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Acoustic scattering from zooplankton and micronekton in relation to a whale feeding site near Georges Bank and Cape Cod

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Abstract—This research was part of the South Channel Ocean Productivity Experiment (SCO

PEX), a multidisciplinary study to investigate the biological and physical processes associated with the very high annual springtime abundance of right whales (*Eubalaena glacialis*) in the Great South

small region in the northern part of the GSC. Virtually the entire known northwest
Atlantic population of the right whale (*Eubalaena glacialis*), an endangered species, may
be found within the GSC at this time (KENNEY *et al.*, 1995). We hypothesized that this

and/or degree of aggregation of their principal prey, the copepod *Calanus finmarchicus*.
The purpose of the SCOPEX project was to investigate the interactions between right

copepods and also be capable of censusing other targets at the depth ranges anticipated. This frequency had been used effectively to detect large copepods (BARRACLOUGH *et al.*, 1969) and *C. finmarchicus* in the Gulf of Maine (KOSLOW, personal communication). We used this frequency in all three studies and were able to detect layers of copepods and other targets as small as 1 mm where they were abundant (more than 100 individuals per m^3). In

Classified

Case	ID	GMT	WNW	DN	Dive	CPK	CPZ	EUP	EUZ	CP50	EU50	AZ	ACOUS
1	M706	123.05	N	N	d	3523	5	34	51	3253	34	11	2100
2	M707	123.15	N	D	d	1062	28	5	25	1062	5	12	970
3	M713	125.17	N	N	d	2116	2	66	90	2116	0	14	1740
4	M714	126.05	N	D	d	2339	3	1188	19	2339	1188	13	2400
5	M715	127.17	W	N	D	2472	83	47	24	80	47	8	24,020
6	M717	129.02	W	D	D	4591	24	0	99	4591	0	15	25,120

1988
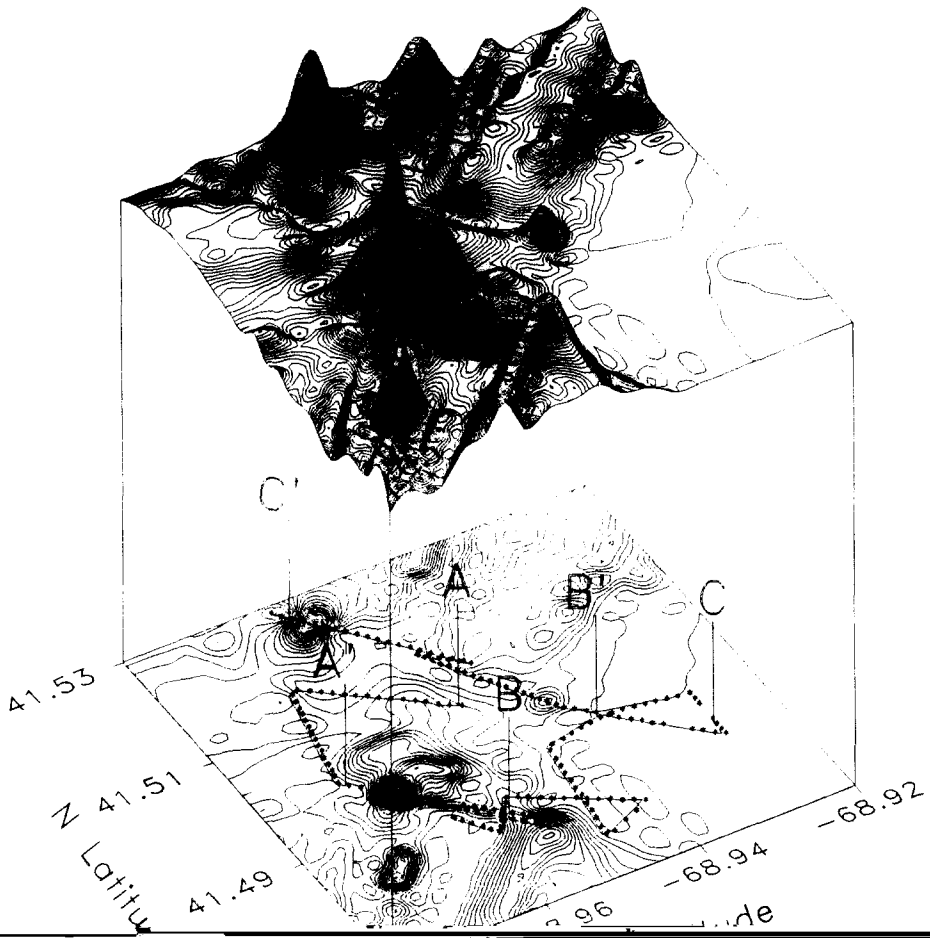
Fig. 10. Distribution of copepods and tagged whale track showing the relation of a tagged right

Spectral Density

Cycles/kilometer

Autocorrelation

Table 5. *Dendrogram of clusters formed using copepod density (CPK) and acoustic biomass (ACOUS). Data used were from Table 2. Distances computed using standardized data (z-transform) single linkage method*

L	N	N	N	N	N	N	N	N	W	W	W	W	W	W
A	W	W	W	W	W	W	W	W						
B	M	M	M	M	M	M	M	M	M	M	M	M	M	M
E	7	9	9	7	7	9	9	7	9	9	9	9	7	7
L	0	3	2	1	1	0	0	0	1	1	3	3	1	1
	6	2	7	3	4	2	3	7	5	2	5	4	7	5

Distance
0.089
0.103
0.189
0.218
0.234
0.266
0.270
0.604
1.097
1.304
1.539
1.951
2.026

Cluster 1 of 2 contains 5 cases   Average distance 1.200
Cluster 2 of 2 contains 9 cases   Average distance 0.563

Cluster means

	Size	COK	ACOUS
1	5	7006.6	21.9880
2	9	2250.3	2.1747

Cluster standard deviations

| 1 | | 3942.88 | 8.9830 |
| 2 | | 1417.46 | 0.7427 |

F-Ratio	11.15	46.279
P-Value	0.006	0.000
D.F.	1 12	1 12

D.F. = degrees of freedom.

For further discussion of the use of discriminant functions, see LACHENBRUCH and MICKEY

Table 8. Discriminant function analysis of biomass parameters using data classified as whale or non-whale to

Table 9. Discriminant function analysis of biomass parameters using data classified as whale or non-whale to develop the discriminant function and then testing it on additional observations. The variables used were CPK,

SEGC *were excluded because they had no matching copepod data*

Variable entered	CPK

	REMOVE				ENTER	
	DF = 1	12	*		DF = 1	11
CPK	4.45		*	7 EUP	0.05	

provide a similar view of the distribution of copepods, though somewhat different in

device. For example, net estimates of biomass are derived from large volumes of water, but acoustic estimates are from a smaller volume (200 m^3 or more for nets and 60–100 m^3 for acoustic samples).

The estimated range of error associated with target strength is about ±3 dB (between models and measured values for the same size target). This is equivalent to a product/ quotient factor of 2 (or 1/2) times the acoustically estimated biomass. Our experience with a large variety of horizontal and vertical net haul replicates indicates that a product/ quotient factor of 1 to several times net catch biomasses is commonly encountered

in distribution of copepods observed in the frontal region of this small scale study may represent examples of both dispersing and concentrating factors dominating to different degrees.

Evidence for right whales modifying their behavior in response to changes in scale factors of copepod patches was examined by spectral analysis of the hydroacoustic data

changes in direction (shown by the shape of the cruise track as the ship stayed some

(*Euphausia superba*) swarms from Elephant Island and Bransfield Strait. Special Issue **4** of *Journal of Crustacean Biology*, pp. 16–44.