10. Megabenthos - Other

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Background

Although not strictly defined in terms of size, the largest benthic invertebrates are often referred to as “megabenthos”. Aside from large filter-feeding bivalves (megabenthos filterers), there are a variety of mostly predators and scavengers that may fit this description. We have chosen to include two groups: large Arthropods and Asteroid Echinoderms. All other large invertebrates, even if of comparable size, have been consigned to macrobenthos (see Section 8 for a list).

Megabenthic species have been assessed by a number of methods: trawls, dredges, grabs, submersible, towed camera sled, and divers (Uzmann *et al.* 1977; Franz *et al.* 1981; Miller 1989; Stehlik *et al.* 1991; Theroux and Wigley 1998). However, no one study has treated all such organisms comprehensively in this region and no one method is suitable for all of them. Therefore, for purposes of biomass quantification, we have divided the megabenthos biomass in this node into two separate elements, defined by the efficiency of various gear types used to collect them: sea stars (Echinodermata: Asteroidea) and large Arthropods. The latter element includes horseshoe crabs (Merostomata), mantis shrimp (Crustacea: Stomatopoda), crabs (Crustacea: Decapoda: Brachyura and Anomura other than hermit crabs) and lobsters (Decapoda: Astacidea).

Twenty-five species of commonly-occurring Asteroids, including sub-tropical, wide ranging, boreal and subarctic-boreal groups, have been identified from NEFSC groundfish survey data (Franz *et al.* 1981). Species listed in Table 10.1 are dominants from among that list. However, comparison of NEFSC Bottom Trawl Survey data with data from bottom video and still photographs and catches with a small-mesh 2 m beam trawl suggest that these Survey Trawl data greatly underestimate sea star (Asteroid) abundance. Asteroid biomass from grab sampling data (Wigley and Theroux 1981, Theroux and Wigley 1998) more closely resembles estimates based on visual assessments and beam trawl catches that ranged from about 0.5 to 5.0 g m^{-2} (Guida, unpublished).

Decapod biomasses from these grab sampling sources were substantially larger than from NEFSC Bottom Trawl Survey data, but were not comparable because they were heavily dominated by small Decapods (e.g., crangonid shrimps and hermit crabs), which are included in the macrobenthos (Section 8) in this document. Larger Decapods were admittedly underrepresented in grab samples (Theroux and Wigley 1998). The species list is given in Table 10.1.

Data Sources

Fisheries-independent survey data from the NEFSC Bottom Trawl Survey were used to estimate biomass density (g wet weight m^{-2}) for large arthropods. Comparison of NEFSC Bottom Trawl Survey data with data from bottom video and still photographs and catches with a small-mesh 2 m beam trawl net suggest that while these Trawl Survey data provide reasonable estimates for large arthropods, they greatly underestimate Asteroid density (Guida, unpublished). Sea star biomass was derived from comprehensive regional benthic grab data (Wigley and Theroux 1981; Theroux and Wigley 1998).

Quantitative Approach for Biomass Estimates

Large Arthropods

For each species and EMAX region, mean catch per tow (in kg tow^{-1}) was first calculated on a per-survey basis over survey strata contained within the EMAX region (Table 10.2, see also Table 1.1) using both spring and fall surveys during the period 1996-2000. If fewer than two stations were completed in a stratum during a given survey, that stratum was dropped from calculations of mean catch per tow. Mean catch per tow in season *s* and year *y*, c_{sy}, was then converted to biomass density (d_{sy}) using the formula

(EQ. 10.1) $$d_{sy} = f \frac{c_{sy}}{a}$$

where *a* is the area swept by the bottom trawl in a standard tow (0.01 nm^2 for the Bottom Trawl Survey) and *f* is a conversion factor from kg naut. mi^{-2} to g m^{-2} (f = [1000 g/kg]/[1852 m/naut. mi]^2). Finally, biomass density estimates were averaged over season and year using the formula

(EQ. 10.2) $$d = \frac{1}{5}\sum_{y}\left\{\frac{1}{12}\sum_{s} 6\, d_{sy}\right\}$$

where equal weight was given to spring and fall survey results (Figure 10.1).

Except in the Mid-Atlantic Bight, American lobster (*Homarus americanus*) comprised the major component of "other" biomass (Figure 10.1). In the Mid-Atlantic Bight, horseshoe crabs (*Limulus polyphemus*) comprised the major component, with American lobster as the second largest component. The mean lobster value for the four subregions calculated here (0.025 g m^{-2}) closely approximates the 1996 NEFSC autumn bottom trawl survey biomass index for lobster: 1.3 kg tow^{-1} = 0.027 g m^{-2} (Idoine 1996).

Comparative sampling of the same set of stations using 36' Yankee otter trawl (as used in the NEFSC Bottom Trawl Survey), 2 m beam trawl with 6.4 mm (1/4") mesh, and video drift vehicle (Guida, unpublished) indicated that a catchability factor was needed for data on large Arthropods other than the American lobster. Table 10.3 compares catches of *Cancer* spp. crabs (*C. borealis* and *C. irroratus* could not be distinguished in the video images) taken from the same stations during three NEFSC Benthic Habitat cruises conducted near Hudson Canyon (SNE Region). Biomass densities for net catches were calculated by dividing total wet weight by the estimated area swept out by the respective trawl gears. Video biomass densities were calculated by multiplying counts of individuals seen in the video by the mean individual weight as determined from the beam trawl catch and dividing by the area of the video drift transect.

Although not all methods were employed during each cruise, it is clear that 36' Yankee estimates were about two orders of magnitude smaller than densities based on either beam trawl catches or bottom video counts. Assuming the bottom video biomass represents the actual crab density, a catchability of about 50% for the beam trawl and 1% for 36' Yankee for these large Arthropods is suggested by the mean values and by the data from August 2004, when all three methods were employed. Therefore, NEFSC survey values for all large Arthropods other than the American lobster will be multiplied by 100 to obtain realistic estimates.

Unlike *Cancer* spp., the American lobster was too rarely caught in the beam trawl or in video images to be able to assess its biomass density by those means for comparison with 36'

Yankee values. Thus, no unique catchability factor could be assigned. From behavioral observation, it appears that catchability factor for lobsters might be far higher than for *Cancer* spp. crabs because the former, unlike the latter, tends to propel itself off the bottom with "tail thrusts" when disturbed, making otter trawl capture more likely. On the other hand, lobsters are more likely than *Cancer* crabs to be found in rocky areas (Hudon and Lamarche 1989), where capture by mobile gear is not possible. This may be disproportionately true of juveniles (Steneck *et al.* 1991). Choosing to err on the side of conservatism, lobsters have therefore been assigned a catchability of 100%, which probably greatly underestimates their abundance and biomass.

<u>Asteroids</u>

General comments provided for macrobenthos (Section 8) regarding biomass estimates from grab sample data apply to our estimates of the Asteroid element of the megabenthos as well.

Example Results

Figures 10.1 and 10.2 show estimated biomass for megabenthos - other sampled from the two survey methodologies, with a single focus on large arthopods (10.1) and all species combined (10.2).

Production/Growth/Reproduction

Production was estimated using a P:B ratio of 1.5 based on the assumption that as large, active invertebrates, P:B should resemble that of squid and shrimp.

Consumption

Consumption was estimated using a C:B ratio of 13.5 based again on the assumption that shrimp should resemble other large benthic invertebrates. We estimated consumption by multiplying the C:B ratio by biomass for the megabenthos - other node 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).

Respiration

We chose to estimate respiration values for the macrobenthic nodes from other composite parameters for the same groups:

(EQ. 10.3) $$R = C \times E_A \times 0.65,$$

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

Values for biomass density, production, consumption, and respiration for megabenthos - other in each of the four subregions are summarized in Table 10.4.

References

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Table 10.1. Species defined as megabenthos - other.

Scientific name	Common Name	NEFSC Species Code
Limulus polyphemus	Horseshoe crab	318
Homarus americanus	American lobster	301
Scyllarides nodifer	Ridged slipper lobster	302
Scyllarides aequinoctialis	Spanish slipper lobster	303
Panulirus argus	Caribbean spiny lobster	304
Geryon fenneri	Golden deepsea crab	308
Geryon affinis	White crab	309
Geryon quinquedens	Red deepsea crab	310
Cancridae	Cancer crabs, unclassified	311
Cancer borealis	Jonah crab	312
Cancer irroratus	Atlantic rock crab	313
Callinectes sapidus	Blue crab	314
Ovalipes sp	Calico crabs, unclassified	315
Majidae	Spider crabs, unclassified	317
Galatheidae	Galatheids, unclassified	319
Portunidae	Swimming crabs, unclassified	320
Ovalipes stephensoni	Coarsehand lady crab	321
Ovalipes ocellatus	Lady crab	322
Stomatopoda	Mantis shrimps, unclassified	323
Lithodes maja	Northern stone crab	324
Chionoecetes opilio	Snow crab	325
Carcinus maenas	Green crab	326
Hepatus epheliticus	Calico box crab	327
Calappa flammea	Flame box crab	328
Calappa sulcata	Yellow box crab	329
Calappidae	Box crabs, unclassified	339
Asterias forbesii	Common sea star	332
Asterias vulgaris	Boreal asterias	333
Astropecten spp.	Margined sea stars	334
Leptasterias sp.	Slender-armed and polar sea stars	332
Solaster sp.	Sun stars	332
Ctenodiscus crispatus	Mud star	332

Table 10.2. EMAX Regions and NEFSC Bottom Trawl Survey strata.

EMAX Region	NEFSC Strata	Area (km^2)
GB	01130-01230, 01250	43,666
GOM	24,26-30,36-40 03570-03900	79,128
SNE	01010-01120; 03010-03140,03450-03560	64,060
MAB	01610-01760; 03150-03440	59,807

Table 10.3. Comparison of biomass density calculated by various methods for *Cancer* spp. crabs from NEFSC Benthic Habitat cruises.

Cruise Month-Year	36 Yankee Biomass Density (g m^{-2})	Beam Trawl Biomass Density (g m^{-2})	Bottom Video Biomass Density (g m^{-2})
Nov-01	0.0066		
Nov-02		0.3128	0.5788
Aug-04	0.0021	0.1302	0.2665
Jan-05		0.1965	
Mean	0.0043	0.2215	0.4227

Table 10.4. Rate values for megabenthos - other.

Subregion	Biomass Density (g m^{-2})	Production (g m^{-2} yr^{-1})	Consumption (g m^{-2} yr^{-1})	Respiration (g m^{-2} yr^{-1})
GOM	1.1256	1.6884	15.1959	6.9142
GB	3.5056	5.2584	47.3259	21.5333
SNE	1.8048	2.7073	24.3654	11.0863
MAB	4.8325	7.2487	65.2385	29.6835

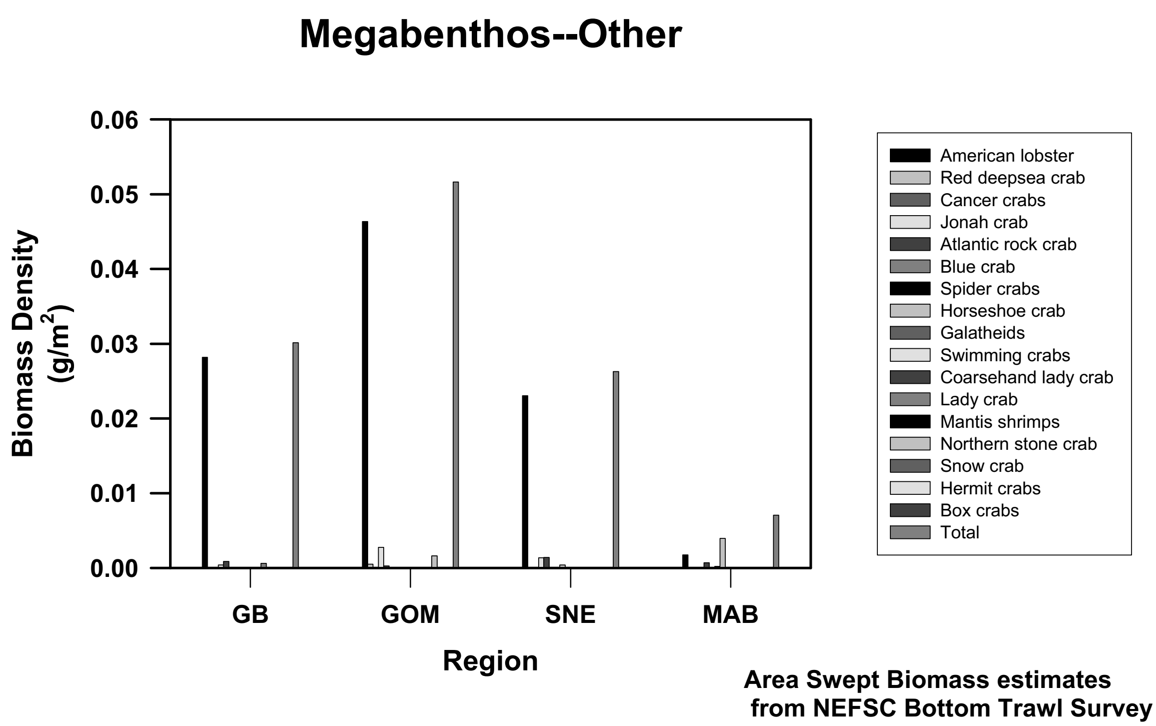

Figure 10.1. Biomass density estimates for the megabenthos - other large arthropod species.

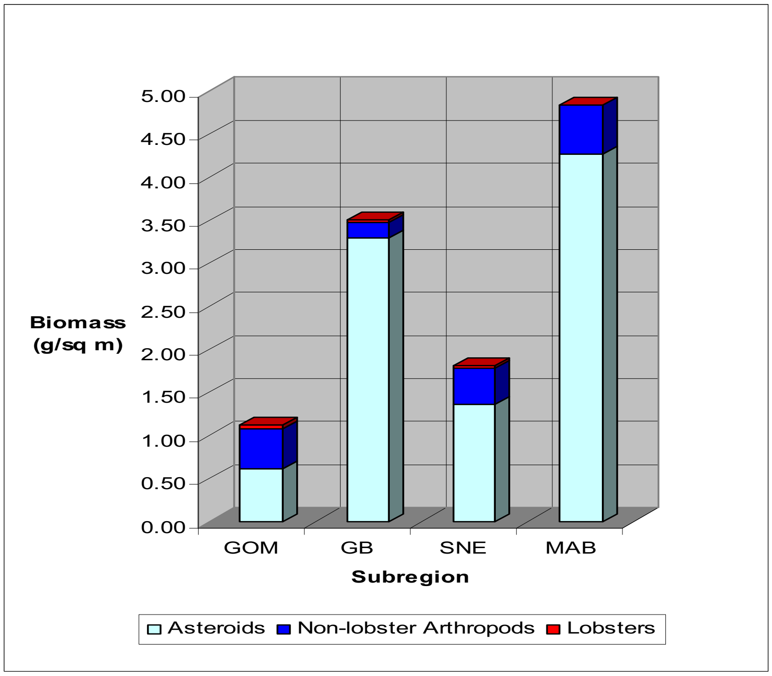

Figure 10.2. Combined biomass density estimates for various elements of the megabenthos - other: Large Non-lobster Arthropods (modified for catchability) from NEFSC Trawl Survey; Lobsters (unmodified) from NEFSC Trawl Survey; and Asteroids from grab sample data (Wigley and Theroux 1981, Theroux and Wigley 1998).