8. Macrobenthos (polychaetes, crustaceans, mollusks, other)

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Background

Macrobenthos are defined as invertebrates living in or on the sediments that are quantitatively sampled by a 0.1 m^2 Smith McIntyre grab and are retained on a 1.0 mm or 0.5 mm sieve. In the NEFSC, a 1.0 mm sieve was used until the middle of 1979 and a 0.5 mm sieve was used thereafter. Wet weight biomasses were determined for each species in a sample by blot-drying the species collections on absorbent paper towels for about three minutes and weighing them to the nearest mg (Holme and McIntyre 1984). Wet weight biomasses include the shell in molluscs, the carapaces in crustaceans, and the tests in echinoderms. For EMAX, the macrobenthos were separated into four major taxonomic groups (polychaetes, crustaceans, molluscs, and other) that will occupy separate network compartments. The macrobenthos group "other" contains the echinoderms, nemerteans, tunicates, and coelenterates.

The specific feeding mechanisms for many benthic invertebrates in nature are uncertain. For example, polychaetes with well-developed jaws and eyes were found in field surveys to have their fecal matter packed with algal cells and enzymes in their gut capable of digesting cellulose (Warwick *et al.* 1979). Many spionid polychaetes are surface deposit feeders under low flow conditions but switch to filter feeding under high flow conditions (Dauer *et al.* 1981). In general, the polychaetes on the Northeast U.S. Continental Shelf Ecosystem are deposit feeders, filter feeders, omnivores and carnivores. The bivalve molluscs such as *Arctica islandica, Spisula solidissima*, and *Pitar morrhuanus* are filter feeders but the bivalves *Nucula proxima* and *Tellina agilis* are deposit feeders. Gastropod molluscs are generally carnivores and scavengers. The crustaceans are carnivores, scavengers, deposit feeders, filter feeders and omnivores. The nemerteans are generally carnivores, while the tunicates are filter feeders. Although the coelenterates are mostly carnivores, the smaller Cerianthids (a dominant coelenterate in our collections) are considered suspension feeders on live and dead material. Sand dollars are a dominant echinoderm in the NEUS Ecosystem and are deposit and suspension feeders. The sea cucumber, *Molpadia oolitica*, is locally abundant in the GOM and is a deposit feeder. Brittle stars are particle feeders and sea stars are carnivores (Caracciolo and Steimle 1983).

Species Lists

Over 2,000 benthic invertebrate species have been identified in the NEFSC surveys in the NEUS Ecosystem and their individual biomasses have contributed to the total biomass of the taxonomic groups in the four EMAX regions. The species listed in Table 8.1 include the 10 dominant taxa in terms of total biomass from each of the taxonomic groups in each geographic region.

Data Sources

Since no benthic data were available for the EMAX regions between 1996 and 2000, we used historical data contained in the Oracle table BENCAT (Benthic Survey Catch database, NEFSC) to estimate biomass for the four macrobenthos taxonomic groups in the EMAX regions. BENCAT includes grab data from a number of surveys conducted by the NEFSC in the NEUS coastal and shelf waters over the past 40 years. These included Wigley and Theroux benthic sampling between 1956 – 1964; Ocean Pulse and Northeast Monitoring Program 1979-1985; and the 12 Mile Dump Site Study 1986-1989 (Wigley and Theroux 1981; Steimle 1990; Reid *et al.* 1991; Theroux and Wigley, 1998).

Quantitative Approach for Biomass Estimates

The total wet weight biomass for each taxonomic group (polychaetes, crustaceans, molluscs, and others) within a grab sample was summed for all grab samples within a specific geographic region (GOM, GB, SNE and MAB) over all years. This value was divided by the total number of grab samples taken within the specific geographic region over all years. Only those grabs where biomass data were available were used to calculate this total. This result is an estimate of the average wet weight biomass in g 0.1 m^{-2} for the specific taxonomic group in the specific geographic region over all years. This value was multiplied by 10 to extrapolate the estimate from the area of the grab (0.1 m^{-2}) to a square meter.

Example Results

The biomass estimates for the taxonomic groups in each of the EMAX regions (Figure 8.1) are comparable to previously published biomass estimates for the same regions, e.g., Wigley and Theroux benthic sampling between 1956 – 1964 (Wigley and Theroux 1981; Theroux and Wigley 1998) and Ocean Pulse (Steimle 1990).

The biomass estimates for macrobenthos on the NEUS Continental Shelf Ecosystem (Figure 8.1) are subject to a number of possible errors. There were differences among the four geographic regions in the total number of data points (grab samples) that were used to estimate biomass values for the entire geographic region. The total number of Smith McIntyre grab samples taken from each of the geographic regions break down as follows: GOM = 330, GB = 344, SNE = 1,648, and MAB = 487. There were also differences in the temporal and spatial distribution of the grab samples within each of the geographic regions. It is well known that the abundances and biomasses of individual marine benthic invertebrate species can be highly variable in both time and space. Thus it cannot be certain if the biomass values (Figure 8.1) are an accurate estimate of the biomasses for the entire geographic region or are representative of the biomasses for the four taxonomic groups between 1996 and 2000 (the time period being modeled in EMAX). However, Steimle (1990) suggests a long-term stability in overall biomass on the NEUS Ecosystem based on data from the Ocean Pulse surveys. Another source of error was the use of different sieve sizes to process the samples in the various surveys. Theroux and Wigley (1998) used a 1.0 mm sieve and Reid *et al.* (1991) used a 0.5 mm sieve. The Ocean Pulse monitoring surveys (Steimle 1990) used a 1.0 mm sieve from 1978 until the first half of 1979 and a 0.5 mm sieve thereafter. Steimle (1990) compared the retention efficiency between the 1.0 mm and 0.5 mm sieves. On average, the 0.5 mm sieve retained only 4% greater biomass than the 1.0 mm sieve. Since this difference is low, no adjustments were made to the biomass estimates.

A number of other possible errors were identified in the macrobenthos biomass estimates. For a number of invertebrate species on the NEUS Ecosystem, there was overlap in the biomass data between the macrobenthos, sampled by Smith McIntyre grab, and the megabenthos, sampled by scallop dredge, otter trawl, and the Campbell grab. Since the Smith McIntyre grab does not quantitatively sample larger mobile invertebrates very well, we made the following adjustments to the macrobenthos biomass estimates to eliminate this overlap. The biomasses for decapod crabs were subtracted out of the biomass estimate for macrobenthos - crustaceans, the biomasses of *Arctica islandica* and *Spisula solidissima* were subtracted out of the biomass estimate for macrobenthos - molluscs, and the biomasses for the asteroids (starfish) were subtracted out of the biomass estimate for macrobenthos - other. The biomass data for all these taxa will be included in the megabenthos compartments. In another situation, the total biomass for an unknown bivalve species in one grab sample from the MAB was 0.5 the total biomass for all molluscs in all 487 grab samples in that region. This one grab contained 12,000 bivalve individuals with a biomass of 3,242 grams. It is unknown if these data are real or if there is a data entry error. Since the data from this one grab collected from the offshore waters near the Chesapeake Bay would have heavily influenced the biomass estimate for molluscs over the entire MAB region, we decided to eliminate the data from this grab in the biomass calculation.

Method for Estimating Annual Macrobenthos Production

A number of studies (Wildish 1984; Collie 1985; Steimle 1989; Steimle *et al.* 1990; Maurer *et al.* 1992; Seitz and Schaffner 1995; Sarda *et al.* 2000) have directly measured the production of benthic invertebrate species populations along the NEUS coast. Of these studies, Collie (1985); Steimle (1989); and Steimle *et al.* (1990) have measured production in the open waters of the NEUS Ecosystem within the EMAX geographic regions. The species for which production estimates have been made represent a small fraction of the important species in terms of biomass in the four EMAX geographic regions (see Table 8.1). Direct production measurements are costly and labor intensive.

Since production data are not available even for the most common species of the NEUS Ecosystem, the general relationship between production and biomass, the P:B ratio, was used to estimate production for each of the taxonomic groups (polychaetes, crustaceans, molluscs, and others) in each of the geographic regions. To help with the decision regarding the best P:B ratios to use for the EMAX network, we relied extensively on Steimle (1985; 1987), the studies listed in the first paragraph, and Brey (1990), Cartes *et al.* (2002), Steimle *et al.* (2002) and others. Steimle (1985; 1987) determined the most appropriate P:B ratios to use for a number of taxonomic groups on Georges Bank and the NY Bight based on published P:B ratios from the direct production studies of species from the NEUS Ecosystem and on production studies of similar species at similar latitudes from around the world. The specific P:B ratios used to calculate production for the macrobenthos compartments in the EMAX network (Table 8.2) were determined based on the dominant species in each taxonomic group within each geographic region (Table 8.1).

The use of P:B ratios to estimate production is subject to a number of general errors as well as errors specific to its use in the EMAX network. The production of a given invertebrate population at a given site is dependent on the annual temperature regime, the quality and quantity of food influx, the size of the individuals in the population, life span, and most likely other environmental and biological variables. The P:B ratio does not account for these variables (Steimle 1990; Brey *et al.*, 1996; and Sarda 2000). In the EMAX network, the P:B ratio is applied to all species in a given taxonomic group and all habitats within a wide geographic region to estimate production over that entire region.

Consumption

Background

Consumption rates have been measured for only a few benthic invertebrate species, and most measurements have been conducted under laboratory conditions and for filter feeding bivalves. There are no measurements of consumption rates for the benthic invertebrates in the four EMAX regions. Both Valiela (1995) and Dame (1996) estimated ecological efficiency (P:C) at approximately 10% based on literature values for invertebrates and bivalves, respectively.

Quantitative Approach for Estimates

We used P:C = 0.10 to estimate consumption from our production estimates for the macrobenthos nodes in the four EMAX regions. These are crude estimates since consumption rates for benthic invertebrates in the field are dependant on temperature, size, age, and food supply (Valiela, 1995; Velasco and Navarro, 2005).

Example Results

Table 8.3 shows the estimates for production and consumption of the macrobenthos nodes. Production was calculated from the biomass estimates (Figure 8.1) and the derived P:B ratios (Table 8.2). Consumption was calculated using the production estimates for each macrobenthos node and an assumed ecological efficiency of 10 percent.

Macrobenthos (polychaetes, crustaceans, molluscs, other) respiration estimates

Background

There is considerable literature on respiration rates among benthos. Most published work falls into two basic categories: benthic system respiration (e.g., Hopkinson *et al.* 2001) and respiration of selected benthic animal species (e.g., Emerson *et al.* 1988). Neither of these categories provided data directly applicable to the current study. Most benthic system studies do not treat functional grouping (like our nodes) separately, and data on such factors as size distributions, feeding status, activity level, and life history stage and temperature responses are inadequately known for all but a few of the nearly 2,000 benthic species of the NEUS Ecosystem (Theroux and Wigley 1998). One study in which system respiration was built up from individual species data and partitioned into functional groupings (Piepenberg *et al.* 1995) is from an arctic system whose species composition, temperature and depth regimes are so different from ours that comparison is questionable.

Quantitative Approach for Respiration Estimates

For the reasons described above, we chose to estimate respiration values for the macrobenthic nodes from other composite parameters for the same groups:

(EQ. 8.1) $R = C \times E_A \times 0.65$,

Where R is respiration, C is consumption, E_A is assimilation efficiency, and 0.65 represents the fraction of assimilated energy that is typically respired by ectotherms (Parry 1983). Values for assimilation efficiencies for this purpose were derived from Valiela (1995).

Example Results

Table 8.4 shows the estimates for respiration of the macrobenthos nodes. Respiration was calculated using Equation 8.1 and the specific assimilation efficiency.

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References

Brey, T. 1990. Estimating productivity of macrobenthic invertebrates from biomass and mean individual weight. *Meeresforsch*. 32:329-343.

Brey, T; Jarre-Teichmann, A; Borlich, O. 1996. Artificial neural network versus multiple linear regression: Predicting P/B ratios from empirical data. *Mar. Ecol. Prog. Ser.* 140 (1-3):251-256.

Caracciolo, JV; Steimle, FW. 1983. An atlas of the distribution and abundance of the dominant benthic invertebrates in the New York Bight Apex with reviews of their life histories. *NOAA Tech. Rept.* NMFS SSRF-766; 58 p.

Cartes, JE; Brey, T; Sorbe, JC; Maynou, F. 2002. Comparing production-biomass ratios of benthos and suprabenthos in macrofaunal marine crustaceans. *Can. J. Fish. Aquat. Sci.* 59(10):1616-1625.

Collie, JS. 1985. Life history and production of three amphipod species on Georges Bank. *Mar. Ecol. Prog. Ser.* 22:229-238.

Dame, RF. 1996. *Ecology of marine bivalves: An ecological approach.* Boca Raton, Florida: CRC Press; 254 p.

Dauer, DM; Maybury, CA; Ewing, RM. 1981. Feeding behavior and general ecology of several spionid polychaetes from the Chesapeake Bay. *J. Exp. Mar. Biol. Ecol.* 54(1):21-38.

Emerson, CW; Minchinton, TE; Grant, J. 1988. Population structure, biomass, and respiration of *Mya arenaria* L. on temperate sandflat. *J. Exp. Mar. Biol. Ecol.* 115(2):99-111.

Holme, NA; McIntyre, DA, eds. 1984. *Methods for the Study of Marine Benthos. 2nd Ed. ISP Handbook 16.* Oxford, UK: Blackwell Scientific Publications; 387 p.

Hopkinson, CS Jr.; Giblin, AE; Tucker, J. 2001. Benthic metabolism and nutrient regeneration on the continental shelf of eastern Massachusetts, USA. *Mar. Ecol. Prog. Ser.* 224:1-19.

Maurer, D; Howe, S; Leathem, W. 1992. Secondary production of macrobenthic invertebrates from Delaware Bay and coastal waters. *Int. Rev. Gesamt. Hydrobiol.* 77(2):187-201.

Parry, GD. 1983. The influence of the cost of growth on ectotherm metabolism. *J. Theor. Biol.* 101:453-477.

Piepenburg, D; Blackburn, TH; von Dorrien, CF; Gutt, J; Hall, POJ; Hulth, S; Kendall MA; Opalinski, KW; Rachor, E; Schmid, M.K. 1995. Partitioning of benthic community respiration in the Arctic (northwestern Barents Sea). *Mar. Ecol. Prog. Ser.* 118:199-213.

Reid, RN; Radosh, DJ; Frame, AB; Fromm, SA. 1991. Benthic macrofauna of the New York Bight, 1979-1989. *NOAA Tech. Rept.* NMFS-103; 50 p.

Sarda, R; Pinedo, S; Dueso, A. 2000. Estimating secondary production in natural populations of polychaetes: Some general constraints. *Bull. Mar. Sci.* 67(1):433-447.

Seitz, RD; Schaffner, LC. 1995. Population ecology and secondary production of the polychaete *Loimia medusa* (Terebellidae). *Mar. Biol*. 121(4):701-711.

Steimle, FW Jr. 1985. Biomass and estimated productivity of the benthic macrofauna in the New York Bight: A stressed coastal area. *Estuar. Coast. Shelf Sci.* 21:539-554.
Steimle, FW Jr. 1987. Benthic fuanal production. *In:* Backus, RH, ed. *Georges Bank*. Cambridge, MA: MIT Press; p. 310-314.
Steimle, FW Jr. 1989. Population dynamics, growth and production estimates for the sand dollar, *Echinarachnius parma*. *Fish. Bull.* 88:179-189.
Steimle, FW Jr. 1990. Benthic macrofauna and habitat monitoring on the continental shelf of the Northeastern United States. 1. Biomass. *NOAA Tech. Rept.* NMFS-86; 28 p.
Steimle, F; Foster, K; Kropp, R; Conlin, B. 2002. Benthic macrofauna productivity enhancement by an artificial reef in Delaware Bay, USA. *ICES J. Mar. Sci.* 59: S100-S105.
Steimle, FW Jr.; Kinner, P; Howe, S; Leathem, W. 1990. Polychaete population dynamics and production in the New York Bight associated with variable levels of sediment contamination. *Ophelia* 31(2):105-123.
Theroux, RB; Wigley, RI. 1998. Quantitative composition and distribution of macrobenthic invertebrate fauna of the continental shelf ecosystems of the Northeastern United States. *NOAA Tech. Rept.* NMFS-140; 240 p.
Valiela, I. 1995. Marine ecological processes. New York, NY: Springer-Verlag Inc.; 686 p.
Velasco, LA; Navarro, JM. 2005. Feeding physiology of two bivalves under laboratory and field conditions in response to variable food concentrations. *Mar. Ecol. Prog. Ser.* 291:115-124.
Warwick, RM; Joint, IR; Radford, PJ. 1979. Secondary Production of the benthos in an estuarine environment. *In:* Jefferies, RL; Davy, AJ, eds. *Ecological Processes in Coastal Environments.* Oxford, UK: Blackwell Scientific Publications.
Wigley, RI; Theroux, RB. 1981. Macrobenthic fauna from the Middle Atlantic Bight region. Faunal composition and quantitive distribution. *U.S. Dept. Int., Geol. Serv. Prof. Pap.* 529 N; 198 p.
Wildish, DJ. 1984. Secondary production of four sublitoral amphipod populations in the Bay of Fundy. *Can. J. Zoo.* 62:1027-1033.

Table 8.1. Dominant benthic taxa in biomass for the EMAX regions.

TAXONOMIC GROUP	GOM	GB	SNE	MAB
CRUSTACEANS	Amphipoda unident.	Amphipoda unident.	Amphipoda unident.	*Ampelisca agassizi*
	Pagurus pubescens	*Corophium crassicorne*	*Ampelisca agassizi*	*Pagurus pollicaris*
	Leptocheirus pinguis	*Ampelisca agassizi*	*Leptocheirus pinguis*	*Unciola irrorata*
	Politolana impressa	*Leptocheirus pinguis*	*Unciola inermis*	*Rhepoxynius hudsoni*
	Meganyctiphanes sp.	*Pagurus* sp.	*Unciola irrorata*	*Pagurus acadianus*
	Pandalus propinquus	*Byblis serrata*	*Gammarus annulatus*	*Ampelisca vadorum*
	Isopoda unident.	*Diastylis quadrispinosa*	*Cirolana polita*	*Unciola inermis*
	Politolana polita	*Unciola irrorata*	*Byblis serrata*	*Pagurus longicarpus*
	Unciola sp.	*Unciola* sp.	*Edotea acuta*	*Crangon septemspinosa*
	Cirolana sp.	*Unciola inermis*	*Crangon septemspinosa*	*Pseudunciola obliqua*
POLYCHAETES	*Spio filicornis*	*Filograna implexa*	*Pherusa affinis*	Polychaeta unident.
	Polychaeta unident.	Polychaeta unident.	*Nephtys incisa*	*Lumbrineris acicularum*
	Nephtys incisa	*Nephtys* sp.	Polychaeta unident.	*Glycera dibranchiata*
	Sternaspis fossor	*Sternaspis scutata*	*Streblosoma* sp.	*Spiophanes bombyx*
	Nephtys sp.	*Ninoe nigripes*	*Lumbrineris acicularum*	*Chone infundibuliformis*
	Maldane sarsi	*Aglaophamus circinata*	*Ninoe nigripes*	*Lumbrineris hebes*
	Onuphis opalina	*Scalibregma inflatum*	*Spio setosa*	*Asabellides oculata*
	Anobothrus gracilis	*Lumbrineris magalhaensis*	Capitellidae	*Ampharete arctica*
	Lumbrineris sp.	*Nephtys bucera*	*Spiophanes bombyx*	*Nephtys picta*
	Aphrodita sp.	*Spiophanes bombyx*	*Glycera dibranchiata*	*Aphrodita hastata*
MOLLUSCS - BIVALVES	*Cyclocardia borealis*	Bivalvia unident.	*Pitar morrhuanus*	*Nucula proxima*
	Astarte crenata	*Cyclocardia borealis*	*Nucula proxima*	*Mytilus edulis*
	Mytilus edulis	*Astarte undata*	Bivalvia unident.	*Cyclocardia borealis*
	Bivalvia unident.	*Modiolus modiolus*	*Astarte undata*	*Ensis directus*
	Nucula sp.	*Anomia aculeata*	*Modiolus modiolus*	*Astarte undata*

Table 8.1, continued.

TAXONOMIC GROUP	GOM	GB	SNE	MAB
MOLLUSCS - GASTROPODS	*Colus stimpsoni* *Aporrhais occidentalis* *Colus pubescens* *Colus pygmaeus* *Buccinum undatum*	Gastropoda unident. *Buccinum undatum* *Euspira heros* *Lunatia triseriata* *Pleurobranchaea* sp.	*Nassarius trivittatus* *Buccinum* sp. *Busycon canaliculatum* *Colus pygmaeus* Gastropoda unident.	*Nassarius trivittatus* *Buccinum undatum* *Neverita duplicata* Gastropoda unident. *Pleurobranchaea tarda*
OTHERS - NEMERTEANS	Rhynchocoela	Rhynchocoela	Rhynchocoela	Rhynchocoela
OTHERS - ECHINODERMS	*Molpadia oolitica* *Echinarachnius parma* *Brisaster fragilis* *Ophiura sarsi* *Schizaster* sp.	*Echinarachnius parma* *Ophiura sarsi* *Arbacia punctulata* *Steroderma unisemita* *Strongylocentrotus droebachiensis*	*Echinarachnius parma* *Havelockia scabra* *Molpadia oolitica* *Amphioplus abditus* Ophiuroidea unident.	*Echinarachnius parma* *Sclerodactyla briareus* *Encope emarginata* *Mellita quinquiesperforata* Cucumariidae unident.
OTHERS - COELENTERATES	*Cerianthus* sp. *Actinauge verrilli* *Pennatula aculeata*	*Cerianthus* sp. Hydrozoa *Ceriantheopsis americanus*	*Ceriantheopsis americanus* *Cerianthus* sp. *Edwardsia elegans*	*Ceriantheopsis americanus* Actiniaria unident. *Paranthus rapiformis*
OTHERS - TUNICATES	Ascidiacea	*Molgula arenata*	Ascidiacea	Ascidiacea

Table 8.2. P:B ratios used to estimate production for the macrobenthos compartments in the EMAX network.

	GOM	GB	SNE	MAE
Polychaetes	2.5	2.5	2.5	2.5
Crustacea	3.0	3.0	3.0	3.0
Molluscs	2.0	2.0	2.0	2.0
Other	2.0	2.0	2.0	2.0

Table 8.3. Production and consumption values for macrobenthos.

Region	Taxonomic Group	Production g/m^2/yr wet wt.	Consumption g/m^2/yr wet wt.
GOM	Macrobenthos - POLYCHAETES	33.7290	337.2902
GOM	Macrobenthos - CRUSTACEANS	5.5049	55.0491
GOM	Macrobenthos - MOLLUSCS	37.7935	377.9352
GOM	Macrobenthos - OTHERS	144.7836	1447.8364
GB	Macrobenthos - POLYCHAETES	12.9177	129.1766
GB	Macrobenthos - CRUSTACEANS	49.3944	493.9439
GB	Macrobenthos - MOLLUSCS	21.6856	216.8564
GB	Macrobenthos - OTHERS	163.3574	1633.5744
SNE	Macrobenthos - POLYCHAETES	88.5906	885.9059
SNE	Macrobenthos - CRUSTACEANS	18.4225	184.2251
SNE	Macrobenthos - MOLLUSCS	86.3779	863.7791
SNE	Macrobenthos - OTHERS	78.0826	780.8258
MAB	Macrobenthos - POLYCHAETES	30.9974	309.9743
MAB	Macrobenthos - CRUSTACEANS	9.8666	98.6661
MAB	Macrobenthos - MOLLUSCS	131.1182	1311.1815
MAB	Macrobenthos - OTHERS	189.0246	1890.2460

[1] Assuming a 10 per cent ecological efficiency

Table 8.4. Respiration values for macrobenthos.

Region	Taxonomic Group	Consumption g m^{-2} yr^{-1} wet wt.	Assimilation Efficiency	Respiration g m^{-2} yr^{-1} wet wt.
GOM	Macrobenthos - POLYCHAETES	337.2909	0.5	109.6195
GOM	Macrobenthos - CRUSTACEANS	55.0491	0.5	17.8910
GOM	Macrobenthos - MOLLUSCS	377.9352	0.4	98.2632
GOM	Macrobenthos - OTHER	1447.8364	0.5	470.5468
GB	Macrobenthos - POLYCHAETES	129.1766	0.5	41.9824
GB	Macrobenthos - CRUSTACEANS	493.9439	0.5	160.5318
GB	Macrobenthos - MOLLUSCS	216.8564	0.4	56.3827
GB	Macrobenthos - OTHER	1633.5744	0.5	530.9117
SNE	Macrobenthos - POLYCHAETES	885.9059	0.5	287.9194
SNE	Macrobenthos - CRUSTACEANS	184.2251	0.5	59.8732
SNE	Macrobenthos - MOLLUSCS	863.7791	0.4	224.5826
SNE	Macrobenthos - OTHER	780.8258	0.5	253.7684
MAB	Macrobenthos - POLYCHAETES	309.9743	0.5	100.7416
MAB	Macrobenthos - CRUSTACEANS	98.6661	0.5	32.0665
MAB	Macrobenthos - MOLLUSCS	1311.1815	0.4	340.9072
MAB	Macrobenthos - OTHER	1890.2460	0.5	614.3300

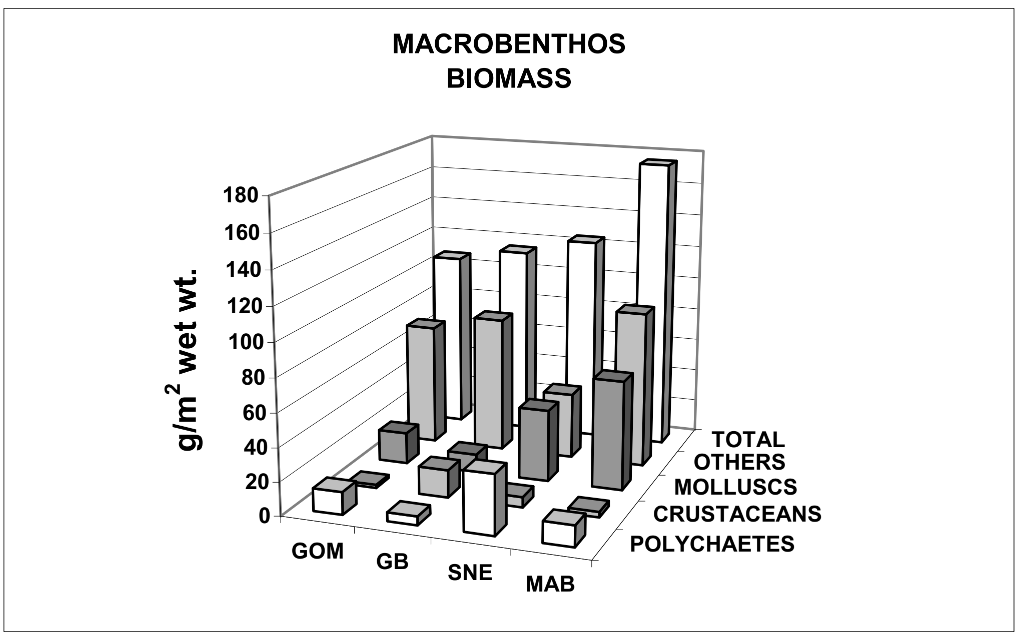

Figure 8.1. Biomass estimates in grams per square meter wet weight for the taxonomic groups in the four EMAX regions.