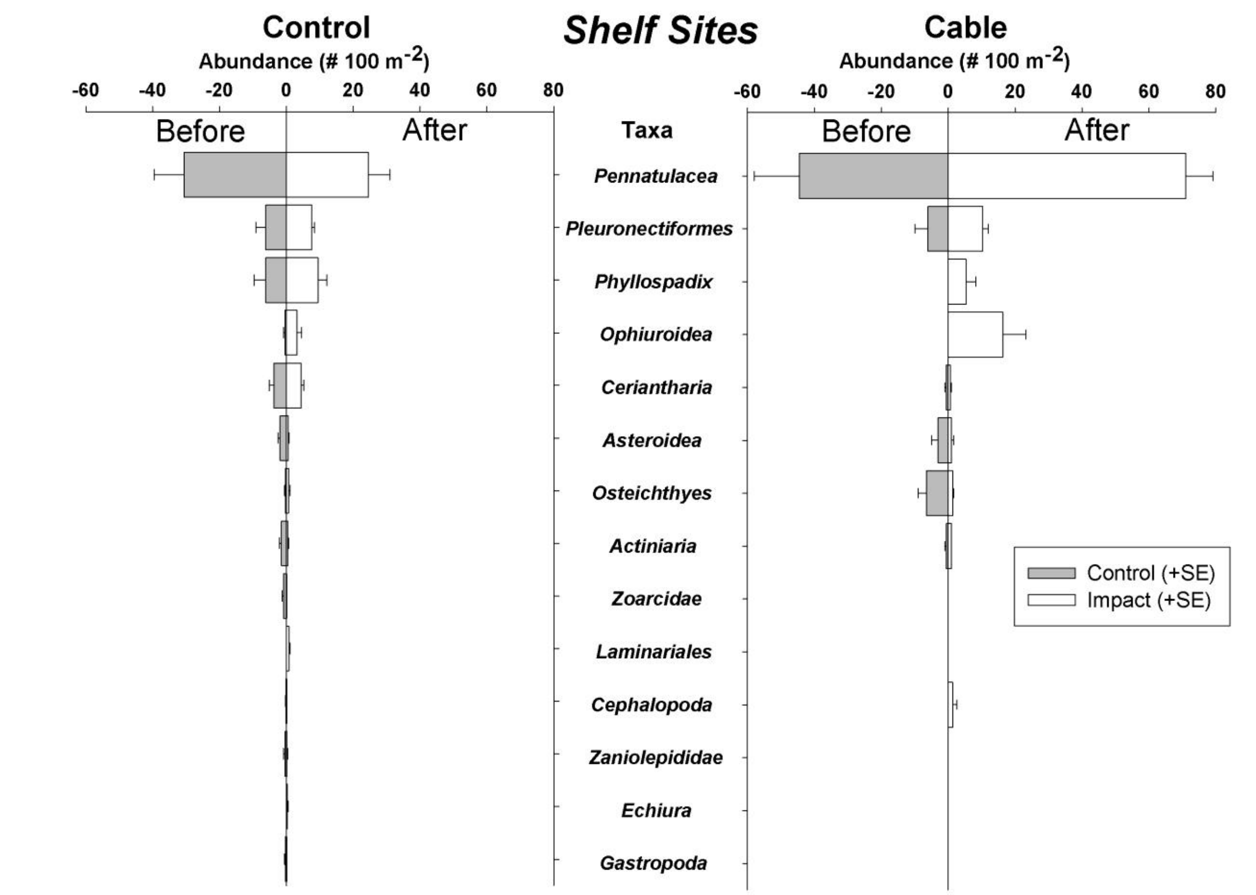

Figure 11. Variation in dominant megafaunal groups at the Shelf depth station.

For these BACI analyses, a significant effect of the installation of the cable would be detected by finding a statistically significant Period x Treatment (PxT) interaction term for the abundance of a particular taxon (for univariate or multivariate tests). This result would indicate that any change in the abundance of the taxon changed between periods (i.e. *Before* and *After* cable installation) at the Cable stations was different than changes in abundance at Control stations.

At Shelf, Neck, and Slope depths, multivariate comparisons (i.e. comparisons between the entire megafaunal assemblage) indicated no significant Period x Treatment interaction terms ($p>0.13$, 0.23, 0.58, for Shelf, Neck, and Slope, respectively), indicating that there was little change in the overall megafaunal community that is attributable to the installation of the cable. These tests also indicated that there was significant variation in megafaunal abundance for the main factors of Periods or Treatments, or both. Overall, these results indicate that most of the variation in the abundance and distribution of megafauna is due to natural variability between stations or periods – in other words, natural variation in megafaunal abundance among Control stations was equal or greater than that measured between Control and Cable stations. These results were found for multivariate tests using either species-level data or higher taxon-level data.

There were few changes in the abundances of individual species or higher taxa in relation to the installation of the MARS cable, based on univariate tests to examine cable impacts. Even

Table 3. Summary of univariate BACI analysis for megafaunal taxa for all cable depths. P=Period, T= Treatment, PxT = Period x Treatment interaction term. A significant PxT term suggests an effect of cable installation. Comments explain patterns of results or propose possible factors influencing differences detected among treatments.

Taxon	**P**	**T**	**PxT**	**P**	**T**	**PxT**	**P**	**T**	**PxT**	**Comment**
Higher Taxa										
Multivariate Tests										
All Groups	**	**	ns	ns	**	ns	**	**	ns	
Univariate Tests										
Actinaria (anemones)	-	-	-	-	-	-	*	ns	ns	> after cable inst.
Ceriantharia (tube anemones)	ns	*	ns	-	-	-	-	-	-	Sig. Station variability
Pennatulacea (sea pens)	ns	ns	ns	-	-	-	ns	**	ns	Sig. Station variability
Phyllospadix (surf grass detritus)	**	ns	ns	ns	**	ns	**	ns	*	Sig. Sta., Period var.
Asteroidea (sea stars)	-	-	-	ns	**	ns	-	-	-	Sig. Station variability
Echinoidea (sea urchins)	-	-	-	ns	*	ns	-	-	-	Cable > Control
Holothuroidea (sea cucumbers)	-	-	-	ns	ns	ns	-	-	-	
Ophiuroidea (brittle stars)	**	ns	ns	-	-	-	ns	ns	ns	> after cable inst.
Gastropoda (snails)	-	-	-	-	-	-	**	ns	**	Natural variation?
Pleuronectiformes (flatfishes)	ns	ns	ns	-	-	-	-	-	-	
Species										
Multivariate Tests										
All Species	*	**	ns	ns	**	ns	*	*	ns	
Univariate Tests										
Funiculina sp. (sea pen)	-	-	-	-	-	-	ns	**	ns	Sig. Station variation
Rathbunaster californicus (sea star)	ns	ns	ns	ns	**	ns	-	-	-	Cable > Control
Allocentrotus fragilis (urchin)	-	-	-	ns	*	ns	ns	ns	ns	Cable > Control
Psolus squamatus (sea cucumber)	-	-	-	ns	ns	ns	-	-	-	
Mesomyaria sp. (anemone)	-	-	-	-	-	-	*	ns	ns	All Treat. increased
Umbellula lindahli (sea pen)	-	-	-	-	-	-	ns	**	ns	Cable > Control
Sebastolobus sp. (fish)	-	-	-	ns	ns	ns	ns	ns	ns	
Pannychia moseleyi (sea cucumber)	-	-	-	-	-	-	**	**	**	Natural variability?
Metridium farcimen (anemone)	ns	ns	ns	-	-	-	-	-	-	

though there was frequently significant variation in the abundance of species or higher taxa between Periods or Treatments (Table 3), very few significant PxT interaction terms were found, indicating little effect of the MARS cable. Univariate tests were conducted for most major taxa shown in Figure 11-13. Among these, the PxT interaction term was significant for only a few taxa. For example, *Phyllospadix* sp. (surf grass) is detritus that was not observed at the Slope Cable site during the pre-installation survey, but occurred there during the 2008 survey. It may have accumulated in the cable trench after cable installation, as observed for other objects and detritus

(Figure 6). Marine snails (Gastropoda) also may have been affected by the cable, as indicated by the significant PxT interaction (Table 3). Snails were low in abundance at the Slope Cable station prior to cable installation (0.3 per 100 m^2), but increased by 2008 to a mean of 45 individuals per 100 m^2. During both periods, snail densities at the Control stations averaged ~17 per 100 m^2. While this may represent natural variability, it is possible that snails (e.g. *Neptunea* sp.) aggregated near the Cable station and in the cable trench in association with increased abundance of detritus and other material. The PxT interaction term was also highly significant at the Slope Depth for the deep-sea cucumber, *Pannychia moseleyi*. It was initially abundant at the Slope Cable station (40 / 100 m^2), but sparse at Slope Control stations (mean = 0.3 / 100 m^2). During the 2008 survey, this sea cucumber was not observed at any Slope Depth stations. Because *P. moseleyi* appears to vary considerably between stations and periods, the observed changes in abundance may be due simply to natural variability rather than specific cable effects.

Although few effects of cable installation were detectable, significant main effects (Treatment or Period) were detected for many taxa and Cable Depth zones (Table 3). Closer examination of these frequently indicated that significant Treatment effects were related to statistically significant variation among Control stations as well as differences between Control and Impact stations. Thus, natural variability in megafaunal abundance and distribution appears to be as large as differences in abundance related to the cable.

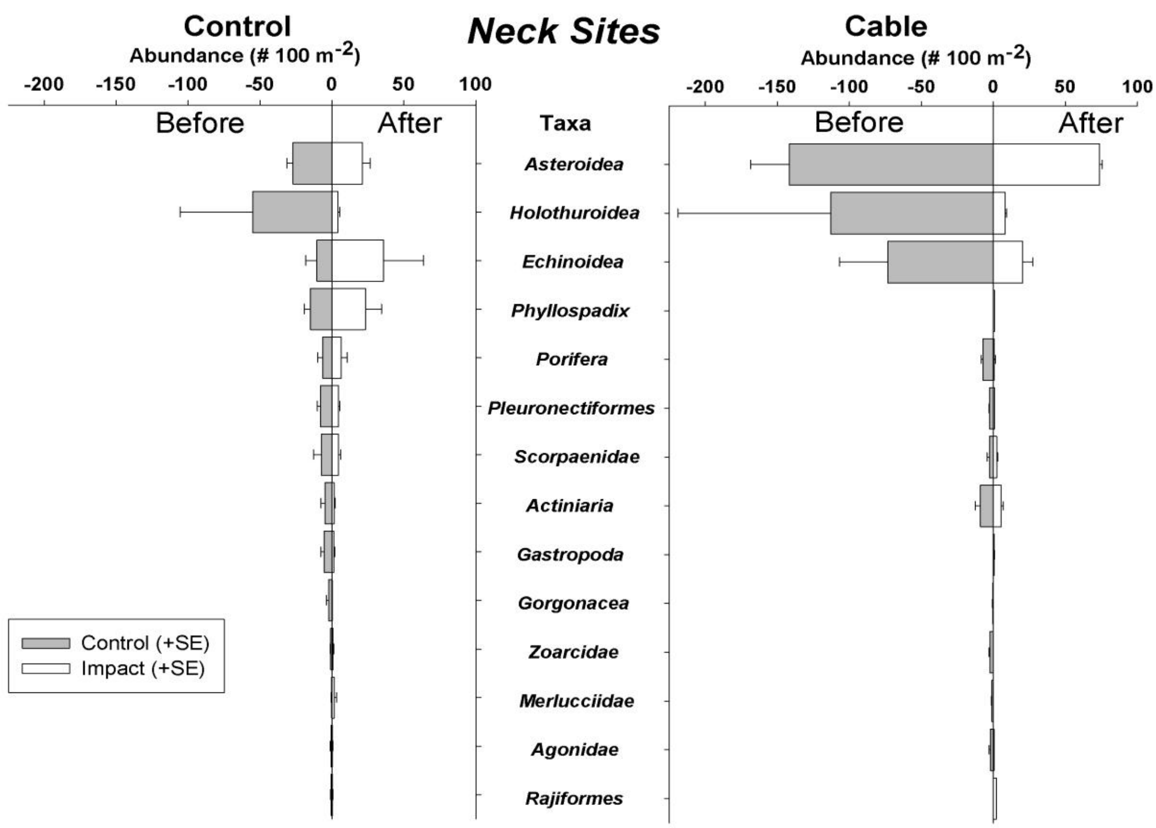

Figure 12. Variation in megafaunal assemblage among periods and treatments at the Neck Depth Zone.

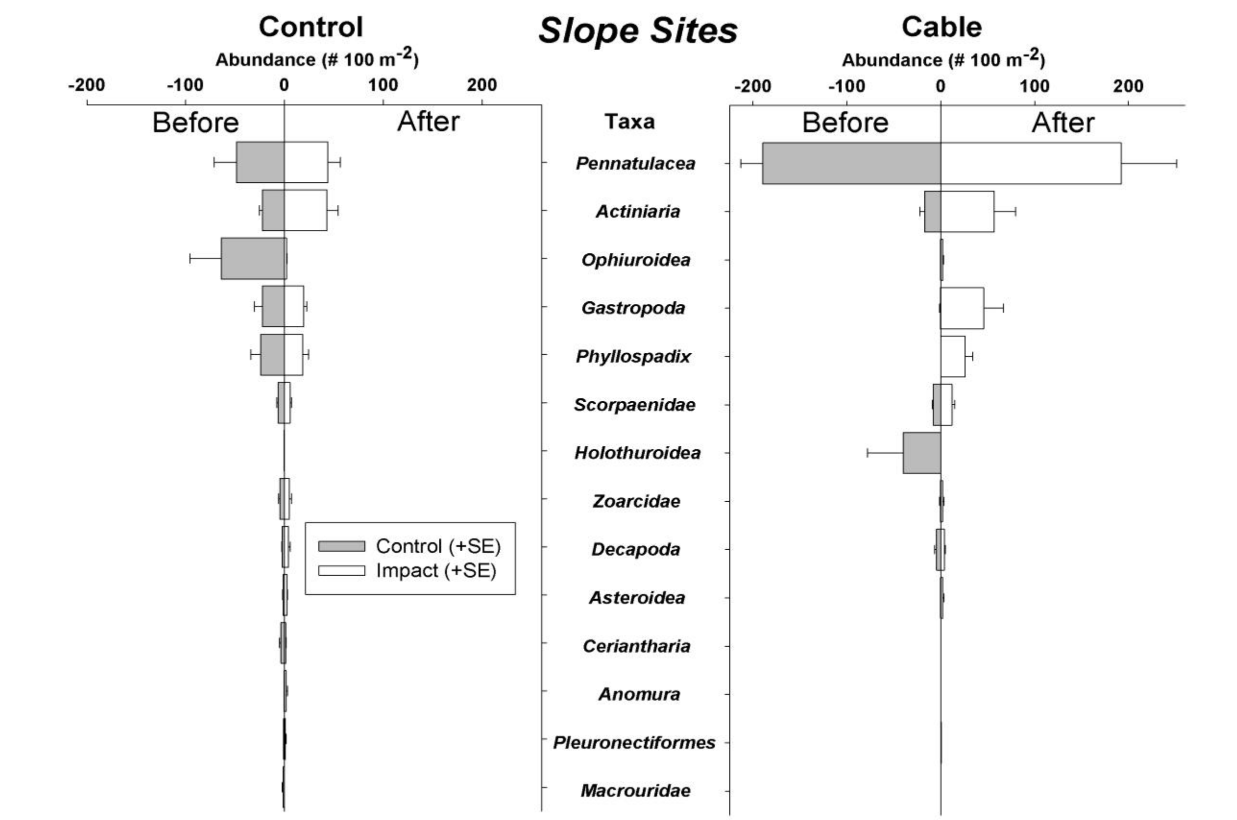

Figure 13. Variation in megafaunal abundance among Treatments and Periods at Slope Depths

Cable Impacts on Macrofaunal Organisms

Macrofaunal assemblages along the cable route appear to be largely unaffected by the installation of the cable, as found for the megafaunal assemblage (Table 4). Multivariate tests indicated that there was no detectable cable effect at the Neck or Slope depths (i.e. PxT = ns), even though there were significant main effects (Period, Treatment) found at one or both depths. At the Shelf depth, however, a significant PxT interaction term was detected for both the higher taxa and species tests (Table 4). Owing to the overwhelming dominance of polychaete worms in the macrofauna, and the Shelf Depth in particular, this group has a large influence on the multivariate test. The abundance of polychaetes, and thus the macrofauna in general, increased at after cable installation, but increased far more at the Shelf Cable station than at Control stations (Figure 14). Simultaneously, the abundance of most macrofaunal taxa at Control stations decreased. While it is possible that cable installation affected conditions (e.g. increased detritus) that lead to an increase in polychaetes and other infauna, it is also possible that other factors drove these changes.

Univariate tests of individual higher taxa or species were very similar to the results from examination of megafaunal patterns, with few detectable impacts of cable installation at any depth (Table 4). As observed for multivariate tests (see above), polychaete worms had a significant PxT term, and were more abundant following cable installation at the Shelf Depth cable site for unknown reasons. Statistically significant PxT terms were also observed at the Neck Cable depth for two amphipod crustacean species, *Photis typhlops* and *Hardematopa nasuta*. Unlike polychaete

Table 4. Summary of Univariate BACI analysis for macrofaunal taxa. P=Period, T= Treatment, PxT = Period x Treatment interaction term. A significant PxT term suggests an effect of cable installation. Comments explain patterns of results or propose possible factors influencing differences detected among treatments. C= Control Stations, I = Cable Stations.

Taxon	**P**	**T**	**PxT**	**P**	**T**	**PxT**	**P**	**T**	**PxT**	**Comment**
Higher Taxa										
Multivariate Tests										
All Groups	**	*	**	ns	**	ns	**	**	ns	Cable St. increased
Univariate Tests										
Polychaeta (worms)	**	ns	**	ns	ns	ns	ns	ns	ns	All increased, C>I
Amphipoda (crustacea)	ns	ns	ns	ns	**	ns	*	*	ns	All inc., sta. var.
Bivalvia (clams)	ns	ns	ns	ns	**	ns	*	ns	ns	All inc., sta. var.
Oligochaeta (worms)	ns	ns	ns	ns	ns	ns	ns	ns	ns	
Tanaidacea (crustacea)	*	ns	ns	ns	*	ns	ns	ns	ns	All increased
Isopoda (crustacea)	**	ns	ns	ns	ns	ns	ns	ns	ns	All increased
Ostracoda (crustacea)	ns	ns	ns	ns	ns	ns	ns	*	ns	Sig. sta. variability
Species										
Multivariate Tests										
All Species	**	**	*	ns	**	ns	*	**	ns	Cable St. increased
Univariate Tests										
Nepthys sp.	ns	ns	ns	-	-	-	-	-	-	
Prionospio sp.	ns	**	ns	ns	*	ns	-	-	-	Sig. sta. variability
Mesometatopa neglecta	-	-	-	ns	**	ns	-	-	-	Sig. sta. variability
Cossura sp.	ns	ns	ns	-	-	-	ns	**	ns	Sig. sta. variability
Gammaropsis cf. ociosa	-	-	-	-	-	-	ns	ns	ns	
Photis typhlops	ns	**	ns	**	**	**	ns	*	ns	St. var., incr. at I
Hardametopa nasuta	*	ns	ns	ns	*	*	-	-	-	Sig. inc. at C., not I.

worms, which increased greatly at the cable site after cable installation, these amphipods did not change in abundance at the Cable site, but did increase significantly at Control sites at this depth (see Amphipoda in Figure 15). Although the change at Control stations may have resulted from various factors unrelated to the cable, this probably resulted in the significant PxT test. Several other macrofaunal taxa varied significantly either between Periods or Treatments at each depth zone (Figure 14-16), but these changes were often related to general changes in abundance at all stations (i.e. Control and Cable) or to natural variation among stations.

These results indicated few detectable effects of the MARS cable on seabed biology are similar to results reported in other studies. Kogan et al. (2003) reported that few statistically significant effects of the ATOC submarine cable were detectable. They noted that the major effect of the cable was on organisms that attached to it, especially anemones, and also reported erosion of the seabed by strumming of the exposed cable at shallow depths.

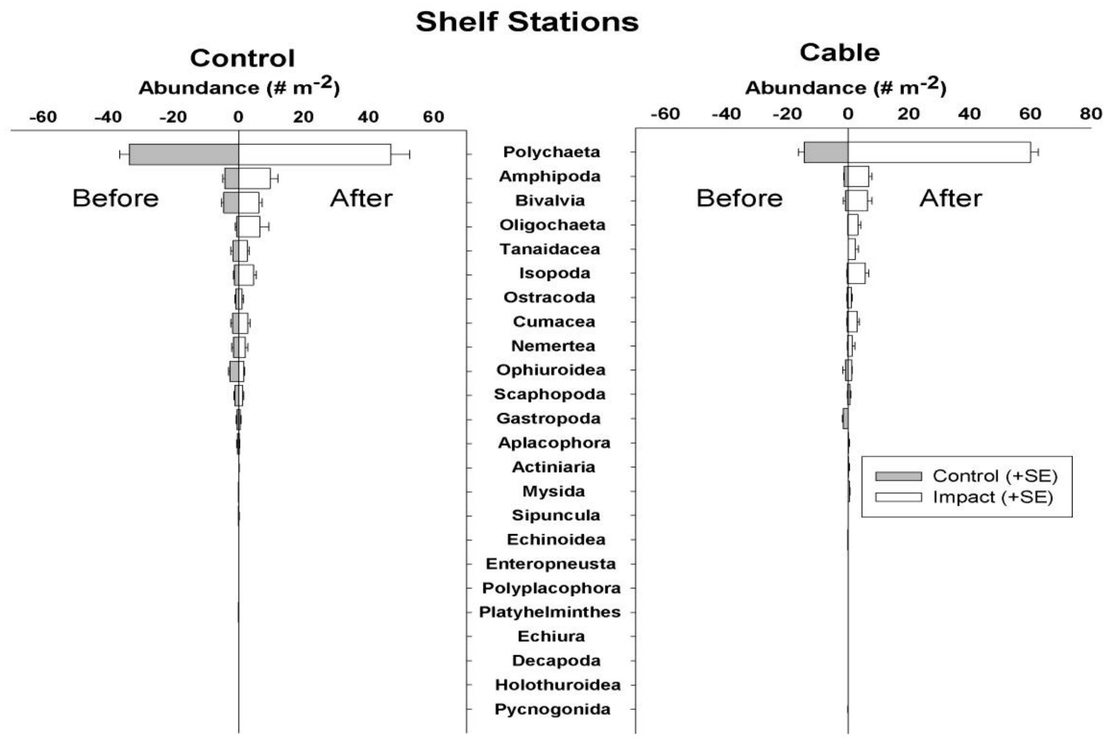

Figure 14. Variation in the abundance of macrofaunal taxa (higher groups) at the Shelf Cable zone among Treatments and Periods.

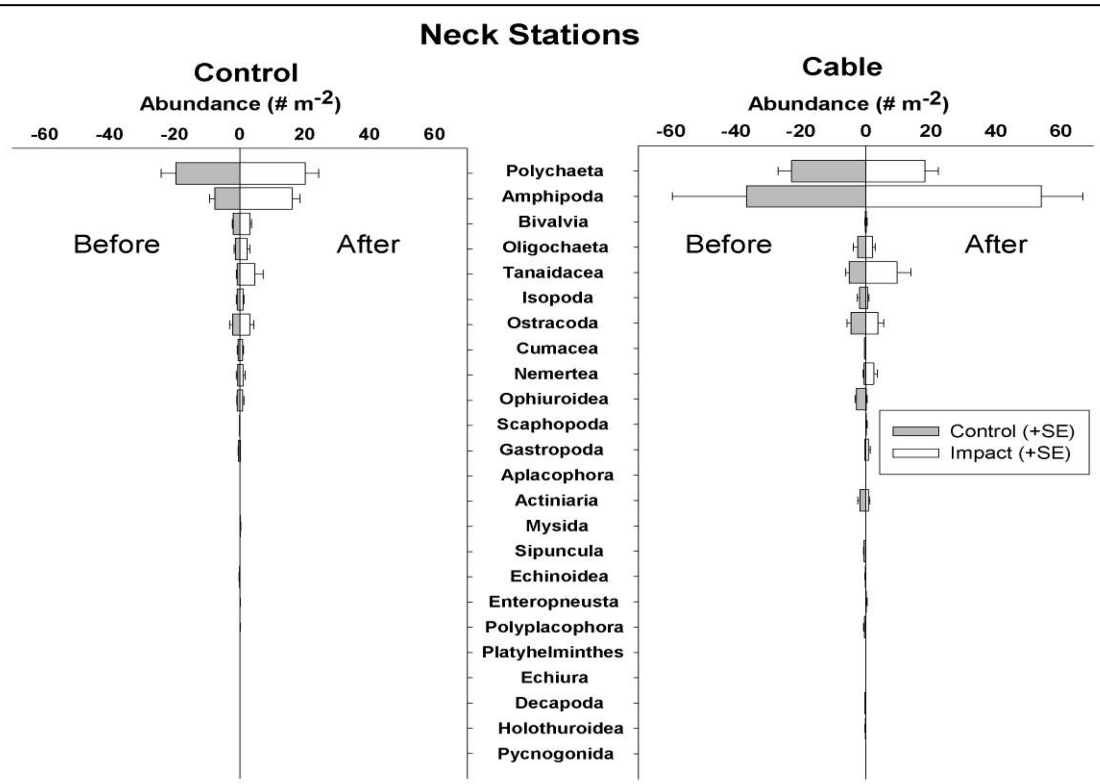

Figure 15. Variation in the abundance of macrofaunal taxa (higher groups) at the Neck Cable zone among Treatments and Periods.

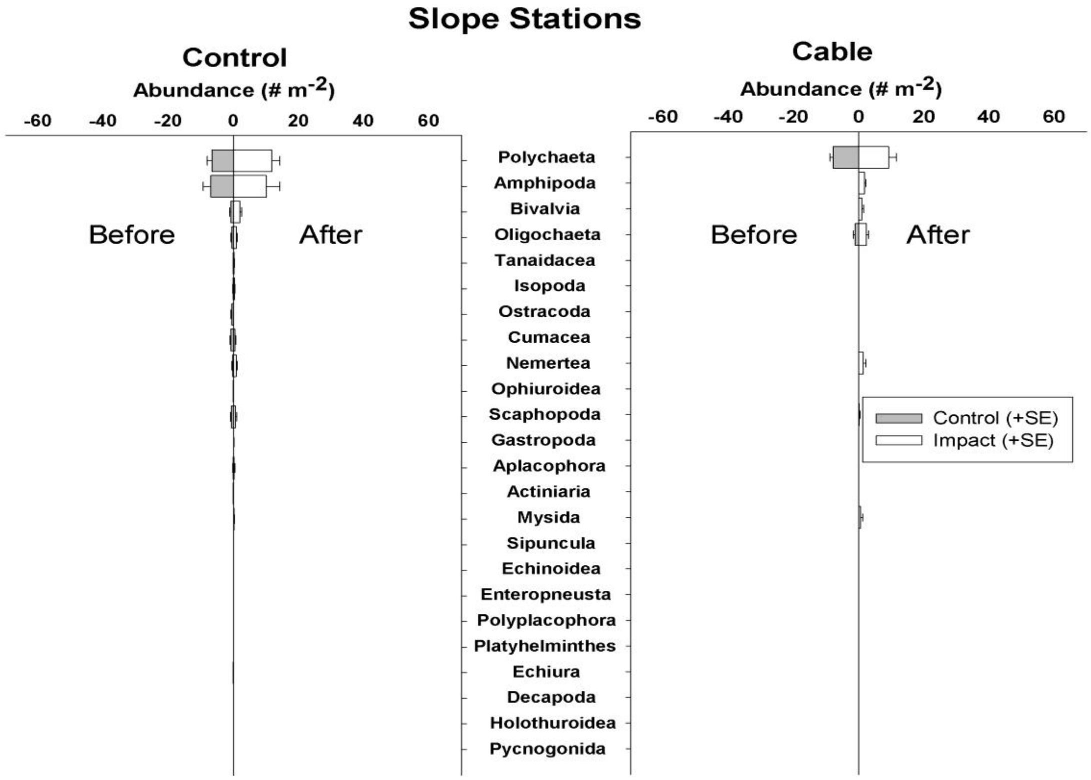

Figure 16. Variation in the abundance of macrofaunal taxa (higher groups) at the Slope Cable zone among Treatments and Periods.

Other factors

Several other factors may have influenced the variability observed in the abundance and distribution of benthic megafauna and macrofauna in relation to the installation of the MARS Cable. First, the geological and biological sampling program included a few samples collected as early 1999 and 2001. Natural variation in faunal abundance during the extended sampling period used for the "Before" sample base may have affected estimates the mean and standard deviation of abundance for many taxa. Considering that the 2007-2008 sample base was collected over only a few months, it is more likely to reflect the status of the benthic faunal communities than the "Before" samples.

Second, although the vast majority of sediment samples were collected using the same method (7.5 inch diameter tube core), 4 samples (again from 1999) were collected using a Smith-MacIntyre Grab (0.1 x 0.1 m). The abundances of macrofauna derived from these samples were adjusted to 45.2 cm^2 (the area of a tube core), but the efficiency of the two collection devices may have affected the results.

Third, there were no adjustments of probability levels to account for the large number of statistical tests. Over 100 statistical tests were performed, using an α of 0.05 – that is the probability of a type 1 error (rejecting a true null hypothesis) is 1 in 20. Thus, for 100 statistical tests, one would by chance detect a significant effect (e.g. Period x Treatment interaction term indicating an effect of the MARS cable) approximately 5 times. There are methods of reducing α to further reduce the probability of a type 1 error, but this is generally avoided, since it also increases type II errors (the acceptance of a false null hypothesis) (Cabin and Mitchell 2000).

CONCLUSIONS

Inspection of the MARS cable, coupled with a sampling program to evaluate changes in geological and biological conditions on local and regional scales with respect to the installation of the cable indicate little detectable influence of the cable. The most conspicuous evidence of cable installation is the cable trench and the cable, where exposed on the seabed. Analyses of the geological and biological sampling program indicate the following:

- Over most of its length, the cable remains buried, with little evidence of change since installation
- No detectable changes in sediment characteristics (mean grain size, or percent organic carbon) can be attributed to the MARS cable
- Local variation in benthic megafaunal communities within 50-100 m of the MARS cable is minor or undetectable.
    - The abundances of most animals observed did not differ between the area over the cable route and 50 m away
    - Longnose skates *(Raja rhina*) are significantly more abundant near regions where the MARS cable is suspended over topography (~300 m depth), and are likely to respond to electromagnetic fields generated by the cable.
- The MARS cable has little or no detectable effect on the distribution and abundance of macrofaunal and megafaunal assemblages on a regional scale (e.g. kilometers).
    - Megafauna and macrofauna compared before and after cable installation among 3 control stations and 1 cable station at each of 3 depth zones (Shelf - <200 m, Neck – 200-500 m, Slope - >500 m) indicated very few potential changes in benthic biological patterns due to the MARS cable.
    - Natural spatial and temporal variation in the abundance and distribution of benthic macrofauna and megafauna appears to be greater than any detectable effects of the MARS cable.

ACKNOWLEDGEMENTS

This study was funded by the David and Lucille Packard Foundation. We are grateful for the expertise and support of the crews of the *R/V Pt. Lobos* and ROV *Ventana*.

REFERENCES

Anderson, M.J., Robinson, j. 2003. Generalised discriminant analysis based on distances. Aust. & New Zealand J. of Statistics, 45: 301-318.

Bullock, T.H. 1982. Electroreception. Ann. Rev. of Neuroscience, 5: 121-170.

Cabin, R.J., Mitchell, R.J. 2009. To Bonferroni or not to Bonferroni: When and how are the questions. Bull. Ecol. Soc. Amer., 81(3): 246-248

Gill, A.B. 2005. Offshore renewable energy: ecological implications of generating electricity in the coastal zone. J. Applied Ecology 42, 605-615.

Hewitt, J.E., Thrush, S.E., Cummings, V.J. 2001. Assessing environmental impacts: effects of spatial and temporal variability at likely impact scales. Ecological Appl. 11(5): 1502-1516.

Kogan, I., Paull, C.K., Kuhnz, L., Burton, E.J., VonThun, S., Greene, H.G., Barry, J.P. 2003. Environmental impact of the ATOC / Pioneer Seamount submarine cable. Monterey Bay National Marine Sanctuary.

Perneger, T.V. 1998. What's wrong with Bonferroni adjustments. BMJ, 316: 1236-38.

Stewart-Oaten, A., Murdoch, W.W. 1986. Environmental impact assessment: "pseudoreplication " in time? Ecology, 67(4): 929-940.

Underwood, A.J. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances. Ecol. Appl., 4(1): 4-15.

Appendix 1. ROV video transect information. Transect Code (Tr. Code), Station, Cable Depth Zone (Zone), Treatment (control or cable location), Period (before or after cable installation, depth in meters, Date, Dive number for ROV *Ventana*, transect length (m), and estimated accuracy of navigation used to calculate transect length. Exact locations were unavailable for some transects, in which case station location information was used.

Tr. Code	**Station**	**Zone**	**Treatment**	**Period**	**Latitude**	**Longitude**	**Depth**	**Date**	**Dive #**	**Length**	**Accuracy**
A-A-2008	A	All	Cable	After	36.756899	-122.188391	710	12/12/2007	3139	115	good
A-B-2008	A	All	Control	After	36.756899	-122.187710	724	12/12/2007	3139	114	good
B-A-2008	B	All	Cable	After	36.799730	-122.186883	435	1/29/2008	3164	97	good
B-B-2008	B	All	Control	After	36.799712	-122.186290	431	1/29/2008	3164	97	good
C-A-2008	C	All	Cable	After	36.836974	-122.158251	172	1/31/2008	3167	83	good
C-B-2008	C	All	Control	After	36.837340	-122.158864	162	1/31/2008	3167	87	good
D-A-2008	D	All	Cable	After	36.857358	-122.108810	95	2/8/2008	3169	100	good
D-B-2008	D	All	Control	After	36.856905	-122.108491	94	2/8/2008	3169	100	good
E-A-2008	E	All	Cable	After	36.879787	-122.059782	72	4/1/2008	3186	100	good
E-B-2008	E	All	Control	After	36.880117	-122.060248	71	4/1/2008	3186	111	good
F-A-2008	F	All	Cable	After	36.885715	-122.006020	48	4/1/2008	3186	100	good
F-B-2008	F	All	Control	After	36.885231	-122.006393	49	4/1/2008	3186	100	good
G-A-2008	G	All	Cable	After	36.883813	-121.949321	39	1/8/2008	3149	100	unknown
G-B-2008	G	All	Control	After	36.883895	-121.949741	40	1/8/2008	3149	100	unknown
H-A-2008	H	All	Cable	After	36.868305	-121.895886	44	1/28/2008	3163	100	poor nav
H-B-2008	H	All	Control	After	36.867867	-121.896324	44	1/28/2008	3163	100	good
I-A-2008	I	All	Cable	After	36.848015	-121.845586	26	1/22/2010	3173	100	VARS, TC
I-B-2008	I	All	Control	After	36.847485	-121.844780	26	1/22/2010	3173	100	poor
J-A-2008	J	All	Cable	After	36.815585	-121.807344	20	3/31/2008	3184	107	good
J-B-2008	J	All	Control	After	36.816038	-121.806923	20	3/31/2008	3184	107	good
SC1-A-2006	SC-1	Shelf	Control	Before	36.714458	-121.909033	90	9/25/2006	2891	100	unknown
SC1-A-2008	SC-1	Shelf	Control	After	36.714458	-121.909033	89	11/30/2007	3135	100	poor
SC1-B-2006	SC-1	Shelf	Control	Before	36.714299	-121.908597	90	9/25/2006	2891	100	unknown
SC1-B-2008	SC-1	Shelf	Control	After	36.714299	-121.908597	90	11/30/2007	3135	100	poor
SC1-C-2006	SC-1	Shelf	Control	Before	36.713548	-121.907717	90	9/25/2006	2891	100	unknown
SC1-C-2008	SC-1	Shelf	Control	After	36.713548	-121.907717	89	11/30/2007	3135	100	poor
SC2-A-2006	SC-2	Shelf	Control	Before	36.821804	-121.944500	87	10/5/2006	2905	100	unknown
SC2-A-2008	SC-2	Shelf	Control	After	36.822428	-121.945564	87	11/30/2007	3134	100	poor
SC2-B-2006	SC-2	Shelf	Control	Before	36.822571	-121.943540	86	10/5/2006	2905	100	unknown

Tr. Code	Station	Zone	Treatment	Period	Latitude	Longitude	Depth	Date	Dive #	Length	Accuracy
SC2-B-2008	SC-2	Shelf	Control	After	36.822978	-121.944894	86	11/30/2007	3134	100	poor
SC2-C-2008	SC-2	Shelf	Control	After	36.823517	-121.944924	86	11/30/2007	3134	100	poor
SC3-A-2006	SC-3	Shelf	Control	Before	36.878461	-122.121178	89	10/5/2006	2904	100	unknown
SC3-A-2008	SC-3	Shelf	Control	After	36.877177	-122.120826	90	1/30/2008	3166	100	good
SC3-B-2006	SC-3	Shelf	Control	Before	36.878765	-122.120205	89	10/5/2006	2904	100	unknown
SC3-B-2008	SC-3	Shelf	Control	After	36.877639	-122.121503	91	1/30/2008	3166	100	good
SC3-C-2008	SC-3	Shelf	Control	After	36.877494	-122.120593	91	1/30/2008	3166	90	moderate
SI1-A-1999	SI-1	Shelf	Cable	Before	36.863391	-122.096900	90	1999	MCI-ACAD90	100	unknown
SI1-A-2008	SI-1	Shelf	Cable	After	36.863391	-122.096900	91	1/23/2008	3161	100	poor
SI1-B-1999	SI-1	Shelf	Cable	Before	36.863186	-122.096707	90	1999	MCI-ACAD90	100	unknown
SI1-B-2008	SI-1	Shelf	Cable	After	36.863186	-122.096707	92	1/23/2008	3161	100	poor
SI1-C-2008	SI-1	Shelf	Cable	After	36.863471	-122.096143	92	1/23/2008	3161	100	poor
NC1-A-2005	NC-1	Neck	Control	Before	36.789158	-122.124280	401	7/13/2005	2687	100	unknown
NC1-A-2008	NC-1	Neck	Control	After	36.788543	-122.117341	399	1/30/2008	3165	109	good
NC1-B-2005	NC-1	Neck	Control	Before	36.789383	-122.125140	400	7/13/2005	2687	100	unknown
NC1-B-2008	NC-1	Neck	Control	After	36.789039	-122.117852	394	1/30/2008	3165	96	good
NC1-C-2005	NC-1	Neck	Control	Before	36.788088	-122.121619	400	7/13/2005	2687	50	unknown
NC1-C-2008	NC-1	Neck	Control	After	36.789491	-122.116151	386	1/30/2008	3165	100	poor
NC2-A-2005	NC-2	Neck	Control	Before	36.803011	-122.122515	196	8/1/2005	2696	100	unknown
NC2-A-2008	NC-2	Neck	Control	After	36.799381	-122.107564	207	1/30/2008	3165	100	good
NC2-B-2005	NC-2	Neck	Control	Before	36.803356	-122.123501	197	8/1/2005	2696	100	unknown
NC2-B-2008	NC-2	Neck	Control	After	36.799928	-122.108486	189	1/30/2008	3165	100	good
NC2-C-2005	NC-2	Neck	Control	Before	36.803646	-122.124485	198	8/1/2005	2696	100	unknown
NC2-C-2008	NC-2	Neck	Control	After	36.799216	-122.108455	195	1/30/2008	3165	100	good
NC3-A-2006	NC-3	Neck	Control	Before	36.842645	-122.189108	361	10/3/2006	2899	100	unknown
NC3-A-2008	NC-3	Neck	Control	After	36.842894	-122.187867	361	1/24/2008	3162	100	good
NC3-B-2006	NC-3	Neck	Control	Before	36.842120	-122.189979	368	10/3/2006	2899	100	unknown
NC3-B-2008	NC-3	Neck	Control	After	36.842918	-122.187669	352	1/24/2008	3162	100	good
NC3-C-2008	NC-3	Neck	Control	After	36.842812	-122.186766	356	1/24/2008	3162	100	good
NI1-A-1999	NI-1	Neck	Cable	Before	36.824453	-122.169606	325	1999	MCI-Pref325	100	unknown
NI1-A-2008	NI-1	Neck	Cable	After	36.824453	-122.169606	321	1/31/2008	3167	100	good
NI1-B-1999	NI-1	Neck	Cable	Before	36.824886	-122.170095	325	1999	MCI-Pref325	100	unknown
NI1-B-2008	NI-1	Neck	Cable	After	36.824886	-122.170095	318	1/31/2008	3167	100	good
NI1-C-1999	NI-1	Neck	Cable	Before	36.824287	-122.170539	325	1999	MCI-ACAD325	100	unknown

Tr. Code	Station	Zone	Treatment	Period	Latitude	Longitude	Depth	Date	Dive #	Length	Accuracy
NI1-C-2008	NI-1	Neck	Cable	After	36.824287	-122.170539	323	1/31/2008	3167	100	good
SLC1-A-2001	SLC-1	Slope	Control	Before	36.743379	-122.275459	1000	10/12/2001	2083	100	unknown
SLC1-A-2008	SLC-1	Slope	Control	After	36.745790	-122.277049	992	1/7/2008	3147	100	good
SLC1-B-2001	SLC-1	Slope	Control	Before	36.742199	-122.274547	1000	10/12/2001	2083	100	unknown
SLC1-B-2008	SLC-1	Slope	Control	After	36.745207	-122.277572	1001	1/7/2008	3147	80	good
SLC1-C-2001	SLC-1	Slope	Control	Before	36.741165	-122.273010	999	10/12/2001	2083	100	unknown
SLC1-C-2008	SLC-1	Slope	Control	After	36.745351	-122.278318	1007	1/7/2008	3147	100	good
SLC2-A-2005	SLC-2	Slope	Control	Before	36.752527	-122.200020	801	6/8/2005	2674	100	unknown
SLC2-A-2008	SLC-2	Slope	Control	After	36.748745	-122.197382	820	1/23/2008	3160	100	good
SLC2-B-2005	SLC-2	Slope	Control	Before	36.752640	-122.200906	800	6/8/2005	2674	100	unknown
SLC2-B-2008	SLC-2	Slope	Control	After	36.748580	-122.197578	817	1/23/2008	3160	100	good
SLC2-C-2005	SLC-2	Slope	Control	Before	36.752558	-122.202336	801	6/8/2005	2674	100	unknown
SLC2-C-2008	SLC-2	Slope	Control	After	36.748988	-122.198433	827	1/23/2008	3160	100	good
SLC3-A-2006	SLC-3	Slope	Control	Before	36.707094	-122.167266	881	10/3/2006	2898	100	unknown
SLC3-A-2008	SLC-3	Slope	Control	After	36.705268	-122.166423	895	1/8/2008	3148	100	good
SLC3-B-2006	SLC-3	Slope	Control	Before	36.707753	-122.166954	877	10/3/2006	2898	100	unknown
SLC3-B-2008	SLC-3	Slope	Control	After	36.706463	-122.165729	884	1/8/2008	3148	100	good
SLC3-C-2006	SLC-3	Slope	Control	Before	36.707710	-122.165860	874	10/3/2006	2898	100	unknown
SLC3-C-2008	SLC-3	Slope	Control	After	36.705928	-122.164967	887	1/8/2008	3148	100	good
SLI1-A-2003	SLI-1	Slope	Cable	Before	36.711241	-122.186781	885	10/13/2003	V2439	100	unknown
SLI1-A-2008	SLI-1	Slope	Cable	After	36.712528	-122.187070	877	12/6/2007	3136	100	poor
SLI1-B-2003	SLI-1	Slope	Cable	Before	36.711353	-122.186449	883	10/13/2003	V2439	100	unknown
SLI1-B-2008	SLI-1	Slope	Cable	After	36.713020	-122.186753	877	12/6/2007	3136	100	poor
SLI1-C-2003	SLI-1	Slope	Cable	Before	36.711883	-122.186523	882	10/13/2003	V2439	100	unknown
SLI1-C-2008	SLI-1	Slope	Cable	After	36.712683	-122.186665	874	12/6/2007	3136	100	poor
Skate1-A	Skate	Skate	Control	After	36.825740	-122.168653	313	1/31/2008	3167	100	good
Skate1-B	Skate	Skate	Control	After	36.826303	-122.168202	310	1/31/2008	3167	82	good
Skate1-C	Skate	Skate	Control	After	36.827346	-122.167738	309	1/31/2008	3167	100	good
Skate2-A	Skate	Skate	Cable	After	36.826029	-122.169319	317	1/31/2008	3167	100	good
Skate2-B	Skate	Skate	Cable	After	36.826903	-122.168852	311	1/31/2008	3167	100	good
Skate2-C	Skate	Skate	Cable	After	36.827570	-122.168474	306	1/31/2008	3167	86	good

Appendix 2. Mean megafaunal density along the MARS cable route and control sites, organized by phylum (or subphylum). The density (# m^{-2}) of each taxon at all available video transects (n=94) and all depths were averaged to produce an overall average density. SD = standard deviation. Percent indicates the percentage of the total average faunal density (1.41 megafaunal individuals 100 m^{-2}).

Phylum	**Major Group**	**Taxa**	**Density**	**SD**	**%**
Agnatha	Myxinidae	*Eptatretus stoutii*	0.17	0.56	0.11
Annelida	Polychaeta	*Diopatra*	7.51	38.79	5.06
Annelida	Polychaeta	Sabellidae	0.05	0.27	0.04
Arthropoda	Anomura	Diogenidae	0.23	1.05	0.15
Arthropoda	Caridea	*Caridea*	0.60	4.16	0.40
Arthropoda	Caridea	*Caridea* sp.1	0.09	0.41	0.06
Arthropoda	Decapoda	*Brachyura*	0.01	0.10	0.01
Arthropoda	Decapoda	Cancer	0.03	0.23	0.02
Arthropoda	Decapoda	*Chionoecetes tanneri*	0.99	2.48	0.67
Arthropoda	Decapoda	*Chorilia longipes*	0.07	0.30	0.05
Arthropoda	Decapoda	Decapoda	0.01	0.10	0.01
Brachipoda	Brachipoda	*Laqueus californianus*	0.06	0.62	0.04
Chondrichthyes	Chimaeridae	*Hydrolagus colliei*	0.18	0.91	0.12
Chondrichthyes	Rajiformes	*Bathyraja kincaidii*	0.05	0.23	0.04
Chondrichthyes	Rajiformes	*Raja binoculata*	0.01	0.10	0.01
Chondrichthyes	Rajiformes	*Raja rhina*	1.52	10.77	1.02
Chondrichthyes	Scyliorhinidae	*Parmaturus xaniurus*	0.11	0.48	0.07
Cnidaria	Actiniaria	Actiniaria	1.02	2.73	0.69
Cnidaria	Actiniaria	Actiniaria sp. 1	0.59	1.95	0.39
Cnidaria	Actiniaria	Actiniaria sp. 3	0.72	2.66	0.49
Cnidaria	Actiniaria	*Liponema brevicornis*	0.44	1.88	0.30
Cnidaria	Actiniaria	*Mesomyaria*	6.58	15.63	4.43
Cnidaria	Actiniaria	*Metridium farcimen*	0.23	0.68	0.16
Cnidaria	Actiniaria	*Stomphia*	1.67	2.89	1.13
Cnidaria	Alcyonacea	*Anthomastus ritteri*	0.07	0.36	0.05
Cnidaria	Anthozoa	Anthozoa	0.03	0.18	0.02
Cnidaria	Ceriantharia	Ceriantharia	1.28	2.40	0.86
Cnidaria	Ceriantharia	Ceriantharia sp. 1	0.07	0.57	0.05
Cnidaria	Ceriantharia	Ceriantharia sp. 2	0.44	1.95	0.30
Cnidaria	Ceriantharia	Ceriantharia sp. 3	0.18	0.71	0.12
Cnidaria	Cnidaria	Cnidaria	0.01	0.10	0.01
Cnidaria	Corallimorphidae	*Corallimorphus pilatus*	0.17	0.86	0.11
Cnidaria	Gorgonacea	Gorgonacea	0.01	0.10	0.01
Cnidaria	Gorgonacea	*Swiftia* simplex	0.22	1.26	0.15
Cnidaria	Hydrozoa	LRJ Complex	0.02	0.15	0.01
Cnidaria	Pennatulacea	*Anthoptilum grandiflorum*	0.03	0.21	0.02
Cnidaria	Pennatulacea	*Funiculina*	17.30	47.23	11.65
Cnidaria	Pennatulacea	*Halipteris californica*	0.64	3.31	0.43

Phylum	Major Group	Taxa	Density	SD	%
Cnidaria	Pennatulacea	*Pennatula aculeata*	0.40	1.96	0.27
Cnidaria	Pennatulacea	*Pennatula phosphorea californica*	0.11	0.58	0.07
Cnidaria	Pennatulacea	Pennatulacea	12.04	24.28	8.11
Cnidaria	Pennatulacea	*Ptilosarcus gurneyi*	0.07	0.37	0.05
Cnidaria	Pennatulacea	*Umbellula lindahli*	2.78	8.30	1.87
	Detritus	Laminariales	0.41	0.89	0.28
	Detritus	*Phyllospadix*	12.63	18.12	8.51
Echinodermata	Asteroidea	Asteroidea	1.03	4.02	0.69
Echinodermata	Asteroidea	*Benthopecten*	0.15	1.05	0.10
Echinodermata	Asteroidea	*Henricia aspera*	0.11	0.50	0.07
Echinodermata	Asteroidea	*Henricia sanguinolenta*	0.02	0.15	0.01
Echinodermata	Asteroidea	*Hippasteria*	0.43	1.44	0.29
Echinodermata	Asteroidea	*Luidia foliolata*	0.28	0.90	0.19
Echinodermata	Asteroidea	*Mediaster*	3.30	8.07	2.22
Echinodermata	Asteroidea	*Pycnopodia helianthoides*	0.01	0.10	0.01
Echinodermata	Asteroidea	*Rathbunaster californicus*	16.90	47.13	11.38
Echinodermata	Asteroidea	*Solaster borealis*	0.40	1.16	0.27
Echinodermata	Asteroidea	*Stylasterias forreri*	0.65	1.88	0.44
Echinodermata	Crinoidea	*Florametra serratissima*	0.10	0.43	0.07
Echinodermata	Echinoidea	*Allocentrotus fragilis*	13.31	40.37	8.96
Echinodermata	Echinoidea	*Brisaster*	0.12	0.41	0.08
Echinodermata	Holothuroidea	Holothuroidea	0.01	0.10	0.01
Echinodermata	Holothuroidea	*Pannychia moseleyi*	1.32	11.96	0.89
Echinodermata	Holothuroidea	*Parastichopus californicus*	0.01	0.10	0.01
Echinodermata	Holothuroidea	*Parastichopus johnsoni*	0.11	0.74	0.07
Echinodermata	Holothuroidea	*Parastichopus leukothele*	1.90	5.47	1.28
Echinodermata	Holothuroidea	*Psolus squamatus*	8.48	53.08	5.71
Echinodermata	Ophiuroidea	*Asteronyx*	0.05	0.27	0.04
Echinodermata	Ophiuroidea	Ophiuroidea	7.22	33.77	4.86
Echiura	Echiura	Echiura	0.03	0.18	0.02
Mollusca	Cephalopoda	Octopoda	0.07	0.44	0.05
Mollusca	Cephalopoda	*Octopus rubescens*	0.11	0.53	0.08
Mollusca	Gastropoda	*Calliostoma platinum*	0.37	1.68	0.25
Mollusca	Gastropoda	Gastropoda	5.31	14.10	3.58
Mollusca	Gastropoda	Gastropoda sp.3	0.11	0.73	0.07
Mollusca	Gastropoda	*Neptunea*	0.82	2.37	0.55
Mollusca	Gastropoda	Nudibranchia	0.03	0.23	0.02
Mollusca	Gastropoda	Nudibranchia sp.1	0.01	0.09	0.01
Mollusca	Gastropoda	*Pleurobranchaea californica*	0.06	0.29	0.04
Mollusca	Gastropoda	*Tritonia diomedea*	0.01	0.10	0.01
Osteichthyes	Agonidae	Agonidae	0.24	0.70	0.16
Osteichthyes	Agonidae	*Xeneretmus*	0.05	0.42	0.04
Osteichthyes	Alepocephalidae	*Alepocephalus tenebrosus*	0.01	0.10	0.01
Osteichthyes	Anoplopomatidae	*Anoplopoma fimbria*	0.04	0.25	0.03

Phylum	**Major Group**	**Taxa**	**Density**	**SD**	**%**
Osteichthyes	Embiotocidae	*Zalembius rosaceus*	0.01	0.10	0.01
Osteichthyes	Hexagrammidae	*Ophiodon elongatus*	0.01	0.12	0.01
Osteichthyes	Liparidae	*Careproctus melanurus*	0.06	0.46	0.04
Osteichthyes	Liparidae	Liparidae	0.02	0.14	0.01
Osteichthyes	Macrouridae	*Coryphaenoides acrolepis*	0.13	0.78	0.09
Osteichthyes	Merlucciidae	*Merluccius productus*	0.25	1.47	0.17
Osteichthyes	Moridae	*Antimora microlepis*	0.06	0.32	0.04
Osteichthyes	Ophidiidae	*Bothrocara brunneum*	0.02	0.21	0.01
Osteichthyes	Ophidiidae	*Ophidion scrippsae*	0.02	0.15	0.02
Osteichthyes	Osmeridae	Osmeridae	0.01	0.11	0.01
Osteichthyes	Osteichthyes	Osteichthyes	0.76	3.18	0.51
Osteichthyes	Pleuronectiformes	*Embassichthys bathybius*	0.11	0.40	0.07
Osteichthyes	Pleuronectiformes	*Glyptocephalus zachirus*	0.82	2.04	0.55
Osteichthyes	Pleuronectiformes	*Lyopsetta exilis*	0.01	0.10	0.01
Osteichthyes	Pleuronectiformes	*Microstomus pacificus*	0.50	1.43	0.34
Osteichthyes	Pleuronectiformes	Pleuronectiformes	2.00	4.02	1.35
Osteichthyes	Scorpaenidae	*Sebastes*	1.93	10.32	1.30
Osteichthyes	Scorpaenidae	*Sebastes aurora*	0.08	0.45	0.06
Osteichthyes	Scorpaenidae	*Sebastes diploproa*	0.96	3.42	0.65
Osteichthyes	Scorpaenidae	*Sebastes paucispinis*	0.02	0.21	0.01
Osteichthyes	Scorpaenidae	*Sebastes rosenblatti*	0.01	0.10	0.01
Osteichthyes	Scorpaenidae	*Sebastes rubrivinctus*	0.01	0.12	0.01
Osteichthyes	Scorpaenidae	*Sebastes saxicola*	0.07	0.72	0.05
Osteichthyes	Scorpaenidae	*Sebastolobus*	2.21	3.96	1.49
Osteichthyes	Scorpaenidae	*Sebastomus* complex	0.01	0.10	0.01
Osteichthyes	Stichaeidae	*Lumpenus sagitta*	0.11	0.50	0.07
Osteichthyes	Torpedinidae	*Torpedo californica*	0.01	0.10	0.01
Osteichthyes	Zaniolepididae	Zaniolepididae	0.07	0.39	0.05
Osteichthyes	Zoarcidae	*Lycenchelys camchatica*	0.91	2.75	0.62
Osteichthyes	Zoarcidae	*Lycodapus*	0.08	0.57	0.05
Osteichthyes	Zoarcidae	*Lycodes cortezianus*	0.29	0.77	0.19
Osteichthyes	Zoarcidae	*Lycodes diapterus*	0.03	0.21	0.02
Osteichthyes	Zoarcidae	*Lyconema barbatum*	0.01	0.10	0.01
Osteichthyes	Zoarcidae	Zoarcidae	0.03	0.18	0.02
Porifera	Porifera	*Asbestopluma*	0.05	0.53	0.04
Porifera	Porifera	Porifera	1.69	5.42	1.14
Urochordata	Urochordata	*Megalodicopia hians*	0.02	0.14	0.01
Total, all taxa			**148.47**	**131.94**	**100.00**

Appendix 3. Sediment core samples collected during the MARS Cable survey, 2007-2008. Depth indicated in meters.

Sample	Depth	Station	Type	Date	Latitude	Longitude	Comment
V3165-C02	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	
V3165-C17	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	
V3165-C23	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	
V3165-C24	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	
V3165-C28	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	extra
V3165-C40	400	NC-1	Macrofauna	1/30/2008	36.788670	-122.116560	
V3165-C10	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	extra
V3165-C31	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	
V3165-C33	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	
V3165-C34	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	
V3165-C37	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	
V3165-C39	200	NC-2	Macrofauna	1/30/2008	36.798840	-122.107930	
V3162-C16	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	extra
V3162-C20	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	
V3162-C22	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	
V3162-C26	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	
V3162-C32	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	
V3162-C36	360	NC-3	Macrofauna	1/24/2008	36.842590	-122.187070	
V3167-C09	324	NI-1A	Macrofauna	1/31/2008	36.834352	-122.170323	
V3167-C16	324	NI-1A	Macrofauna	1/31/2008	36.834352	-122.170323	
V3167-C21	324	NI-1A	Macrofauna	1/31/2008	36.834352	-122.170323	
V3167-C25	324	NI-1A	Macrofauna	1/31/2008	36.834352	-122.170323	
V3167-C32	324	NI-1A	Macrofauna	1/31/2008	36.834352	-122.170323	
V3135-C29	88	SC-1	Macrofauna	11/30/2007	36.714237	-121.909300	
V3135-C31	88	SC-1	Macrofauna	11/30/2007	36.715420	-121.908850	
V3135-C33	88	SC-1	Macrofauna	11/30/2007	36.714290	-121.909004	
V3135-C35	88	SC-1	Macrofauna	11/30/2007	36.714220	-121.908160	
V3135-C39	88	SC-1	Macrofauna	11/30/2007	36.713783	-121.907860	
V3134-C04	86	SC-2	Macrofauna	11/30/2007	36.821796	-121.945610	
V3134-C23	86	SC-2	Macrofauna	11/30/2007	36.822098	-121.945680	
V3134-C24	86	SC-2	Macrofauna	11/30/2007	36.822850	-121.945175	extra
V3134-C26	86	SC-2	Macrofauna	11/30/2007	36.823080	-121.944670	
V3134-C27	86	SC-2	Macrofauna	11/30/2007	36.823370	-121.944730	
V3134-C32	86	SC-2	Macrofauna	11/30/2007	36.823883	-121.945390	
V3166-C05	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	
V3166-C11	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	
V3166-C12	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	extra
V3166-C14	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	

Sample	Depth	Station	Type	Date	Latitude	Longitude	Comment
V3166-C18	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	
V3166-C38	89	SC-3	Macrofauna	1/30/2008	36.877770	-122.121320	
V3161-C02	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	extra
V3161-C05	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	
V3161-C08	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	
V3161-C09	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	
V3161-C11	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	
V3161-C15	89	SI-1A	Macrofauna	1/23/2008	36.863070	-122.096550	
V3147-C11	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3147-C14	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3147-C17	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3147-C23	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3147-C24	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3147-C27	1000	SLC-1	Macrofauna	1/7/2008	36.744930	-122.277850	
V3160-C06	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	
V3160-C13	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	extra
V3160-C17	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	
V3160-C18	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	
V3160-C28	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	
V3160-C35	820	SLC-2	Macrofauna	1/23/2008	36.749540	-122.197410	
V3148-C02	893	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3148-C04	885	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3148-C05	891	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3148-C07	884	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3148-C08	891	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3148-C09	896	SLC-3	Macrofauna	1/8/2008	36.706360	-122.166440	
V3136-C21	877.66	SLI-1	Macrofauna	12/6/2007	36.712677	-122.187160	
V3136-C22	872.59	SLI-1	Macrofauna	12/6/2007	36.713020	-122.185814	
V3136-C26	874.46	SLI-1	Macrofauna	12/6/2007	36.712856	-122.186360	extra
V3136-C29	876.71	SLI-1	Macrofauna	12/6/2007	36.712910	-122.187080	
V3136-C33	874.72	SLI-1	Macrofauna	12/6/2007	36.713290	-122.187400	
V3136-C34	875.98	SLI-1	Macrofauna	12/6/2007	36.712753	-122.186745	
V3165-C08	400	NC-1	Tracer	1/30/2008	36.788670	-122.116560	
V3165-C15	400	NC-1	Tracer	1/30/2008	36.788670	-122.116560	
V3165-C35	400	NC-1	Tracer	1/30/2008	36.788670	-122.116560	
V3165-C03	200	NC-2	Tracer	1/30/2008	36.798840	-122.107930	
V3165-C29	200	NC-2	Tracer	1/30/2008	36.798840	-122.107930	
V3165-C30	200	NC-2	Tracer	1/30/2008	36.798840	-122.107930	
V3162-C19	360	NC-3	Tracer	1/24/2008	36.842590	-122.187070	
V3162-C25	360	NC-3	Tracer	1/24/2008	36.842590	-122.187070	
V3162-C27	360	NC-3	Tracer	1/24/2008	36.842590	-122.187070	

Sample	Depth	Station	Type	Date	Latitude	Longitude	Comment
V3167-C20	324	NI-1A	Tracer	1/31/2008	36.834352	-122.170323	
V3167-C22	324	NI-1A	Tracer	1/31/2008	36.834352	-122.170323	
V3167-C36	324	NI-1A	Tracer	1/31/2008	36.834352	-122.170323	
V3135-C30	88	SC-1	Tracer	11/30/2007	36.715400	-121.908930	
V3135-C34	88	SC-1	Tracer	11/30/2007	36.714413	-121.908966	
V3135-C38	88	SC-1	Tracer	11/30/2007	36.713850	-121.907920	
V3134-C02	86	SC-2	Tracer	11/30/2007	36.822210	-121.945710	
V3134-C25	86	SC-2	Tracer	11/30/2007	36.822853	-121.945170	
V3134-C28	86	SC-2	Tracer	11/30/2007	36.823875	-121.945370	
V3166-C04	89	SC-3	Tracer	1/30/2008	36.877770	-122.121320	
V3166-C06	89	SC-3	Tracer	1/30/2008	36.877770	-122.121320	
V3166-C07	89	SC-3	Tracer	1/30/2008	36.877770	-122.121320	
V3161-C04	89	SI-1A	Tracer	1/23/2008	36.863070	-122.096550	
V3161-C24	89	SI-1A	Tracer	1/23/2008	36.863070	-122.096550	
V3161-C40	89	SI-1A	Tracer	1/23/2008	36.863070	-122.096550	
V3147-C13	1000	SLC-1	Tracer	1/7/2008	36.744930	-122.277850	
V3147-C15	1000	SLC-1	Tracer	1/7/2008	36.744930	-122.277850	
V3147-C28	1000	SLC-1	Tracer	1/7/2008	36.744930	-122.277850	
V3160-C12	820	SLC-2	Tracer	1/23/2008	36.749540	-122.197410	
V3160-C14	820	SLC-2	Tracer	1/23/2008	36.749540	-122.197410	
V3160-C23	820	SLC-2	Tracer	1/23/2008	36.749540	-122.197410	
V3148-C03	891	SLC-3	Tracer	1/8/2008	36.706360	-122.166440	
V3148-C06	891	SLC-3	Tracer	1/8/2008	36.706360	-122.166440	
V3148-C12	891	SLC-3	Tracer	1/8/2008	36.706360	-122.166440	
V3136-C25	877.68	SLI-1	Tracer	12/6/2007	36.712597	-122.187040	
V3136-C30	874.46	SLI-1	Tracer	12/6/2007	36.712880	-122.186360	
V3136-C37	874.69	SLI-1	Tracer	12/6/2007	36.713290	-122.187570	
V3136-A07	878	SLI-1	Actiniaria sp. 1	12/6/2007	36.712560	-122.186950	voucher
V3162-C19	360	NC-3	Enteropneusta?	1/24/2008	36.842590	-122.187070	voucher
V3136-A03	878	SLI-1	Gastropoda	12/6/2007	36.712322	-122.186770	voucher
V3136-A02	878	SLI-1	Mesomyaria	12/6/2007	36.712260	-122.186870	voucher
V3136-A06	878	SLI-1	Pennatulacea (red)	12/6/2007	36.712660	-122.187096	voucher
V3136-A04	878	SLI-1	Pennatulacea (white)	12/6/2007	36.712326	-122.186740	voucher
V3136-A01	879	SLI-1	Solaster	12/6/2007	36.712337	-122.186830	voucher
V3136-A05	878	SLI-1	Stomphia	12/6/2007	36.712654	-122.187096	voucher