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COMMENTS ON EFFICIENCY OF NEFC MARMAP SURVEYS

by

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Since late 1976, with implementation of the MARMAP program in its present form, approximately six cruises per year have been conducted in the Gulf of Maine, Georges Bank, southern New England, and Middle Atlantic Bight waters (Figure 1). These surveys are designed to sample or measure ichthyoplankton, zooplankton, and chlorophyll-a density, various hydrographic parameters, and primary production.

Now that some data resulting from these cruises have been analyzed it is reasonable to try and address some of the questions which always arise over such large-scale programs; namely, is sampling (in area and time) insufficient, adequate, or excessive in the attempt to attain major goals of the design? Such introspection is timely in light of present financial constraints, both real and feared, on federal budgets. Since my experience is limited, then my response to that question is also limited. I can only respond to the question of sampling adequacy as it relates to the distribution and abundance of fish eggs and larvae. I feel this is proper, as well as timely, and invite additional discussion of this perennial problem from workers in other disciplines involved in the MARMAP surveys.

The above question (concerning adequacy of sampling) can be addressed from three approaches, concerning the adequacy of: 1) geographic coverage; 2) sampling frequency over time, i.e. the time interval between cruises; and 3) the number of stations sampled on a cruise. My comments here are confined to the first of these three items, geographic coverage.

At the inception of any large-scale survey, such as those under MARMAP, investigators have to sample some areas out of ignorance in order to be sure of good geographic coverage of unknown spawning areas. If it later turns out that sampling, data handling, and analysis are too costly for the amount of information gained from certain areas, then perhaps the geographic coverage should be re-evaluated with possible reductions in mind. The question becomes: Can some areas sampled be eliminated, either partially or entirely in order to maximize the information gained from the resources expended? In the case of these surveys: Do we more than adequately cover spawning areas of the species of interest; or, are there areas which contribute only insignificantly to the total abundance estimate?

The accompanying tables list the relative amounts of information we have gained from four geographic areas for various species as eggs or larvae (Tables 1-4). Obviously the tables are incomplete - not all years are represented for all species; furthermore, and more importantly, not all species of interest are presented - the data were not yet available. Species omitted which would be of interest include butterfish, bluefish, summer flounder, and possibly weakfish, redfish, scup, and hakes (*Urophycis* sp.). In the setting up of these tables some information from certain surveys was necessarily omitted. I only included data when all four subareas

had been sampled; thus incomplete surveys were excluded from this compilation. In evaluation of the amount of information gained for a given species, it is important to compare the tabulated percent abundance against the percentages of area, stations, and survey time which each subarea comprises within the total MARMAP survey. These latter three values are given on the tables.

The Gulf of Maine appears to be quite important to the abundance estimate of herring and marginally so for silver hake and mackerel. For these three species the western portion within the Gulf of Maine contributed most occurrences while the central portion was generally quite void of eggs and larvae. The Gulf of Maine would undoubtedly be important to a census of redfish larvae also.

Georges Bank is important to abundance estimates of all species considered with the possible exception of mackerel. This area would probably figure prominently in a census of butterfish eggs and larvae.

Southern New England waters also appear to be important spawning and nursery areas for most species tabulated, except for herring. Cod and haddock vary from year-to-year in their utilization of these waters, formerly being more abundant than recently. In addition to those tabulated, this area would probably be important to census work for eggs and larvae of butterfish, bluefish, summer flounder, and weakfish.

The Middle Atlantic Bight is important to mackerel, and in some years to yellowtail flounder. This area can be expected to be important to census work on butterfish, bluefish, weakfish, and summer flounder. The high percentages under "all spp." for both eggs and larvae are heavily augmented in this area by anchovies, sea robins, hakes, bothid flatfishes, and cunner.

It is apparent from the above that each of the above geographic subareas sampled is important to some species of interest. Coverage appears to be adequate for spawning population estimates of Atlantic mackerel, yellowtail flounder, bluefish, butterfish, cod, haddock, summer flounder, herring, and sand lance. The only part of the MARMAP survey area which appears to be relatively non-productive of information is the central and north-eastern portions of the Gulf of Maine. It might be reasonable to reduce sampling intensity in that area. For two species of interest the areal coverage appears to be inadequate. We do not sample shorward enough to completely cover the spawning area of weakfish. Nor do we sample far enough seaward to completely describe the spawning area of silver hake. While we might consider a slight seaward extension of the survey area in order to adequately sample silver hake, it would be very difficult if not impossible to fully describe the spawning area of weakfish which spawns in bays and sounds as well as the near shore area of the continental shelf.

Table 1. Abundance in Gulf of Maine* waters, as percent of abundance in a total MARMAP survey.

	Spawning season ending in						
	1974	1975	1976	1977	1978	1979	1980
Eggs							
All spp.				7.8	10.6	5.8	
Limanda ferruginea				6.6			
Merluccius bilinearis						18.3	
Scomber scombrus				1.8			
Larvae							
All spp.				2.8	3.9	8.2	
Ammodytes sp.		3.2	3.0	0.2	3.4	2.5	
Clupea harengus					60.8	70.7	99.6
Gadus morhua		1.1		6.1	1.9	17.6	9.7
Limanda ferruginea				3.3	9.6	4.8	1.4
Melanogrammus aeglefinus	1.1	0.5	2.1	5.3	1.6	16.2	5.9
Merluccius bilinearis				0.5	6.0	19.8	
Scomber scombrus				5.4	30.9	2.1	

*The Gulf of Maine subarea comprised 38% of the area, 29% of the stations and approximately 32% of the sampling time within a total MARMAP survey.

Table 2. Abundance in Georges Bank* waters, as percent of abundance in a total MARMAP survey.

	Spawning season ending in						
	1974	1975	1976	1977	1978	1979	1980
Eggs							
All spp.				22.3	32.8	25.7	
Limanda ferruginea				36.4			
Merluccius bilinearis						37.8	
Scomber scombrus				0.7			
Larvae							
All spp.				28.2	13.3	18.8	
Ammodytes sp.		32.7	68.5	3.4	1.4	18.1	
Clupea harengus					30.9	28.3	0.1
Gadus morhua	24.3	66.9	47.1	85.0	95.3	72.4	87.5
Limanda ferruginea				23.2	48.7	42.3	25.6
Melanogrammus aeglefinus	44.7	53.6	96.1	84.7	98.4	75.2	88.0
Merluccius bilinearis				66.4	48.6	54.4	
Scomber scombrus				0.6	32.0	0.7	

*The Georges Bank subarea comprises 16% of the area, 16% of the stations, and approximately 17% of the sampling time in a total MARMAP survey.

Table 3. Abundance in southern New England* waters, as percent of abundance in a total MARMAP survey.

	Spawning season ending in						
	1974	1975	1976	1977	1978	1979	1980
Eggs							
All spp.				51.9	29.9	49.4	
Limanda ferruginea				55.5			
Merluccius bilinearis						33.1	
Scomber scombrus				89.7			
Larvae							
All spp.				56.4	44.3	34.2	
Ammodytes sp.		30.5	23.2	86.0	52.3	44.0	
Clupea harengus					8.3	1.0	0.3
Gadus morhua	69.8	19.7	39.7	8.2	1.5	7.8	2.6
Limanda ferruginea				49.9	39.7	44.5	67.4
Melanogrammus aeglefinus	54.2	45.9	1.7	9.9		8.7	6.1
Merluccius bilinearis				32.9	42.9	22.6	
Scomber scombrus				41.0	32.9	71.1	

*The southern New England subarea comprises 23% of the area, 25% of the stations and approximately 24% of the sampling time within a total MARMAP survey.

Table 4. Abundance in Middle Atlantic Bight* waters, as percent of abundance in a total MARMAP survey.

	Spawning season ending in						
	1974	1975	1976	1977	1978	1979	1980
Eggs							
All spp.				18.0	26.7	19.2	
Limanda ferruginea				1.5			
Merluccius bilinearis						10.8	
Scomber scombrus				7.8			
Larvae							
All spp.				12.6	38.5	38.8	
Ammodytes sp.		33.6	5.3	10.4	42.9	35.4	
Clupea harengus							
Gadus morhua	5.9	12.3	13.2	0.6	1.2	2.2	0.1
Limanda ferruginea				23.6	2.0	8.3	5.6
Melanogrammus aeglefinus							
Merluccius bilinearis				0.2	2.5	3.2	
Scomber scombrus				53.0	4.2	26.1	

*The Middle Atlantic Bight subarea comprises 23% of the area, 29% of the stations and approximately 28% of the sampling time within a total MARMAP survey.

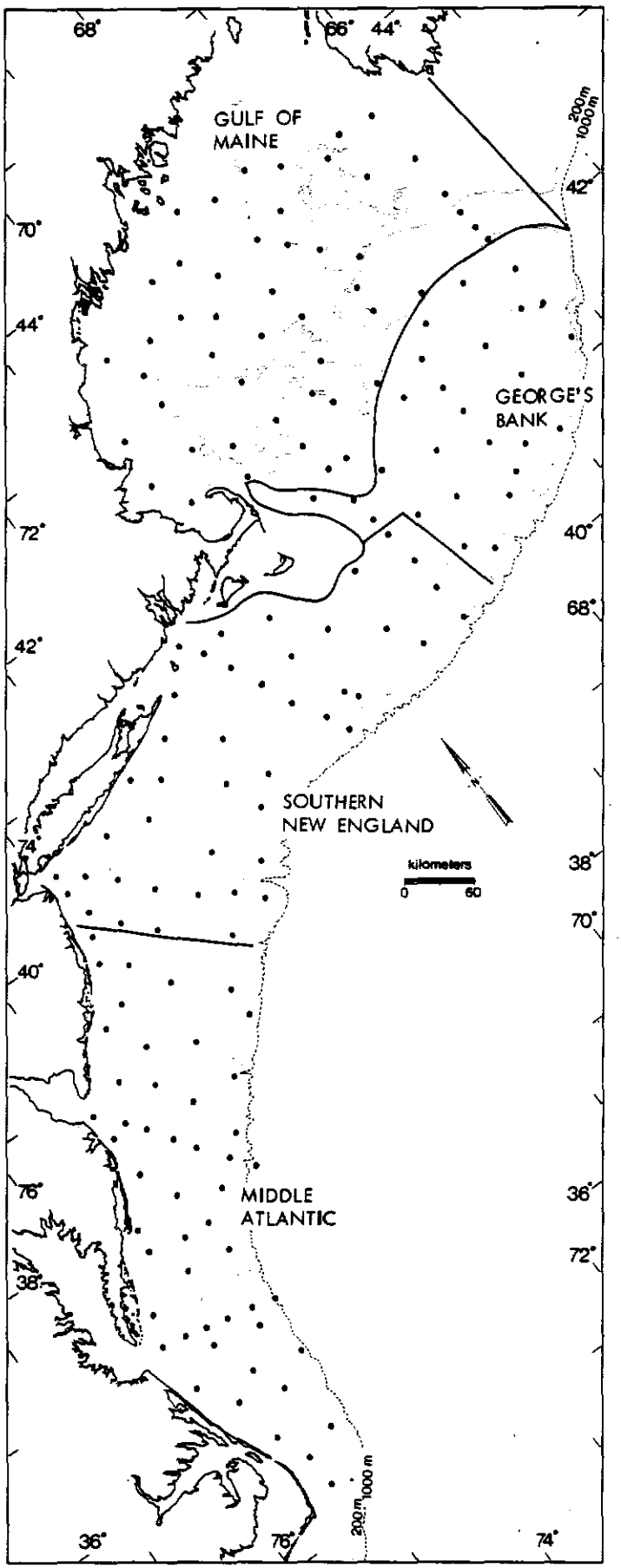

Figure 1. MARMAP survey area, showing subareas and sampling stations.