THE CONSERVATION APPLICATIONS OF GLOBAL SCALE MODELING: A LOOK AT CLIMATE CHANGE AND BENTHIC BIOMASS DISTRIBUTION AND ABUNDANCE

by
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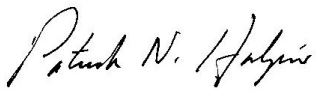

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ABSTRACT

This project considers the conservation applications of global scale modeling by evaluating the impacts of climate change on benthic biomass distribution and abundance. Marine benthic organisms, the organisms buried in or living on the sea floor, comprise a range of invertebrate phyla, are largely immobile, have distributions and abundances tied directly to physical oceanographic characteristics and provide food and shelter for higher tropic levels. These characteristics suggest that changes in this single class of organisms related to large scale disturbances can be extrapolated to the ecosystem scale and provide guidance for marine conservation planning. Spatial models of benthic biomass abundance for 1997 and 2006 are compared to assess changes in benthic biomass. Changes are summarized within a number of politically and ecologically relevant boundaries. The study shows that, overall, modeled benthic biomass values were 17% lower in 2006 than in 1997, which suggests a potential decrease in benthic biomass due to climate change. However, resulting percent change estimates at smaller scales varied widely and were often unrealistically high. Thus while global scale models are effective at elucidating large scale trends, they are unlikely, on their own, to be useful in guiding conservation planning. In order to maintain biodiversity and ecosystem functionality in the face of climate change, conservation planners should use environmental analysis approaches that incorporate regional and global scale data to develop adaptive management techniques, such as protected areas with mobile boundaries, which foster ecosystem resilience.

TABLE OF CONTENTS

INTRODUCTION

The increase of atmospheric greenhouse gas concentrations over the past century, due primarily to increased use of fossil fuels and changes in land use, is drastically altering the earth's climate system (IPCC 2007b). The 2001 Climate Change Synthesis Report prepared by the IPCC details the increasingly visible impacts of our changing climate, ranging from non-polar glacial retreat to greater frequency, persistence and intensity of El Nino Southern Oscillation events. Projections using IPCC emissions scenarios suggest global average temperature increases between 1.4 and 5.8º C from 1900 to 2100 (IPCC 2007b). The predicted changes in weather patterns will alter biological and physical systems and likely have adverse economic impacts on related human actions, such as agriculture, shoreline development and fisheries (Scavia 2002; Tompkins and Adger 2004).

Evidence of the effects of climate change on ecological systems is particularly worrisome to the conservation and resource management communities (McCarthy 2001). Climate change is an unwelcome addition to a long list of threats to species diversity and abundance that already includes habitat fragmentation, pollution and over-harvest, particularly because of the debate surrounding the degree to which it is currently affecting natural systems (Hughes 2000). Ecological stresses imposed by climate change are often subtle, particular to specific regions and spread out over a long time horizon (Parmesan and Yohe 2003). Thus it is not only challenging to separate the impacts of climate change from other ecological phenomena, but it is also difficult to weight its importance as a driver of species or ecosystem change.

The body of literature supporting shifts in biological timing, species distribution and abundance and community interactions attributable to climate change grows larger each year. Notable examples, presented in Walther et al. 2002 and McCarthy 2001, include among others earlier appearance of butterfly species and earlier breeding of amphibians in the UK, earlier

migration of bird species in Europe and North America, altered distribution of Arctic and Antarctic vegetation, increased abundance of intertidal invertebrates off the California coast and increased zooplankton and fish species abundance in the North Atlantic. In their 2003 meta-analysis of the current visible "fingerprint" of climate change on natural systems, Parmesan and Yohe were able to find evidence of shifts in phenology and range for over 270 terrestrial and marine species. In particular, they found significant advancements in spring events and poleward range migrations averaging 2.3 days and 6.1 kilometers per decade.

Given the IPCC (2007b) projection that erratic global weather patterns and sea level rise could persist for centuries even with significant greenhouse gas emission reduction because of the timescales associated with climatic systems, conservation planners and natural resource managers are faced with the task of creating spatially adaptive management regimes that can simultaneously address sudden catastrophes like hurricanes *and* gradual shifts in species range and distribution (Allison et al. 2003; Halpin 1997; Soto 2002). Species and habitat conservation is traditionally accomplished through the designation of land- and seascapes as "protected areas" (Noss 1995). However, the enduring pressures of climate change will continue to shift species range and distribution and will reduce the efficacy of static nature reserves.

Halpin (1997) puts forward that realistic, dynamic management approaches designed to address conservation in the face of climate change will be grounded in ecological processes and, in cases where precise regional data is unavailable, take place on broadly defined geographic scales. This study represents just such an attempt and focuses on the conservation applications of geospatial models predicting the global distribution and abundance of marine benthos. While these models were initially created to elucidate trends in benthic community structure, provide for a finer understanding of deep-sea biodiversity, and to furnish missing components to mass-balanced ecosystem models, it is important to explore the ways in which such large scale models

focused on single classes of organisms can be utilized by the environmental management community.

After reviewing the physical oceanographic and marine biological issues associated with climate change and the related use of marine reserves in ocean conservation, this paper will present the methods used to develop estimates of benthic biomass distribution and abundance for 1997 and 2006 and analyze changes due to climate change over this time period by ocean basins and within politically, geographically and ecologically relevant boundaries. The paper will conclude with suggestions for adaptive management strategies and recommendations for future research. The results suggest that modeling at this scale and over such a time period cannot offer useful information about regional changes in benthic biomass distribution and abundance. However, with sufficient regional benthic biomass measurements, information collected over longer time horizons and information collected at higher resolutions, this type of modeling can begin to offer useful, regional scale projections about changes in benthic biomass due to climate change.

I. Benthic Biomass: modeling and importance

Benthic organisms, the organisms that live on or within the first few centimeters of oceanic sediments, comprise an array of species from invertebrate phyla ranging from 1µm to several decameters in size (Rex et al. 2006). Understanding the spatial distribution of benthic biomass can provide valuable information about regional variability in biogeochemical processes (Marcus 1998), and allow for the more complete construction of mass-balance models of oceanic systems (Vasconcellos 2004). Estimates of benthic biomass can also serve as a time averaged proxy for the flux of carbon to the deep ocean (Rex et al. 2006). The continental shelves, which receive organic input from terrestrial sources, and upwelling regions are considered to have the greatest abundance of benthic biomass, but primary production from chemoautotrophic bacteria

in communities at great depths surrounding cold seeps (Gatehouse 1998) and hydrothermal vent (Van Dover 2000) can also support high levels of biomass. In general, with increasing distance from land, benthic communities, especially those in the deep sea, depend on a small amount of organic input from large animal and plant remains and marine snow—macroscopic aggregations of detritus, inorganic matter and living organisms that fall to the ocean floor from the euphotic zone (Alldredge and Silver 1988). While it is widely accepted that benthic biomass for all size classes falls steadily with depth (Rowe 1984; Thiel 1975), spatial variation in a variety of physical, chemical and biological factors may play a significant role in determining biomass distribution and abundance (Gooday and Turley 1990; Galeron et al. 2000).

The input of organic matter varies by season and region. Miller (2004) credits greater benthic biomass in high latitudes to seasonal blooms in primary productivity. Unlike higher latitudes, primary production at low latitudes is utilized year-round by pelagic communities, which reduces food availability for benthic communities. Lateral transfer by currents at the surface and at depth is important in the distribution of organic material (Kroncke 2000; Soltwedel 1997). Additional biotic and abiotic factors, such as nutrient (silicate, nitrate, phosphate) and oxygen availability, local sedimentation and substrate composition (Lovell and Trengo 2003) and inter- and intra- species interaction may also influence the spatial distribution of benthic biomass (Alongi 1992).

The spatial variation of the biotic and abiotic environmental characteristics outlined above suggests that the accepted assumption that benthic biomass decreases with depth may not be valid for many regions of the world's oceans and that prediction of biomass distribution must take these variables into account. While benthic biomass measurements have been recorded for all ocean basins, the vast majority of measurements have been taken in the Atlantic and Arctic Oceans by long-established European and American oceanographic institutions (Rex 2006). The

scarcity of measurements from the Indian, Pacific, and Southern Oceans, makes modeling benthic biomass for these regions difficult. Further, a number of the factors speculated to be important in influencing benthic biomass distribution are complicated, if not impossible, to estimate on any scale. Modeled values of benthic biomass for these under-explored/remote regions must be inferred from correlations between measured benthic biomass and available estimates of environmental variables in other ocean basins.

Predictions of 1997 and 2006 estimates of spatial distribution and abundance of benthic meiofaunal, macrofaunal and megafaunal biomass for the world's oceans presented in this paper use point measurements of benthic biomass from published sources and environmental data known to influence biomass production. Spatial variability in food availability is handled by proxy environmental variables in the predictive model. Surface chlorophyll-*a* concentration was included as a proxy to indicate spatial variability in primary production. Sea surface temperature and bottom temperature were included to capture the latitudinal variation in the use of primary production in the euphotic zone with the assumption that stratified low latitude areas provide less organic input to benthic communities than well-mixed high latitude regions. The effects of salinity, nutrient (silicate, phosphate and nitrate) and oxygen availability on predicting benthic biomass were also considered. Prior to the precursory study that led to this analysis, no study to date had attempted to create a continuous global estimate of benthic biomass.

II. Why benthic biomass can help explain the impacts of climate change on marine ecosystems

While it can be argued that the assessments of the impacts of climate change on ecosystems for the purpose of developing conservation measures should take into account all components of an ecosystem rather than a single class of organisms, I assert that, for marine ecosystems, the consideration of benthic organisms may be sufficient. Benthic organisms provide a suitable proxy for ecosystem changes related to climate change because of their

relative immobility, the dependence of their distribution and abundance on physical oceanographic characteristics such as ocean temperature and chemical composition and their relationship to higher trophic levels. This section will further detail these characteristics and the current standards for protecting this and other important component of marine ecosystems.

Benthic organisms and immobility. The benthic organisms considered in this study exhibit many different modes of locomotion. Some organisms are sessile or semi-sessile, and others borrow or have the ability to creep or crawl across the sediment. These differences in locomotion imply that benthic organisms in different phyla are able to adapt to changing habitat to differing degrees, but, on the whole, organisms in this class are tied to a very limited geographic range and can thus be considered effectively immobile. Evidence pointing to benthic invertebrate range shifts refers to species on the upward end of the mobility scale and focus on very limited geographic ranges, whereas the scope of this exercise is the entire expanse of the worlds oceans (Sagarin et al. 1999). Thus while migratory organisms are able to shift their ranges in response habitat changes related to climate change such as increased water temperature, sever storms or altered water composition, benthic organism are either completely unable to do so, or are unable to do so at a time scale consistent with the speed of habitat change.

Benthic organisms and the importance of oceanography. In their 2007 IPCC Assessment report, Working Group II focused on impacts, adaptations and vulnerabilities associated with climate change listed increases in sea level and sea-surface temperature, decreases in sea ice cover and changes in salinity, alkalinity, wave climate and ocean circulation as the primary large scale impacts of climate change on coastal zones and marine ecosystems (IPCC 2007a). Here I will discuss the three potential impacts that I feel are most relevant to benthos, namely 1) increased sea surface temperature, 2) changes in ocean chemical composition and 3) differences in ocean movement and circulation.

Levitus et al. (2000) suggest that the mean temperature of the uppermost 300 meters of the ocean has increased by 0.31ºC from the mid-1950s to the mid-1990s. This rate of change in mean ocean temperature, which will continue accelerate if we do not curb greenhouse gas emissions, has the potential for harmful impacts on a number of benthic invertebrate species. For example, there is concern that because tropical reef building corals are quite long-lived and have evolved geographic differences in temperature tolerances over a long time frame of relatively stable temperatures, an accelerated rate of change could exceed adaptive capabilities (Hughes et al. 2004). Both the spread of coral disease and regional episodes of coral bleaching—the loss of coral microalgal endosymbionts often due to sever thermal stress—have increased over the past 30 years (Donner et al. 2005).

Sea water chemistry also influences distribution and defines range boundaries for benthic species. The addition of carbon to the atmosphere has caused a rise in ocean acidity. As the ocean sequesters anthropogenic carbon, chemical reactions occur in seawater which increase the concentration of hydrogen ions and reduces the number of carbonate ions (Sigman and Boyle 2000). The resulting lower seawater pH will have implications for marine organisms that use calcium carbonate to build their skeletons or shells (Scavia et al. 2002). Guinotte et al. (2006) stresses the urgent need for research to assess the impacts of changing sea water chemistry on deep-sea scleractinian corals. Changes in freshwater inflow and precipitation related to climate change will also alter nutrient input and salinity, particularly in nearshore and estuarine environments.

Finally, climatologists predict differences in ocean movement resulting from climate change, including changes in oceanic currents, increases in wave climate and heightened severity of coastal storms. Changes in currents could have impacts on the delivery of larval benthic

invertebrates to suitable substrate, as many species depend on currents for larval dispersal (Soto 2002).

Benthic organisms and their relationship to higher trophic levels. It is clear from the previous two sections that benthic organisms are particularly susceptible to the impacts of climate change. Arguably the most important reason to consider benthos as a proxy for the ecosystem impacts of climate change, however, is the relationship of benthic communities to higher tropic levels. A number of commercially important fish species depend on benthic epifauna such as sponges, coral assemblages, mollusks and echinoderms for food and shelter. Change in benthic communities is traditionally studied in the context of the use of mobile fishing gear, specifically bottom trawls. Likened to forest clearcutting by Watling and Norse (1998), the destructive effects of bottom trawling and dredging on marine benthic habitats have been well documented and are associated with changes in tropic structure, ecosystem function and the reduction of species diversity (Jennings et al. 2001). While the impacts of alteration of benthic community structure and ecosystem function at the scale of the fishery are unknown, Thursh et al. (1998) demonstrated a significantly lower density of benthic epifauna in areas under high fishing pressure than areas under low fishing pressure. Although these findings relate single- or multiple-event high-impact disturbances related to fisheries extraction, they still offer valuable insight into the possible cascade of impacts of a chronic disturbance like climate change.

Thus it seems reasonable to assume that changes in benthic community structure due to climate change may have significant effects at higher trophic levels. As fisheries have been, and will continue to be, a vastly important global resource, and because there has been a continual shift towards the use of holistic, ecosystem-based management of fisheries, the assessment of the impact of climate change on benthos might be a useful indicator for the impact of climate change on fisheries. Fisheries provide 2.6 billion people worldwide with at least one fifth of their animal

protein and provide direct and indirect economic support for 200 million people (FAO 2007). Between 1980 and 2002 fisheries export value rose from US$15 billion to nearly $58 billion, a figure which would continue to rise if we weren't already working from all angles to deplete fish stocks (Kourous 2004). Worldwide fisheries stocks are currently in decline because of unsustainable harvesting, habitat destruction and poor water quality. Additional habitat loss, as in changes in the availability of food and substrate provided by marine benthos due to climate change, could have devastating impacts on fisheries worldwide.

Marine protected areas and global climate change. Evidence suggests that the protection of marine areas from fishing and human activities, though costly, can be invaluable in the maintenance of biodiversity and sustainable fisheries (Pauly et al. 2002). Through the use of modeling based on surveys of the running costs of marine protected areas (MPAs), Balmford et al. (2004) estimate that protecting the World Parks Congress (WPC) recommendation of 20 – 30% of marine habitats could cost between $5 billion and $19 billion annually. They note that these costs are sizeable but that they are still less than the current cost of government subsidies to fisheries (which often lead to stock overexploitation) and could be outweighed by social benefits including the creation of new jobs, the promotion of fisheries sustainability and the maintenance of ecosystem integrity.

However, the efficacy of protected areas, both marine and terrestrial, in the face of the borderless threat of climate change is debatable. Mobile animals may shift their ranges outside of established protected areas to inhabit areas with more favorable climates or environmental conditions (McCarthy 2001). While many have suggested the use of temporally responsive marine and terrestrial reserves to address shifting species ranges associated with climate change (Halpin 1997; Soto 2002), Walther et al. 2002 suggests that habitat loss and fragmentation outside of reserves may mean that area that will become suitable in climate with future warming

may be far beyond the dispersal capacity of many species. Additionally, nearly 60% of worldwide marine protected areas were created after 1980 (WDPA 2004). Monitoring systems for these areas may not have been in place for long enough to detect changes resulting from climate change. Means for adapting protected area designation and management may prove the only way to mitigate the impacts of climate change on ecosystems.

III. Global Scale Modeling for conservation planning

The models presented in this paper are alterations of a model originally intended to predict current benthic biomass distribution for use in regional mass-balance modeling, such as those models produced with the Ecopath with Ecosim software suite created by the University of British Columbia Fisheries Centre. Because there are relatively few field measurements of benthic biomass, with an extreme paucity of measurements in the Pacific and Indian Ocean basins, the idea was to use known global measurements of environmental variables and published point measurements or benthic biomass to make continuous estimates or benthic biomass for all of the world's oceans. This endeavor was quite successful and resulted in current estimates of the global distribution of meiobenthos, macrobenthos, and megabenthos. While these models will be important components of mass-balance models, it is important to examine their other uses in conservation planning.

Given the characteristics listed above, especially the relationship of benthic organisms to oceanography, the exploration of the impacts of climate change on benthic biomass is a perfect opportunity to explore the conservation applications of global scale modeling. The predictions are based on environmental variables that respond to climate change, namely sea surface temperature and surface chlorophyll-*a*, making it a logical extension to run these models using variables from different time periods to estimate changes over time attributable to climate change. While model predicting environmental shifts related to climate change are often

projections into the future which draw on outputs from General Circulation Models (GCMs) based on varying carbon emissions scenarios (as in Donner et al. 2005), variables included in the models presented here, specifically surface chlorophyll-*a* concentration, are difficult to predict. Given this limitation, it seemed reasonable to instead model biomass distribution from some time in the past and compare it to a model of the present. If we assume that trends in carbon emissions from the past to the present will persist into the future, then areas that showed marked changes related to climate change over the time period analyzed might be expected to continue to change.

The interval of time over which changes in benthic biomass are estimated, from 1997 to 2006, was selected because of data availability. 2006 was the most recent year for which a full annual average for sea surface temperature and surface chlorophyll-*a* concentration were available. 1997 was the first year for which annual averages for these two variables was accessible. In their 2006 study, Behrenfeld et al. were able to detect statistically significant decreases in ocean productivity related to global climate change over a similar period. This study suggests that the nine year period proposed in this study may be a significant enough time horizon over which to observe changes in ocean ecosystem structure related to changes in ocean productivity and temperature. Again, this exploration will be a good test as to whether or not global scale analysis can effectively hold resolution at a regional scale.

Overall, the objectives of this project are to first model benthic biomass distribution and abundance at different time periods, and then evaluate the conservation applications of modeling at this scale. In other words, can we predict changes in benthic biomass with models of this scale and can we use those predictions to guide research and conservation?

METHODS

I. Benthic samples and environmental variables

Benthic biomass samples. Table 1 summarizes the key features of the three datasets assembled here from 34 publications which reported to geographic coordinates for their benthos biomass estimate (see also Figure 1 and listed references). Selected literature grouped organisms by size rather than by taxa. Metazoan meiofauna included those invertebrate groups retained on sieves of 30 to 74 μm mesh size and comprises foraminaferans, nematodes, harpactidcoid copepods and a number of other minute taxa. Metazoan macrofauna included those organisms retained on sieves between 250 and 1000 μm mesh size and included polychaete worms, crustaceans and mollusks among others. Megafauna were generally considered those organisms visible on the sediment and comprised cnidarians, crustaceans and echinoderms. Demersal fish were not included here, as their mobility and relative independence from the substrate warrant another type of analysis. These measurements are used to global benthic biomass for both 1997 and 2006. Figure 1 shows the geographic distribution of measured data for each size class.

ETOPO2 bathymetry data were obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Geophysical Data Center (NGDC). This dataset was constructed by combining available depth soundings with high-resolution marine gravity information from the Geosat and ERS-1 spacecraft. Spatial resolution of ETOPO2 bathymetry is 2-minute (13.7 km^2 at the equator) (Smith and Sandwell 1997).

Environmental grids for the estimation of benthic biomass. Bottom temperature, bottom salinity, bottom phosphate, bottom nitrate, bottom silicate, bottom dissolved oxygen, apparent bottom oxygen utilization, and percent bottom oxygen saturation are from the World Ocean Atlas 2001 (WOA01) annual mean measurements of these variables (Conkright 2002) taken at standard intervals down to 5500 meters. The native resolution of WOA01 data is 1-degree, but

this data was resampled by the Kansas Geological Survey (KGS) at ETOPO2 resolution and depth. There were several regions of the world's oceans that did not have values for these grids. These areas were interpolated by the KGS using the ESRI ArcGIS Nibble Algorithm, which replaces missing values with the value of the nearest neighbor.

Sea surface temperature and chlorophyll-*a* data for 2006 were obtained from NASA's Goddard Space Flight Center. Both data sets were derived from the Moderate Resolution Imaging Spectroradiometer (MODIS), a key instrument aboard the Aqua Earth Observing System PM satellite (Feldman 2007). Chlorophyll-*a* for 1997 also came from NASA's Goddard Space Flight Center, but from the Sea-veiwing Wide Field-of-view (SeaWiFS) Sensor. Sea surface temperature for 1997 came from the NASA/National Oceanographic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) Pathfinder (Citation). Missing values in sea surface temperature data from a single pentad from each month in 1997 were interpolated using the ESRI ArcGIS Nibble algorithm and then averaged to form a single grid for the year. Spatial resolution was resampled from 1 km^2 resolution to 2-minute resolution using ESRI's resampling algorithm.

Inconsistencies in the yearly average grids for sea surface temperature and chlorophyll-*a* were found for areas presumably covered by ice for a significant portion of the year. The extent of the errors related to sea ice extent appear to be larger in the grids representing average sea surface temperature and chlorophyll-*a* from 1997, thus this extent of the error on these grids was masked out of all grids used in the analysis.

Boundary grids for biomass change comparison. Predicted benthic biomass will be summarized in politically and ecologically relevant terms using publicly available spatial data. Comparisons will be made between ocean basins, within Exclusive economic zones (EEZs) and on the High Seas, between continental shelf regions and the deep ocean, within Food and

Agriculture Organization (FAO) Fishing Areas, by Large Marine Ecosystems (LMEs) and at the site of marine protected areas.

World ocean and seas boundaries were obtained from the Flanders Marine Data and Information Centre (VLIZ 2007), who compiled boundary information using the data published by the International Hydrographic Organization (International Hydrographic Organization 1953). For the purposes of this study, oceans have been divided into 5 larger basins: the Atlantic Ocean basin, the Pacific Ocean basin, the Indian Ocean basin, the Arctic Ocean basin and the Southern Ocean basin. Seas and oceans within each of these basins were joined using the ESRI ArcGIS Dissolve Algorithm. EEZ and high seas, FAO fishing area and LME boundaries were also obtained from the Flanders Marine Data and Information Centre (VLIZ 2007). Point locations of marine protected areas came from the World Database on Protected Areas (WDPA 2004). The continental shelf was considered to be waters less than 150 meters in depth (Pinet 1996).

II. Analyses

Selection of environmental variables. I investigated seven environmental variables for their relationship measurements to benthic biomass. Depth, surface and bottom temperature and chlorophyll-*a* concentration were included to represent spatial variation in food availability. Other variables, such as bottom nutrient concentrations (silicate, nitrate and phosphate), salinity and several expressions of oxygen content were tested to determine if they might have an effect. The correlation matrices (Table 2) evaluate the degree of global covariation of the environmental variables. Though the presented correlation matrix was from the first permutation of this study, in which benthic biomass distribution and abundance was modeled using sea surface temperature and surface chlorophyll-*a* data from 2002 to 2005, the revealed trends apply to this study. In particular, the strongest correlation was found between the bottom nutrient concentrations and the variants of bottom water oxygen content.

As sea surface temperature and surface chlorophyll-*a* concentration were the only environmental variables that changed over the time horizon presented, an analysis of the change in average annual satellite measured sea surface temperature and surface chlorophyll-*a* concentration between 1997 and 2006 is presented.

Modeling benthic biomass distribution and abundance. The ArcGIS sample algorithm was used to link values from the bathymetry, bottom temperature, sea surface temperature, chlorophyll-*a*, silicate, nitrate, phosphate and oxygen grids to the log biomass values associated with the points shown in Figure 1. Again, data points from areas that appeared to be covered in ice for a significant portion of the year were not included in the final analysis. Multiple linear regression analysis was performed in STATA™ to develop a model for predicting log meiofauna, macrofauna and megafauna biomass using a number of combinations of environmental variables (Table 3). Though these regression values come from the first permutation of this model, they illustrate that the addition of environmental variables aside from those that proxy spatial variation in food availability did not significantly strengthen models across size classes. Thus the final regression equations took the following form and only included depth, surface and bottom temperature and surface chlorophyll-*a* concentration:

$$LogBiomass = \alpha + (\beta_1 * Chlorphyll - a) + (\beta_2 * SST) + (\beta_3 * Bathymetry) + (\beta_4 * BottomTemperature)$$

where α is a constant specific to each equation and β_n are regression coefficients for each of the variables.

The resulting regression equations were used with the variable grids to create an estimate of global benthic log biomass for each size class. For the meiofauna grids for 1997 and 2006, the macrofauna grid for 2006 and the megafauna grid for 1997, values above two standard deviations away from the mean were omitted from outputs, thus the maximum value presented on all output maps is two standard deviations from the mean. This served to eliminate erroneous

values due to discrepancies in satellite measurements for sea surface temperature and surface chlorophyll-*a* concentration. Values higher than one standard deviation for 1997 macrofauna and 1.25 standard deviations for 2006 megafauna were excluded from the analysis because the volume of erroneous values above these limits were inconsistent with previous analyses. Modeled values less than zero were also omitted from outputs.

Finally, results were summarized by ocean basin, exclusive economic zone and high seas, continental shelf and non-continental shelf regions, FAO fishing areas, large marine ecosystems and at the site of marine protected areas using the ESRI Zonal Statistics algoritm. Estimates for 1997 and 2006 were compared for each size class.

RESULTS

Changes in sea surface temperature from 1997 to 2006. Figure 2 shows annual average sea surface temperature for 1997 and 2006 as well as a spatial representation of the differences in average annual temperatures observed during these years. Differences were grouped into five subjective categories to represent relative degrees of difference in measured annual sea surface temperature, with "0" representing a negligible positive or negative difference, "±1" representing a difference between 0.5 and 2ºC, and "±2" representing a difference greater than 2ºC. Table 4 summarizes the difference in sea surface temperature by ocean basin using the classifications detailed above. This subjective analysis indicates that all ocean basins had a greater annual average temperature in 2006 than in 1997. A majority of the 13.7 km^2 cells in the Southern and Atlantic Oceans had annual average temperatures between 0.5 and 2ºC greater in 2006 than in 1997, and a majority of the cells in the Arctic Ocean had annual average temperatures greater than 2ºC higher in 2006 than in 1997. A majority of the cells in the Pacific and Indian Oceans had a value of "0," indicating a negligible positive or negative difference between the annual average 1997 and 2006 temperatures.

Changes in surface chlorophyll-a concentration from 1997 to 2006. Figure 3 is a spatial representation of the difference in annual surface chlorophyll-*a* concentration observed in 1997 and 2006. Just as with average annual sea surface temperature, differences were grouped into five subjective categories to represent relative degrees of difference in measured surface chlorophyll-*a* concentration, with "0" representing a negligible positive or negative difference, "0.15 to 0.3" or "-0.15 to -0.3" representing a positive or negative difference between 0.15 and 0.3 mg/m^3, and ">0.3" or "<-0.3" representing a positive or negative difference greater than 0.3 mg/m^3. Table 5 summarizes the difference in surface chlorophyll-*a* concentration by ocean basin using the classifications detailed above. The subjective analysis indicates that the average

surface chlorophyll-*a* concentration was comparable in 1997 and 2006. A majority of the cells in the Atlantic, Pacific, Indian and Southern Oceans had a value of "0", indicating a negligible positive or negative difference between the annual average 1997 and 2006 surface chlorophyll-*a* concentrations. The Arctic Ocean is the only basin that showed a difference between 2006 and 1997—most cells had a value of "> 0.3," meaning that there was a measured annual average surface chlorophyll-*a* concentration more than 0.3 mg/m^3 higher in 2006 than in 1997 for most areas.

1997 and 2006 Benthic model outputs. Regression coefficients for benthic biomass models for all size classes for 1997 and 2006 are shown in Table 5. The models for meiofauna, macrofauna and megafauna for 1997 biomass accounted for 29%, 56% and 52% of the variation in measured biomass values ($p < 0.0001$). The models for 2006 account for 30%, 56% and 53% of the variation in meiofauna, macrofauna and megafauna biomass, respectively. Bathymetry had significant influence in all of the models ($p < 0.05$) except for 2006 model for megafauna biomass. Sea surface temperature also had significant influence ($p < 0.05$) on all models except for 1997 meiofauna biomass and 1997 and 2006 megafauna biomass. The resulting maps (Figures 4 – 6) spatially represent log biomass values for each of the size classes for both 1997 and 2006. In addition, each figure includes a spatial representation of differences in kilograms of benthic biomass for each 3.71 km^2 cell. As with sea surface temperature, differences are grouped subjectively. Rather than making comparisons by degree of change, changes are termed classified as either a "loss" or "gain" in biomass.

In comparisons between modeled 1997 and 2006 benthic biomass presented below, percentage change presented assumes that the area across which benthic biomass is totaled is the same for both time periods analyzed. In order to quantify differences in modeled benthic biomass and highlight areas of particular concern, percentage change will be grouped into the

following four categories: 1) increase—for areas that show a higher modeled benthic biomass in 2006 than in 1997, 2) mild decrease—for areas that show a modeled benthic biomass between 0 and 25% less in 2006 than in 1997, 3) moderate decrease—for areas that show a modeled benthic biomass between 26% and 50% less in 2006 than in 1997, and 4) severe decrease—for areas that show a modeled benthic biomass greater than 50% less in 2006 than in 1997.

Comparison by ocean basin. Figure 7 shows the delineation of ocean basins used for the summaries presented in this analysis. Table 6 is a summary of the total modeled benthic biomass for each ocean basin for both 1997 and 2006, as well as a percentage of change for each basin summarized by size class. Full ocean basin summaries, including minimum and maximum values, means, standard deviations and areas of analysis, are included in the Appendix. Benthic biomass for all size classes across ocean basins was estimated at 2.2 million teragrams for 1997 and 1.9 million teragrams for 2006. Overall, the modeled value for total biomass across all ocean basins was 17.35% lower in 2006 than in 1997. This level of change falls into the "moderate decrease" category. For meiofauna, the Atlantic, Pacific and Southern Oceans showed moderate decrease in meiofauna biomass, with losses ranging from 28 to 46%, between 1997 and 2006. The Arctic Ocean had a modeled 8.7% increase in meiofauna biomass between 1997 and 2006, and the Indian Ocean showed a severe decrease in biomass—a loss of 54.49%. For macrofauna, all ocean basins showed at least moderate decreases in biomass between 1997 and 2006, with the Arctic Ocean showing severe decreases. Megafauna showed increases in the Atlantic, Indian and Pacific Ocean basins, and a mild decrease of 8.89% in the Arctic Ocean basin. Table 7 presents the same summaries by ocean basin rather than by size class. The Arctic, Indian and Pacific Oceans show a mild decrease in overall benthic biomass, while the Atlantic Ocean shows an overall increase in benthic biomass.

Comparisons within Exclusive Economic Zones and on the High Seas. Figure 8 shows the Exclusive Economic Zone boundaries used for this analysis. All areas outside of the EEZ boundaries presented here are considered high seas. Table 8 summaries the differences in 1997 and 2006 modeled benthic biomass totaled across Exclusive Economic Zones by size class. A full summary detailing minimum and maximum values, means, standard deviations and areas of analysis for all Exclusive Economic Zones is featured in the Appendix. Both meiofauna and macrofauna had modeled 1997 biomass values 58% higher in 1997 than in 2006, indicating severe decreases, while megafauna had a modeled biomass value nearly 14% higher in 2006 than in 1997. When biomass values for all size classes are totaled, there is only a mild decrease in total biomass within Exclusive Economic Zones (14.42%).

Tables 9 summarizes differences in 1997 and 2006 modeled benthic biomass on the high seas by size class. A full summary detailing minimum and maximum values, means, standard deviations and areas of analysis is featured in the Appendix. Meiofauna and macrofauna showed very small increases or decreases in total biomass for high seas areas. Modeled megafauna values for 1997 and 2006 were vastly different from each other. This change is assumed to be erroneous. High seas percent change calculations totaled across size classes indicate a moderate decrease in benthic biomass—a decrease of 31.43%. The magnitude of this estimated decrease is likely due to the erroneous values presented for high seas megafauna biomass.

Comparison between continental shelf and non-continental shelf regions. As stated above, the continental shelf was considered to be waters less than 150 meters in depth (Pinet 1996). Summaries of benthic biomass abundance for continental shelf and non-continental shelf regions are included in the Appendix. While total figures for the continental shelf regions for 1997 and 2006 are presented, they are not assessed for percentage change because of discrepancies in summary areas calculated in the analysis. Table 10 is a summary of totals and

percentage change for non-continental shelf regions. Results are consistent with the high seas summary, where meiofauna and megafauna show a mild decrease in benthic biomass between 1997 and 2006 and megafauna shows a much larger decrease. The percentage change for non-continental shelf regions totaled across size classes indicates a mild decrease in benthic biomass—a decrease of 19.31%. Again, the magnitude of this estimated decrease is likely due to unrealistically high estimated changes in the megafauna biomass category.

Comparison within FAO fishing areas. Figure 9 shows boundaries for the FAO fishing areas used in this analysis. Table 11 is a summary of the total modeled benthic biomass for each FAO fishing area for both 1997 and 2006 by size class, as well as a percentage of change for each fishing area. Table 12 is a summary of total benthic biomass for each FAO fishing area totaled across size classes. A complete summary detailing minimum and maximum values, means, standard deviations and areas of analysis is featured in the Appendix. With these summaries, close attention should be paid to areas that consistently list severe decrease, namely fishing areas 31 and 71. Nearly 50% of the FAO fishing regions have a higher modeled benthic biomass for 2006 than for 1997.

Comparison by Large Marine Ecosystems. Figure 10 shows boundaries for the Large Marine Ecosystems (LMEs) used in this analysis. The 64 LMEs of the world have been divided into six overarching regions. Table 13 presents a summary of each of the six regions by size class. A detailed summary of minimum and maximum values, means, standard deviations and areas of analysis is featured in the Appendix. For meiofauna, LME areas show a range of change, with mild to severe decrease in all areas except for the Western Pacific ocean, which has a higher modeled biomass in 2006 than in 1997. For macrofauna, all LME areas show severe decrease. In contrast, all LME areas show increase except for the Polar Oceans LME area, which shows severe decrease.

Closer look at Marine Reserves. Because the size of many marine protected areas is smaller than the grid size used in this analysis, the only appropriate means of analysis was a simple sampling of benthic biomass at the centroid point of each protected area. Many protected areas were located in regions removed from analysis because they were considered to have erroneous biomass estimates. For many protected areas, estimates were available for one time period and not the other. Accordingly, only protected areas that had values for both time periods were considered. A total of 676 marine protected areas were sampled for this analysis. For the 95 sites available for analysis of change in meiofauna biomass between 1997 and 2006, 86% showed a higher value in 2006 than in 1997. For the 19 marine protected areas available for analysis of change in macrofauna biomass, 58% showed a higher value in 2006 than in 1997. Finally, for the 61 marine protected areas available for analysis of change in megafauna biomass, 84% showed a higher value in 2006 than in 1997.

DISCUSSION

The models presented here suggest that benthic biomass abundance totaled across size classes is lower in 2006 than in 1997. While the models for each individual size class suggest vast changes in benthic biomass abundance within many of the boundaries of analysis, it is unlikely that this level of change is reflective of the true change in benthic biomass that might be observed in nature over this time horizon. Error in estimates is due to limitations in the information used to create the models and lack of knowledge about appropriate model parameters. However, in exploring the limitations of these global scale models, appropriate uses and avenues for model improvement have been elucidated. This section will review model results, discuss the limitations of these models, offer suggestions for model improvements, and end with general recommendations for conservation and management in the face of climate change.

Results of model comparisons. Upon visual inspection, the maps for benthic biomass for 1997 and 2006 for each size class look quite similar to each other. This is due to the fact that bathymetry is the most significant variable in each permutation of the model. All models were significant with respect to the data used to create them, but, because of the small number of sample points available, there is no way to compare these estimates to measurements found in nature or test overall model validity. When benthic biomass is summed across size classes, as in summaries presented by ocean basin (Table 7), by Exclusive Economic Zone (Table 8), by high seas (Table 9), by non-continental shelf (Table 10) and by FAO fishing area (Table 12), the models suggest an overall lower level of benthic biomass in 2006 than in 1997.

Presented summaries considered analysis at both large and small scales. Large scale summaries of change—namely those at the level of the ocean basin, on the high seas and by FAO fishing areas—suggested that meiofauna and macrofauna biomass were lower overall in

2006 than in 1997, while megafauna biomass was higher overall in 2006 than in 1997. Small scale summaries—namely those at the level of the Exclusive Economic Zone, Large Marine Ecosystem—showed the same general trend with more pronounced decreases in benthic biomass. In general, the severity of change in many of the areas analyzed is likely to be an overestimate. Differences in degree of change observed at large and small scales within each size class are explained in the next section.

Recall the central questions of this study: can we predict changes in benthic biomass due to climate change with models of this scale and can we use those predictions to guide research and conservation? Based on this analysis, it seems that these models may be refined to predict change at large scales, but that the wide range of changes shown at smaller scales may not help to highlight areas that are of particular conservation concern.

Model limitations and improvements. There were a number of assumptions used to create global estimates for benthic biomass for 1997 and 2006 that undoubtedly led to model error. The point measurements were collected using a number of different methods, presented in a wide array of units and assumed to be entirely accurate. While Johnson et al. (working paper) suggests that there is benthic sampling gear type and mesh size have no impact on sampling accuracy and efficiency, several studies have found the opposite (Gage 1975; Hughes and Gage 2004; Gage et al. 2002; Gage and Bett 2005). The data points used for the analysis were collected over a 30 year period and used to create benthic biomass estimates for both 1997 and 2006. Given that the purpose of this analysis was to assess changes in benthic biomass over a nine year time period, the inclusion of data from a longer time horizon was likely to confound the results. Finally, a scant number of point estimates (n = 145 for meiofauna, n = 101 for macrofauna and n = 44 for megafauna) concentrated mostly in the Atlantic Ocean were used to extrapolate benthic biomass for all the world's ocean basins. Thus estimates of change for other

basins, such as the Indian and Pacific basins, are based entirely upon modeled data. Collection of field measurements of benthic biomass is often cost prohibitive. However, estimates of benthic biomass at both the regional and global scale will be strengthened by additional point measurements around the world. Additionally, the collection of more field measurements will allow for the estimation of error associated with the presented models, as these measurements could be compared with predictions to gauge model accuracy.

Limitations and assumptions related to the environmental variables selected to proxy the spatial variability of input of organic material to the sea floor in the model may also have led to model error. Bathymetry and bottom temperature were assumed to be constant over the time horizon considered in this analysis. The assumption that bathymetry did not change included the notions that there were no marked changes in sea level or ocean floor topography over this time horizon and is fairly safe. Bottom temperature, however, may not have been constant over this time horizon over many of the depths considered in this analysis. Levitus et al. (2000) found evidence of substantial changes in the heat content of sea water over the period from 1948 to 1998 from the surface through 3,000 meter depth. Since it is likely that these changes persisted to the present, bottom temperature measurements for each of the time periods modeled in this study, especially for areas at depths less than 3,000 meters, would have added to the validity of change estimation.

The availability of grids for the other environmental variables used to proxy spatial variability of the input of organic material to the sea floor, sea surface temperature and surface chlorophyll-*a* concentration, influenced the decision to model change over the nine-year period presented in this study. Again, the initial scope of the project was to compare present and future models of benthic biomass distribution and abundance, with environmental variables for future models coming from general circulation models based on a number of emissions scenarios for

the year 2100. While a number of GCMs include global sea surface temperature as a model output, no models included surface chlorophyll-a concentration or surface productivity as an output. Difficulty in modeling surface productivity is likely due to the complex dynamics of plankton communities. Thus modeling from the past into the future was the most reasonable alternative, and the earliest year for which grids for annual average sea surface temperature and surface chlorophyll-*a* concentration were available was 1997. This exercise should be reattempted once GCM-generated surface chlorophyll-*a* based on future emissions scenarios become available.

Grids for sea surface temperature and surface chlorophyll-*a* concentration were compiled from satellite imagery. The instruments that collect this imagery are unable to take measurements through ice cover, which varies in extent by season at the earth's poles. Thus ice cover was masked from the environmental variables used in the analysis. Since polar oceans are recorded as having a remarkable amount of benthic biomass (Brey and Gerdes 1997), it is worth investigating alternatives methods for modeling benthos distribution in these regions. Satellites also have trouble taking readings around coastlines and in shallow waters, so a number of coastal areas were excluded from the analysis. In certain cases, the areas considered within the same boundary for the same size class for different time periods would be vastly different. This amplified the difference between biomass estimates in a number of the presented comparisons. Finally, the cell size for all grids in this analysis was set to match the largest cells on the ETOPO2 grid—about 13.7 km^2. Though it would not be more appropriate to analyze benthic biomass distribution and abundance at a resolution any higher than that presented here, the cell size used was too coarse for use of change in analysis at coastlines with high curvature, within Exclusive Economic Zones, Large Marine Ecosystems and within marine protected areas. Analyses done at the regional scale would avoid these issues.

Further investigation about the relationship between benthos distribution and environmental variables would improve the predictive capabilities of these models. While a linear relationship was assumed between benthic biomass and the environmental variables used here, the true relationship likely takes a much different shape. Other environmental variables, such as bottom oxygen, bottom nutrients and bottom salinity should be also investigated for their influence on biomass distribution. The addition of variables accounting for the sinking rate of organic matter to the sea floor and ocean currents will allow for more valid estimates. Finally, this model does nothing to address the variable impacts of environmental variables on different invertebrate taxa and lumps all benthic organisms into categories based on size classes. Modeling the distribution of smaller groups of more evolutionarily related organisms may be a more reasonable endeavor.

Recommendations for conservation and management in the face of climate change. The IPCC notes that even if the world were to curb carbon emissions substantially erratic weather patterns and changes in sea level could endure into the coming centuries (IPCC 2007b). This is because climate systems operate on a very long time scale. Despite their limitations, protected areas may still be the best bet. Welch (2005) suggests that protected area managers should try to maintain ecosystem resilience in order to reduce vulnerability. For the protection of marine and terrestrial ecosystems, increasing resilience in the face of climate change includes four primary objectives:

1. *The integration of long-term monitoring in management plans* – Long-term monitoring of outside and within protected area boundaries will allow managers to quickly perceive ecosystem or species changes and assign to changes to specific causes.
2. *The establishment of adjustable protected area boundaries* – Protected area managers should be ready to re-establish reserve boundaries as needed to encompass changing

species range and distribution (Soto 2002). This does not mean that existing static reserves should be eliminated, but rather implies that the notion of reserves can be revised and incorporated into adaptive land and seascape management systems (Bengtsson et al. 2003).

3. *The minimization or elimination of non-climate induced threats inside and outside of park boundaries* – The threats associated with habitat fragmentation and degradation become even more menacing in light of climate change. Minimizing ecosystem disturbances that occur at the local or regional scale will preserve habitat that could become suitable for species as our climate continues to change (Walther et al. 2002).
4. *The inclusion of climate change as an aspect of marine protected area citation* – Future protected areas selection should be guided in part by the threat of climate change. While this does not mean that protected areas should be cited in around areas that may eventually become climactically suitable as a result of climate change, it does mean that appropriate consideration should be given to the impacts of climate change in management plans.

CONCLUSION

The evaluation of the impacts of climate change on the natural world, whether it is accomplished by considering single organisms, entire classes of organisms as in this study, or ecosystems as a whole, will require the integration of data at a wide range of spatial and temporal scales. Global scale models may be too large to guide conservation initiatives at the regional scale on their own. However, they will continue to be invaluable components to regional scale analyses, especially in the cases where data at finer resolutions is unavailable. In order to maintain biodiversity and ecosystem functionality in the face of climate change, conservation planners should use integrative data analysis approaches to develop adaptive management techniques that foster ecosystem resilience.

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Tables

Table 1. Size classes used to categorize benthos, mesh sizes from literature published between 1962 and 1998, and number of measurements used for each prediction.

Class	Size	Lower sieve mesh size (µm)	Data points
Meiofauna	0.1-1mm	30 – 74	145
Macrofauna	1 mm – 1 cm	250 – 1000	101
Megafauna	>1 cm	--	44

Table 2. Correlation matrices of variables for the datapoints associated with meiofauna, macrofauna (gray) and megafauna (light blue) biomass samples modeled using averaged sea surface temperature and chlorophyll-*a* concentration from 2002 to 2005. Similar trends in correlation are assumed for the analyses presented in this study. 1: depth; 2: average annual sea surface temperature; 3: bottom temperature; 4: bottom salinity; 5: average annual chlorophyll-*a* concentration; 6A: bottom silicate; 6B: bottom phosphate; 6C: bottom nitrate; 7A: apparent bottom oxygen utilization; 7B: bottom dissolved oxygen; 7C: percent bottom oxygen saturation.

	1	2	3	4	5	6	7	8	9A	9B	9C
1		-0.208	0.457	0.235	-0.078	-0.600	-0.500	-0.495	-0.324	-0.095	0.206
2	-0.105		0.389	0.142	-0.338	0.135	0.237	0.241	0.381	-0.602	-0.431
3	0.356	0.509		0.564	-0.249	-0.404	-0.545	-0.565	-0.227	-0.538	0.055
4	-0.243	0.067	0.147		-0.141	-0.310	-0.595	-0.563	-0.261	-0.255	0.139
5	-0.349	-0.528	-0.375	0.152		0.030	0.025	0.012	-0.045	0.264	0.084
6	-0.451	0.401	-0.043	0.006	-0.067		0.763	0.711	0.618	-0.204	-0.486
7	-0.344	0.545	0.024	0.124	-0.123	0.876		0.976	0.846	-0.292	-0.729
8	-0.407	0.480	-0.066	0.185	-0.082	0.882	0.977		0.861	-0.301	-0.749
9A	-0.259	0.506	0.115	0.204	-0.081	0.796	0.956	0.935		-0.682	-0.973
9B	0.050	-0.636	-0.478	-0.224	0.258	-0.676	-0.845	-0.793	-0.920		0.796
9C	0.181	-0.533	-0.201	-0.232	0.118	-0.726	-0.925	-0.894	-0.990	0.948	
1		-0.210	0.649	-0.287	0.323	-0.972	-0.848	-0.839	-0.746	-0.417	-0.080
2			-0.168	-0.144	0.511	0.235	0.139	0.127	0.236	-0.200	-0.277
3				0.365	-0.239	-0.649	-0.509	-0.468	-0.308	0.066	0.431
4					-0.833	0.264	0.511	0.552	0.521	0.894	0.906
5						-0.275	-0.486	-0.517	-0.465	-0.773	-0.757
6							0.800	0.792	0.698	0.382	0.070
7								0.990	0.887	0.600	0.281
8									0.903	0.619	0.309
9A										0.414	0.155
9B											0.915
9C											

Table 3. Table displaying model results, including coefficients and F-statistics with various combinations of environmental variables. using averaged sea surface temperature and chlorophyll-*a* concentration from 2002 to 2005. Similar trends in correlation are assumed for the analyses presented in this study. Values in bold are significant at the 5% level.

	Constant	Depth	SST	Bottom Temperature	Chloro-a	Bottom DO	Bottom Silicate	Bottom Phosphate	Bottom Nitrate	Bottom Salinity	F Statistic
Meiofauna	2.04917	**0.00021**	**0.03647**	0.00867	0.02554	**0.12989**					**14.90**
Macrofauna	3.913507	**0.0002**	-0.0127	**0.0480025**	0.005154	0.013					**18.45**
Megafauna	9.221654	0.0005	-0.0602	-0.0871131	-0.2708	-0.6725					**45.01**
Meiofauna	3.04933	**0.00012**	**0.02769**	-0.00732	0.01624		**-0.00878**				**23.22**
Macrofauna	4.011165	**0.0002**	-0.0113	**0.0439631**	0.004856		-0.00121				**18.30**
Megafauna	4.404511	0.0004	-0.0394	0.0015556	0.047205		0.003264				**41.71**
Meiofauna	3.128763	**0.0002**	**0.0341**	-0.0142824	0.024583			**-0.2242124**			**15.48**
Macrofauna	4.061777	**0.0002**	-0.0096	**0.0421532**	0.005708			-0.0719674			**18.12**
Megafauna	4.306998	**0.0004**	-0.0406	0.0068914	0.053407			0.0837682			**45.83**
Meiofauna	3.071009	**0.0002**	**0.0323**	-0.010452	0.023819				-0.01102		**15.42**
Macrofauna	4.098855	**0.0002**	-0.0069	**0.0378015**	0.006593				-0.00829		**18.13**
Megafauna	4.318838	**0.0004**	-0.0403	0.0056206	0.052703				0.004987		**43.39**
Meiofauna	3.814637	**0.0002**	**0.0249**	0.00804	0.020874					-0.02586	**18.34**
Macrofauna	12.64822	**0.0002**	**-0.0156**	**0.0565871**	0.006039					**-0.25045**	**19.96**
Megafauna	-30.41473	0.0002	-0.0534	-0.1174383	**2.330831**					**0.973106**	**68.06**
Meiofauna	2.896224	**0.0002**	**0.0357**	0.0124879	0.023908	**0.1292**				-0.02404	**12.59**
Macrofauna	13.28688	**0.0002**	-0.0188	**0.0577905**	0.004596	-0.0166				**-0.26546**	**16.86**
Megafauna	-26.54457	**0.0002**	**-0.0641**	**-0.1605261**	**2.075937**	-0.3612				**0.93714**	**64.38**
Meiofauna	2.040126	**0.0002**	**0.0354**	0.0207405	0.02501	0.1701			0.00688	-0.01022	**10.49**
Macrofauna	14.14172	**0.0001**	-0.0188	0.0199961	-0.00206	**-0.2025**			**-0.03472**	-0.2399	**15.83**
Megafauna	-25.98931	**0.0002**	**-0.0635**	-0.1709765	**2.039486**	-0.392			-0.00806	**0.932025**	**55.29**

Table 4. Table summarizing the difference between 1997 and 2006 sea surface temperature by ocean basin. Differences were grouped into five subjective categories to represent relative degrees of difference in measured annual sea surface temperature, with "0" representing a negligible positive or negative difference, "±1" representing a difference between 0.5 and 2ºC, and "±2" representing a difference greater than 2ºC. Majority value is the cell value that appears the most times within a given basin. This table corresponds with the bottom panel of Figure 2.

Basin	Area (km²)	Mean	Standard Deviation	Majority Value
Arctic	2,775,195	1.40	0.70	2
Atlantic	84,213,859	0.71	0.63	1
Indian	70,938,408	0.29	0.62	0
Pacific	166,931,637	0.41	0.78	0
Southern	11,523,276	0.91	0.38	1

Table 5. Table summarizing the differences between 1997 and 2006 surface chlorophyll-*a* concentration by ocean basin. Differences were grouped into five subjective categories to represent relative degrees of difference in measured surface chlorophyll-*a* concentration, with "0" representing a negligible positive or negative difference, "0.15 to 0.3" or "-0.15 to -0.3" representing a positive or negative difference between 0.15 and 0.3 mg/m^3, and ">0.3" or "<-0.3" representing a positive or negative difference greater than 0.3 mg/m^3. Majority value is the cell value that appears the most times within a given basin. This table corresponds with Figure 3.

Basin	Area (km²)	Majority
Arctic	2,365,415	> 0.3
Atlantic	83,022,164	0
Indian	70,738,909	0
Pacific	166,231,909	0
Southern	9,916,827	0

Table 5. Parameters of multiple regressions used to predict global benthic biomass for meiofauna, macrofauna and megafauna for 1997 and 2006. Significant variables are in bold. The result for the equation is a log transformed value of biomass.

1997	**Meiofauna**		**Macrofauna**		**Megafauna**	
	N = 145		N = 101		N = 45	
	β	Correlation	β	Correlation	β	Correlation
Chlorphyll a	0.1713	0.356	0.5772	0.198	0.6199	0.216
Sea Surface Temperature	0.0191	0.057	**-0.0277**	**< 0.0001**	-0.345	0.341
Bathymetry	**0.0002**	**< 0.0001**	**0.0002**	**< 0.0001**	**0.0004**	**0.016**
Bottom Temperature	-0.0045	0.635	0.0286	0.131	-0.0115	0.9
Constant	**3.1705**	**< 0.0001**	**4.2666**	**< 0.0001**	**4.327**	**< 0.0001**
R^2	0.29		0.56		0.52	
F Statistic	13.47		26.77		14.74	

2006	**Meiofauna**		**Macrofauna**		**Megafauna**	
	N = 145		N = 140		N = 45	
	β	Correlation	β	Correlation	β	Correlation
Chlorphyll a	0.0203	0.075	0.135	0.167	1.134	0.08
Sea Surface Temperature	**0.0195**	**0.05**	**-0.028**	**< 0.0001**	-0.0489	0.062
Bathymetry	**0.0002**	**< 0.0001**	**0.0002**	**< 0.0001**	0.0002	0.061
Bottom Temperature	-0.0058	0.52	0.0271	0.114	0.032	0.708
Constant	**2.90873**	**< 0.0001**	**4.3308**	**< 0.0001**	**3.593**	**< 0.0001**
R^2	0.3		0.56		0.53	
F Statistic	15.58		27.27		18.67	

Table 6. Table summarizing benthic biomass by size class for each ocean basin for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Full ocean basin summaries, including minimum and maximum values, means, standard deviations and areas of analysis, are included in the Appendix.

		1997	2006	Percent Change	Category
Meiofauna (Teragrams)	**Arctic**	3,872	4,241	8.70%	Increase
	Atlantic	68,780	53,588	-28.35%	Moderate Decrease
	Indian	63,570	41,149	-54.49%	Severe Decrease
	Pacific	127,652	98,952	-29.00%	Moderate Decrease
	Southern	5,309	3,629	-46.28%	Moderate Decrease
Macrofauna (Teragrams)	**Arctic**	44,667	25,941	-72.19%	Severe Decrease
	Atlantic	294,801	212,402	-38.79%	Moderate Decrease
	Indian	207,082	156,876	-32.00%	Moderate Decrease
	Pacific	374,940	275,575	-36.06%	Moderate Decrease
	Southern	69,052	46,790	-47.58%	Moderate Decrease
Megafauna (Teragrams)	**Arctic**	112,672	103,473	-8.89%	Mild Decrease
	Atlantic	228,891	361,680	36.71%	Increase
	Indian	76,326	96,189	20.65%	Increase
	Pacific	222,238	346,339	35.83%	Increase
	Southern	334,746	77,445	-332.24%	---
	TOTAL	**2,234,598**	**1,904,270**	**-17.35%**	**Mild Decrease**

Table 7. Table summarizing benthic biomass totaled across size classes for each ocean basin for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams.

	Arctic	Atlantic	Indian	Pacific	Southern
1997	161,211	592,471	346,979	724,830	409,107
2006	133,656	627,670	294,214	720,866	127,864
Percent Change	-20.62%	5.61%	-17.93%	-0.55%	---
Category	Mild Decrease	Increase	Mild Decrease	Mild Decrease	---

Table 8. Table summarizing benthic biomass by size class contained within all Exclusive Economic Zones for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Summaries with values for each Exclusive Economic Zone, including minimum and maximum values, means, standard deviations and areas of analysis, are included in the Appendix.

	Meiofauna	Macrofauna	Megafauna	TOTAL
1997	178,110	770,545	808,092	1,756,747
2006	112,320	486,306	936,743	1,535,368
Percent Change	-58.57%	-58.45%	13.73%	-14.42%
Category	Severe Decrease	Severe Decrease	Increase	Mild Decrease

Table 9. Table summarizing benthic biomass by size class on the high seas for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Summaries including minimum and maximum values, means, standard deviations and areas of analysis, are included in the Appendix.

	Meiofauna	Macrofauna	Megafauna	TOTAL
1997	92,678	236,076	201,612	530,366
2006	90,486	238,384	74,672	403,542
Percent Change	-2.42%	0.97%	---	-31.43%
Category	Mild Decrease	Increase	---	Moderate Decrease

Table 10. Table summarizing benthic biomass by size class in non-continental shelf regions for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Summaries including minimum and maximum values, means, standard deviations and areas of analysis for both non-continental shelf and continental shelf regions are included in the Appendix.

Non-shelf	Meiofauna	Macrofauna	Megafauna	TOTAL
1997	212,347	576,507	590,134	1,378,988
2006	186,739	523,905	445,169	1,155,813
Percent Change	-13.71%	-10.04%	-32.56%	-19.31%
Category	Mild Decrease	Mild Decrease	Moderate Decrease	Mild Decrease

Table 11. Table summarizing benthic biomass by size class in FAO fishing areas for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Summaries including minimum and maximum values, means, standard deviations and areas of analysis for are included in the Appendix.

	Meiofauna				Macrofauna			
	1997	2006	Percent Change	Category	1997	2006	Percent Change	Category
18	683	742	7.95%	Increase	7,854	3,507	-123.94%	---
21	6,812	7,057	3.47%	Increase	72,808	44,464	-63.75%	Severe Decrease
27	10,137	9,949	-1.89%	Mild Decrease	71,143	49,167	-44.70%	Moderate Decrease
31	16,845	8,914	-88.96%	Severe Decrease	46,753	28,195	-65.82%	Severe Decrease
34	10,035	8,052	-24.63%	Mild Decrease	19,011	14,189	-33.98%	Moderate Decrease
37	5,384	3,368	-59.86%	Severe Decrease	35,772	21,141	-69.21%	Severe Decrease
41	12,968	10,096	-28.45%	Moderate Decrease	50,518	39,676	-27.33%	Moderate Decrease
47	9,916	9,421	-5.26%	Mild Decrease	26,951	25,716	-4.80%	Mild Decrease
48	3,115	2,200	-41.59%	Moderate Decrease	38,978	29,345	-32.83%	Moderate Decrease
51	28,573	21,029	-35.88%	Moderate Decrease	57,826	45,268	-27.74%	Moderate Decrease
57	26,625	17,132	-55.41%	Severe Decrease	88,858	64,649	-37.45%	Moderate Decrease
58	4,362	3,649	-19.54%	Mild Decrease	49,498	45,407	-9.01%	Mild Decrease
61	17,512	11,673	-50.02%	Severe Decrease	99,506	56,746	-75.35%	Severe Decrease
67	4,093	4,086	-0.18%	Mild Decrease	29,879	17,335	-72.37%	Severe Decrease
71	47,825	24,319	-96.66%	Severe Decrease	146,245	86,575	-68.92%	Severe Decrease
77	28,893	25,828	-11.87%	Mild Decrease	33,154	31,079	-6.67%	Mild Decrease
81	13,916	13,692	-1.63%	Mild Decrease	53,330	55,641	4.15%	Mild Decrease
87	20,209	19,051	-6.08%	Mild Decrease	41,757	40,346	-3.50%	Mild Decrease
88	2,186	1,761	-24.14%	Mild Decrease	28,928	22,275	-29.87%	Moderate Decrease
TOTAL	**270,090**	**202,017**	**-33.70%**	**Moderate Decrease**	**998,769**	**720,722**	**-38.58%**	**Moderate Decrease**

	Megafauna			
	1997	2006	Percent Change	Category
18	26,310	19,118	-37.62%	Moderate Decrease
21	117,804	139,241	15.40%	Increase
27	88,851	117,246	24.22%	Increase
31	16,457	27,451	40.05%	Increase
34	9,603	25,497	62.34%	Increase
37	17,999	11,698	-53.87%	Severe Decrease
41	20,809	97,814	78.73%	Increase
47	8,989	25,843	65.22%	Increase
48	146,398	39,919	-266.74%	---
51	16,379	39,433	58.46%	Increase
57	31,193	30,148	-3.47%	Mild Decrease
58	142,441	25,491	-458.78%	---
61	86,347	152,956	43.55%	Increase
67	37,368	96,884	61.43%	Increase
71	62,638	48,920	-28.04%	Moderate Decrease
77	10,435	17,590	40.68%	Increase
81	16,422	13,359	-22.93%	Mild Decrease
87	18,894	26,952	29.90%	Increase
88	105,079	34,634	-203.40%	---
TOTAL	**980,417**	**990,195**	**0.99%**	**Increase**

Table 12. Table summarizing benthic biomass totaled across size classes for each FAO fishing area for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams.

	Grand Totals			
	1997	2006	Percent Change	Category
18	34,848	23,368	-49.13%	Moderate Decrease
21	197,424	190,762	-3.49%	Mild Decrease
27	170,131	176,362	3.53%	Increase
31	80,054	64,560	-24.00%	Moderate Decrease
34	38,650	47,738	19.04%	Increase
37	59,155	36,207	-63.38%	Severe Decrease
41	84,294	147,586	42.88%	Increase
47	45,857	60,980	24.80%	Increase
48	188,491	71,464	-163.76%	---
51	102,778	105,730	2.79%	Increase
57	146,676	111,929	-31.04%	Moderate Decrease
58	196,301	74,548	-163.32%	---
61	203,365	221,375	8.14%	Increase
67	71,340	118,305	39.70%	Increase
71	256,708	159,813	-60.63%	Severe Decrease
77	72,482	74,497	2.71%	Increase
81	83,668	82,692	-1.18%	Mild Decrease
87	80,860	86,349	6.36%	Increase
88	136,194	58,670	-132.14%	---
TOTAL	**2,249,275**	**1,912,934**	**-17.58%**	**Mild Decrease**

Table 13. Table summarizing benthic biomass by size class in Large Marine Ecosystem areas for 1997 and 2006, with percent change from 1997 to 2006 and categorizations for degree of change. Listed values are in teragrams. Summaries including minimum and maximum values, means, standard deviations and areas of analysis for are included in the Appendix.

	LME Area	1997	2006	Percent Change	Category	Comments
Meiofauna	Atlantic East	15832.34131	11233.24323	-40.94%	Moderate Decrease	
	Atlantic West	21693.09235	11149.78711	-94.56%	Severe Decrease	
	Indian Ocean	26656.06609	13101.41596	-103.46%	---	
	Pacific East	11434.24628	8546.271211	-33.79%	Moderate Decrease	
	Pacific West	34837.31462	39582.56565	11.99%	Increase	Gulf of Thailand and North Australian Shelf excluded
	Polar Oceans	5409.275994	5212.718542	-3.77%	Mild Decrease	
Macrofauna	Atlantic East	83222.93711	51384.89773	-61.96%	Severe Decrease	Baltic Sea excluded
	Atlantic West	108225.3289	64129.21418	-68.76%	Severe Decrease	
	Indian Ocean	83898.96411	50376.98849	-66.54%	Severe Decrease	
	Pacific East	48181.81854	27479.21255	-75.34%	Severe Decrease	
	Pacific West	217130.2321	125900.6601	-72.46%	Severe Decrease	
	Polar Oceans	59806.65795	31896.23924	-87.50%	Severe Decrease	Laptev Sea excluded
Megafauna	Atlantic East	57,429	163,854	64.95%	Increase	
	Atlantic West	61,927	176,429	64.90%	Increase	
	Indian Ocean	31,527	61,201	48.49%	Increase	
	Pacific East	57,990	108,542	46.57%	Increase	
	Pacific West	136,910	181,092	24.40%	Increase	
	Polar Oceans	242,698	127,378	-90.53%	Severe Decrease	

Figures

Figure 1. Global distribution of the sample benthos measurements used to estimate biomass abundance for 1997 and 2006 for all size classes. References for measurements are included in references. Some points represent multiple samples.

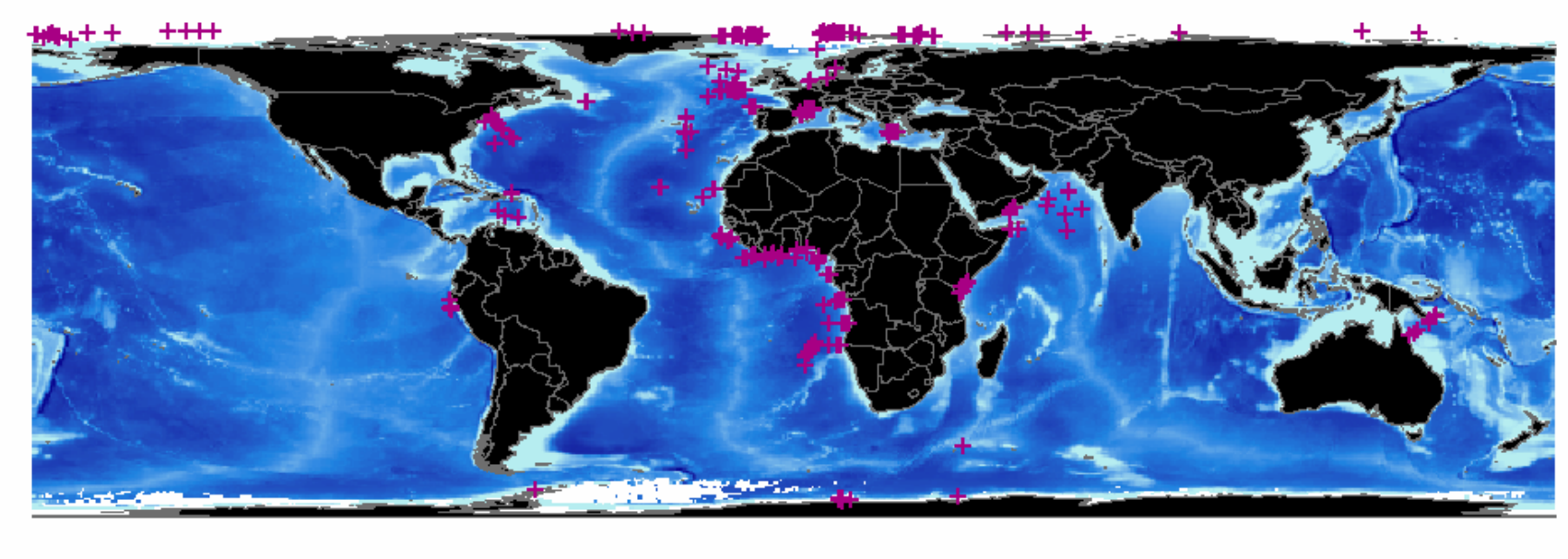


Figure 2. Annual average sea surface temperature for 1997 and 2006. The bottom panel of this figure is the difference between 2006 and 1997 sea surface temperature. Differences were grouped into five subjective categories to represent relative degrees of difference in measured annual sea surface temperature, with "0" representing a negligible positive or negative difference, "±1" representing a difference between 0.5 and 2ºC, and "±2" representing a difference greater than 2ºC. The bottom panel corresponds with Table 4.

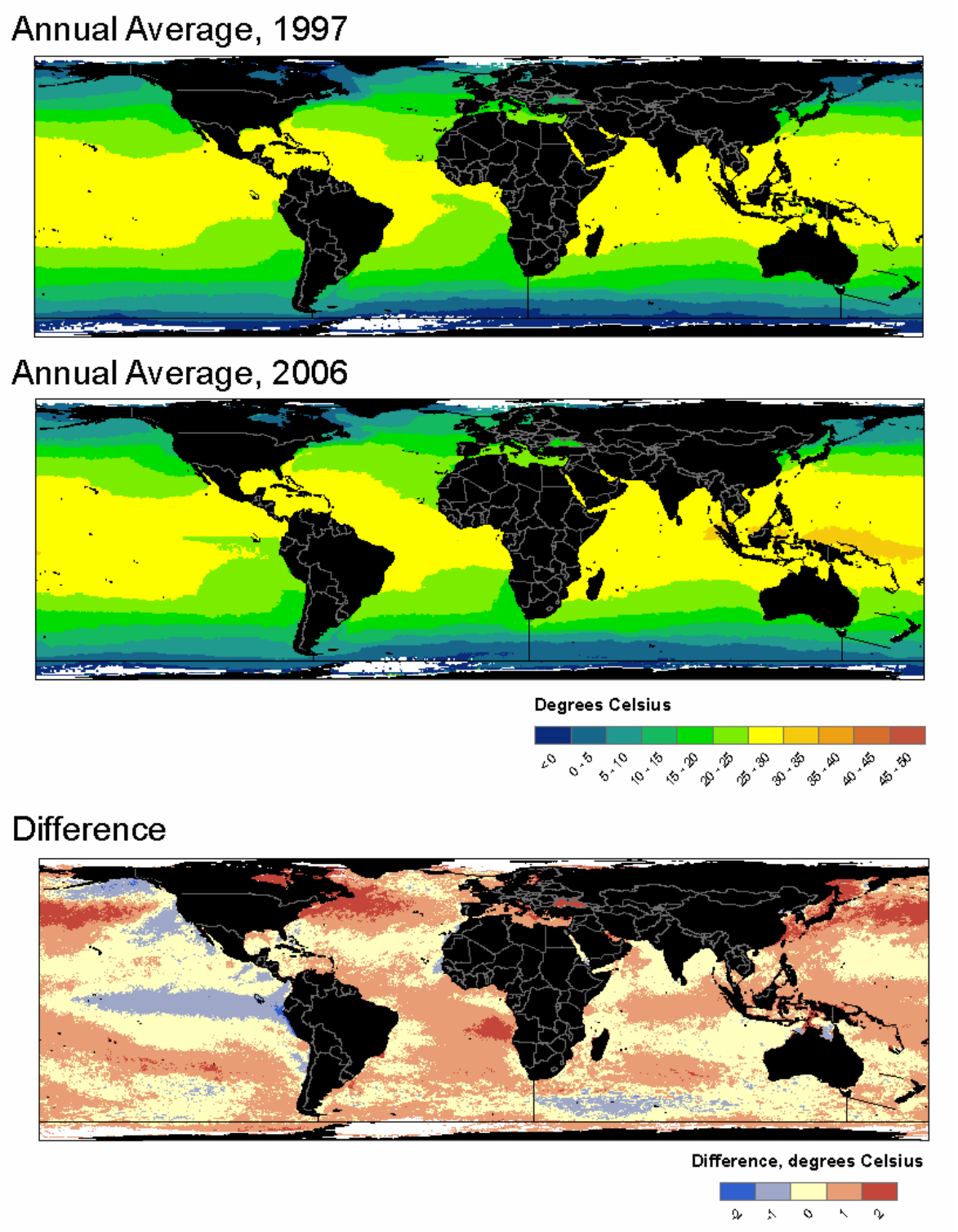


Figure 3. Difference between 2006 and 1997 surface chlorophyll-*a* concentration. Differences were grouped into five subjective categories to represent relative degrees of difference in measured surface chlorophyll-*a* concentration, with "0" representing a negligible positive or negative difference, "0.15 to 0.3" or "-0.15 to -0.3" representing a positive or negative difference between 0.15 and 0.3 mg/m^3, and ">0.3" or "<-0.3" representing a positive or negative difference greater than 0.3 mg/m^3. This figure corresponds with Table 5.

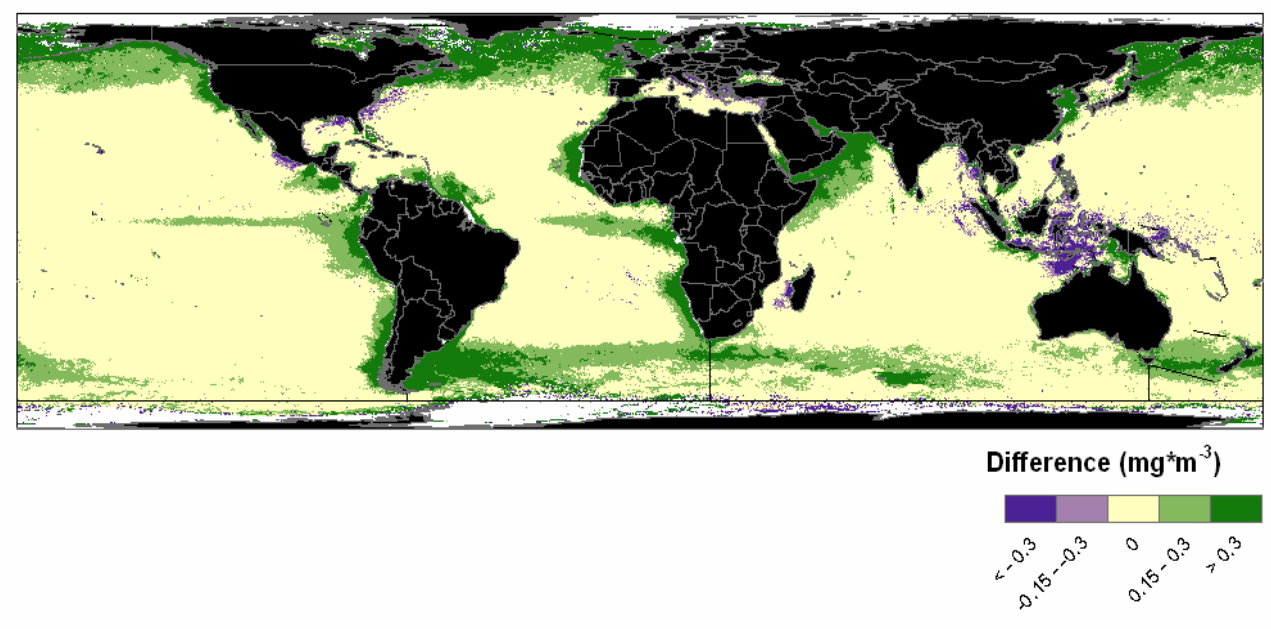


Figure 4. Modeled log meiofauna biomass for 1997 and 2006. The bottom panel represents the difference between 2006 and 1997 modeled biomass. Positive differences are labeled "gain" and negative values are labeled loss.

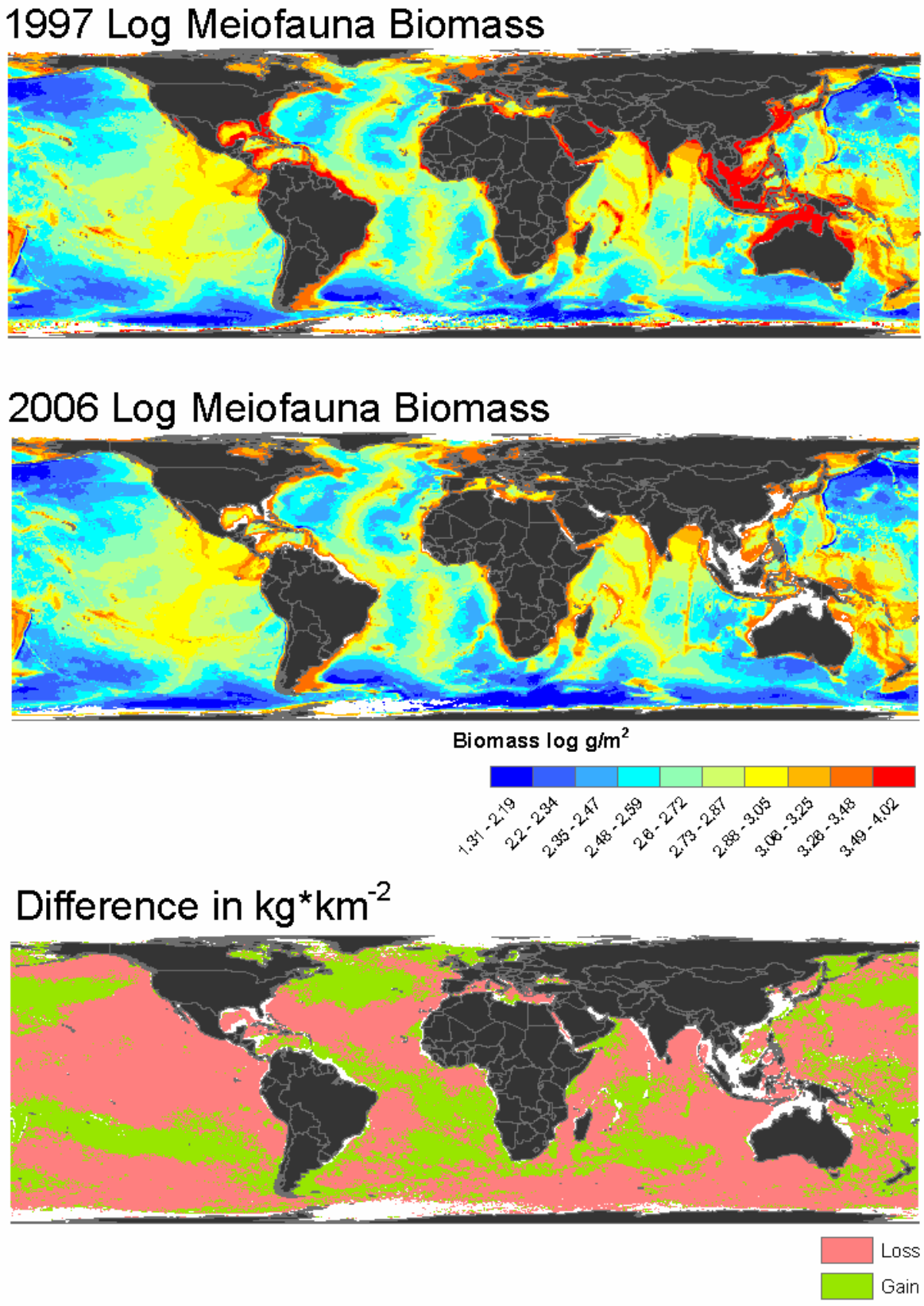


Figure 5. Modeled log macrofauna biomass for 1997 and 2006. The bottom panel represents the difference between 2006 and 1997 modeled biomass. Positive differences are labeled "gain" and negative values are labeled loss.

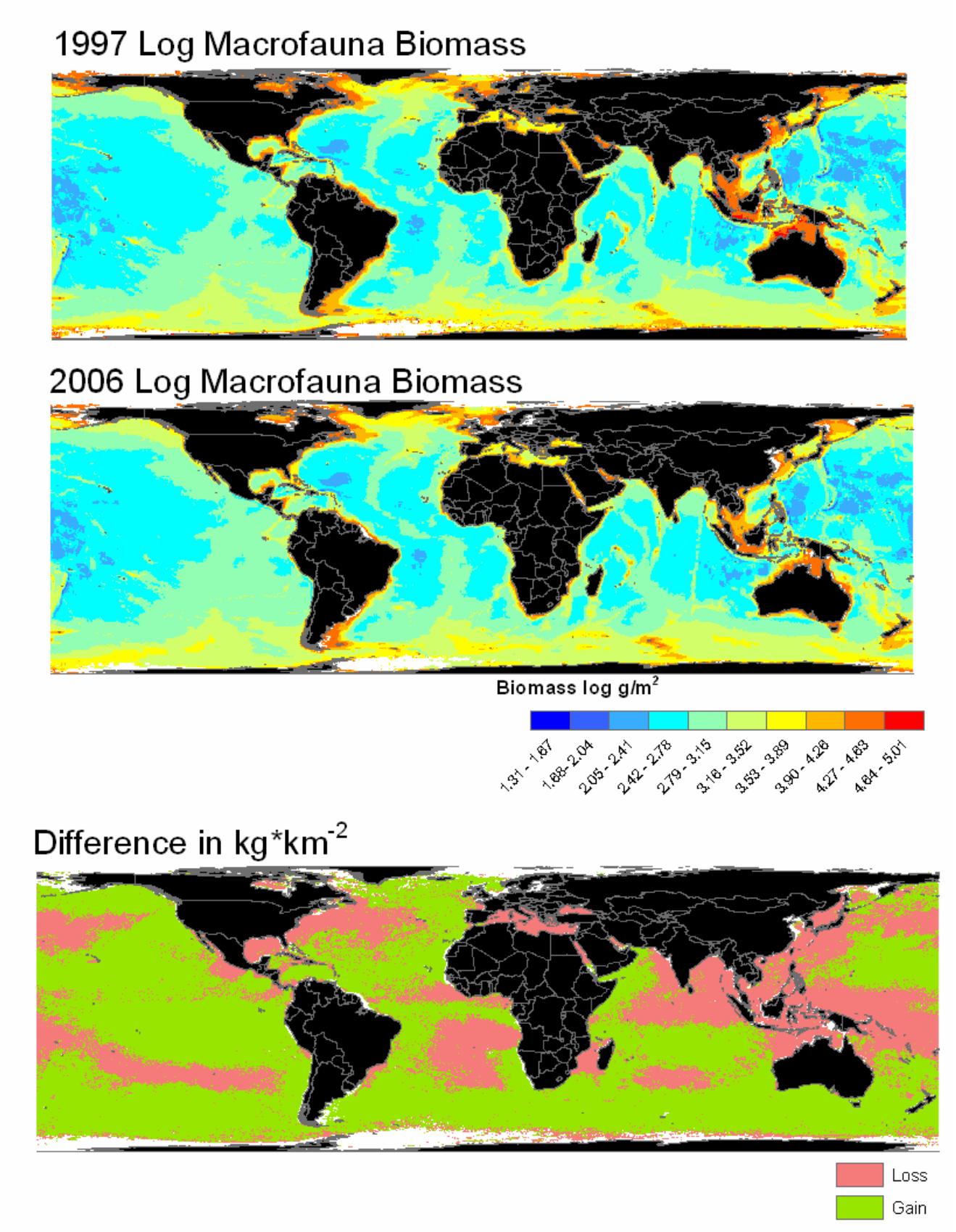


Figure 6. Modeled log megafauna biomass for 1997 and 2006. The bottom panel represents the difference between 2006 and 1997 modeled biomass. Positive differences are labeled "gain" and negative values are labeled loss.

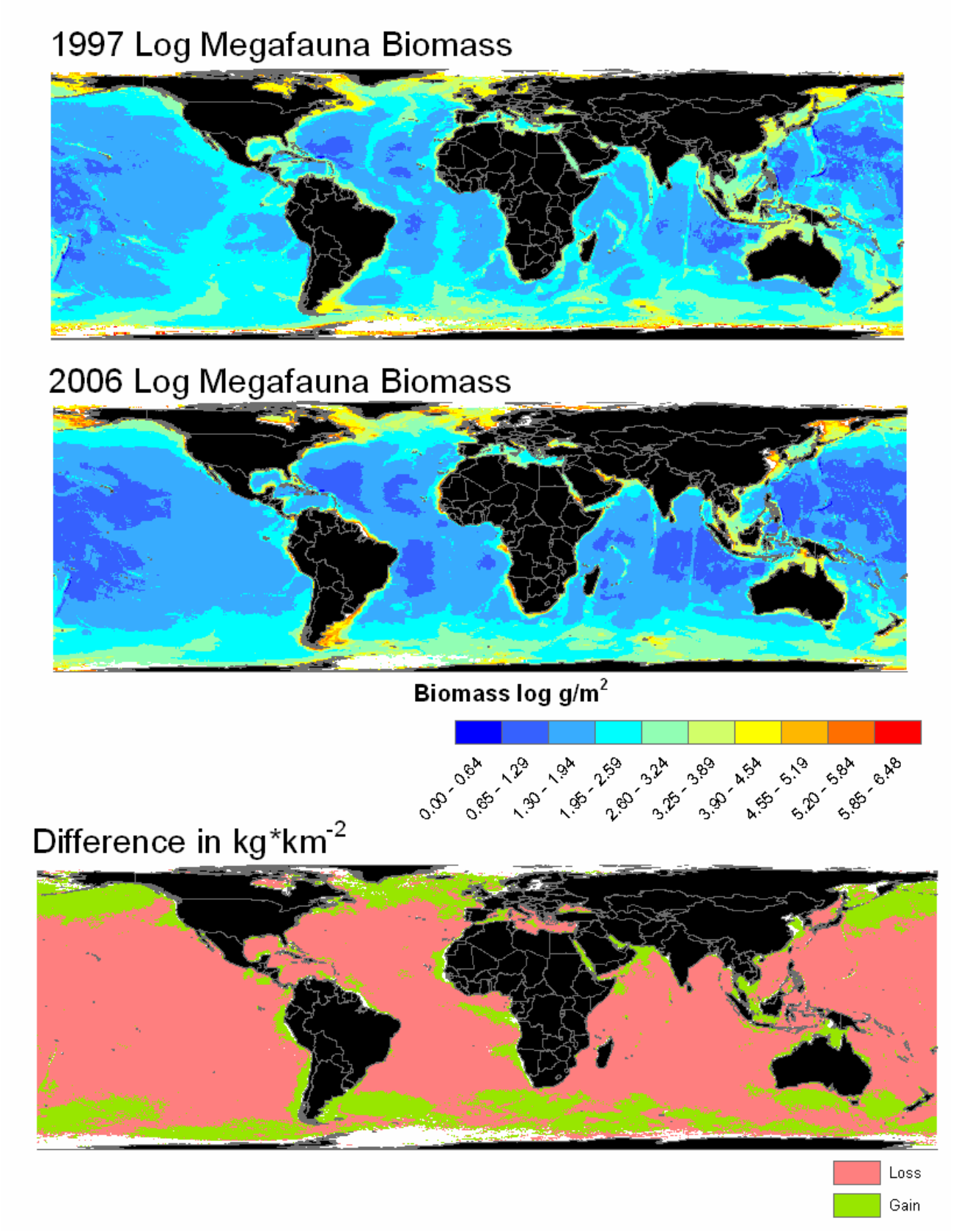


Figure 7. Boundaries for the Arctic, Atlantic, Indian, Pacific and Southern Ocean basins. World ocean and seas boundaries were obtained from the Flanders Marine Data and Information Centre (VLIZ 2007), who compiled boundary information using the data published by the International Hydrographic Organization (International Hydrographic Organization 1953).

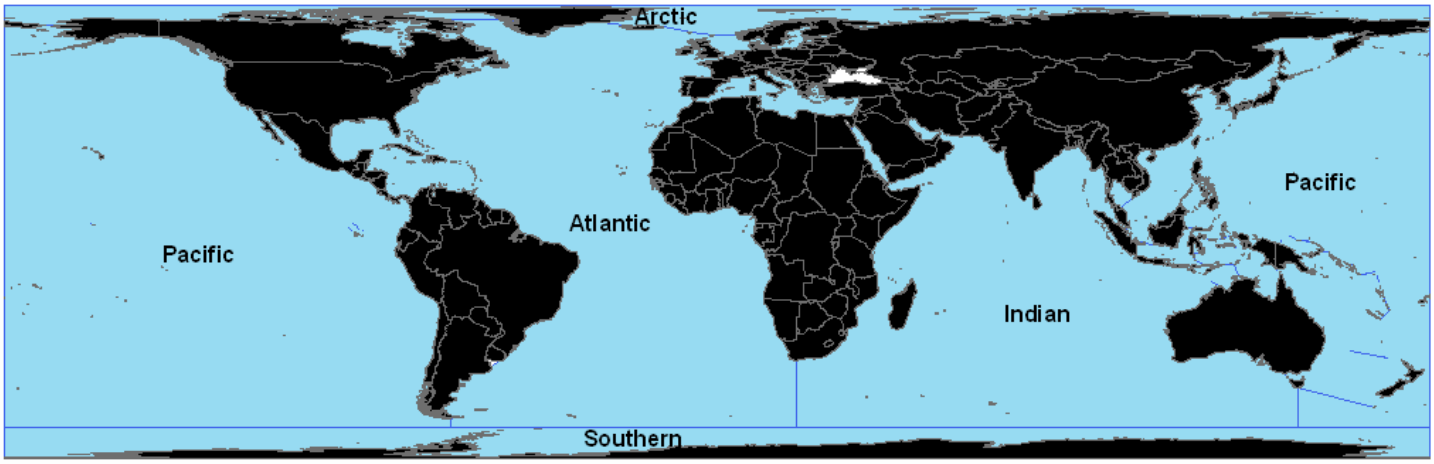


Figure 8. Boundaries of World Exclusive Economic Zones. Boundaries, in light blue, extend to 200-miles beyond the shore of the nations holding jurisdiction over each area. High seas areas are uncolored. Map obtained from CephBase Project of the University of Texas Medical Branch (http://www.cephbase.utmb.edu/graphics/eez.gif).

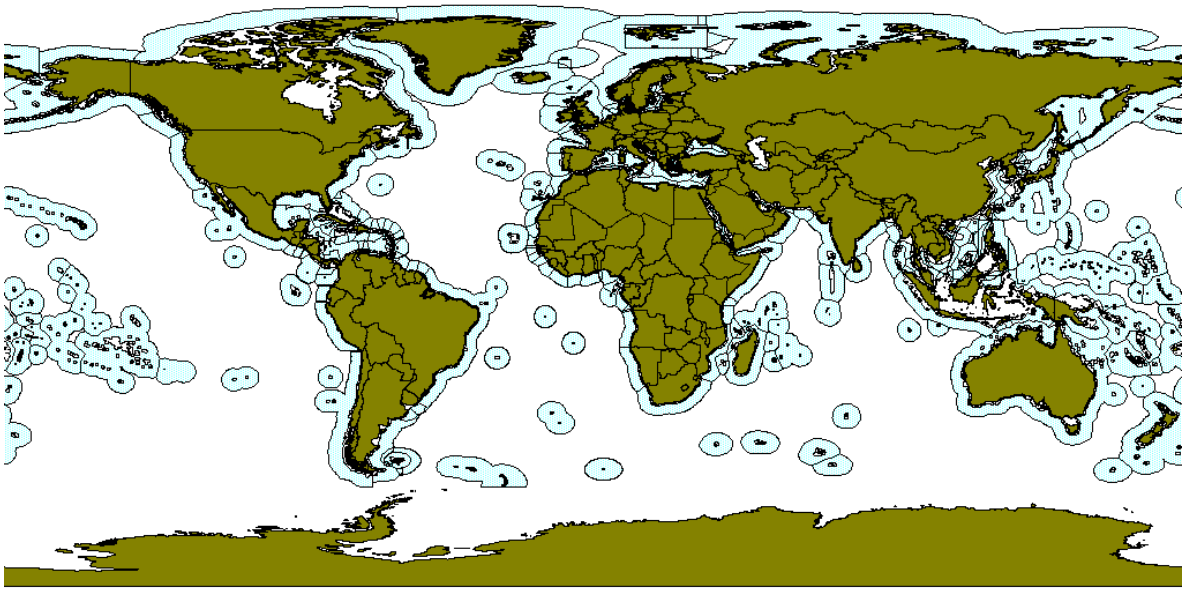


Figure 9. Food and Agriculture Organization fishing area boundaries from the United Nations Atlas of the Oceans (http://www.oceansatlas.org/).

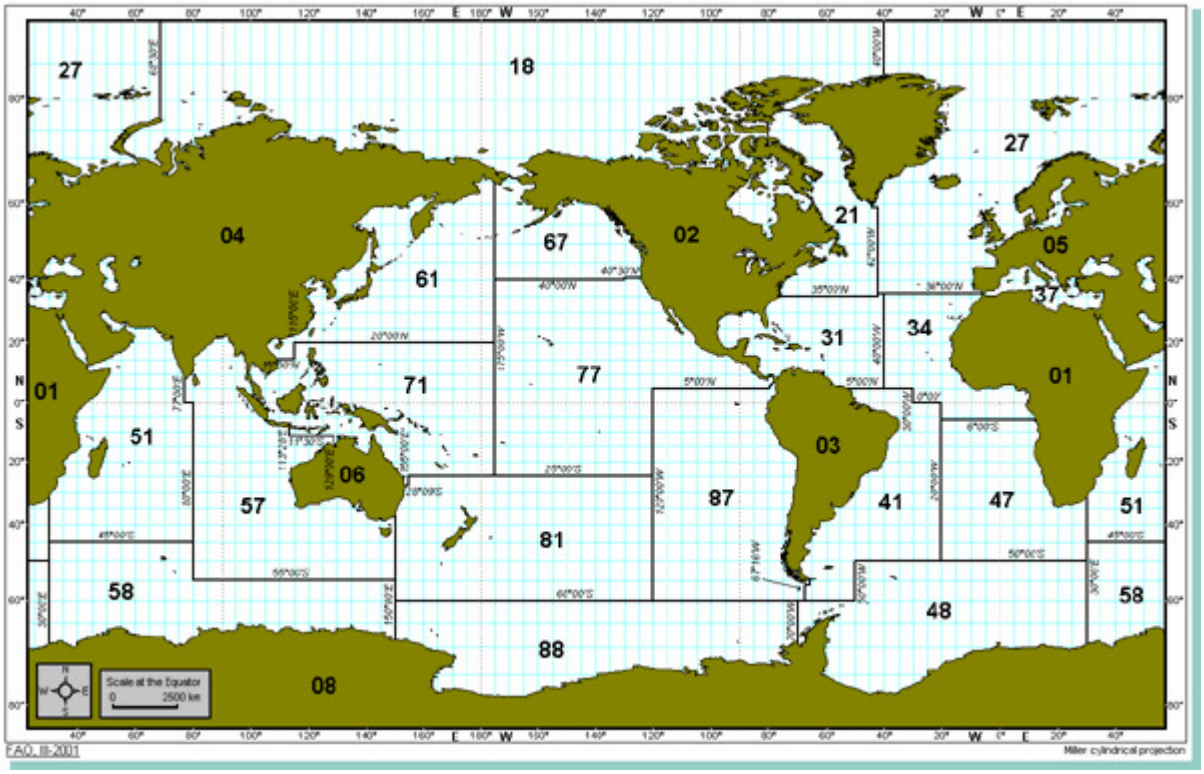
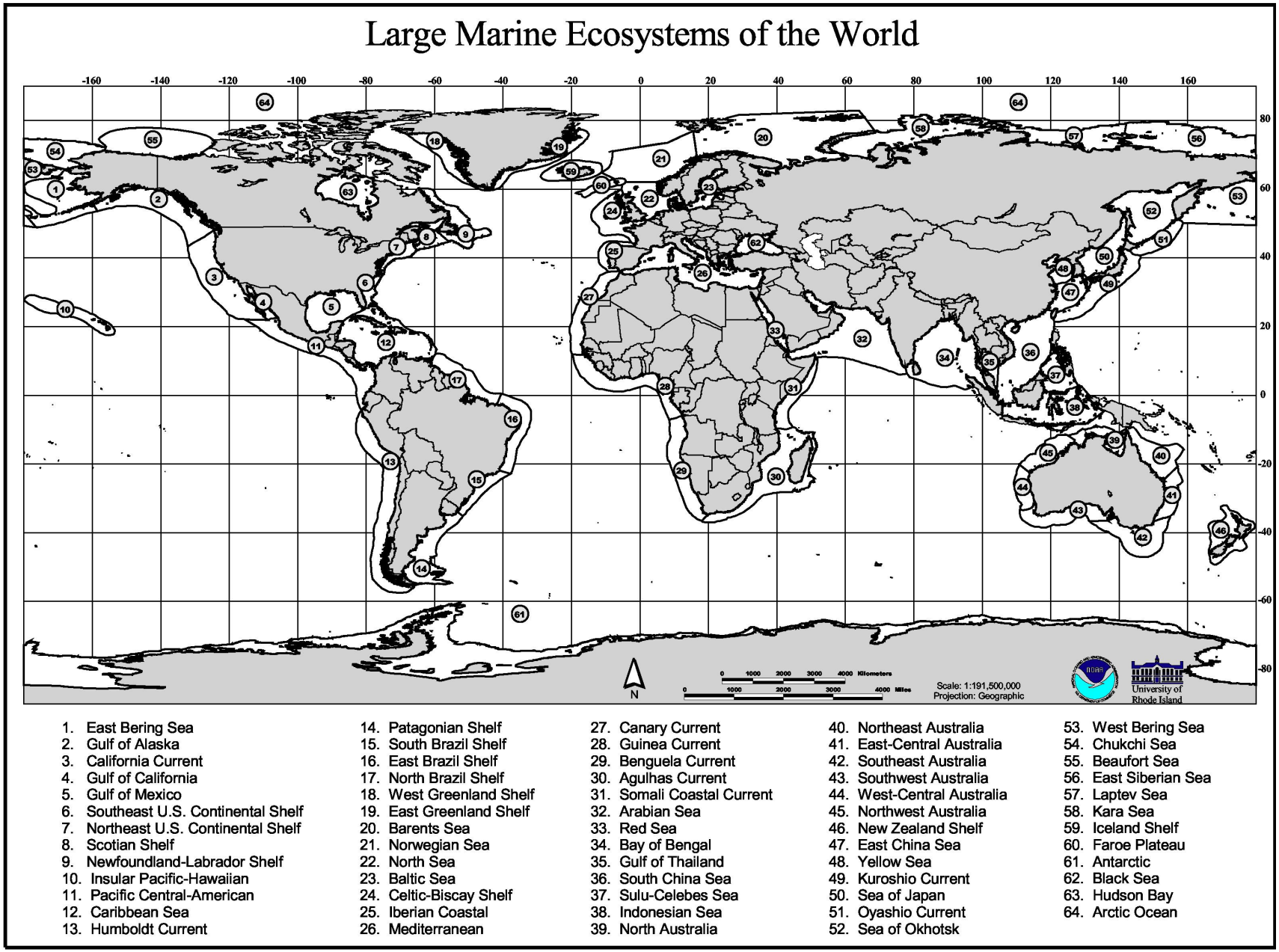


Figure 10. Large marine ecosystem boundaries. Map from the Large Marine Ecosystem Information Portal (http://woodsmoke.edc.uri.edu/Portal/ptk)



APPENDIX

Table A1(a). Summary by ocean basin for each size class for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 MEIOFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	2,449,396	685	25,647	3,872	2,202	3,872
Atlantic	83,578,658	2,534	874,987	68,780	73,736	68,780
Indian	70,729,250	5,043	740,433	63,570	76,760	63,570
Pacific	166,436,806	3,399	1,742,786	127,652	140,686	127,652
Southern	10,318,840	508	108,047	5,309	10,550	5,309
					TOTAL	**269,184**
1997 MACROFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	2,326,589	4,423	237,968	44,667	27,371	44,667
Atlantic	83,219,951	4,860	8,514,982	294,801	609,914	294,801
Indian	70,567,604	8,737	7,220,971	207,083	513,412	207,082
Pacific	166,146,038	3,341	17,000,229	374,940	974,857	374,940
Southern	9,532,131	6,624	975,347	69,052	119,240	69,052
					TOTAL	**990,543**
1997 MEGAFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	2,421,297	1,060	7,473,200	112,672	465,973	112,672
Atlantic	83,547,929	86	257,966,062	228,891	3,954,947	228,891
Indian	70,772,323	299	218,436,572	76,326	2,006,910	76,326
Pacific	166,470,536	166	513,324,560	222,238	5,042,914	222,238
Southern	10,055,910	464	31,070,597	334,746	2,031,353	334,746
					TOTAL	**974,872**
					Grand Total	**2,234,598**

Table A1(b). Summary by ocean basin for each size class for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 MEIOFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	2,626,674	738	7,575	4,241	1,215	4,241
Atlantic	79,727,068	2,239	229,935	53,588	45,838	53,588
Indian	65,763,439	4,389	189,663	41,149	33,332	41,149
Pacific	159,457,711	2,956	459,880	98,952	79,126	98,952
Southern	11,223,684	525	32,366	3,629	3,747	3,629
					TOTAL	**201,560**
2006 MACROFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	1,667,660	4,244	40,004	25,941	9,830	25,941
Atlantic	80,816,300	4,882	1,938,646	212,402	367,848	212,402
Indian	69,913,963	8,071	1,677,112	156,876	272,688	156,876
Pacific	163,404,996	3,373	3,919,805	275,575	553,676	275,575
Southern	10,711,222	4,604	256,942	46,790	45,819	46,790
					TOTAL	**717,585**
2006 MEGAFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Arctic	2,141,091	1,627	1,149,738	103,473	189,625	103,473
Atlantic	82,280,912	179	44,187,072	361,680	2,284,538	361,680
Indian	70,354,281	456	37,782,289	96,189	1,049,207	96,189
Pacific	164,389,533	93	88,280,799	346,339	3,479,239	346,339
Southern	10,884,650	406	5,845,101	77,445	387,525	77,445
					TOTAL	**985,126**
					Grand Total	**1,904,270**

Table A2. Meiofauna summary by Exclusive Economic Zone for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	464,896	103	2,145	218	123	218
Christmas Island	326,567	56	2,554	148	91	148
Norfolk Island	429,262	136	3,476	458	217	458
Macquarie Island	475,226	37	2,826	135	71	135
New Caledonia	1,413,580	197	12,932	1,947	1,114	1,947
Vanuatu	632,474	47	6,623	828	501	828
Solomon Islands	1,579,692	113	16,250	2,116	1,343	2,116
Palau	601,005	68	5,204	423	280	423
Micronesia	2,978,257	91	29,055	2,771	1,846	2,771
Nauru	307,086	172	1,449	222	42	222
Marshall Islands	1,983,020	507	9,865	1,272	1,089	1,272
Wake Island	405,452	96	1,554	177	116	177
Northern Mariana Islands and Guam	965,850	34	9,009	792	572	792
Taiwan	335,828	93	3,442	761	440	761
Philippines	1,762,957	78	18,413	2,885	2,745	2,885
Australia	6,813,873	921	71,172	13,413	10,668	13,413
Papua New Guinea	2,347,687	187	24,537	4,390	3,102	4,390
Fiji	1,268,798	331	12,689	1,794	969	1,794
Tuvalu	745,280	183	3,633	482	406	482
South Korea	306,455	170	3,185	851	303	851
North Korea	110,326	55	1,128	182	115	182
Paracel Islands	291,646	163	1,302	567	299	567
Spratly Islands	436,989	227	2,191	774	494	774
Cambodia	45,799	144	475	193	23	193
Thailand	292,687	440	3,056	1,257	208	1,257
Andaman and Nicobar	651,175	400	6,678	1,196	707	1,196
Southern Kuriles	210,720	5	2,103	125	145	125
Comoro Islands	163,249	114	1,301	183	82	183
Mayotte	62,321	51	454	71	34	71
Glorioso Islands	43,224	27	196	44	24	44
Seychelles	1,325,790	484	10,047	1,328	1,086	1,328
R棘nion	313,182	98	2,709	180	102	180
Juan de Nova Island	61,856	67	315	117	38	117
Bassas da India	121,108	110	515	155	33	155
Ile Europa	124,437	73	579	129	24	129
Ile Tromelin	269,205	102	940	144	24	144
Mauritius	1,266,223	409	12,559	1,276	934	1,276
Sri Lanka	521,806	321	5,420	628	541	628
Mozambique	561,371	247	5,490	1,238	571	1,238
Madagascar	1,178,570	378	12,274	1,600	1,317	1,600
Kenya	109,052	68	1,031	203	127	203
Somalia	819,342	299	7,962	1,149	906	1,149
Eritrea	73,199	176	745	293	30	293
Djibouti	6,014	13	58	22	5	22
Yemen	537,807	173	5,533	972	597	972
Oman	528,587	310	5,068	778	527	778

Table A2. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	209,994	278	2,191	715	175	715
Kuwait	10,508	30	102	39	6	39
Pakistan	218,159	133	2,155	499	257	499
United Arab Emirates	49,663	156	506	204	24	204
Azores	1,049,831	244	9,161	837	464	837
Cape Verde	791,613	253	6,764	505	314	505
Madeira	451,881	98	4,297	234	126	234
Canary Islands	452,073	152	4,622	362	267	362
Belgium	2,822	6	19	7	2	7
Tunisia	97,571	80	978	284	63	284
Morocco	264,136	97	2,748	417	290	417
Western Sahara	294,879	147	3,045	456	300	456
Mauritania	151,056	113	1,577	246	151	246
Gambia	20,728	10	170	33	30	33
Senegal	155,618	69	1,562	217	185	217
Libya	346,843	160	3,618	667	330	667
Malta	54,663	31	199	127	41	127
Latvia	26,660	50	277	58	16	58
Estonia	28,948	54	299	61	15	61
Bulgaria	34,291	33	328	69	30	69
Romania	19,440	27	154	55	9	55
Russia	3,491,349	71	36,558	4,249	3,016	4,249
Georgia	21,975	26	223	48	21	48
Ukraine	132,506	129	1,366	289	129	289
Turkey	239,613	111	2,484	430	254	430
Syria	9,494	15	94	22	8	22
Lebanon	18,413	24	188	33	16	33
Israel	26,249	36	270	59	23	59
Greece	474,774	131	4,965	831	566	831
Cyprus	96,174	74	953	152	66	152
Albania	9,905	19	101	31	10	31
Bornholm	8,891	18	91	20	5	20
Algeria	123,615	96	1,233	148	92	148
Ascension	439,592	198	1,742	389	109	389
Saint Helena	442,674	93	3,379	229	104	229
Trindade	466,389	112	1,733	190	73	190
Tristan da Cunha	751,226	210	6,991	412	137	412
South Georgia and the South Sandwich Islands	1,039,967	32	10,878	484	679	484
Prince Edward Islands	470,979	69	4,326	222	130	222
Crozet Islands	571,879	91	1,421	266	169	266
Amsterdam Island and Saint Paul Island	506,832	157	1,315	332	120	332
Kerguelen Islands	562,728	95	5,869	492	288	492
Heard and McDonald Islands	414,658	73	2,423	275	166	275
Falkland Islands	543,287	102	5,248	748	295	748
Sierra Leone	156,769	67	1,639	205	218	205
Liberia	243,997	85	2,487	264	268	264
Togo	15,303	9	67	18	14	18
Benin	29,907	19	134	40	30	40

Table A2. continued….

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
R駱ublique du Congo	38,483	25	393	73	45	73
Namibia	552,521	145	5,697	775	486	775
South Africa	1,056,736	246	10,993	1,385	982	1,385
Sao Tome and Principe	129,451	74	1,298	160	83	160
Equatorial Guinea	301,880	106	3,105	299	273	299
Bouvet Island	438,893	47	4,022	153	68	153
Ghana	223,392	78	1,999	239	254	239
Clipperton Island	429,303	124	1,902	387	91	387
Bermuda	448,100	129	2,443	179	87	179
Galapagos Islands	830,302	554	8,635	1,119	505	1,119
Bahamas	615,582	187	6,395	1,115	886	1,115
Turks and Caicos Islands	151,837	46	1,477	118	150	118
Cuba	350,652	68	3,649	669	462	669
Cayman Islands	118,587	14	555	125	81	125
Haiti	120,081	62	1,221	193	134	193
Dominican Republic	265,328	20	2,749	280	249	280
Puerto Rico and Virgin Islands of the United States	208,528	16	2,058	186	203	186
British Virgin Islands	79,748	7	554	52	69	52
Anguilla	91,667	10	683	55	77	55
Saint Kitts and Nevis	10,179	21	103	31	7	31
Antigua and Barbuda	107,011	15	980	76	104	76
Montserrat	7,453	13	60	20	5	20
Saint Lucia	15,358	17	119	31	14	31
Dominica	28,345	8	256	37	27	37
Barbados	184,950	56	1,449	193	136	193
Grenada	25,962	29	221	60	28	60
Trinidad and Tobago	75,734	53	768	207	71	207
Saint Vincent and the Grenadines	36,004	39	251	66	30	66
Netherlands Antilles	68,308	25	530	97	72	97
Panama	320,786	197	3,337	635	414	635
Costa Rica	566,701	252	5,927	992	500	992
Nicaragua	125,780	44	1,262	386	172	386
Colombia	784,942	382	8,214	1,242	838	1,242
Honduras	235,804	69	2,422	569	322	569
El Salvador	93,078	29	863	167	153	167
Mexico	3,221,870	807	33,725	5,095	4,230	5,095
Guatemala	116,628	32	1,117	187	190	187
Ecuador	228,612	104	2,383	431	283	431
Peru	792,244	97	8,226	887	900	887
Venezuela	445,483	156	4,505	837	607	837
Guadeloupe and Martinique	136,370	27	1,268	140	133	140
Faeroe Islands	264,848	74	2,523	325	143	325
Jan Mayen	9,083	3	87	8	11	8
Pitcairn	832,138	330	2,953	625	136	625
French Polynesia	4,749,831	1,325	47,640	3,532	2,347	3,532
Line Group	1,637,547	455	14,296	950	504	950
Jarvis Island	315,032	108	1,120	141	41	141

Table A2. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	344,884	124	1,636	258	169	258
American Samoa	402,492	103	3,867	196	122	196
Samoa	130,027	16	903	99	80	99
Cook Islands	1,950,962	448	17,990	1,102	611	1,102
Niue	315,004	79	1,628	122	54	122
Tonga	661,655	17	6,335	872	620	872
Tokelau	317,539	98	1,455	192	76	192
Phoenix Group	739,759	83	3,642	306	162	306
Howland Island and Baker Island	433,016	127	1,932	179	58	179
Johnston Atoll	440,551	104	1,934	233	155	233
Hawaii	2,458,424	551	25,642	1,364	1,235	1,364
Wallis and Futuna	256,944	83	1,840	344	178	344
New Zealand	3,994,852	149	41,736	4,283	2,783	4,283
United States	2,352,578	673	24,600	4,877	3,558	4,877
Belize	34,908	22	333	84	49	84
Colombia - Jamaica	18,605	28	83	40	13	40
Jamaica	242,011	56	2,509	444	237	444
Guyana	132,383	93	1,359	319	172	319
Suriname	125,122	62	1,260	358	146	358
French Guiana	131,589	63	1,370	279	186	279
Alaska	3,098,351	156	32,419	2,852	2,768	2,852
Brazil	3,087,514	1,073	32,307	4,922	3,776	4,922
Argentina	1,059,983	196	10,798	1,989	850	1,989
Uruguay	124,382	53	1,292	234	132	234
Finland	64,664	110	665	130	34	130
Denmark	77,542	152	785	176	50	176
Germany	45,100	88	465	107	33	107
Netherlands	58,979	125	617	146	35	146
Poland	29,140	57	194	63	7	63
Spain	542,068	119	5,675	691	548	691
Portugal	317,511	67	3,179	258	266	258
Italy	522,176	225	5,454	942	562	942
Monaco	288	0	1	0	0	0
Serbia-Montenegro	7,165	13	66	21	6	21
Croatia	51,909	93	541	168	38	168
Slovenia	137	0	1	1	0	1
Lithuania	5,412	11	44	12	3	12
Iran	155,536	153	1,585	551	159	551
Iraq	397	1	4	2	0	2

Table A2. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Guinea Bissau	100,517	48	1,044	240	172	240
Guinea	107,038	51	1,110	274	175	274
Ivory Coast	171,757	64	1,694	169	158	169
Nigeria	176,853	108	1,807	394	241	394
Cameroon	9,480	19	98	37	11	37
Gabon	183,786	97	1,923	321	241	321
Democratic Republic of the Congo	617	2	6	3	1	3
Angola	493,543	155	5,158	711	550	711
Nigeria - Sao Tome and Principe	34,469	23	215	37	15	37
Tanzania	235,996	161	2,447	415	248	415
India	1,591,324	861	16,653	3,855	2,313	3,855
Bangladesh	62,253	146	650	274	64	274
Myanmar	497,063	583	5,175	1,721	777	1,721
Malaysia	447,278	378	4,673	1,864	442	1,864
Viet Nam	640,968	412	6,689	2,158	636	2,158
Singapore	329	1	3	2	1	2
China	775,489	1,402	8,116	2,641	599	2,641
Japan	3,969,287	151	41,435	4,191	4,152	4,191
Japan - Korea	83,091	205	504	275	24	275
Kiribati	1,043,145	240	6,593	689	441	689
Antarctica	3,694,712	356	38,682	3,350	5,175	3,350
Indonesia	5,782,455	363	60,544	15,762	10,737	15,762
Conflict Zone	72,829	112	301	229	49	229
Canada	3,390,956	873	35,505	4,918	2,721	4,918
Saint Pierre and Miquelon	11,796	5	85	19	8	19
Southern Saint-Martin	12,056	20	50	38	7	38
Northern Saint-Martin	5,412	3	44	17	5	17
Sweden	145,658	243	1,473	303	62	303
Norway	344,295	143	3,604	621	284	621
Chile	2,860,163	223	29,915	1,785	1,778	1,785
Easter Island	717,003	362	2,616	622	154	622
Japan - South Korea Conflict Zone	66,048	36	251	99	39	99
Greenland	960,877	299	10,051	962	868	962
Iceland	650,668	227	6,807	815	535	815
Ireland	368,092	108	3,778	601	306	601
United Kingdom	920,366	314	9,547	1,680	621	1,680
France	323,498	86	3,378	576	365	576
Jersey	2,822	6	23	7	2	7
Guernsey	8,604	18	43	21	2	21
Maldives	911,804	380	4,660	1,211	823	1,211
British Indian Ocean Territory	635,502	210	2,931	713	528	713
Egypt	249,148	171	2,553	540	268	540
Sudan	64,239	92	601	210	45	210
Bahrain	7,042	22	69	26	5	26
Qatar	30,072	91	310	118	13	118
Grand Total	131,788,547					178,110

Table A3. Meiofauna summary by Exclusive Economic Zone for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	463,745	98	1,330	207	100	207
Christmas Island	325,964	51	931	138	75	138
Norfolk Island	426,687	133	1,231	449	208	449
Macquarie Island	475,253	34	847	131	67	131
New Caledonia	1,321,283	171	3,810	1,641	823	1,641
Vanuatu	581,729	43	1,677	692	339	692
Solomon Islands	1,469,270	108	4,237	1,767	842	1,767
Palau	594,895	62	1,716	396	207	396
Micronesia	2,919,854	83	8,420	2,570	1,442	2,570
Nauru	306,949	170	811	220	37	220
Marshall Islands	1,946,619	485	5,613	1,127	704	1,127
Wake Island	404,835	92	1,163	171	108	171
Northern Mariana Islands and Guam	953,794	31	2,751	747	499	747
Taiwan	198,034	55	571	258	130	258
Philippines	1,363,506	55	3,932	1,187	909	1,187
Australia	4,886,749	633	14,093	5,495	4,262	5,495
Papua New Guinea	1,965,772	141	5,669	2,723	1,457	2,723
Fiji	1,162,705	287	3,353	1,512	609	1,512
Tuvalu	730,868	169	2,107	434	292	434
South Korea	118,135	62	341	215	92	215
North Korea	103,271	47	298	139	79	139
Paracel Islands	226,475	125	653	341	159	341
Spratly Islands	358,707	182	1,035	487	274	487
Thailand	7,343	11	21	15	3	15
Andaman and Nicobar	559,768	334	1,614	785	307	785
Southern Kuriles	210,870	4	607	127	137	127
Comoro Islands	160,071	110	460	165	46	165
Mayotte	60,116	47	173	61	19	61
Glorioso Islands	41,936	25	121	38	14	38
Seychelles	1,256,208	446	3,623	1,054	607	1,054
R駸nion	312,442	96	899	175	84	175
Juan de Nova Island	59,033	61	169	98	21	98
Bassas da India	120,492	104	344	146	25	146
Ile Europa	124,286	67	332	116	20	116
Ile Tromelin	269,150	98	726	142	22	142
Mauritius	1,187,119	377	3,424	1,004	476	1,004
Sri Lanka	483,459	285	1,394	429	165	429
Mozambique	410,000	178	1,182	675	221	675
Madagascar	1,036,487	333	2,989	1,019	620	1,019
Kenya	80,720	51	233	104	46	104
Somalia	701,673	245	2,023	720	456	720
Eritrea	2,137	5	6	5	0	5
Djibouti	849	2	2	2	0	2
Yemen	437,482	140	1,262	604	282	604
Oman	450,456	266	1,299	501	181	501

Table A3. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	80,597	98	232	194	24	194
Pakistan	159,824	92	461	249	81	249
Azores	1,049,735	242	3,027	879	492	879
Cape Verde	784,065	242	2,261	474	228	474
Madeira	451,360	97	1,300	230	114	230
Canary Islands	448,086	148	1,292	334	212	334
Belgium	1,699	4	5	5	0	5
Tunisia	27,852	22	80	62	19	62
Morocco	236,832	86	683	314	206	314
Western Sahara	249,326	123	719	310	175	310
Mauritania	117,217	87	338	141	54	141
Gambia	15,385	7	44	12	6	12
Senegal	128,684	52	371	114	66	114
Libya	252,423	114	728	372	164	372
Malta	42,004	23	121	89	31	89
Latvia	12,700	24	37	34	1	34
Estonia	6,425	16	19	18	0	18
Bulgaria	24,687	25	71	38	13	38
Romania	3,589	5	10	8	2	8
Russia	3,499,624	65	10,093	4,423	2,711	4,423
Georgia	19,112	22	55	32	8	32
Ukraine	71,528	74	206	110	41	110
Turkey	202,568	71	584	290	114	290
Syria	8,946	13	26	18	2	18
Lebanon	17,920	23	51	28	5	28
Israel	22,468	30	65	43	7	43
Greece	446,154	112	1,287	629	356	629
Cyprus	92,598	69	267	134	50	134
Albania	6,042	11	17	14	2	14
Bornholm	8,782	21	25	23	1	23
Algeria	117,505	90	339	124	60	124
Ascension	439,017	197	1,261	396	108	396
Saint Helena	441,825	93	1,268	232	90	232
Trindade	465,978	110	1,318	186	63	186
Tristan da Cunha	751,240	208	2,148	418	135	418
South Georgia and the South Sandwich Islands	1,091,013	31	3,138	411	329	411
Prince Edward Islands	470,992	62	1,279	212	125	212
Crozet Islands	571,879	84	1,076	254	167	254
Amsterdam Island and Saint Paul Island	506,832	155	1,341	339	126	339
Kerguelen Islands	563,303	88	1,464	481	278	481
Heard and McDonald Islands	414,932	69	1,162	272	167	272
Falkland Islands	543,726	105	1,564	794	317	794
Sierra Leone	128,821	55	371	88	51	88
Liberia	219,611	75	632	164	99	164
Togo	13,892	8	39	13	6	13
Benin	26,345	16	75	26	11	26

Table A3. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
R駱ublique du Congo	26,674	18	77	40	16	40
Namibia	500,434	134	1,443	672	429	672
South Africa	937,683	216	2,704	1,062	751	1,062
Sao Tome and Principe	126,232	70	364	142	48	142
Equatorial Guinea	286,988	99	827	234	154	234
Bouvet Island	438,975	47	675	152	65	152
Ghana	196,403	65	566	131	91	131
Clipperton Island	428,851	120	1,236	375	85	375
Bermuda	446,976	128	1,286	175	60	175
Galapagos Islands	805,560	500	2,323	979	348	979
Bahamas	444,962	127	1,283	464	403	464
Turks and Caicos Islands	139,987	41	403	71	62	71
Cuba	265,903	46	767	334	187	334
Cayman Islands	115,340	13	332	111	64	111
Haiti	105,654	53	305	136	74	136
Dominican Republic	244,586	18	705	204	131	204
Puerto Rico and Virgin Islands of the United States	191,882	14	553	127	111	127
British Virgin Islands	75,282	6	217	35	38	35
Anguilla	86,105	9	248	36	39	36
Saint Kitts and Nevis	4,548	9	13	12	1	12
Antigua and Barbuda	97,243	14	280	41	38	41
Montserrat	4,631	8	13	11	1	11
Saint Lucia	12,604	14	36	21	7	21
Dominica	25,948	7	75	29	17	29
Barbados	180,470	53	520	182	121	182
Grenada	15,536	18	45	24	8	24
Trinidad and Tobago	43,141	31	124	90	20	90
Saint Vincent and the Grenadines	30,058	33	87	47	15	47
Netherlands Antilles	58,787	21	169	67	46	67
Panama	250,272	143	722	332	130	332
Costa Rica	529,272	226	1,526	799	298	799
Nicaragua	42,539	14	122	55	28	55
Colombia	682,945	303	1,970	816	352	816
Honduras	128,109	36	369	172	113	172
El Salvador	71,596	21	206	64	27	64
Mexico	2,651,868	575	7,648	2,556	1,300	2,556
Guatemala	96,667	23	279	80	32	80
Ecuador	199,486	79	575	275	106	275
Peru	697,810	74	2,012	501	392	501
Venezuela	302,606	105	873	328	229	328
Guadeloupe and Martinique	125,917	24	363	104	84	104
Faeroe Islands	265,670	75	747	342	146	342
Jan Mayen	12,234	4	19	6	3	6
Pitcairn	831,713	342	2,377	649	137	649
French Polynesia	4,677,509	1,295	13,490	3,340	1,746	3,340
Line Group	1,635,095	432	4,715	906	447	906
Jarvis Island	314,990	102	875	131	38	131

Table A3. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	342,432	118	987	247	149	247
American Samoa	400,739	106	1,152	196	92	196
Samoa	126,355	15	363	89	56	89
Cook Islands	1,947,756	436	5,616	1,103	581	1,103
Niue	314,771	80	895	123	49	123
Tonga	610,143	15	1,760	742	515	742
Tokelau	316,963	97	909	191	67	191
Phoenix Group	738,471	76	2,119	290	121	290
Howland Island and Baker Island	432,824	122	1,242	173	51	173
Johnston Atoll	440,222	100	1,258	230	154	230
Hawaii	2,414,707	543	6,964	1,216	798	1,216
Wallis and Futuna	247,011	80	712	327	155	327
New Zealand	3,993,714	134	11,516	4,312	2,713	4,312
United States	1,668,687	441	4,813	2,023	1,387	2,023
Belize	19,591	12	56	25	12	25
Colombia - Jamaica	15,248	23	44	29	5	29
Jamaica	201,568	44	581	307	146	307
Guyana	76,487	55	220	110	40	110
Suriname	54,197	27	156	96	39	96
French Guiana	76,268	37	220	78	42	78
Alaska	3,165,522	145	9,129	2,968	2,499	2,968
Brazil	2,317,259	805	6,683	2,228	1,203	2,228
Argentina	1,014,417	178	2,925	1,953	806	1,953
Uruguay	72,446	31	209	93	60	93
Finland	26,715	65	77	73	3	73
Denmark	69,596	129	201	173	13	173
Germany	30,483	68	88	79	5	79
Netherlands	49,841	111	144	123	8	123
Poland	20,947	52	60	56	2	56
Spain	502,639	108	1,450	541	393	541
Portugal	312,292	66	900	233	214	233
Italy	436,290	181	1,258	607	317	607
Monaco	288	0	1	0	0	0
Serbia-Montenegro	4,055	7	12	9	2	9
Croatia	24,098	42	69	61	10	61
Slovenia	96	0	0	0	0	0
Lithuania	1,863	5	5	5	0	5
Iran	33,990	33	98	64	22	64
Guinea Bissau	55,115	24	158	51	31	51
Guinea	51,676	23	149	48	32	48
Ivory Coast	157,482	57	454	118	76	118
Nigeria	113,272	66	327	148	74	148
Cameroon	1,178	3	3	3	0	3

Table A3. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Gabon	142,823	75	411	168	81	168
Angola	417,439	136	1,204	455	268	455
Nigeria - Sao Tome and Principe	34,497	22	84	36	13	36
Tanzania	196,581	134	567	268	107	268
India	1,138,977	594	3,285	1,707	644	1,707
Bangladesh	9,480	20	27	23	2	23
Myanmar	241,353	254	696	422	82	422
Malaysia	42,086	32	121	84	23	84
Viet Nam	175,579	111	506	340	93	340
China	125,328	230	361	333	19	333
Japan	3,566,644	125	10,286	2,835	2,476	2,835
Japan - Korea	4,124	11	12	12	0	12
Kiribati	1,031,377	234	2,972	646	275	646
Antarctica	4,188,337	396	12,078	2,240	1,924	2,240
Jordan	27	0	0	0	0	0
Indonesia	3,190,072	185	9,200	3,526	2,324	3,526
Conflict Zone	16,344	26	47	34	5	34
Canada	3,489,568	973	10,063	5,292	2,188	5,292
Saint Pierre and Miquelon	11,878	5	27	22	7	22
Southern Saint-Martin	3,809	6	11	10	1	10
Northern Saint-Martin	1,658	1	5	3	1	3
Sweden	112,326	189	324	297	14	297
Norway	373,942	163	1,077	669	179	669
Chile	2,838,941	198	8,188	1,703	1,473	1,703
Easter Island	716,209	373	2,063	652	162	652
Japan - South Korea Conflict Zone	64,445	34	186	89	34	89
Greenland	1,035,556	332	2,897	909	465	909
Iceland	690,795	244	1,977	841	314	841
Ireland	371,065	109	1,067	595	271	595
United Kingdom	911,351	300	2,628	1,686	526	1,686
France	307,387	78	886	495	298	495
Jersey	2,740	7	8	7	0	7
Guernsey	8,645	20	22	21	0	21
Maldives	844,824	355	2,435	917	414	917
British Indian Ocean Territory	593,744	194	1,712	575	312	575
Egypt	181,758	120	524	296	134	296
Sudan	19,043	26	55	44	7	44
Grand Total	116,386,542					112,320

Table A4. Macrofauna summary by Exclusive Economic Zone for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	464,896	78	9,926	172	214	172
Christmas Island	326,526	43	11,859	116	151	116
Norfolk Island	429,235	232	32,163	841	920	841
Macquarie Island	475,143	361	22,776	1,102	673	1,102
New Caledonia	1,413,114	187	144,114	3,395	6,018	3,395
Vanuatu	631,926	33	63,162	1,005	2,166	1,005
Solomon Islands	1,577,171	79	161,315	2,644	7,552	2,644
Palau	600,964	47	55,606	353	933	353
Micronesia	2,978,051	60	293,340	2,206	4,517	2,206
Nauru	307,086	112	3,814	151	51	151
Marshall Islands	1,983,020	332	43,551	1,165	3,364	1,165
Wake Island	405,452	75	3,292	134	106	134
Northern Mariana Islands and Guam	965,809	22	93,349	603	964	603
Taiwan	334,951	82	32,994	2,317	3,171	2,317
Philippines	1,750,148	49	179,077	7,505	16,827	7,505
Australia	6,786,720	1,632	693,867	67,289	96,433	67,289
Papua New Guinea	2,329,671	167	238,290	9,637	22,919	9,637
Fiji	1,267,908	334	127,409	2,473	5,076	2,473
Tuvalu	745,280	118	17,902	392	960	392
South Korea	300,523	673	30,529	5,583	3,457	5,583
North Korea	108,052	259	11,023	1,203	1,301	1,203
Paracel Islands	291,646	116	6,610	638	738	638
Spratly Islands	436,989	160	10,092	865	1,326	865
Cambodia	45,128	808	4,616	1,109	316	1,109
Thailand	288,111	389	29,437	6,082	3,712	6,082
Andaman and Nicobar	649,695	271	66,335	1,836	4,192	1,836
Southern Kuriles	209,994	37	20,166	1,114	1,492	1,114
Comoro Islands	163,140	86	14,389	175	373	175
Mayotte	62,308	39	4,698	86	216	86
Glorioso Islands	43,224	21	894	41	62	41
Seychelles	1,325,749	346	132,645	1,585	3,885	1,585
R騏nion	313,114	85	29,507	179	412	179
Juan de Nova Island	61,856	52	1,996	135	128	135
Bassas da India	121,108	103	2,876	153	87	153
Ile Europa	124,437	75	2,680	149	53	149
Ile Tromelin	269,205	86	1,275	116	24	116
Mauritius	1,266,086	314	92,765	1,710	3,459	1,710
Sri Lanka	519,929	205	52,912	1,077	3,451	1,077
Mozambique	560,111	246	57,314	3,213	5,002	3,213
Madagascar	1,175,227	359	119,791	3,820	8,824	3,820
Kenya	108,751	52	10,154	355	695	355
Somalia	818,534	221	82,552	1,976	4,423	1,976
Eritrea	72,925	527	7,395	1,302	436	1,302
Djibouti	5,960	28	356	70	39	70
Yemen	537,328	137	53,918	1,798	3,028	1,798
Oman	527,971	260	53,343	1,749	3,541	1,749

Table A4. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	207,678	284	21,073	3,351	1,934	3,351
Kuwait	10,261	182	1,034	243	93	243
Pakistan	217,679	130	22,060	1,539	2,127	1,539
United Arab Emirates	49,060	214	4,882	1,100	350	1,100
Azores	1,049,653	423	105,709	1,996	1,839	1,996
Cape Verde	791,476	250	76,207	674	1,443	674
Madeira	451,812	187	38,832	440	548	440
Canary Islands	451,511	230	44,898	740	1,420	740
Belgium	2,644	49	216	61	23	61
Tunisia	96,982	341	9,921	1,618	691	1,618
Morocco	262,547	172	26,693	1,744	2,120	1,744
Western Sahara	292,988	201	28,793	1,810	2,675	1,810
Mauritania	150,453	138	15,210	701	1,032	701
Gambia	20,577	9	2,018	94	160	94
Senegal	155,084	65	15,321	570	1,117	570
Libya	345,829	660	34,603	2,976	2,145	2,976
Malta	54,663	124	2,188	562	213	562
Latvia	26,194	346	2,452	454	193	454
Estonia	28,482	374	2,904	508	222	508
Bulgaria	33,702	234	3,434	667	397	667
Romania	19,194	234	1,827	587	220	587
Russia	3,423,192	521	350,141	50,158	42,494	50,158
Georgia	21,468	179	2,135	477	256	477
Ukraine	128,410	867	13,129	2,777	1,701	2,777
Turkey	234,818	730	23,974	3,454	2,678	3,454
Syria	9,289	64	748	105	69	105
Lebanon	18,111	98	1,816	156	126	156
Israel	25,907	142	2,445	258	197	258
Greece	467,403	714	47,765	6,270	6,742	6,270
Cyprus	95,955	341	9,690	710	501	710
Albania	9,248	107	934	252	149	252
Bornholm	8,809	124	731	153	44	153
Algeria	123,218	403	11,843	718	688	718
Ascension	439,592	191	9,213	416	168	416
Saint Helena	442,483	142	42,404	349	392	349
Trindade	466,389	102	5,796	175	100	175
Tristan da Cunha	751,198	568	49,529	1,315	731	1,315
South Georgia and the South Sandwich Islands	1,006,731	362	102,361	6,167	8,280	6,167
Prince Edward Islands	470,924	414	44,822	1,486	919	1,486
Crozet Islands	571,879	588	29,804	1,861	1,460	1,861
Amsterdam Island and Saint Paul Island	506,832	377	10,000	969	469	969
Kerguelen Islands	562,193	799	52,404	4,546	2,939	4,546
Heard and McDonald Islands	414,548	731	39,621	3,304	2,089	3,304
Falkland Islands	542,342	754	55,244	6,625	3,178	6,625
Sierra Leone	156,440	54	15,435	567	1,221	567
Liberia	243,449	76	24,339	477	1,261	477
Togo	15,303	8	540	32	72	32
Benin	29,893	16	3,016	76	181	76

Table A4. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
R駉ublique du Congo	38,292	26	3,731	200	345	200
Namibia	550,274	276	55,474	3,283	4,110	3,283
South Africa	1,055,256	366	106,619	4,498	6,735	4,498
Sao Tome and Principe	129,342	64	13,096	198	445	198
Equatorial Guinea	301,167	112	30,385	503	1,439	503
Bouvet Island	438,770	651	16,192	2,033	917	2,033
Ghana	223,159	68	21,434	521	1,324	521
Clipperton Island	429,303	92	4,442	281	80	281
Bermuda	448,086	155	34,996	254	480	254
Galapagos Islands	829,932	473	84,186	1,156	1,908	1,156
Bahamas	613,650	155	62,788	2,902	4,531	2,902
Turks and Caicos Islands	151,591	36	15,507	231	714	231
Cuba	348,240	60	35,496	1,696	3,173	1,696
Cayman Islands	118,587	10	3,380	121	177	121
Haiti	119,505	55	11,993	290	713	290
Dominican Republic	264,931	15	26,509	439	1,205	439
Puerto Rico and Virgin Islands of the United States	208,377	13	20,674	301	861	301
British Virgin Islands	79,734	6	7,777	96	321	96
Anguilla	91,653	8	8,186	86	278	86
Saint Kitts and Nevis	10,138	19	642	49	56	49
Antigua and Barbuda	106,970	12	7,426	140	403	140
Montserrat	7,453	12	591	24	39	24
Saint Lucia	15,303	15	848	38	56	38
Dominica	28,304	6	2,120	45	99	45
Barbados	184,950	44	12,799	175	217	175
Grenada	25,920	26	2,273	88	112	88
Trinidad and Tobago	75,638	41	5,923	514	593	514
Saint Vincent and the Grenadines	36,004	35	2,678	88	137	88
Netherlands Antilles	68,253	23	5,953	144	270	144
Panama	319,539	150	32,615	1,269	2,480	1,269
Costa Rica	565,988	179	57,215	1,010	2,089	1,010
Nicaragua	125,478	32	12,821	1,347	1,195	1,347
Colombia	782,736	312	79,700	2,028	4,574	2,028
Honduras	235,339	49	22,691	1,673	2,001	1,673
El Salvador	93,009	21	9,487	340	622	340
Mexico	3,211,609	578	328,464	12,932	25,957	12,932
Guatemala	116,354	25	11,904	404	939	404
Ecuador	226,790	120	23,085	878	1,953	878
Peru	789,435	156	77,447	2,449	5,083	2,449
Venezuela	444,223	144	44,699	2,326	3,689	2,326
Guadeloupe and Martinique	136,274	21	12,149	187	478	187
Faeroe Islands	264,479	503	25,441	2,359	1,435	2,359
Jan Mayen	8,015	17	764	80	113	80
Pitcairn	832,138	393	16,967	664	216	664
French Polynesia	4,749,763	1,029	354,999	3,541	6,878	3,541
Line Group	1,637,465	297	156,506	657	1,143	657
Jarvis Island	315,032	67	1,379	95	33	95

Table A4. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	344,884	80	7,358	191	258	191
American Samoa	402,479	76	40,214	147	406	147
Samoa	130,027	11	8,982	103	312	103
Cook Islands	1,950,935	287	55,872	823	850	823
Niue	315,004	65	20,969	102	194	102
Tonga	661,587	16	65,399	1,056	1,647	1,056
Tokelau	317,539	61	5,328	125	102	125
Phoenix Group	739,759	52	19,090	201	281	201
Howland Island and Baker Island	433,016	81	3,776	118	59	118
Johnston Atoll	440,551	81	9,155	194	208	194
Hawaii	2,457,917	606	244,523	1,759	4,587	1,759
Wallis and Futuna	256,930	56	13,282	278	350	278
New Zealand	3,988,303	198	406,005	22,158	24,183	22,158
United States	2,316,122	972	236,976	29,759	40,231	29,759
Belize	34,702	20	2,977	288	377	288
Colombia - Jamaica	18,605	25	397	53	67	53
Jamaica	241,819	40	24,450	583	953	583
Guyana	131,890	71	12,663	1,069	1,327	1,069
Suriname	124,656	46	12,688	1,111	1,172	1,111
French Guiana	131,328	47	13,031	967	1,216	967
Alaska	3,053,785	1,185	312,445	27,467	30,705	27,467
Brazil	3,080,472	768	314,387	16,896	27,485	16,896
Argentina	1,055,119	963	107,842	14,778	7,845	14,778
Uruguay	123,478	85	12,634	1,250	1,172	1,250
Finland	63,650	872	6,392	1,208	400	1,208
Denmark	75,583	1,112	7,542	1,479	560	1,480
Germany	43,635	626	3,993	977	350	977
Netherlands	57,389	893	5,806	1,446	545	1,446
Poland	28,784	378	2,875	462	133	462
Spain	539,821	297	54,515	3,715	4,357	3,715
Portugal	316,429	151	32,288	1,029	2,119	1,029
Italy	518,326	980	53,020	6,369	5,813	6,369
Monaco	288	2	10	3	2	3
Serbia-Montenegro	7,028	82	694	190	84	190
Croatia	50,635	626	5,167	1,599	601	1,599
Slovenia	110	3	7	6	1	6
Lithuania	5,275	68	503	96	55	96
Iran	153,974	137	15,681	2,318	1,488	2,318
Iraq	370	8	29	12	6	12

Table A4. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Guinea Bissau	98,928	42	9,937	940	1,362	940
Guinea	106,778	45	10,268	1,055	1,223	1,055
Ivory Coast	171,469	56	11,075	291	741	291
Nigeria	176,292	87	17,671	1,028	1,666	1,028
Cameroon	8,932	22	908	159	144	159
Gabon	182,333	95	18,554	812	1,605	812
Democratic Republic of the Congo	562	7	56	12	8	12
Angola	491,611	275	49,486	1,767	3,376	1,767
Nigeria - Sao Tome and Principe	34,456	19	1,682	38	57	38
Tanzania	235,517	120	23,901	760	1,522	760
India	1,581,199	567	161,581	11,497	19,566	11,497
Bangladesh	59,842	147	6,056	1,324	909	1,324
Myanmar	491,899	475	50,310	7,405	8,853	7,405
Malaysia	438,619	351	44,869	9,551	6,089	9,551
Viet Nam	638,009	335	64,933	8,669	6,699	8,669
Singapore	206	6	19	10	3	10
China	752,020	1,201	76,828	16,786	7,842	16,786
Japan	3,954,711	172	404,547	13,912	30,745	13,912
Japan - Korea	83,091	262	7,020	1,212	578	1,212
Kiribati	1,043,132	153	88,612	548	1,494	548
Antarctica	3,165,837	4,176	323,935	42,448	54,604	42,448
Indonesia	5,635,509	238	576,586	70,397	97,672	70,397
Conflict Zone	72,829	118	1,845	890	474	890
Canada	3,294,165	1,965	336,888	58,145	39,647	58,145
Saint Pierre and Miquelon	11,686	26	1,180	161	85	161
Southern Saint-Martin	12,056	18	268	79	72	79
Northern Saint-Martin	5,398	2	154	49	39	49
Sweden	143,987	1,925	14,710	2,577	876	2,577
Norway	334,554	838	34,219	4,682	2,855	4,682
Chile	2,849,258	366	290,772	8,111	16,909	8,111
Easter Island	717,003	487	18,483	837	354	837
Japan - South Korea Conflict Zone	66,048	146	1,164	344	162	344
Greenland	913,228	2,335	93,437	12,333	12,236	12,333
Iceland	632,255	1,671	64,512	6,843	5,168	6,843
Ireland	365,379	382	37,091	4,453	3,390	4,453
United Kingdom	912,365	1,100	93,153	13,735	7,779	13,735
France	320,210	269	32,657	4,675	4,067	4,675
Jersey	2,767	60	225	81	25	81
Guernsey	8,590	170	840	239	64	239
Maldives	911,804	248	29,894	1,492	3,392	1,492
British Indian Ocean Territory	635,502	143	18,476	877	2,112	877
Egypt	247,463	636	25,127	2,731	2,225	2,731
Sudan	64,116	74	6,388	827	448	827
Bahrain	6,919	119	603	176	50	176
Qatar	29,784	509	2,823	665	195	665
Grand Total	130,457,620					770,545

Table A5. Macrofauna summary by Exclusive Economic Zone for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	464,896	83	9,530	180	211	180
Christmas Island	326,512	46	4,842	120	114	120
Norfolk Island	429,290	239	9,269	860	866	860
Macquarie Island	475,253	403	11,176	1,224	739	1,224
New Caledonia	1,411,470	193	33,857	3,272	5,122	3,272
Vanuatu	633,420	31	15,064	857	1,238	857
Solomon Islands	1,581,912	78	37,828	1,857	3,461	1,857
Palau	601,005	44	13,711	310	653	310
Micronesia	2,978,544	61	66,575	2,070	3,960	2,070
Nauru	307,086	100	3,381	133	41	133
Marshall Islands	1,983,007	334	44,756	1,162	3,198	1,162
Wake Island	405,452	80	3,245	140	108	140
Northern Mariana Islands and Guam	966,069	23	19,452	607	694	607
Taiwan	330,814	73	7,936	1,600	1,940	1,600
Philippines	1,766,889	51	42,383	5,233	9,340	5,233
Australia	6,488,347	1,343	155,644	43,365	53,011	43,365
Papua New Guinea	2,319,506	111	55,638	5,013	9,694	5,013
Fiji	1,266,291	307	30,360	2,242	3,904	2,242
Tuvalu	745,280	105	15,063	348	821	348
South Korea	257,834	438	6,184	3,370	1,737	3,370
North Korea	86,790	158	2,082	453	362	453
Paracel Islands	291,605	118	6,981	622	707	622
Spratly Islands	436,989	161	10,161	819	1,214	819
Cambodia	43,484	726	1,043	808	53	808
Thailand	274,151	350	6,570	3,979	1,741	3,979
Andaman and Nicobar	652,668	243	15,632	1,329	2,242	1,329
Southern Kuriles	191,690	37	4,598	870	1,093	870
Comoro Islands	163,359	93	3,860	167	228	167
Mayotte	62,308	39	1,467	74	144	74
Glorioso Islands	43,224	23	874	42	60	42
Seychelles	1,325,694	369	31,766	1,527	3,358	1,527
R麒nion	313,401	89	4,895	176	170	176
Juan de Nova Island	61,856	52	1,301	102	78	102
Bassas da India	121,108	93	2,166	132	65	132
Ile Europa	124,437	68	1,775	110	34	110
Ile Tromelin	269,205	88	1,287	123	25	123
Mauritius	1,266,099	336	30,298	1,736	3,335	1,736
Sri Lanka	511,996	198	12,266	609	1,432	609
Mozambique	534,862	235	12,830	2,067	2,791	2,067
Madagascar	1,160,280	377	27,831	2,462	4,727	2,462
Kenya	107,572	50	2,577	278	394	278
Somalia	805,218	241	19,306	1,749	3,016	1,749
Eritrea	28,058	226	673	440	130	440
Djibouti	5,864	31	140	68	29	68
Yemen	522,915	141	12,542	1,607	2,242	1,607
Oman	490,350	258	11,762	1,063	1,767	1,063

Table A5. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	184,580	251	4,426	2,357	936	2,357
Kuwait	4,137	71	99	86	8	86
Pakistan	188,759	121	4,526	749	974	749
United Arab Emirates	29,989	148	719	629	82	629
Azores	1,050,078	416	23,202	1,971	1,533	1,971
Cape Verde	792,326	253	18,058	709	1,083	709
Madeira	451,895	193	10,320	448	418	448
Canary Islands	452,867	237	10,468	746	987	746
Tunisia	89,804	287	2,152	1,216	369	1,216
Morocco	244,079	164	5,854	1,374	1,495	1,374
Western Sahara	245,271	194	5,884	924	1,164	924
Mauritania	119,930	128	2,871	416	443	416
Gambia	15,604	8	365	29	46	29
Senegal	133,465	64	3,191	318	465	318
Libya	347,062	579	8,319	2,531	1,519	2,531
Malta	54,663	111	1,066	464	166	464
Bulgaria	30,154	137	722	283	152	283
Romania	11,700	71	280	170	55	170
Russia	2,378,169	439	57,047	22,098	17,063	22,098
Georgia	21,865	103	515	173	75	173
Ukraine	99,202	436	2,378	912	467	912
Turkey	233,585	313	5,593	1,754	1,071	1,754
Syria	9,576	44	223	62	19	62
Lebanon	18,550	70	421	95	40	95
Israel	26,057	105	617	180	87	180
Greece	476,294	459	11,424	3,330	2,419	3,330
Cyprus	96,873	257	2,182	479	221	479
Albania	10,152	81	242	130	37	130
Algeria	123,341	367	2,921	629	468	629
Ascension	439,619	185	6,827	398	149	398
Saint Helena	442,866	134	7,964	311	217	311
Trindade	466,389	106	5,290	178	97	178
Tristan da Cunha	751,322	560	16,285	1,448	757	1,448
South Georgia and the South Sandwich Islands	1,087,821	433	26,072	5,317	4,209	5,317
Prince Edward Islands	470,910	516	10,633	1,774	1,003	1,774
Crozet Islands	571,852	711	13,654	2,288	1,761	2,288
Amsterdam Island and Saint Paul Island	506,832	408	10,394	1,042	509	1,042
Kerguelen Islands	545,287	947	13,079	5,334	3,336	5,334
Heard and McDonald Islands	414,206	857	9,927	3,904	2,500	3,904
Falkland Islands	461,485	701	11,070	6,327	3,178	6,327
Sierra Leone	147,001	48	3,525	291	646	291
Liberia	242,408	81	5,796	346	737	346
Togo	15,234	7	361	28	60	28
Benin	29,277	15	700	53	102	53

Table A5. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
R駱ublique du Congo	26,975	23	647	183	159	183
Namibia	463,005	257	11,107	2,404	2,668	2,404
South Africa	976,851	362	23,432	3,554	5,080	3,554
Sao Tome and Principe	129,602	63	3,002	159	191	159
Equatorial Guinea	302,099	128	7,220	387	643	387
Bouvet Island	438,975	700	10,395	2,228	1,012	2,228
Ghana	220,502	63	5,276	403	878	403
Clipperton Island	429,303	93	4,388	290	82	290
Bermuda	448,127	153	9,793	248	402	248
Galapagos Islands	830,700	485	19,864	1,264	1,333	1,264
Bahamas	576,195	153	13,822	2,120	3,321	2,120
Turks and Caicos Islands	149,974	37	3,585	186	500	186
Cuba	325,115	50	7,799	994	1,677	994
Cayman Islands	118,601	10	2,760	121	167	121
Haiti	120,985	56	2,899	236	368	236
Dominican Republic	265,451	16	6,322	383	756	383
Puerto Rico and Virgin Islands of the United States	209,007	13	4,923	276	637	276
British Virgin Islands	79,816	6	1,713	92	271	92
Anguilla	91,790	8	1,853	84	245	84
Saint Kitts and Nevis	10,330	20	199	44	34	44
Antigua and Barbuda	107,216	13	2,197	136	365	136
Montserrat	7,508	12	134	21	12	21
Saint Lucia	15,385	16	332	36	38	36
Dominica	28,441	7	548	42	62	42
Barbados	185,073	46	3,701	179	182	179
Grenada	25,742	29	606	101	113	101
Trinidad and Tobago	61,951	36	1,481	290	358	290
Saint Vincent and the Grenadines	36,031	38	798	89	119	89
Netherlands Antilles	68,404	24	1,523	143	234	143
Panama	308,456	137	7,391	943	1,458	943
Costa Rica	564,851	217	13,527	866	1,015	866
Nicaragua	118,697	35	2,847	1,203	1,005	1,203
Colombia	770,721	330	18,480	1,574	2,567	1,574
Honduras	230,448	51	5,524	1,515	1,763	1,515
El Salvador	92,352	20	2,212	256	415	256
Mexico	3,146,561	593	75,479	9,005	15,116	9,005
Guatemala	114,559	19	2,747	216	409	216
Ecuador	225,351	163	5,404	725	891	725
Peru	710,893	140	17,052	1,448	2,507	1,448
Venezuela	398,930	136	9,569	1,380	2,201	1,380
Guadeloupe and Martinique	136,753	22	3,278	174	334	174
Faeroe Islands	259,807	706	6,232	2,822	1,431	2,822
Jan Mayen	12,234	31	282	60	43	60
Pitcairn	832,138	384	14,906	650	199	650
French Polynesia	4,750,489	1,029	111,341	3,523	6,387	3,523
Line Group	1,637,753	318	37,620	697	763	697
Jarvis Island	315,032	74	1,445	103	36	103

Table A5. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	344,884	85	6,868	197	248	197
American Samoa	402,533	75	7,349	141	219	141
Samoa	130,082	11	2,695	93	243	93
Cook Islands	1,950,935	288	46,226	819	774	819
Niue	315,100	67	3,332	103	71	103
Tonga	661,587	17	15,550	1,032	1,456	1,032
Tokelau	317,539	60	4,575	119	92	119
Phoenix Group	739,759	57	14,858	201	242	201
Howland Island and Baker Island	433,016	79	3,640	120	59	120
Johnston Atoll	440,551	84	8,588	199	204	199
Hawaii	2,459,534	645	57,737	1,690	3,481	1,690
Wallis and Futuna	256,916	54	5,253	260	278	260
New Zealand	3,944,093	219	94,608	22,362	21,943	22,362
United States	2,010,489	794	48,228	11,904	13,559	11,904
Belize	30,113	17	722	161	220	161
Colombia - Jamaica	18,605	26	381	53	64	53
Jamaica	242,339	41	5,724	561	753	561
Guyana	107,751	63	2,583	522	723	522
Suriname	105,230	43	2,523	702	731	702
French Guiana	99,352	38	2,379	376	609	376
Alaska	2,227,168	1,031	53,426	12,810	14,477	12,810
Brazil	2,832,009	736	67,931	10,379	17,675	10,379
Argentina	719,291	702	17,254	10,592	5,690	10,592
Uruguay	72,939	57	1,749	369	510	369
Denmark	30,250	515	725	586	49	586
Germany	8,535	151	204	174	14	174
Netherlands	19,892	355	477	412	36	412
Spain	534,944	330	12,825	2,933	2,690	2,933
Portugal	309,072	165	7,405	807	1,288	807
Italy	518,107	824	12,427	3,796	2,457	3,796
Monaco	288	1	3	2	0	2
Serbia-Montenegro	7,302	56	159	86	22	86
Croatia	52,005	394	1,244	753	171	753
Slovenia	96	2	2	2	0	2
Iran	131,712	157	3,159	1,674	910	1,674

Table A5. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Guinea Bissau	71,391	30	1,712	238	352	238
Guinea	79,679	30	1,911	406	569	406
Ivory Coast	169,661	56	4,065	221	441	221
Nigeria	160,290	80	3,845	497	680	497
Cameroon	6,686	14	160	68	45	68
Gabon	174,675	116	4,187	663	781	663
Angola	463,060	229	11,104	1,194	1,753	1,194
Nigeria - Sao Tome and Principe	34,497	19	77	31	11	31
Tanzania	233,434	122	5,599	636	1,084	636
India	1,466,366	523	35,172	5,327	8,068	5,327
Bangladesh	43,004	79	1,031	473	278	473
Myanmar	432,427	396	10,373	2,594	2,877	2,594
Malaysia	396,053	222	9,499	5,364	2,526	5,364
Viet Nam	582,825	286	13,981	6,269	4,624	6,269
China	436,222	706	10,464	6,746	2,133	6,746
Japan	3,923,721	166	94,118	9,043	15,776	9,043
Japan - Korea	83,091	223	1,466	878	374	878
Kiribati	1,043,255	156	24,527	516	1,243	516
Antarctica	3,682,711	1,583	88,341	26,047	22,421	26,047
Jordan	14	0	0	0	0	0
Indonesia	5,470,328	220	131,223	32,688	41,886	32,688
Conflict Zone	72,829	106	1,289	701	361	701
Canada	2,677,377	1,375	64,226	36,305	19,380	36,305
Saint Pierre and Miquelon	11,645	21	279	147	60	147
Southern Saint-Martin	12,056	18	241	76	68	76
Northern Saint-Martin	5,412	2	108	46	35	46
Sweden	630	12	15	14	1	14
Norway	298,112	907	7,149	4,632	1,864	4,632
Chile	2,723,998	378	65,339	5,882	8,336	5,882
Easter Island	717,003	465	13,195	802	292	802
Japan - South Korea Conflict Zone	66,048	120	656	220	87	220
Greenland	815,438	2,446	19,560	7,784	5,209	7,784
Iceland	580,565	1,959	13,926	6,293	3,068	6,293
Ireland	336,362	371	8,069	3,786	2,481	3,786
United Kingdom	665,519	768	15,964	9,150	4,205	9,150
France	274,027	244	6,573	2,592	2,081	2,592
Jersey	260	6	6	6	0	6
Guernsey	808	18	19	19	0	19
Maldives	909,886	237	21,824	1,369	3,137	1,369
British Indian Ocean Territory	635,584	146	13,646	838	1,919	838
Egypt	240,915	547	5,776	2,024	1,312	2,024
Sudan	60,787	70	1,458	703	327	703
Bahrain	2,398	37	57	51	6	51
Qatar	21,975	351	527	445	50	445
Grand Total	124,098,806					486,306

Table A6. Megafauna summary by Exclusive Economic Zone for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	464,896	4	987	18	38	18
Christmas Island	326,567	2	6,135	13	57	13
Norfolk Island	429,262	21	39,853	201	315	201
Macquarie Island	475,226	31	573,151	297	4,555	297
New Caledonia	1,413,730	7	4,213,784	803	17,890	803
Vanuatu	632,872	1	1,653,323	564	16,306	564
Solomon Islands	1,581,158	2	4,875,247	1,551	47,821	1,551
Palau	601,088	1	347,061	66	2,015	66
Micronesia	2,974,640	3	2,174,939	394	7,241	394
Nauru	307,086	11	517	18	9	18
Marshall Islands	1,983,020	17	3,904	141	337	141
Wake Island	405,452	4	603	14	32	14
Northern Mariana Islands and Guam	954,493	1	549,999	137	2,920	137
Taiwan	336,472	5	900,415	814	13,369	814
Philippines	1,766,259	2	5,443,709	7,240	123,532	7,240
Australia	6,820,860	95	20,992,291	14,417	242,831	14,417
Papua New Guinea	2,357,797	3	7,226,247	7,363	126,678	7,363
Fiji	1,269,237	21	3,839,326	785	26,162	785
Tuvalu	745,280	6	1,477	52	119	52
South Korea	307,277	159	944,441	4,114	30,995	4,114
North Korea	110,504	59	334,151	1,422	11,556	1,422
Paracel Islands	291,646	11	571	153	131	153
Spratly Islands	436,989	13	963	170	175	170
Cambodia	46,279	46	90,071	276	3,031	276
Thailand	294,906	65	779,495	1,635	21,318	1,635
Andaman and Nicobar	652,435	27	1,872,966	899	23,931	899
Southern Kuriles	210,651	1	608,423	1,132	12,490	1,132
Comoro Islands	163,249	10	13,932	34	201	34
Mayotte	62,321	5	1,697	14	35	14
Glorioso Islands	43,224	2	90	7	10	7
Seychelles	1,325,818	25	311,002	228	1,304	228
R騩nion	313,251	6	676,629	92	5,889	92
Juan de Nova Island	61,856	9	203	32	23	32
Bassas da India	121,108	17	325	31	17	31
Ile Europa	124,437	10	389	26	12	26
Ile Tromelin	269,205	7	408	13	7	13
Mauritius	1,266,277	22	2,475,760	354	12,870	354
Sri Lanka	522,943	21	1,492,060	758	20,970	758
Mozambique	561,769	26	1,487,538	795	16,349	795
Madagascar	1,180,337	28	3,571,853	1,974	46,746	1,974
Kenya	109,189	6	203,235	185	4,050	185
Somalia	819,603	16	1,503,951	428	9,758	428
Eritrea	73,624	31	104,062	232	2,914	232
Djibouti	6,028	2	8,563	29	408	29
Yemen	538,342	9	1,625,964	538	14,245	538
Oman	528,834	28	778,452	370	7,877	370

Table A6. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	211,405	40	641,737	1,353	19,017	1,353
Kuwait	10,631	18	29,599	158	1,685	158
Pakistan	218,488	14	554,638	451	8,224	451
United Arab Emirates	50,402	51	137,096	611	5,971	611
Azores	1,049,845	27	1,005,296	493	5,364	493
Cape Verde	791,682	16	1,050,093	151	6,105	151
Madeira	451,881	12	168,039	78	1,399	78
Canary Islands	452,319	19	1,379,154	531	17,481	531
Belgium	2,850	19	6,118	103	605	103
Tunisia	97,736	27	210,567	485	4,714	485
Morocco	264,753	17	802,855	1,060	15,565	1,060
Western Sahara	295,290	23	862,557	922	14,257	922
Mauritania	151,426	20	336,969	534	8,138	534
Gambia	20,797	1	50,362	96	1,753	96
Senegal	155,824	5	308,449	225	4,473	225
Libya	347,377	29	1,004,379	1,076	17,440	1,076
Malta	54,663	6	301	100	49	100
Latvia	26,633	209	66,653	562	2,918	562
Estonia	28,907	257	64,169	547	2,698	547
Bulgaria	34,291	40	43,246	297	1,005	297
Romania	19,440	52	12,750	291	396	291
Russia	3,480,663	10	10,741,319	74,225	376,564	74,225
Georgia	22,043	33	55,305	368	2,283	368
Ukraine	132,712	151	389,707	2,252	13,181	2,252
Turkey	240,394	29	692,761	2,425	21,992	2,425
Syria	9,549	8	6,738	67	422	67
Lebanon	18,522	10	50,840	194	2,167	194
Israel	26,331	15	67,947	133	1,750	133
Greece	475,938	20	1,373,107	3,628	40,227	3,628
Cyprus	96,380	23	236,549	322	5,336	322
Albania	10,056	20	27,820	353	2,181	353
Bornholm	8,891	75	25,665	213	1,602	213
Algeria	123,780	31	214,230	266	4,401	266
Ascension	439,592	18	1,415	70	47	70
Saint Helena	442,674	8	1,182,730	114	7,034	114
Trindade	466,389	6	972	18	28	18
Tristan da Cunha	751,212	62	1,769,245	301	7,560	301
South Georgia and the South Sandwich Islands	1,028,171	15	3,136,441	14,159	131,806	14,159
Prince Edward Islands	470,965	45	127,979	462	1,096	462
Crozet Islands	571,879	72	21,081	651	1,049	651
Amsterdam Island and Saint Paul Island	506,832	44	2,539	234	182	234
Kerguelen Islands	562,673	120	1,506,782	3,111	15,863	3,111
Heard and McDonald Islands	414,631	126	442,276	1,947	3,996	1,947
Falkland Islands	543,260	107	1,642,911	3,990	17,110	3,990
Sierra Leone	157,002	4	482,061	250	6,695	250
Liberia	244,285	5	750,582	355	10,214	355
Togo	15,303	1	37	4	8	4
Benin	29,907	2	231	11	19	11

Table A6. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
R駉ublique du Congo	38,771	3	119,267	400	4,613	400
Namibia	552,727	21	1,660,982	1,966	27,240	1,966
South Africa	1,056,887	28	3,137,654	1,587	26,745	1,587
Sao Tome and Principe	129,547	7	380,746	155	5,301	155
Equatorial Guinea	302,523	8	887,020	688	16,108	688
Bouvet Island	438,880	85	146,334	762	1,167	762
Ghana	223,420	4	54,005	81	532	81
Clipperton Island	429,303	5	732	42	26	42
Bermuda	448,100	11	6,041	25	71	25
Galapagos Islands	830,604	59	1,540,506	495	16,222	495
Bahamas	617,240	9	1,905,815	1,219	26,024	1,219
Turks and Caicos Islands	151,988	2	378,282	94	3,815	94
Cuba	352,583	2	1,063,416	1,394	23,864	1,394
Cayman Islands	118,628	0	87,603	43	1,337	43
Haiti	120,341	4	369,529	285	6,841	285
Dominican Republic	265,561	0	214,883	127	2,644	127
Puerto Rico and Virgin Islands of the United States	208,925	0	247,709	147	3,233	147
British Virgin Islands	79,761	0	39,337	17	516	17
Anguilla	91,722	0	234,438	53	2,890	53
Saint Kitts and Nevis	10,261	5	24,480	98	1,242	98
Antigua and Barbuda	107,038	0	52,312	29	766	29
Montserrat	7,453	3	175	6	10	6
Saint Lucia	15,358	2	407	9	20	9
Dominica	28,373	0	10,475	20	290	20
Barbados	185,032	3	94,550	55	1,104	55
Grenada	25,975	4	47,107	44	1,082	44
Trinidad and Tobago	75,912	5	213,711	236	5,005	236
Saint Vincent and the Grenadines	36,017	5	5,732	18	113	18
Netherlands Antilles	68,336	1	21,330	31	313	31
Panama	322,046	15	979,545	934	18,779	934
Costa Rica	567,358	14	1,701,552	639	20,147	639
Nicaragua	126,026	2	360,744	345	6,675	345
Colombia	786,860	27	2,412,319	1,681	39,323	1,681
Honduras	236,257	3	694,933	454	10,320	454
El Salvador	93,119	1	143,097	94	2,263	94
Mexico	3,227,884	27	9,857,936	6,593	139,584	6,593
Guatemala	116,847	1	204,462	155	3,312	155
Ecuador	229,886	12	706,551	1,006	15,935	1,006
Peru	793,353	6	2,308,298	1,967	36,705	1,967
Venezuela	446,428	8	1,292,201	789	16,329	789
Guadeloupe and Martinique	136,452	1	110,897	68	1,672	68
Faeroe Islands	264,835	116	749,985	1,412	10,588	1,412
Jan Mayen	8,837	5	16,919	639	2,562	639
Pitcairn	832,138	38	1,829	106	59	106
French Polynesia	4,749,927	64	7,893,757	599	21,129	599
Line Group	1,637,588	16	550,232	87	1,895	87
Jarvis Island	315,032	4	367	8	9	8

Table A6. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	344,884	5	673	29	49	29
American Samoa	402,492	4	11,870	16	82	16
Samoa	130,082	0	138,486	43	1,844	43
Cook Islands	1,950,962	13	866,469	106	2,307	106
Niue	315,032	4	248,808	22	1,652	22
Tonga	651,860	1	129,119	256	760	256
Tokelau	317,539	4	542	14	18	14
Phoenix Group	739,759	1	1,533	17	43	17
Howland Island and Baker Island	433,016	4	718	9	14	9
Johnston Atoll	440,551	4	933	26	44	26
Hawaii	2,458,671	36	6,506,656	407	19,671	407
Wallis and Futuna	256,944	4	2,997	61	66	61
New Zealand	3,994,920	4	12,318,640	10,026	111,083	10,026
United States	2,358,030	74	7,278,459	15,162	159,299	15,162
Belize	34,976	2	35,890	61	927	61
Colombia - Jamaica	18,605	5	35	10	6	10
Jamaica	242,161	2	310,803	155	2,658	155
Guyana	132,671	8	324,661	217	4,291	217
Suriname	125,478	4	309,709	354	6,592	354
French Guiana	131,849	4	386,030	296	6,941	296
Alaska	3,090,912	49	9,466,859	42,637	308,441	42,637
Brazil	3,091,131	58	9,273,243	4,694	105,570	4,694
Argentina	1,060,257	146	3,111,156	8,434	50,407	8,434
Uruguay	124,656	12	354,916	753	8,896	753
Finland	64,541	569	184,921	1,336	6,999	1,336
Denmark	77,556	554	220,619	1,668	9,698	1,668
Germany	45,100	321	127,963	1,277	8,026	1,277
Netherlands	59,074	408	177,371	1,387	8,356	1,387
Poland	29,140	237	20,287	322	552	322
Spain	542,438	22	1,387,578	1,446	19,861	1,446
Portugal	317,635	10	575,127	522	8,996	522
Italy	522,861	41	1,589,567	2,514	30,057	2,514
Monaco	288	0	2	0	0	0
Serbia-Montenegro	7,220	14	20,589	149	1,175	149
Croatia	52,115	100	135,784	898	5,608	898
Slovenia	151	1	150	27	52	27
Lithuania	5,412	47	6,818	107	423	107
Iran	156,440	23	446,121	1,011	13,724	1,011
Iraq	411	1	128	8	26	8

Table A6. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Guinea Bissau	101,640	4	291,173	917	10,470	917
Guinea	107,435	4	268,884	420	6,614	420
Ivory Coast	171,771	4	112,498	68	1,040	68
Nigeria	177,388	9	533,111	446	7,790	446
Cameroon	10,001	7	25,102	427	2,322	427
Gabon	184,772	10	567,498	1,130	16,528	1,130
Democratic Republic of the Congo	658	1	1,054	40	164	40
Angola	494,392	24	1,367,187	1,382	25,621	1,382
Nigeria - Sao Tome and Principe	34,469	2	1,732	8	38	8
Tanzania	236,407	14	451,112	277	5,963	277
India	1,597,023	52	4,828,431	4,918	89,427	4,918
Bangladesh	65,281	43	178,997	2,033	12,662	2,033
Myanmar	500,598	73	1,545,080	3,004	41,086	3,004
Malaysia	452,401	37	1,389,700	3,687	43,836	3,687
Viet Nam	642,845	34	1,883,020	1,999	34,114	1,999
Singapore	370	1	194	19	49	19
China	780,516	323	2,384,694	14,554	109,047	14,554
Japan	3,966,232	4	12,195,958	9,630	166,394	9,630
Japan - Korea	83,091	89	1,536	231	74	231
Kiribati	1,043,187	7	822,324	80	3,277	80
Antarctica	3,527,092	542	10,897,957	249,451	1,021,726	249,451
Jordan	14	8	8	8	0	8
Indonesia	5,831,213	6	17,957,118	39,237	486,517	39,237
Conflict Zone	72,829	27	235	122	47	122
Canada	3,371,269	169	10,405,235	101,183	468,929	101,183
Saint Pierre and Miquelon	11,796	5	23,353	214	1,122	214
Southern Saint-Martin	12,056	4	20	12	3	12
Northern Saint-Martin	5,412	0	106	6	6	6
Sweden	145,631	927	433,523	2,539	12,376	2,539
Norway	342,980	272	1,049,576	7,857	51,125	7,857
Chile	2,860,615	10	8,812,008	8,864	161,541	8,864
Easter Island	717,003	58	2,606	166	105	166
Japan - South Korea Conflict Zone	66,048	41	845	169	132	169
Greenland	948,889	470	2,913,550	27,474	155,361	27,474
Iceland	646,777	450	1,991,507	13,758	96,604	13,758
Ireland	368,146	43	1,026,006	2,796	25,288	2,796
United Kingdom	920,558	136	2,794,743	9,367	71,192	9,367
France	323,882	26	961,566	2,689	23,323	2,689
Jersey	2,836	19	5,645	71	421	71
Guernsey	8,617	53	21,012	112	835	112
Maldives	911,804	18	2,420	198	271	198
British Indian Ocean Territory	635,502	9	1,457	121	183	121
Egypt	249,655	38	703,027	805	12,492	805
Sudan	64,335	12	56,212	86	931	86
Bahrain	7,069	10	6,718	46	384	46
Qatar	30,263	39	56,228	215	2,252	215
Grand Total	131,682,879					808,092

Table A7. Megafauna summary by Exclusive Economic Zone for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Cocos Islands	464,896	4	1,311	10	20	10
Christmas Island	326,526	3	5,901	8	52	8
Norfolk Island	429,290	17	1,415	76	108	76
Macquarie Island	475,253	50	3,007	206	165	206
New Caledonia	1,413,511	9	702,956	397	5,230	397
Vanuatu	633,447	1	327,374	135	3,202	135
Solomon Islands	1,582,405	3	820,029	408	10,958	408
Palau	601,019	1	187,853	41	1,572	41
Micronesia	2,978,558	2	461,623	112	1,460	112
Naurua	307,086	4	268	6	3	6
Marshall Islands	1,983,020	13	51,822	68	366	68
Wake Island	405,452	3	221	6	6	6
Northern Mariana Islands and Guam	965,987	1	241,147	36	1,261	36
Taiwanese	335,869	3	168,659	679	4,240	679
Philippines	1,775,794	2	948,118	2,087	24,646	2,087
Australia	6,729,248	63	3,612,355	19,714	131,843	19,714
Papua New Guinea	2,341,536	4	1,254,035	2,941	35,946	2,941
Fiji	1,268,538	11	671,669	427	8,515	427
Tuvalu	745,280	4	3,349	16	63	16
South Korea	282,056	87	151,133	9,299	18,196	9,299
North Korea	90,790	28	48,026	1,010	4,535	1,010
Paracel Islands	291,646	6	22,818	52	209	52
Spratly Islands	436,989	7	3,805	58	124	58
Cambodia	44,676	71	23,581	249	1,381	249
Thailand	285,179	22	152,986	1,747	8,977	1,747
Andaman and Nicobar Islands	653,559	12	306,968	226	3,918	226
Russia-Japan conflict zone	199,171	12	106,730	4,295	12,973	4,295
Comoros	163,277	5	62,208	19	589	19
Mayotte	62,349	2	8,017	9	129	9
Glorioso	43,224	1	100	3	6	3
Seychelles	1,325,722	18	603,865	148	3,031	148
R駸nion	313,388	4	6,318	10	45	10
Juan de Nova	61,856	3	306	7	10	7
Bassas da India	121,108	5	343	8	9	8
Ile Europa	124,437	4	166	7	3	7
Ile Tromelin	269,205	4	97	6	2	6
Mauritius	1,266,428	17	135,577	146	952	146
Sri Lanka	519,326	9	276,646	1,243	11,669	1,243
Mozambic	553,617	14	293,540	1,949	14,152	1,949
Madagasca	1,167,761	19	623,985	1,614	18,333	1,614
Kenya	108,710	3	50,164	148	1,670	148
Somailia	816,369	17	433,375	2,332	17,119	2,332
Eritria	54,718	70	29,384	4,566	6,660	4,566
Djibouti	6,110	7	1,915	40	123	40
Yemen	533,752	11	286,600	2,113	14,279	2,113
Oman	500,708	23	268,249	4,315	21,114	4,315

Table A7. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Saudi Arabia	204,747	20	109,741	3,043	10,685	3,043
Kuwait	5,521	43	2,800	357	572	357
Pakistan	196,444	32	105,323	3,007	10,853	3,007
United Arab Emirates	45,498	176	24,298	2,378	3,425	2,378
Azores	1,050,174	25	417,777	223	3,137	223
Cape Verde	792,244	14	313,750	86	1,422	86
Madeira	451,908	12	32,173	37	251	37
Canary Islands	452,922	14	184,481	128	2,321	128
Tunisia	92,023	29	47,747	645	3,243	645
Morocco	255,409	12	136,394	2,166	10,627	2,166
Western Sahara	258,272	18	138,606	4,149	16,027	4,149
Mauritania	111,463	16	59,748	2,143	6,812	2,143
Gambia	14,673	1	7,806	217	839	217
Senegal	124,752	5	66,699	1,993	7,153	1,993
Libya	347,459	42	186,152	333	2,800	333
Malta	54,663	8	121	44	18	44
Bulgaria	29,524	40	15,256	719	2,121	719
Romania	10,741	19	5,452	633	1,176	633
Russia	2,507,333	115	1,346,445	115,681	239,576	115,681
Georgia	21,632	34	9,882	313	951	313
Ukrain	99,311	123	52,273	1,401	4,750	1,401
Turkey	235,298	25	124,765	3,221	12,308	3,221
Syria	9,535	4	3,852	22	195	22
Lebanon	18,495	6	8,316	33	327	33
Israel	26,249	8	13,475	73	627	73
Greece	477,815	33	254,260	753	5,767	753
Cyprus	96,873	16	45,516	74	1,123	74
Albania	10,261	10	2,889	50	168	50
Algeria	123,629	34	63,456	204	1,825	204
Ascension	439,619	10	614	23	11	23
St. Helena	442,866	7	766	19	18	19
Trindad	466,389	5	412	8	6	8
Tristan Da Cunha	751,322	42	16,983	207	191	207
South Georgia	1,088,397	74	582,795	3,809	17,182	3,809
Prince Edward Islands	470,924	77	241,629	316	1,331	316
Crozet Islands	571,879	109	10,297	498	524	498
Amsterdam Island & St. Paul Island	506,832	38	2,340	123	84	123
Kerguelen Islands	556,604	154	298,210	4,726	17,395	4,726
Heard and McDonald Islands	414,891	146	44,548	1,317	1,451	1,317
Falkland Islands	533,464	125	283,009	16,973	30,291	16,973
Sierra Leon	151,303	2	80,826	1,031	5,614	1,031
Liberia	243,271	5	115,827	372	3,664	372
Togo	15,303	0	1,920	9	63	9
Benin	29,825	1	5,283	48	319	48

Table A7. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Congo	8,741	2	4,647	470	944	470
Namibia	465,088	34	249,707	11,867	35,798	11,867
South Africa	1,002,361	28	538,039	7,700	39,403	7,700
Sao Tome and Principe	129,588	4	45,600	37	781	37
Equatorial Guinea	301,619	9	156,099	588	5,703	588
Bouvet Island	438,975	119	13,309	521	326	521
Ghana	222,817	4	118,605	378	3,183	378
Clipperton Island	429,303	4	400	17	6	17
Bermuda	448,127	7	3,038	17	77	17
Galapagos	831,056	26	355,234	191	2,770	191
Bahamas	607,403	7	325,817	3,000	18,484	3,000
Turks and Caicos	151,892	2	78,780	198	2,541	198
Cuba	336,664	2	180,069	1,599	10,869	1,599
Cayman Islands	118,587	0	3,786	8	47	8
Haiti	121,040	3	54,230	42	808	42
Dominican Republic	265,890	1	141,079	94	2,059	94
Puerto Rico	209,213	0	95,941	42	949	42
Virgin Islands	79,816	0	383	8	33	8
Anguilla	91,790	0	248	6	24	6
Saint Kitts and Nevis	10,330	1	19	3	3	3
Antigua and Barbuda	107,216	0	330	11	38	11
Montserrat	7,508	1	11	1	1	1
Saint Lucia	15,371	1	935	4	32	4
Dominica	28,428	0	792	3	18	3
Barbados	184,991	2	41,674	18	484	18
Grenada	25,674	3	13,225	173	934	173
Trinidad and Tobago	64,253	3	34,365	745	3,167	745
Saint Vincent and the Grenadines	36,031	3	1,033	11	31	11
Netherlands Antilles	68,390	1	22,173	24	425	24
Panama	315,456	10	169,321	3,425	15,046	3,425
Costa Rica	565,728	14	298,074	443	6,379	443
Nicaragua	122,560	4	63,989	1,065	4,849	1,065
Colombia	774,516	24	411,754	1,722	16,472	1,722
Honduras	233,626	2	114,173	545	4,233	545
El Salvador	92,653	1	43,730	160	1,511	160
Mexico	3,179,195	42	1,703,921	10,957	81,852	10,957
Guatemala	116,080	1	60,958	305	2,688	305
Ecuador	226,886	14	121,229	789	4,696	789
Peru	694,028	12	372,708	8,084	35,529	8,084
Venezuela	416,494	8	221,483	3,166	16,361	3,166
Guadeloupe & Martinique	136,822	1	23,865	24	398	24
Faeroe Islands	265,506	322	124,777	2,565	3,256	2,565
Jan Mayen	12,234	9	235	31	35	31
Pitcairn	832,138	18	1,155	32	13	32
French Polynesia	4,750,598	39	2,312,449	221	4,282	221
Line Group	1,637,780	13	48,774	39	225	39
Jarvis Island	315,032	4	126	6	3	6

Table A7. continued…

Country	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Palmyra Atoll	344,884	4	776	11	21	11
American Samoa	402,533	3	555	6	15	6
Samoa	130,068	0	675	5	22	5
Cook Islands	1,950,976	11	51,319	37	222	37
Niue	315,073	3	39,377	6	260	6
Tonga	661,696	1	59,057	77	402	77
Tokelau	317,539	2	473	5	7	5
Phoenix Group	739,759	2	1,979	10	22	10
Howland and Baker Island	433,016	3	309	6	4	6
Johnston Atoll	440,551	3	937	10	17	10
Hawaii	2,459,575	30	1,084,085	155	4,877	155
Wallis and Futuna	256,930	2	126,828	24	1,042	24
New Zealand	3,988,919	10	2,128,077	8,744	56,678	8,744
United States	2,148,612	49	1,153,697	27,298	105,965	27,298
Belize	33,031	1	15,282	266	1,216	266
Colombia - Jamaica	18,605	1	60	4	8	4
Jamaica	242,353	2	58,942	49	532	49
Guyana	113,916	5	60,348	823	4,324	823
Suriname	111,354	4	59,734	916	4,004	916
French Guiana	108,737	3	57,354	2,164	6,630	2,164
Alaska	2,645,128	282	1,420,251	102,571	237,351	102,571
Brazil	2,947,103	33	1,579,291	13,513	86,974	13,513
Argentina	985,564	135	529,102	58,061	85,645	58,061
Uruguay	101,421	8	53,869	5,540	9,518	5,540
Denmark	36,182	181	19,271	1,662	3,066	1,662
Germany	10,850	75	5,772	648	1,118	648
Netherlands	27,866	188	14,958	1,819	3,225	1,819
Spain	538,944	33	288,542	1,488	10,312	1,488
Portugal	312,881	14	166,163	957	7,638	957
Italy	521,189	62	274,235	1,292	8,934	1,292
Monaco	288	0	1	0	0	0
Serbia-Montenegria	7,343	7	2,157	22	105	22
Croatia	52,553	47	27,257	215	1,204	215
Slovenia	123	1	22	4	6	4
Iran	141,932	166	76,185	3,941	8,525	3,941

Table A7. continued…

Country	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Guinea Bissau	67,486	2	36,206	1,299	4,576	1,299
Guinea	89,228	2	47,471	1,711	5,551	1,711
Ivory Coast	170,894	3	89,753	489	4,059	489
Nigeria	164,564	5	86,835	1,309	6,845	1,309
Cameroon	5,631	1	3,006	431	670	431
Gabon	157,673	13	84,270	6,169	13,819	6,169
Angola	449,456	16	240,168	3,991	19,618	3,991
Nigeria	34,497	1	21	2	1	2
Tanzania	235,298	7	111,872	236	2,813	236
India	1,512,987	26	812,518	8,749	52,096	8,749
Bangladesh	46,018	6	24,644	807	2,851	807
Myanmar	455,265	25	244,396	3,600	19,054	3,600
Malaysia	420,891	12	225,873	5,152	21,243	5,152
Vietnam	617,199	15	331,144	4,224	20,508	4,224
Singapore	110	12	54	28	14	28
China	510,613	53	273,936	20,943	46,605	20,943
Japan	3,947,052	7	2,113,686	9,764	82,009	9,764
Joint Japan - Korea	83,091	15	1,094	167	130	167
Kiribati	1,043,282	6	42,737	34	285	34
Antarctica	3,862,879	144	2,074,382	68,505	219,267	68,505
Jordan	14	1	1	1	0	1
Indonesia	5,659,840	7	3,038,961	29,113	176,998	29,112
Conflict Zone	72,829	6	178	81	50	81
Canada	3,139,972	137	1,686,124	113,950	232,697	113,950
Saint-Pierre and Miquelon	11,851	4	3,739	101	232	101
Southern Saint-Martin	12,056	1	33	7	8	7
Northern Saint-Martin	5,412	0	13	4	4	4
Sweden	2,274	92	1,218	600	298	600
Norway	336,047	320	180,313	14,094	27,643	14,094
Chile	2,762,715	31	1,483,243	14,117	91,127	14,117
Easter Island	717,003	24	1,150	44	22	44
Japan - South Korea Conflict Zone	66,048	21	158	48	22	48
Greenland	1,006,032	837	540,129	29,593	63,579	29,593
Iceland	661,600	548	354,933	23,316	50,647	23,316
Ireland	362,406	53	194,622	4,835	14,791	4,835
United Kingdom	839,002	159	450,507	29,997	63,110	29,997
France	303,633	43	162,813	5,375	16,666	5,375
Jersey	2,699	44	1,371	269	259	269
Guernsey	8,645	144	1,690	452	238	452
Maldives	911,913	10	84,395	211	1,085	211
British Indian Ocean Territory	635,584	6	3,046	63	200	63
Egypt	245,394	41	126,571	717	5,298	717
Sudan	63,883	5	31,636	242	1,123	242
Bahrain	4,329	27	2,324	421	551	421
Qatar	28,085	157	14,456	1,174	2,092	1,174
Grand Total	127,642,955					936,743

Table A8. Summary of high seas benthic biomass for 1997 and 2006 by size class, including minimum and maximum values, means, standard deviations and areas of analysis.

		Area (km²)	Min	Max	Mean	Standard Deviation	Sum
1997	Meiofauna	202,594,942	10,634	2,121,339	92,678	64,011	92,678
	Macrofauna	202,156,967	13,385	20,683,084	236,077	471,976	236,076
	Megafauna	202,447,215	316	624,528,086	201,612	6,468,995	201,612
2006	Meiofauna	203,220,347	10,180	586,090	90,486	55,462	90,486
	Macrofauna	203,036,110	15,046	4,870,461	238,384	279,407	238,384
	Megafauna	203,149,149	649	109,078,091	74,672	1,207,675	74,672

Table A9 Summary of continental shelf and non-continental shelf benthic biomass for 1997 and 2006 by size class, including minimum and maximum values, means, standard deviations and areas of analysis.

1997		Area (km²)	Min	Max	Mean	Standard Deviation	Sum
	Shelf	17,274,741	9,316	180,887	57,149	21,542	57,149
Meiofauna	**Non-shelf**	316,465,520	6,463	3,313,659	212,347	211,859	212,347
						TOTAL	**269,496**
	Shelf	16,659,871	15,904	1,704,755	417,283	213,858	417,283
Macrofauna	**Non-shelf**	315,400,701	6,342	32,272,431	576,508	1,300,583	576,507
						TOTAL	**993,790**
	Shelf	17,364,490	3,556	53,630,333	357,568	2,279,491	357,568
Megafauna	**Non-shelf**	316,131,610	316	976,778,653	590,134	13,379,226	590,134
						TOTAL	**947,701**
					Grand Total	**2,210,987**	

2006		Area (km²)	Min	Max	Mean	Standard Deviation	Sum
	Shelf	6,945,777	1,602	20,032	15,234	2,512	15,234
Meiofauna	**Non-shelf**	312,103,522	5,787	900,115	186,739	148,020	186,739
						TOTAL	**201,972**
	Shelf	10,699,810	10,467	256,670	195,424	39,954	195,424
Macrofauna	**Non-shelf**	316,111,978	6,525	7,582,967	523,905	847,525	523,905
						TOTAL	**719,329**
	Shelf	13,827,876	724	7,425,970	543,003	1,158,028	543,002
Megafauna	**Non-shelf**	316,514,183	178	169,975,084	445,171	4,806,743	445,169
						TOTAL	**988,171**
					Grand Total	**1,909,473**	

Table A10(a). Summary of meiofauna biomass by FAO fishing for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 MEIOFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	370,407	448	3,873	683	393	683
21	6,400,654	1,252	67,018	6,812	5,662	6,812
27	10,011,563	1,540	104,811	10,137	8,346	10,137
31	14,431,868	1,089	151,028	16,845	17,771	16,845
34	13,948,326	1,531	145,914	10,035	10,020	10,035
37	2,869,492	794	30,010	5,384	3,026	5,384
41	17,341,350	1,717	181,457	12,968	14,264	12,968
47	18,236,289	1,539	190,588	9,916	8,595	9,916
48	6,604,167	200	69,118	3,115	5,541	3,115
51	29,088,292	3,540	304,410	28,573	26,791	28,573
57	30,866,443	3,442	323,127	26,625	34,463	26,625
58	11,110,344	1,044	116,335	4,362	7,467	4,362
61	21,197,229	433	221,956	17,512	21,739	17,512
67	7,344,871	370	76,852	4,093	5,015	4,093
71	32,667,212	999	342,064	47,825	45,777	47,825
77	47,834,920	1,236	500,711	28,893	24,695	28,893
81	27,527,410	1,024	287,595	13,916	13,646	13,916
87	30,528,792	2,058	319,305	20,209	13,767	20,209
88	5,594,080	621	58,561	2,186	4,353	2,186
					TOTAL	**270,090**

Table A10(b). Summary of meiofauna biomass by FAO fishing for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 MEIOFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	415,631	539	1,199	742	100	742
21	6,519,748	1,312	18,803	7,057	4,959	7,057
27	9,986,999	1,497	28,803	9,949	7,325	9,949
31	12,402,679	888	35,770	8,914	7,210	8,914
34	13,446,893	1,441	38,780	8,052	5,243	8,052
37	2,318,547	585	6,687	3,368	1,622	3,368
41	16,474,661	1,544	47,513	10,096	9,259	10,096
47	18,016,802	1,367	51,961	9,421	7,103	9,421
48	6,953,175	195	20,051	2,200	1,949	2,200
51	27,211,926	3,166	78,479	21,029	13,234	21,029
57	28,926,303	3,072	83,424	17,132	15,268	17,132
58	11,521,426	1,025	33,194	3,649	3,495	3,649
61	19,476,523	361	56,171	11,673	12,524	11,673
67	7,382,999	338	21,292	4,086	4,590	4,086
71	27,078,228	769	78,094	24,319	16,942	24,319
77	47,263,918	1,142	136,310	25,828	15,104	25,828
81	27,475,240	920	79,236	13,692	13,233	13,692
87	30,326,813	1,966	87,463	19,051	10,328	19,051
88	5,917,852	619	17,041	1,761	1,723	1,761
					TOTAL	**202,017**

Table A11(a). Summary of macrofauna biomass by FAO fishing for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 MACROFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	338,143	4,602	34,493	7,854	3,930	7,854
21	6,268,983	1,807	641,116	72,808	81,256	72,808
27	9,896,442	3,369	1,012,554	71,143	90,713	71,143
31	14,391,453	840	1,472,519	46,753	122,681	46,753
34	13,936,010	1,470	1,418,073	19,012	55,376	19,011
37	2,839,407	4,335	290,477	35,772	32,460	35,772
41	17,325,020	2,333	1,772,644	50,518	102,686	50,518
47	18,228,521	5,100	1,852,546	26,951	47,880	26,951
48	6,239,788	2,245	638,468	38,978	64,910	38,978
51	29,066,180	5,203	2,974,255	57,826	146,776	57,826
57	30,817,273	3,816	3,152,422	88,858	229,007	88,858
58	10,788,161	5,987	1,103,823	49,498	85,526	49,498
61	21,107,508	916	2,159,193	99,506	189,431	99,506
67	7,304,909	2,672	747,394	29,879	52,590	29,879
71	32,475,740	653	3,322,950	146,244	346,234	146,245
77	47,824,179	1,189	4,892,940	33,154	100,526	33,154
81	27,519,450	1,365	2,801,453	53,330	84,768	53,330
87	30,510,119	3,920	3,113,619	41,757	75,684	41,757
88	5,365,961	6,187	549,002	28,928	51,603	28,928
					TOTAL	**998,769**

Table A11(b). Summary of macrofauna biomass by FAO fishing for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 MACROFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	165,482	2,342	3,969	3,507	288	3,507
21	5,627,919	1,623	135,004	44,464	45,531	44,464
27	8,856,420	3,324	212,449	49,167	55,571	49,167
31	13,996,646	845	335,751	28,195	60,513	28,195
34	13,700,343	1,542	328,647	14,189	29,292	14,189
37	2,793,704	2,693	67,009	21,141	13,462	21,141
41	16,613,387	2,374	398,526	39,676	81,602	39,676
47	18,051,805	4,534	433,026	25,716	36,812	25,716
48	6,816,956	2,713	163,526	29,345	25,586	29,345
51	28,716,008	5,221	688,836	45,268	89,175	45,268
57	30,599,799	3,532	734,035	64,649	116,075	64,649
58	11,370,521	7,807	272,754	45,407	44,635	45,407
61	19,829,243	841	475,667	56,746	99,802	56,746
67	6,521,063	2,453	156,428	17,335	25,736	17,335
71	32,028,655	661	768,312	86,575	178,320	86,575
77	47,764,160	1,245	1,145,656	31,079	59,928	31,079
81	27,473,336	1,526	659,011	55,641	79,244	55,641
87	30,304,030	4,206	726,895	40,346	40,971	40,346
88	5,670,745	5,190	136,029	22,275	19,076	22,275
					TOTAL	**720,722**

Table A12(a). Summary of megafauna biomass by FAO fishing for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 MEGAFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	362,365	4,396	1,116,083	26,310	87,495	26,310
21	6,372,692	100	19,670,390	117,804	724,455	117,804
27	9,993,479	176	30,839,854	88,851	879,416	88,851
31	14,447,212	15	44,607,812	16,457	455,546	16,457
34	13,955,505	42	42,929,891	9,603	361,541	9,603
37	2,874,808	121	8,739,807	17,999	194,041	17,999
41	17,344,556	87	52,452,931	20,809	381,635	20,809
47	18,237,015	268	54,803,523	8,989	295,064	8,989
48	6,477,620	97	19,993,104	146,398	1,069,415	146,398
51	29,100,047	253	88,342,683	16,379	579,836	16,379
57	30,891,253	131	95,344,891	31,193	851,830	31,193
58	11,004,826	485	34,002,546	142,441	1,376,005	142,441
61	21,197,366	21	65,180,801	86,347	1,019,849	86,347
67	7,339,227	117	22,474,916	37,368	449,691	37,368
71	32,718,189	33	100,881,278	62,638	1,417,043	62,638
77	47,832,934	48	146,081,442	10,435	587,129	10,435
81	27,527,273	28	84,882,440	16,422	316,851	16,422
87	30,532,889	103	94,055,327	18,894	658,931	18,894
88	5,520,525	711	17,051,541	105,079	837,804	105,079
					TOTAL	**980,417**

Table A12(b). Summary of megafauna biomass by FAO fishing for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 MEGAFAUNA in teragrams						
	Area (km²)	Min	Max	Mean	Standard Deviation	Sum
18	274,808	1,439	147,512	19,118	29,671	19,118
21	6,206,744	104	3,332,941	139,242	370,601	139,241
27	9,414,873	264	5,056,041	117,246	442,536	117,246
31	14,216,134	31	7,625,975	27,451	274,587	27,451
34	13,688,972	108	7,346,405	25,497	278,068	25,497
37	2,806,418	195	1,503,547	11,698	73,501	11,698
41	17,095,038	107	9,177,505	97,814	532,577	97,814
47	18,063,190	238	9,698,199	25,843	315,949	25,843
48	6,848,520	255	3,676,621	39,919	204,969	39,919
51	28,900,451	246	15,519,774	39,433	459,113	39,433
57	30,745,609	199	16,511,283	30,148	379,819	30,148
58	11,433,746	966	6,133,347	25,491	178,748	25,491
61	20,017,878	35	10,749,661	152,957	815,785	152,956
67	6,877,811	244	3,692,910	96,884	392,980	96,884
71	32,464,972	18	17,431,548	48,920	530,445	48,920
77	47,775,462	45	25,653,035	17,590	399,669	17,590
81	27,522,341	68	14,683,086	13,359	152,442	13,359
87	30,326,498	337	16,285,997	26,952	399,937	26,952
88	5,757,699	278	3,091,908	34,634	192,752	34,634
					TOTAL	**990,195**

Table A13. Summary of meiofauna biomass Large Marine Ecosystem for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 Meiofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Baltic Sea	320,059	533	3,323	671	155	671
	Benguela Current	1,439,870	376	15,048	1,920	1,388	1,920
	Black Sea	432,057	387	4,453	803	381	803
	Canary Current	1,097,480	403	11,459	1,615	1,144	1,615
	Celtic-Biscay Shelf	722,401	189	7,538	1,498	619	1,498
	Faroe Plateau	148,755	114	1,417	222	53	222
	Guinea Current	1,871,584	650	19,579	2,731	2,468	2,731
	Iberian Coastal	295,345	71	3,092	375	309	375
	Mediterranean Sea	2,437,175	674	25,489	4,580	2,635	4,580
	North Sea	655,751	642	6,839	1,419	333	1,419
Atlantic West	Caribbean Sea	3,173,126	371	33,207	5,980	4,034	5,980
	East Brazil Shelf	1,062,517	420	10,503	1,501	1,181	1,501
	Gulf of Mexico	1,499,397	1,013	15,679	3,982	2,172	3,982
	Newfoundland-Labrador Shelf	838,988	595	8,736	1,457	354	1,457
	North Brazil Shelf	972,892	458	10,154	2,491	1,311	2,491
	Northeast U.S. Continental Shelf	301,797	376	3,153	798	216	798
	Patagonian Shelf	1,133,661	882	11,777	2,451	526	2,451
	Scotian Shelf	273,575	212	2,833	537	111	537
	South Brazil Shelf	550,548	390	5,761	1,392	517	1,392
	Southeast U.S. Continental Shelf	292,317	565	3,037	1,103	178	1,103
Indian Ocean	Agulhas Current	2,586,916	871	26,941	4,227	2,667	4,227
	Arabian Sea	3,861,646	1,427	40,412	7,013	5,201	7,013
	Bay of Bengal	3,552,259	1,514	37,164	7,633	5,451	7,633
	Northwest Australian Shelf	892,062	270	9,242	2,990	1,460	2,990
	Red Sea	435,729	576	4,546	1,486	358	1,486
	Somali Coastal Current	826,343	331	8,569	1,306	900	1,306
	Southwest Australian Shelf	1,032,227	140	10,597	1,317	1,151	1,317
	West Central Australian Shelf	536,944	117	5,508	685	645	685

Table A13. continued…

1997 Meiofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,189,863	584	22,800	1,759	1,684	1,759
	East Bering Sea	1,176,515	59	12,310	1,477	1,169	1,477
	Gulf of Alaska	1,391,673	127	14,387	1,308	1,084	1,308
	Gulf of California	209,980	180	2,198	671	292	671
	Humboldt Current	2,444,655	190	25,569	2,066	2,243	2,066
	Insular Pacific-Hawaiian	972,933	244	10,148	749	710	749
	Pacific Central-American Coastal	1,945,852	487	20,352	3,404	2,630	3,404
Pacific West	East Central Australian Shelf	645,708	181	6,617	696	641	696
	East China Sea	725,073	696	7,589	2,346	447	2,346
	Gulf of Thailand	369,407	1,158	3,838	1,566	197	1,566
	Indonesian Sea	2,130,460	301	22,303	7,067	3,859	7,067
	Kuroshio Current	1,298,349	57	13,527	1,551	1,431	1,551
	New Zealand Shelf	941,368	305	9,835	1,692	613	1,692
	North Australian Shelf	749,006	2,200	7,814	3,179	426	3,179
	Northeast Australian Shelf	1,264,263	556	13,133	2,892	1,394	2,892
	Oyashio Current	527,656	11	5,266	301	366	301
	Sea of Japan	957,945	363	10,000	1,538	975	1,538
	Sea of Okhotsk	1,514,576	467	15,843	2,240	992	2,240
	South China Sea	3,067,718	1,486	32,085	8,982	4,430	8,982
	Southeast Australian Shelf	1,177,981	208	12,304	984	1,031	984
	Sulu-Celebes Sea	956,274	295	9,988	2,202	1,635	2,202
	West Bering Sea	1,961,977	84	20,544	1,190	1,236	1,190
	Yellow Sea	384,080	840	4,013	1,158	330	1,158
Polar Oceans	Antarctica	807,478	379	8,454	1,755	1,447	1,755
	Barents Sea	269,794	246	2,815	500	265	500
	Beaufort Sea	28,893	35	302	63	40	63
	Chukchi Sea	237,147	312	2,474	411	186	411
	East Greenland Shelf	185,498	118	1,929	274	144	274
	East Siberian Sea	31,674	44	329	69	52	69
	Hudson Bay	748,828	926	7,833	1,275	512	1,275
	Iceland Shelf	259,930	174	2,719	421	238	421
	Kara Sea	3,315	5	32	8	6	8
	Laptev Sea	3,014	4	29	6	3	6
	Norwegian Sea	385,600	108	4,037	421	332	421
	West Greenland Shelf	127,191	60	1,323	205	134	205

Table A14. Summary of meiofauna biomass Large Marine Ecosystem for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 Meiofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Baltic Sea	192,266	314	554	514	20	514
	Benguela Current	1,288,677	341	3,717	1,521	1,033	1,521
	Black Sea	317,018	322	914	455	157	455
	Canary Current	951,753	347	2,745	1,098	629	1,098
	Celtic-Biscay Shelf	709,509	181	2,046	1,423	493	1,423
	Faroe Plateau	149,494	124	420	232	48	232
	Guinea Current	1,521,865	501	4,389	1,356	861	1,356
	Mediterranean Sea	2,001,529	505	5,772	2,913	1,454	2,913
	Iberian Coastal	283,111	67	816	322	243	322
	North Sea	621,432	661	1,792	1,400	168	1,400
Atlantic West	Caribbean Sea	2,333,918	253	6,731	2,892	1,665	2,892
	East Brazil Shelf	863,169	340	2,489	805	433	805
	Gulf of Mexico	794,806	507	2,292	1,075	496	1,075
	Newfoundland-Labrador Shelf	842,249	753	2,426	1,604	263	1,604
	North Brazil Shelf	486,939	233	1,404	669	307	669
	Northeast U.S. Continental Shelf	268,054	349	773	659	64	659
	Patagonian Shelf	1,038,720	829	2,996	2,302	339	2,302
	Scotian Shelf	264,437	244	763	578	70	578
	South Brazil Shelf	250,217	174	722	423	145	423
	Southeast U.S. Continental Shelf	50,854	95	147	142	3	142
Indian Ocean	Agulhas Current	2,196,288	720	6,334	2,756	1,359	2,756
	Arabian Sea	3,043,976	1,096	8,779	3,559	1,781	3,559
	Bay of Bengal	2,665,582	1,161	7,688	3,375	1,379	3,375
	Northwest Australian Shelf	398,218	106	1,148	649	323	649
	Red Sea	158,057	191	456	380	49	380
	Somali Coastal Current	686,247	269	1,979	795	381	795
	Southwest Australian Shelf	1,020,239	132	2,942	1,241	1,081	1,241
	West Central Australian Shelf	434,112	91	1,252	346	327	346

Table A14. continued…

2006 Meiofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,101,840	511	6,062	1,378	1,032	1,378
	East Bering Sea	1,232,397	56	3,554	1,593	955	1,593
	Gulf of Alaska	1,388,248	120	4,002	1,261	993	1,261
	Gulf of California	97,202	78	280	182	55	182
	Humboldt Current	2,334,261	163	6,732	1,628	1,452	1,628
	Insular Pacific-Hawaiian	929,244	236	2,680	603	432	603
	Pacific Central-American Coastal	1,662,098	360	4,794	1,901	816	1,901
Pacific West	East Central Australian Shelf	572,605	157	1,651	446	347	446
	East China Sea	80,022	81	231	190	32	190
	Indonesian Sea	991,277	123	2,859	1,366	732	1,366
	Kuroshio Current	1,159,883	52	3,345	1,069	888	1,069
	New Zealand Shelf	940,532	306	2,712	1,683	514	1,683
	Northeast Australian Shelf	770,666	334	2,223	1,184	530	1,184
	Oyashio Current	528,847	10	1,523	293	337	293
	Sea of Japan	852,441	288	2,458	1,111	602	1,111
	Sea of Okhotsk	1,505,644	475	4,342	2,396	885	2,396
	South China Sea	1,311,145	599	3,781	1,872	938	1,872
	Southeast Australian Shelf	1,178,022	198	3,391	974	994	974
	Sulu-Celebes Sea	609,897	174	1,758	668	447	668
	West Bering Sea	1,973,143	81	5,690	1,237	1,255	1,237
	Yellow Sea	162,386	342	468	434	23	434
Polar Oceans	Antarctica	955,808	431	2,756	1,243	219	1,243
	Barents Sea	286,179	257	825	562	73	562
	Beaufort Sea	37,661	49	108	77	12	77
	Chukchi Sea	247,710	368	714	440	46	440
	East Greenland Shelf	195,047	133	540	258	39	258
	East Siberian Sea	43,045	66	124	79	13	79
	Hudson Bay	775,680	1,159	2,237	1,453	145	1,453
	Iceland Shelf	282,891	207	810	449	106	449
	Kara Sea	4,179	7	11	8	1	8
	Laptev Sea	630	1	2	2	0	2
	Norwegian Sea	417,439	117	1,202	436	238	436
	West Greenland Shelf	142,823	65	399	205	42	205

Table A15. Summary of macrofauna biomass Large Marine Ecosystem for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 Macrofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Baltic Sea	315,566	0.18	32,238	5,630	2,009	5,630
	Benguela Current	1,435,089	0.01	144,783	6,622	9,770	6,622
	Black Sea	425,070	0.08	43,462	7,514	4,879	7,514
	Canary Current	1,092,000	0.01	110,933	5,497	8,630	5,497
	Celtic-Biscay Shelf	712,578	0.01	72,684	12,749	7,647	12,749
	Faroe Plateau	148,385	0.06	14,613	1,722	759	1,722
	Guinea Current	1,864,844	0.00	189,759	6,847	14,747	6,847
	Iberian Coastal	293,358	0.01	29,934	1,937	2,668	1,937
	Mediterranean Sea	2,414,241	0.02	246,982	28,257	27,021	28,257
	North Sea	647,106	0.06	65,930	12,078	4,606	12,078
Atlantic West	Caribbean Sea	3,163,357	0.00	323,672	13,837	23,882	13,837
	East Brazil Shelf	1,061,380	0.00	104,860	4,363	8,456	4,363
	Gulf of Mexico	1,475,901	0.01	151,008	17,447	23,517	17,447
	Newfoundland-Labrador Shelf	829,823	0.08	84,844	16,886	7,170	16,886
	North Brazil Shelf	967,754	0.00	98,767	9,069	9,956	9,069
	Northeast U.S. Continental Shelf	293,481	0.07	29,862	8,743	3,574	8,743
	Patagonian Shelf	1,127,113	0.03	115,323	18,955	6,204	18,955
	Scotian Shelf	271,219	0.08	27,680	5,512	1,806	5,512
	South Brazil Shelf	548,356	0.01	55,657	6,534	5,711	6,534
	Southeast U.S. Continental Shelf	286,494	0.03	29,216	6,880	6,238	6,880
Indian Ocean	Agulhas Current	2,581,491	0.00	264,156	10,307	19,355	10,307
	Arabian Sea	3,850,084	0.00	393,436	19,605	37,082	19,605
	Bay of Bengal	3,527,229	0.00	360,814	21,578	43,232	21,578
	Northwest Australian Shelf	884,815	0.00	90,266	14,135	16,231	14,135
	Red Sea	431,975	0.02	43,861	6,636	3,680	6,636
	Somali Coastal Current	824,904	0.00	83,714	2,357	5,098	2,357
	Southwest Australian Shelf	1,030,651	0.00	101,921	6,939	8,867	6,939
	West Central Australian Shelf	535,163	0.00	54,521	2,342	4,306	2,342

Table A15. continued…

	1997 Macrofauna in teragrams	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,185,438	0.01	223,345	5,430	10,621	5,430
	East Bering Sea	1,145,923	0.01	117,244	15,079	12,747	15,078
	Gulf of Alaska	1,383,344	0.01	140,838	9,274	11,230	9,274
	Gulf of California	206,226	0.01	21,092	2,416	3,039	2,416
	Humboldt Current	2,430,832	0.00	248,071	8,862	17,656	8,862
	Insular Pacific-Hawaiian	972,412	0.00	96,739	1,111	2,834	1,111
	Pacific Central-American Coastal	1,939,824	0.00	198,465	6,011	13,582	6,011
Pacific West	East Central Australian Shelf	645,010	0.01	63,530	2,197	4,747	2,197
	East China Sea	714,181	0.01	72,728	12,772	7,774	12,772
	Gulf of Thailand	364,215	0.24	37,253	9,030	2,997	9,030
	Indonesian Sea	2,029,641	0.00	207,659	33,850	40,522	33,850
	Kuroshio Current	1,291,266	0.00	131,406	5,184	11,445	5,184
	New Zealand Shelf	935,121	0.01	95,194	9,227	7,415	9,227
	North Australian Shelf	737,197	0.21	75,370	25,106	10,639	25,106
	Northeast Australian Shelf	1,262,756	0.01	127,442	9,623	12,113	9,623
	Oyashio Current	525,943	0.00	52,867	2,955	4,136	2,955
	Sea of Japan	948,109	0.02	96,987	9,489	10,220	9,489
	Sea of Okhotsk	1,492,738	0.04	152,555	27,672	17,751	27,672
	South China Sea	3,045,263	0.00	311,515	35,463	38,961	35,463
	Southeast Australian Shelf	1,175,707	0.01	118,171	5,807	9,238	5,807
	Sulu-Celebes Sea	942,122	0.00	96,399	7,044	12,016	7,044
	West Bering Sea	1,949,058	0.00	199,291	13,213	16,331	13,213
	Yellow Sea	364,502	0.18	37,238	8,500	3,930	8,500
Polar Oceans	Antarctica	563,933	0.09	57,701	18,252	10,993	18,252
	Barents Sea	251,655	0.07	25,729	5,457	2,786	5,457
	Beaufort Sea	24,139	0.19	2,458	561	348	561
	Chukchi Sea	225,228	0.23	22,975	5,132	2,266	5,132
	East Greenland Shelf	175,744	0.07	17,981	4,115	2,343	4,115
	East Siberian Sea	25,482	0.24	2,587	664	367	664
	Hudson Bay	722,319	0.19	73,870	15,902	6,816	15,902
	Iceland Shelf	249,573	0.07	25,298	3,792	2,156	3,792
	Kara Sea	2,192	0.23	221	54	33	54
	Laptev Sea	2,493	0.26	229	82	39	82
	Norwegian Sea	375,188	0.03	38,375	2,784	2,830	2,784
	West Greenland Shelf	116,628	0.08	11,918	3,011	1,680	3,011

Table A16. Summary of macrofauna biomass Large Marine Ecosystem for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

	2006 Macrofauna in teragrams	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Benguela Current	1,278,690	0.01	30,673	4,806	6,466	4,806
	Black Sea	376,435	0.06	9,023	2,982	1,661	2,982
	Canary Current	964,973	0.01	23,148	3,482	4,375	3,482
	Celtic-Biscay Shelf	504,489	0.01	12,102	7,074	3,689	7,074
	Faroe Plateau	144,097	0.08	3,456	1,983	658	1,983
	Guinea Current	1,753,066	0.00	42,052	3,971	7,184	3,971
	Iberian Coastal	279,466	0.01	6,700	1,460	1,648	1,460
	Mediterranean Sea	2,416,872	0.01	57,970	18,152	11,784	18,152
	North Sea	392,820	0.08	9,423	7,474	1,388	7,474
Atlantic West	Caribbean Sea	3,042,373	0.00	72,980	10,577	16,670	10,577
	East Brazil Shelf	1,032,309	0.00	24,762	3,420	6,440	3,420
	Gulf of Mexico	1,348,313	0.01	32,340	8,679	9,753	8,679
	Newfoundland-Labrador Shelf	700,919	0.06	16,814	11,836	2,612	11,836
	North Brazil Shelf	733,484	0.01	17,594	4,184	5,548	4,184
	Northeast U.S. Continental Shelf	157,166	0.03	3,770	2,919	654	2,919
	Patagonian Shelf	668,793	0.02	16,043	12,985	2,626	12,985
	Scotian Shelf	180,196	0.08	4,323	3,465	581	3,465
	South Brazil Shelf	470,485	0.01	11,286	3,954	3,294	3,954
	Southeast U.S. Continental Shelf	225,886	0.03	5,419	2,110	1,488	2,110
Indian Ocean	Agulhas Current	2,513,169	0.01	60,286	7,158	11,568	7,158
	Arabian Sea	3,629,116	0.00	87,053	11,554	19,496	11,554
	Bay of Bengal	3,374,365	0.00	80,943	9,809	16,541	9,809
	Northwest Australian Shelf	839,796	0.00	20,145	6,631	6,430	6,631
	Red Sea	356,132	0.02	8,541	4,466	1,766	4,466
	Somali Coastal Current	813,492	0.00	19,513	1,943	3,298	1,943
	Southwest Australian Shelf	1,025,623	0.01	24,602	6,854	8,299	6,854
	West Central Australian Shelf	524,148	0.00	12,572	1,963	3,222	1,963

Table A16. continued…

2006 Macrofauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,127,144	0.01	51,013	4,819	6,752	4,819
	East Bering Sea	646,352	0.01	15,505	5,883	5,469	5,883
	Gulf of Alaska	1,102,055	0.01	26,436	4,863	4,600	4,863
	Gulf of California	187,813	0.01	4,505	1,262	1,160	1,262
	Humboldt Current	2,227,223	0.00	53,424	5,468	8,542	5,468
	Insular Pacific-Hawaiian	974,056	0.00	22,866	1,038	2,132	1,038
	Pacific Central-American Coastal	1,918,041	0.00	45,999	4,145	6,699	4,145
Pacific West	East Central Australian Shelf	638,420	0.01	15,314	1,773	3,381	1,773
	East China Sea	621,227	0.01	14,901	7,435	3,691	7,435
	Gulf of Thailand	329,869	0.21	7,913	6,132	509	6,132
	Indonesian Sea	2,059,918	0.00	49,410	15,451	17,039	15,451
	Kuroshio Current	1,272,415	0.00	30,514	3,142	5,207	3,142
	New Zealand Shelf	891,884	0.01	21,394	8,445	5,341	8,445
	North Australian Shelf	584,141	0.10	14,012	12,065	1,271	12,065
	Northeast Australian Shelf	1,196,476	0.01	28,701	7,370	9,312	7,370
	Oyashio Current	482,583	0.00	11,576	2,209	2,969	2,209
	Sea of Japan	934,367	0.02	22,409	5,494	4,435	5,494
	Sea of Okhotsk	951,479	0.04	22,824	12,573	5,435	12,573
	South China Sea	2,885,521	0.00	69,218	22,594	21,865	22,594
	Southeast Australian Shelf	1,161,185	0.01	27,854	5,519	8,209	5,519
	Sulu-Celebes Sea	947,574	0.00	22,730	4,416	6,162	4,416
	West Bering Sea	1,705,773	0.01	40,918	8,608	8,167	8,608
	Yellow Sea	148,056	0.19	3,552	2,675	379	2,675
Polar Oceans	Antarctica	481,487	0.01	11,550	9,795	1,327	9,795
	Barents Sea	25,016	0.10	600	558	38	558
	Beaufort Sea	3,863	0.25	93	79	5	79
	Chukchi Sea	101,161	0.26	2,426	2,199	102	2,199
	East Greenland Shelf	103,230	0.11	2,476	1,964	413	1,964
	East Siberian Sea	14,330	0.28	344	321	11	321
	Hudson Bay	566,714	0.19	13,593	9,945	1,382	9,945
	Iceland Shelf	174,113	0.09	4,177	2,647	875	2,647
	Kara Sea	55	0.32	1	1	0	1
	Norwegian Sea	408,794	0.03	9,801	3,545	2,286	3,545
	West Greenland Shelf	46,854	0.11	1,124	842	173	842

Table A17. Summary of megafauna biomass Large Marine Ecosystem for 1997, including minimum and maximum values, means, standard deviations and areas of analysis.

1997 Megafauna in Teragrams		Area (km²)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Baltic Sea	319,840	2,496	952,119	5,972	32,110	5,972
	Benguela Current	1,441,007	54	4,330,328	4,197	68,250	4,197
	Black Sea	432,413	426	1,269,776	4,364	29,082	4,364
	Canary Current	1,099,905	37	3,353,687	3,654	62,302	3,654
	Celtic-Biscay Shelf	722,785	58	2,194,318	8,568	61,685	8,568
	Faroe Plateau	148,741	209	418,016	958	6,968	958
	Guinea Current	1,876,242	37	5,771,692	5,067	104,438	5,067
	Iberian Coastal	295,591	13	756,134	1,108	13,853	1,108
	Mediterranean Sea	2,442,094	103	7,424,296	13,511	163,961	13,511
	North Sea	655,997	1,670	1,958,165	10,030	66,197	10,030
Atlantic West	Caribbean Sea	3,180,743	7	9,820,993	6,297	142,955	6,297
	East Brazil Shelf	1,062,750	25	2,938,224	640	15,510	640
	Gulf of Mexico	1,504,657	107	4,643,553	6,987	100,201	6,987
	Newfoundland-Labrador Shelf	837,810	1,383	2,463,046	18,487	64,037	18,487
	North Brazil Shelf	976,810	29	2,895,566	3,182	56,258	3,182
	Northeast U.S. Continental Shelf	302,345	483	933,240	6,471	32,139	6,471
	Patagonian Shelf	1,134,182	460	3,429,962	11,414	62,549	11,414
	Scotian Shelf	273,425	545	744,165	4,950	20,327	4,950
	South Brazil Shelf	551,041	55	1,653,097	1,695	21,967	1,695
	Southeast U.S. Continental Shelf	293,714	160	871,006	1,804	15,824	1,804
Indian Ocean	Agulhas Current	2,589,122	80	7,835,017	3,500	78,004	3,500
	Arabian Sea	3,867,825	81	11,693,965	6,507	150,547	6,507
	Bay of Bengal	3,569,768	70	11,017,977	12,653	222,764	12,653
	Northwest Australian Shelf	893,870	13	2,751,029	2,860	40,163	2,860
	Red Sea	438,290	82	1,330,467	2,160	31,910	2,160
	Somali Coastal Current	827,042	20	2,534,864	752	19,421	752
	Southwest Australian Shelf	1,032,501	21	2,821,884	1,970	29,843	1,970
	West Central Australian Shelf	537,615	10	1,511,573	1,126	23,207	1,126

Table A17. continued…

	1997 Megafauna in Teragrams	Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,190,781	117	6,571,269	3,889	82,613	3,889
	East Bering Sea	1,171,090	19	3,572,367	28,359	162,121	28,359
	Gulf of Alaska	1,391,495	52	4,216,664	7,913	76,519	7,913
	Gulf of California	212,021	25	647,511	2,184	22,483	2,184
	Humboldt Current	2,446,108	8	7,535,135	10,694	164,761	10,694
	Insular Pacific-Hawaiian	973,180	15	2,575,434	342	12,375	342
	Pacific Central-American Coastal	1,951,647	16	5,998,355	4,609	95,585	4,609
Pacific West	East Central Australian Shelf	645,887	20	1,699,883	598	17,184	598
	East China Sea	728,018	104	2,189,509	7,176	70,487	7,176
	Gulf of Thailand	372,298	372	1,089,730	2,073	27,033	2,073
	Indonesian Sea	2,158,887	8	6,605,088	22,081	217,774	22,081
	Kuroshio Current	1,299,198	1	3,994,968	3,354	58,521	3,354
	New Zealand Shelf	941,985	94	2,904,681	5,216	54,125	5,216
	North Australian Shelf	752,610	889	2,307,648	4,008	49,222	4,008
	Northeast Australian Shelf	1,264,688	41	3,778,447	1,427	22,826	1,427
	Oyashio Current	527,505	1	1,582,034	2,758	29,137	2,758
	Sea of Japan	958,288	325	2,940,486	9,519	69,141	9,519
	Sea of Okhotsk	1,512,809	861	4,645,689	32,728	120,419	32,728
	South China Sea	3,080,322	89	9,414,100	11,395	185,477	11,395
	Southeast Australian Shelf	1,178,145	39	3,117,478	2,152	31,951	2,152
	Sulu-Celebes Sea	964,960	11	2,907,532	6,402	85,846	6,402
	West Bering Sea	1,960,004	24	6,003,110	13,596	115,600	13,596
	Yellow Sea	386,600	1,510	1,188,246	12,426	70,005	12,426
Polar Oceans	Antarctica	732,210	2,355	2,262,243	143,581	333,630	143,581
	Barents Sea	266,150	778	821,338	15,588	61,844	15,588
	Beaufort Sea	27,866	338	83,443	3,591	10,008	3,591
	Chukchi Sea	234,489	3,840	689,571	11,909	41,033	11,909
	East Greenland Shelf	183,786	346	555,870	6,961	29,315	6,961
	East Siberian Sea	29,866	665	90,811	4,352	11,746	4,352
	Hudson Bay	743,663	10,698	2,283,798	33,374	123,566	33,374
	Iceland Shelf	257,998	474	794,409	8,097	46,411	8,097
	Kara Sea	3,028	66	6,320	528	962	528
	Laptev Sea	2,973	69	7,385	449	1,132	449
	Norwegian Sea	383,312	168	1,173,002	6,861	55,606	6,861
	West Greenland Shelf	124,985	204	369,473	7,408	27,497	7,408

Table A16. Summary of macrofauna biomass Large Marine Ecosystem for 2006, including minimum and maximum values, means, standard deviations and areas of analysis.

2006 Megafauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Atlantic East	Baltic Sea	905,200	96	486,030	56,849	96,036	56,849
	Benguela Current	1,277,594	35	685,945	19,028	75,066	19,028
	Black Sea	375,449	463	197,619	4,944	17,528	4,944
	Canary Current	970,494	45	520,831	10,731	47,965	10,731
	Celtic-Biscay Shelf	661,463	70	355,224	23,800	49,496	23,800
	Faroe Plateau	149,330	275	78,998	1,644	2,723	1,644
	Guinea Current	1,728,392	28	927,282	14,569	74,197	14,569
	Iberian Coastal	286,645	14	153,247	1,842	9,782	1,842
	Mediterranean Sea	2,430,366	169	1,302,076	6,741	51,061	6,741
	North Sea	499,516	1,107	268,218	23,708	41,921	23,708
Atlantic West	Caribbean Sea	3,118,819	10	1,672,962	10,696	80,027	10,696
	East Brazil Shelf	1,054,626	13	565,096	2,113	19,568	2,113
	Gulf of Mexico	1,416,717	47	759,029	8,278	47,179	8,278
	Newfoundland-Labrador Shelf	798,463	765	428,724	26,915	50,326	26,915
	North Brazil Shelf	798,669	24	428,431	9,701	38,810	9,701
	Northeast U.S. Continental Shelf	228,954	59	122,902	16,410	21,430	16,410
	Patagonian Shelf	1,028,856	269	552,344	73,609	91,925	73,609
	Scotian Shelf	220,734	485	118,506	18,709	23,131	18,709
	South Brazil Shelf	525,313	24	281,099	6,324	23,899	6,324
	Southeast U.S. Continental Shelf	275,959	35	147,817	3,675	13,955	3,676
Indian Ocean	Agulhas Current	2,562,434	51	1,369,219	7,748	59,721	7,748
	Arabian Sea	3,718,166	65	1,996,481	23,630	127,779	23,630
	Bay of Bengal	3,449,838	38	1,852,663	13,860	103,323	13,860
	Northwest Australian Shelf	876,416	8	469,657	3,502	21,518	3,502
	Red Sea	411,233	35	220,835	8,287	26,539	8,287
	Somali Coastal Current	824,439	22	437,659	1,603	14,100	1,603
	Southwest Australian Shelf	1,033,227	38	470,990	1,618	9,100	1,618
	West Central Australian Shelf	532,341	8	276,916	953	9,209	953

Table A16. continued…

2006 Megafauna in teragrams		Area (km^2)	Min	Max	Mean	Standard Deviation	Sum
Pacific East	California Current	2,126,007	88	1,141,560	8,450	59,543	8,450
	East Bering Sea	1,325,187	160	711,630	30,502	96,832	30,502
	Gulf of Alaska	1,219,506	216	654,724	36,454	100,744	36,454
	Gulf of California	194,348	14	103,612	3,624	11,470	3,624
	Humboldt Current	2,249,472	25	1,208,016	21,495	103,181	21,495
	Insular Pacific-Hawaiian	974,097	12	429,344	123	3,093	123
	Pacific Central-American Coastal	1,923,850	24	1,032,624	7,895	55,034	7,895
Pacific West	East Central Australian Shelf	645,284	16	305,875	527	5,277	527
	East China Sea	647,928	26	347,128	8,810	30,940	8,810
	Gulf of Thailand	354,597	454	190,225	3,222	13,675	3,222
	Indonesian Sea	2,127,596	15	1,142,379	9,445	56,687	9,445
	Kuroshio Current	1,287,156	3	688,555	3,611	29,095	3,611
	New Zealand Shelf	935,217	72	498,935	6,017	26,820	6,017
	North Australian Shelf	688,603	455	369,652	8,380	30,099	8,380
	Northeast Australian Shelf	1,259,674	23	675,988	2,718	18,034	2,718
	Oyashio Current	505,283	23	270,768	9,501	31,035	9,501
	Sea of Japan	944,382	178	505,726	6,673	29,514	6,673
	Sea of Okhotsk	1,000,936	1,112	537,505	59,844	101,580	59,844
	South China Sea	2,972,284	39	1,594,710	14,060	87,998	14,060
	Southeast Australian Shelf	1,177,200	52	631,397	2,091	13,847	2,091
	Sulu-Celebes Sea	959,685	7	515,020	2,454	20,251	2,454
	West Bering Sea	637,790	2,029	342,485	25,685	52,153	25,685
	Yellow Sea	195,458	1,396	104,860	18,055	22,136	18,055
Polar Oceans	Antarctica	695,618	34	373,442	42,317	68,668	42,317
	Barents Sea	117,423	1,046	63,012	19,036	16,587	19,036
	Beaufort Sea	190,129	810	101,614	7,224	12,577	7,224
	Chukchi Sea	253,806	509	136,161	19,716	27,636	19,716
	East Greenland Shelf	416,713	317	206,635	5,191	9,862	5,191
	East Siberian Sea	22,482	196	12,023	1,083	1,855	1,083
	Hudson Bay	69	14	32	23	6	23
	Iceland Shelf	339,198	57	182,028	8,916	25,875	8,916
	Kara Sea	356	40	169	111	39	111
	Laptev Sea	5,740	32	3,077	314	545	314
	Norwegian Sea	131,534	439	70,619	9,232	12,075	9,232
	West Greenland Shelf	180,196	1,287	96,726	14,215	20,631	14,215