Trophic Interactions in Caribbean Coral Reefs

Silvia Opitz

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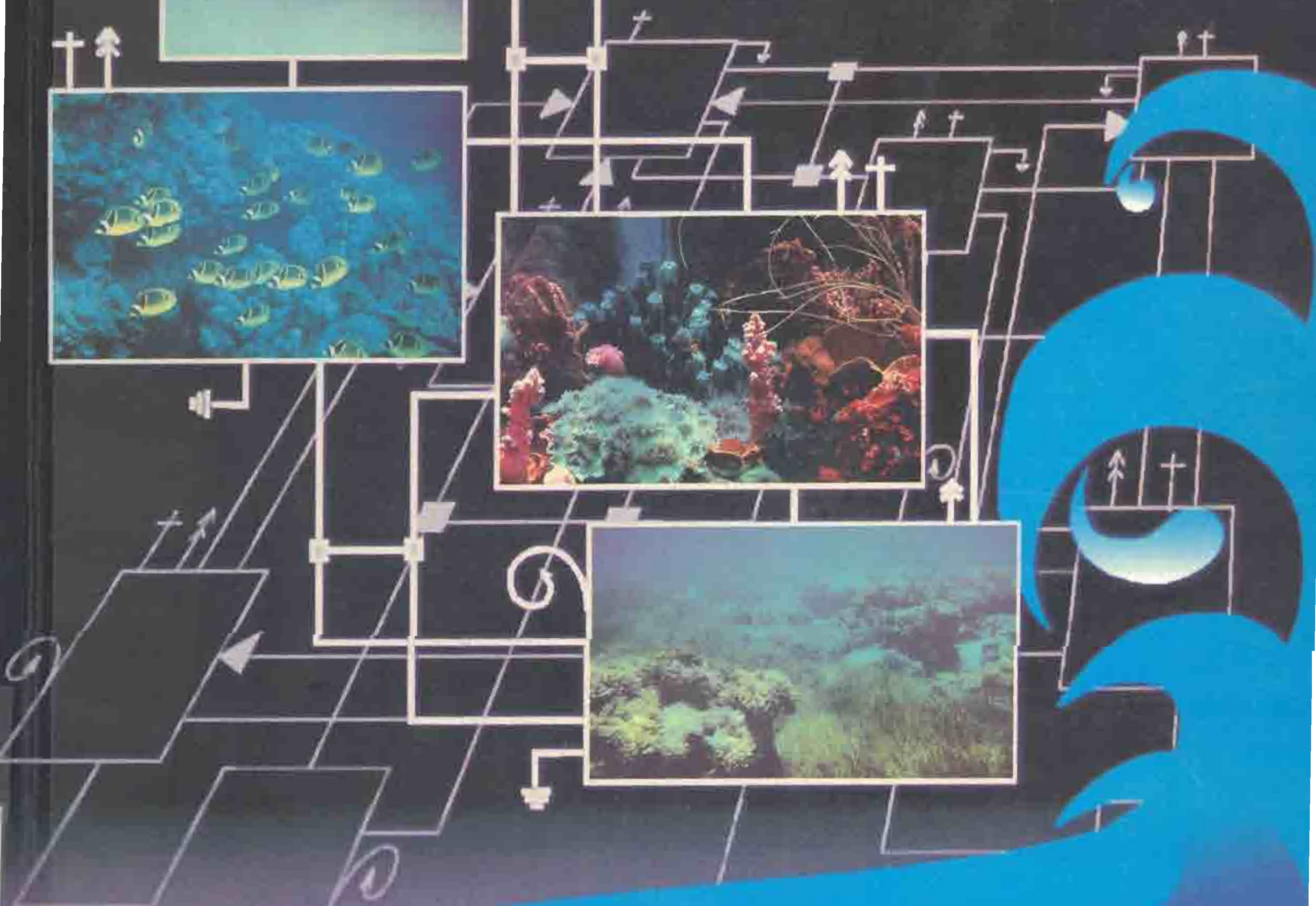

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Cover: Design emphasizes the systematic properties of coral reefs (central insert), inhabited by a variety of fishes (insert, left below), and often connected to other equally productive and equally threatened ecosystems, mangroves (insert, upper left) and seagrasses (insert, lower right). The wave at the lower right side symbolizes how the Sea interconnects these elements, also connected in the models (background diagram).

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

FOREWORD

Coral reefs are important tropical resource systems and, through a rigorous priority setting process (ICLARM Strategic Plan 1992), were selected by ICLARM as one of the three major aquatic resource systems for research focus. The others were coastal inshore systems and inland small ponds and rice flood waters.

As one activity on coral reefs, ICLARM - in collaboration with a number of partner institutions - is developing a global database on coral reefs, ReefBase - to provide managers and scientists access to a standardized, key subset of widely scattered information on coral reefs. Comprehensive and standardized information on such complex systems as coral reefs is critical to understanding their function.

The present document - although it describes an earlier, unfished state of a small part of the world's coral reefs, the Virgin Island/Puerto Rico, area of the Caribbean - therefore presents a vast amount of standardized information. Here, the information presented was standardized through its incorporation into a mass-balance (ECOPATH) model of trophic interactions within a reef - the most detailed model of this type so far published.

The information thus standardized and validated should be useful for many other coral reef modeling efforts.

The trophic models themselves should also be of interest, as they show, also for the first time at this level of details, how groups - corals, algae, invertebrates and fish - usually studied by different scientists - interact, and impact on each other, thus providing a quantitative underpinning for a systems view.

This study*, therefore, represents a significant contribution to coral reef and aquatic systems trophodynamics research.

Meryl J. Williams
Director General
ICLARM

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*Conducted by Dr. S. Opitz towards her doctorate requirements at the University of Kiel, Germany, under the guidance of Dr. D. Pauly and with advice from Dr. V. Christensen of ICLARM.

FOREWORD

The work before you is the most detailed account ever published of the energy fluxes within a coral reef ecosystem — and I am well aware that this is a strong claim to make in view of the enormous research effort which has been devoted to coral reefs to date, and of the enormous literature which presents the results of this effort.

Upon perusing that literature, however, it quickly becomes clear that only a small fraction deals with the energetics of more than two species at a time: the bulk of published coral reef studies deals with the dynamics or trophic biology of either one species, or the interactions between two species.

Studies referring to ensembles of coral reef species obviously do exist as well but they tend to concentrate on the definition, identity and maintenance of the "communities" formed by coral reef species, with little attention devoted to their energetics: few coral reef researchers followed the path opened by the pioneering study of the metabolism of Eniwetak lagoon, published in 1955 by the Odum brothers.

One reason for this may be the lack of a straightforward tool for integrating scattered knowledge on the interactive elements of coral reef ecosystems: simulation modeling, e.g., as brilliantly applied by T.R. McClanahan to coral reef systems, requires formal skills possessed by only few biologists potentially interested in using a formal modeling framework.

This situation changed in the mid-1980s, when J.J. Polovina and coworkers developed the ECOPATH approach and software, and applied this to the description of a coral reef system in the Northern Hawaiian Island, the French Frigate Shoals. This approach, fully described in the present work, does not need restating here. Suffice to say that, while based on a simple "Master Equation" with parameters that are relatively easy to estimate, it allows incorporation, into a formal framework, of the immense amount of single-species data, and on data on species interactions alluded to above.

The creators of this approach — J. Polovina and colleagues for the initial version, V. Christensen and this author for its vastly expanded successor ECOPATH II — earlier attributed the versatility of the ECOPATH approach to the "steady-state" or "equilibrium" assumption that seemed to underlie its Master Equation.

However, this assumption is not necessary for the ECOPATH approach to work. Rather, what is needed is *mass-balance*, i.e., one must not only be able to account for all flows of biomass among the different elements of an ecosystem, during the period being modeled (usually one year), but one should also account for any *difference* in biomass that may occur between the beginning and the end of that period.

Equilibrium or steady-state implies that this difference should be zero — a problem when the system being modeled is known to display interannual changes of biomass. However, recent changes incorporated on the Windows version of ECOPATH (ECOPATH 3.0) not only allow considering between-year changes of biomass (through a term for "biomass accumulated", added to the Master Equation), but also explicitly consider seasonal changes of all biomass and fluxes during an annual production cycle.

These features, along with the explicit consideration of uncertainty on the input values (accommodated through a Monte-Carlo simulation, whose output can be interpreted in a Bayesian context), have given the ECOPATH approach dynamic features that were lacking when Dr. Opitz began the work which led to this document.

The fact that Dr. Opitz could assemble as many biomass and rate estimates as she did, and then establish mass-balance in her models — without recourse to the routines recently developed to assist users of the ECOPATH software — speaks for the depth of understanding she achieved of the energetics of Caribbean coral reef systems, and of the biology of their components.

Indeed, I assume that many future models of coral reef systems — whether constructed using the ECOPATH approach or not — will rely on the biomass and rate estimates obtained by Dr. Opitz, and validated by their "fit" to her model.

I conclude, thus, by congratulating Dr. Opitz for a work destined to be found, much thumbed, on the desk of every would-be modeler of coral reef ecosystems.

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ABSTRACT

Five thermodynamically balanced models of the trophic interactions and organic matter transfer between compartments of a Caribbean coral reef system are presented. Inputs to the models were obtained from published data and from parameter estimates based on multivariate statistics. The models were analyzed using the ECOPATH II program (Version 1.0) of Daniel Pauly, Villy Christensen and coworkers at the International Center for Living Aquatic Resources Management (ICLARM) (in Manila, Philippines) which combines elements of network flow analysis with the steady-state approach of Jeffrey Polovina's original ECOPATH. A single model with 50 boxes, 2 models with 20 boxes and 2 with 11 boxes were constructed, based on two different methods of aggregation. Their features were compared.

These balanced models indicate that coral reef systems are in a "steady-state" or "flow-through equilibrium", when the appropriate spatial and temporal scale is selected. This implies that investigations on reef community structure which relied on a small spatial scale, and which suggest a high degree of stochastic variability may not address issues related to the stability of structures at larger scales.

The models' outputs indicate the existence of short cycles, effectively recycling organic matter within the reef system, with the larger part of net primary production being recycled directly to the detrital pool. Thus, transfer efficiencies between trophic levels are generally low.

Selected outputs of the models were compared with features of the original coral reef system, i.e., unfished segments of the Puerto Rico - Virgin Islands (PRVI) coral reef area and were found to be compatible.

Summary statistics of the models were compared with those of two other coral reefs also modelled using ECOPATH II. The models presented here refer to a large system in terms of biomass and throughput, compared to French Frigate Shoals, Hawaii, and to Bolinao, Philippines. These statistics indicate an intermediate stage of system maturity when compared to the other two systems. Features of the modelled system (degree of piscivory, avoidance, by piscivorous fish, of larger herbivorous reef fish as prey, sediment production by parrotfish) were compared with those of other coral reef systems and were found to be compatible.

A potential fisheries yield of 4 $gm^{-2}year^{-1}$ for unfished segments of the PRVI reef area was estimated from the models' outputs. Present overexploitation of lobsters and conchs in the PRVI area may in part be explained by the strong predation pressure already exerted on these resources in the unexploited system as indicated by the high ecotrophic efficiencies of crustaceans and gastropods.

Possible solutions could be developed or suggested for several methodological problems identified during the modelling process. Also, worthwhile areas of future theoretical and field research were identified:

1. A large number of fish species can effectively be reduced to fewer groups by cluster analysis. Appropriate aggregation parameters are those referring to energetic requirements of a species such as size, activity level and type of food.
2. The impact of predator abundance on predation pressure may be accounted for by introducing a weighting factor, which should be the product of density, mean weight and relative food requirements of a predator.

3. Density estimates from visual censuses, especially for migrating species, such as apex predators, should be divided by the time an individual fish was actually seen during the census. This would lead to more realistic values of "effective" biomass, i.e., a biomass which is related to the carrying capacity of the reef system for this species.

4. Density estimates for small and/or cryptic reef species should be obtained from repeated rotenone or similar samplings.

5. Density estimates for small schooling pelagics are urgently needed and may be obtained by hydroacoustic methods.

6. For the construction of nonfish groups one should, as was done for fishes, start from the species level and define appropriate energetic aggregation criteria by objective selection of ecological variables.

7. For future models, it will be a worthwhile theoretical task to identify objective criteria for the determination of spatial and temporal scales of the system which is to be modelled, to define appropriate system boundaries.

8. More information on diet, food consumption requirements, abundances and growth performance should be obtained for nonfish taxa in the PRVI reef area. This could strongly improve the reliability of the models' output.

9. Information on length-weight data and growth parameters for fish species without interest for fisheries (e.g., very small ones) are needed as well as catch data on a species level or for ecological guilds, i.e., on a generic or family level, for the PRVI reef area.

1. INTRODUCTION

All kinds of superlatives have been used to describe the ecosystem "coral reef", the most famous being "the oasis in the desert", which is related to the high production rates often measured for components of the coral reef community compared to rates measured in the nutrient-poor water masses surrounding coral reefs (Polovina 1984b).

There is general agreement that coral reefs are characterized by three main features: (1) high species diversity; (2) pronounced complexity of relationships within the system community; and (3) high rates of production in usually nutrient- and plankton-poor oceanic waters (see Lewis 1981).

It is hypothesized here that coral reefs can survive under such unfavorable conditions mainly because these three features are interconnected, resulting in an effective recycling and conservation of organic matter within the system. This hypothesis is based on small-scale observations such as the symbiosis between the coral polyps and their symbionts, the "zooxanthellae". Whether this hypothesis applies to an entire coral reef ecosystem unit is, to date, not known. There is further disagreement on the question whether coral reefs may be considered to be in a steady-state, i.e., whether import plus consumption are balanced by production plus respiration for the entire system.

The main objective of this report was to test whether it is possible to construct a thermodynamically balanced model of a Caribbean coral reef system, the assumption being that if such model could be constructed, this would indicate that the coral reef system in question can indeed be considered as being in some form of steady state.

A Caribbean coral reef area was selected as study site for a modelling effort because I became enthralled by these beautiful ecosystems since I have "dived" Caribbean coral reefs in 1983/1984. Another reason was that several Caribbean reef areas have been studied in such detail that enough input data appeared to exist for the creation of a model representative of the larger Caribbean area. My choice of a model of a Caribbean coral reef as a research topic was also influenced by the consideration that tools for proper management of coral reef systems, especially of fisheries resources, are urgently needed.

The whole system approach seems very promising, since it will provide information for conservationists with a holistic claim as well as for fisheries managers concerned with fisheries yields from a small number of target species. Several of these commercially interesting species are already heavily exploited and some show declines in catch/effort although they are reported to be only lightly exploited. Munro (1984), in an unpublished report to the Caribbean Fisheries Management Council (CFMC) "on assessment of the fisheries of Puerto Rico and the U.S. Virgin Islands", attempted to find out why "the reported landings for the Virgin Islands only amount to 5%-13% of the 'norm' (for other Caribbean reef areas) of 5 tonnes km^{-2}". He concluded that "either the landings are greatly underestimated or the fisheries are rather lightly exploited or both". In contrast to this statement, fisheries statistics in CFMC (1984, 1985) showed a decline in landings for target fish species in the Puerto Rico - Virgin Islands (PRVI) area, and contributions in Mahon (1987) reported on the overexploitation of target invertebrates (conchs, lobsters) along with an increasing fishing effort for the same area.

The lack of appropriate data for proper stock assessment is emphasized regularly throughout the relevant literature (see e.g., Munro 1984; Mahon 1987; PDT 1990). Many unpublished reports of investigations and surveys lead a poor life in shelves or drawers; the more lucky ones are distributed through the person-to-person method. Thus, there is a need to pool, check and quantify data scattered over a wide range of formal and informal documentation. The construction of a model is an excellent reason for such compilatory work. By logical combination of the elements of a system, one may obtain new insights in its functioning as a whole and in that of its elements as well.

Holistic steady-state models, in contrast to simulation models, can be parameterized with relatively small expenditure in input data while they may, at the same time, correctly describe properties of the system being modelled (Silvert 1981). In spite of their "simplicity", these models may reflect relevant structures of the system and contribute to its understanding; simultaneously, they may indicate gaps of knowledge and thus identify areas of future practical research. According to Silvert (1981), the "complexity of a model is not in itself a criterion of its quality. The degree of complexity is determined chiefly by its function and the observations it is supposed to describe, not by the internal structure of the system" that is being modelled.

Leontief (1951) developed economic input-output analysis aiming to quantify the amount of raw materials and industrial services required to produce a quantity of consumer goods. Augustinovics (1970) later worked out an inverse analysis where the fate of system inputs is traced to their destination through the economic flow diagram. Hannon (1973) and Finn (1976) were the first to apply these techniques to biological systems.

Network analysis today provides tools for unifying the concepts of food chains, food webs, species richness, diversity, etc., by depicting ecosystems as number of compartments, interconnected by flows of energy or matter from one compartment to another. Wulff et al. (1989) believed that "network flow analysis contains a lot of information about the dynamic structure of a whole system and how it functions".

Network analysis today includes analysis of cycles, through-flows, storages and information theory. Finn (1976) developed an index showing the proportion of the flow in a system that is recycled, relative to total flow. The magnitude of this "cycling index" depends to some extent on the substance used as currency (biomass, carbon, nitrogen, phosphorus, etc.). Ulanowicz (1980, 1986), one of the leading scientists of Working Group 59/73 of the Scientific Committee on Oceanographic Research devoted to "Mathematical Models in Biological Oceanography", (Platt et al. 1981), introduced three indices describing the state of an ecosystem: (1) Total System Throughput, the sum of all flows occurring within a system; (2) Ascendency, a measure of the mutual information content within the system; and which concerns the size of the system as well as diversity of flows; and (3) Development Capacity, a measure of the potential for growth of a system towards maturity.

In network analysis, comparison of two different elements (e.g., species) within a system may be established by defining their relative position in the food web as one plus the weighted mean trophic level of their preys. Conversely, the division of any kind of diet into compartments allows the construction of pyramids (see Lindeman 1942) representing flows and transfer efficiencies between trophic levels. This technique allows intercomparison of ecosystems or comparison of different states of a single system based on the analysis of the food web linking its components.

1.1. The ECOPATH Model

The modelling approach used here was developed by J.J. Polovina (1984a, 1984b, 1984c, 1985, 1986) and Polovina and Ow (1983), named "ECOPATH", was originally designed to estimate standing stock and production budget of an entire coral reef ecosystem, the "French Frigate Shoals", in the Northwestern Hawaiian Islands.

ECOPATH II is derived from the original ECOPATH software. It was considerably enhanced and modified by combining the steady-state approach of the original ECOPATH with techniques derived from network analysis and information theory. ECOPATH II was designed as a tool to produce straightforward equilibrium box models for any kind of aquatic system. The development and updating of ECOPATH II are part of a project funded by the Danish International Development Agency (DANIDA) on "Global Comparisons of Aquatic Ecosystems", executed by Drs. Villy Christensen and Daniel Pauly at the International Center for Living Aquatic Resources Management (ICLARM). Aquatic scientists, spread all around the world, are contributing to this project by applying ECOPATH II to "their" ecosystems. The present report is based on a thesis written as part of this project; therein, ECOPATH II was used to generate five quantitative steady-state models of the trophic interactions in a Caribbean coral reef.

In the following, a short comparative description is given of the theoretical background of inputs required and outputs provided by Polovina and Ow's original ECOPATH and by the ECOPATH II software of Pauly, Christensen and coworkers (Christensen and Pauly 1990a, 1990b; Pauly et al. 1993a). Analyses of models included here were executed with version 1.0 of ECOPATH II. Since version 2.0 of ECOPATH II is distributed together with a comprehensive user's manual (Christensen and Pauly 1991), I advise the reader to consult this manual for additional information on differences between versions 1.0 and 2.0 (see also Christensen and Pauly 1992b for version 2.1 and Christensen and Pauly 1995 and 1996 for ECOPATH 3.0).

1.1.1. Comparative Description of ECOPATH I and ECOPATH II

1.1.1.1. POLOVINA'S ORIGINAL ECOPATH

Theoretical Background

The basic assumption of the original version of the ECOPATH model (termed here ECOPATH I) is that the ecosystem which will be modelled must be under equilibrium conditions, i.e., in a "steady-state". Polovina (1984b) stated that "equilibrium conditions exist when the mean annual biomass for each species (group) does not change from year to year. This assumption results in a system of biomass budget equations which, for each species (group), can be expressed as:

Production of biomass for species (i) - all predation on species (i) - nonpredatory biomass mortality for species (i) = 0 for all (i) **...1.1)**

The ECOPATH model expresses each term in the budget equation as a linear function of the unknown mean annual biomasses (B_i's), so the resulting biomass budget equations become a system of simultaneous equations linear in the B_i's." This system of equations can be expressed in matrix form as AB = 0, where A is an n x n matrix of coefficients, and B is an n-dimensional vector.

Outputs

Outputs of ECOPATH I are: estimates of mean annual biomass, mean annual consumption and mean annual production of each species (group). Additionally, an estimate of necessary net primary production to support the system is computed which may be compared with "external" estimates to validate the model.

Inputs

The inputs required by ECOPATH I (and ECOPATH II) are few compared to, e.g., simulation models. In the following, the inputs necessary to solve the system of biomass budget equations via the ECOPATH I computer program are briefly introduced.

Species Groups

Subsequent to identifying the various components of the ecosystem under study, these may be regrouped into species groups. ECOPATH I allows a maximum input of 20 species (groups). A species group is an aggregation of species with a common physical habitat, similar diet and similar life history characteristics (Polovina 1984b).

Biomass

ECOPATH I is a "top-down model", i.e., the biomasses of the subordinated species (groups) are determined by the biomass (and food consumption) of the apex predator (group). When there is no fishery catch, a biomass estimate for at least one top predator (group) must be provided to produce a unique and nontrivial set of B_i's (i.e., $B_i > 0$) which solves the system of equations. In an ecosystem where there is fishing mortality, the fish catches may be entered instead of an estimate of a species' (group's) biomass to insure a nontrivial solution.

Production/Biomass Ratio (P/B)

Polovina (1984b, 1985) defined production (P) over one year for a cohort of animals as:

$$P = \int_0^1 N_t \frac{d}{dt}(W_t)\, dt \qquad \text{...1.2)}$$

and mean annual biomass (B) for the cohort as:

$$B = \int_0^1 N_t W_t dt \qquad \text{...1.3)}$$

where N_t is the number of animals and W_t the mean individual weight at time t.

Allen (1971) showed that, under equilibrium conditions, for a number of growth and mortality functions, including negative exponential mortality and "von Bertalanffy" growth, the ratio of annual production to mean biomass for a cohort of fish is equal to the annual instantaneous total mortality (Z). When mortality is expressed by a negative exponential function, total species group production (P) is equal to the sum of the production (P_i) of n cohorts (or species) i with annual instantaneous total mortality (Z_i).

In an ecosystem under equilibrium (i.e., under steady state) and where (when) there is very little or no fishing mortality, the P/B ratio of fishes and invertebrates is thus equal to their instantaneous rate of natural mortality (M) (Christensen and Pauly 1991).

Predation Mortality

Predation mortality is the fraction of the biomass of a species group which is consumed by its predator in a given ecosystem. Polovina's ECOPATH model computes this mortality in the same fashion as the PROBUB model by Laevastu and Larkins (1981). Here, two types of information are needed:

Diet Composition Matrix

A diet composition matrix DC_{ij} must be specified, where an entry DC_{ij} from this matrix refers to the proportion of prey j in the diet of predator (or consumer) i. The primary source of this information is the analysis of consumers' stomach contents. Composition of stomach contents may be expressed in percent of total volume, weight or energy contents. Macdonald and Green (1983) showed that the estimation of diet composition is largely unaffected by the units used (volume, weight or energy); on the other hand, "numbers of items" or "occurrence" produce misleading diet compositions, due to the large difference in energy contents between small and large prey items (Pauly 1985, 1986).

Food Required

The second type of information needed to ascertain predation mortality is the food requirements of the predator. Food required (R_i) by a species (group) (i) is expressed as:

$$R_i = b_i B_i + a_i P_i \qquad \text{...1.4)}$$

where B_i is the mean annual species (group) biomass, P_i is the annual production of species (group) i, and a_i and b_i are parameters to be estimated from energetics studies. The component $b_i B_i$ is the food required to maintain the biomass B_i and the component $a_i P_i$ is the food required to support the biomass production P_i (Laevastu and Larkins 1981).

In the original ECOPATH model, the production of species (group) i is $P_i = C_i B_i$, so the food required for species (group) B_i is

$$R_i = b_i B_i + a_i P_i = b_i B_i + a_i C_i B_i = (b_i + a_i C_i) B_i \qquad \text{...1.5)}$$

Thus, the amount of species (group) j consumed by predator species (group) i is given as:

$$R_iDC_{ij} = (b_i + a_iC_i)B_iDC_{ij} \quad \text{...1.6)}$$

Predation mortality consumes generally between 75% and 90% of the populations' production (Ricker 1969; Polovina 1984a, 1984b); a change in predation mortality has little influence on the biomasses of species groups calculated by ECOPATH I, as was shown by Polovina (1984c) by simple sensitivity analysis on the input parameters.

Nonpredation Mortality

All mortality attributable to causes other than predation, such as fishing, spawning and disease, is considered "nonpredation mortality".

Habitat Area

For each species (group) included in ECOPATH I, an estimate of the area of distribution for which the other input values are valid was required. This was not included in ECOPATH II as biomass and flows are easy to adjust to any standard area, without using a special software or routine.

Summary of inputs required for the original version of ECOPATH:

1. number and names of species (groups) considered in the model;
2. at least one biomass estimate of one of the apex predators or its annual fisheries catch;
3. annual fisheries catch (including discard) for all exploited species (groups), or nonpredation mortality (d_iB_i) when there is no fishing;
4. P/B ratio (usually M_i or Z_i) for each species (group);
5. food required to support biomass production (a_iP_i) of each species (group);
6. food required to maintain the biomass (b_iB_i) of each species (group);
7. diet composition DC_{ij} of each species (group); and
8. habitat area of each species (group).

1.1.1.2. ECOPATH II

Theoretical Background

ECOPATH II shares with ECOPATH I its "basic equation" (1.1). This routine balances an equilibrium model using the mass-balance equation:

Consumption + Import = Production + Respiration

where "production" is the sum of "export + mortality due to predation + flow to detritus". Both versions of ECOPATH (I and II) are structured around the feature that, in a balanced system, the consumption of a predator (group) generates the predation mortality of its prey (group/s).

New Features and Outputs

Definitions and Parameter Estimation Routine. In ECOPATH II, the set of simultaneous linear equations, representing an ecosystem, is solved using the "generalized inverse method" (Mackay 1981); this has the advantage that a generalized inverse can be found even if the set of equations is overdetermined (more equations than unknowns) or underdetermined (less equations than unknowns). By linking the species groups into a combined system, the basic routines of ECOPATH I and II allow the estimation of one missing parameter (= unknown) of each species (group). In ECOPATH I, only biomass could be the unknowns, whereas other parameters may be unknown in ECOPATH II (see Christensen and Pauly 1992a, 1992b and further below).

For all consumers of the system, a request was incorporated into ECOPATH II for the percentages of ingestion that are lost due to egestion (feces) and to excretion (urine); values of 15% and 5%, respectively, are provided as defaults, based on Winberg (1956). The entries (or defaults) are subsequently used for the computation of net conversion efficiencies (production/ [ingestion - egestion]) and of flows to the "detritus box". Detritus is derived from nonpredatory "leaks" of organic substance from any trophic level, mainly egestion, excretion and nonpredatory mortality.

ECOPATH II was provided with checks for "i's" that do not balance, i.e., for which production is larger or equal to the amount of food consumed. Gross efficiency (GE = production/consumption) should be < 0.5 for all species (groups). Ecotrophic efficiency (EE), the part of production consumed by predators, was, throughout, a required input in ECOPATH I. It is now either an input or output of ECOPATH II and is used to ascertain that the amount consumed by predators does not surpass production of a species (group). In a balanced system, EE must be ≤ 1.0.

ECOPATH II calculates fractional trophic levels as suggested by Odum and Heald (1975). A routine assigns a trophic level (TL) of 1 to primary producers and detritus and a TL of 1+ (the weighted average of the prey's TL) to consumers.

The concept of "omnivory index" was included into ECOPATH II in 1987 (see Pauly et al. 1993a). It is calculated as the variance of the trophic levels of a consumer's prey groups. When the output value is zero, the consumers in question feed on a single discrete trophic level.

Ivlev's electivity index E_i (Ivlev 1961) is computed by ECOPATH II for each species (group), based on biomasses, not numbers. E_i is scaled so that $E_i = -1$ corresponds to total avoidance, $E_i = 0$ to nonselective feeding, and $E_i = 1$ to exclusive feeding. Since this index is not independent of prey density a further index, the "standardized forage ratio" of Chesson (1983) was incorporated into ECOPATH II. This is independent of prey availability and initially ranged between 0 and 1, with $S_i = 0$ representing avoidance and $S_i = 1$ exclusive feeding. In ECOPATH II, this index has been reexpressed such that it can now range between -1 and 1, and thus allows direct comparison with Ivlev's index of electivity.

Network Flow Indices. A routine for calculating "ascendency" was included in ECOPATH II based on Ulanowicz (1986) as modified by Ulanowicz and Norden (1990). "Ascendency" is a measure of the "average mutual information in a system". It is scaled by system throughput (sum of all flows) and expressed in flowbits (e.g., bit * $gm^{-2} \cdot year^{-1}$ WW). In addition to ascendency and related statistics (overhead, capacity, etc.), holistic properties of ecosystems that can be computed using ECOPATH II are total system throughput and Finn's cycling index

(Finn 1976). The theory leading to these system properties can be found in Ulanowicz (1986) and is further discussed in Christensen and Pauly (1991).

Flows and Transfer Efficiencies. Based on Lindeman (1942), Christensen and Pauly (1990b) provided ECOPATH II with routines to calculate discrete trophic levels and, since an ecosystem is treated as a thermodynamical unit, to calculate flows and transfer efficiencies between trophic levels. The combination of throughput and transfer efficiency of each trophic level allows the construction of solid "trophic pyramids" (see Christensen and Pauly 1992b) representing an entire system; these pyramids can be used for intercomparison of ecosystems.

Mixed Trophic Impacts. This routine allows the computation of direct and indirect impacts which a change in biomass of a predator group will have on other groups in the system, assuming that the diet matrix remains unchanged. This routine, based on Hannon (1973) and Hannon and Joiris (1989), may thus be viewed as a tool for sensitivity analysis.

Aggregation of Boxes. The ascendency and related features of an ecosystem are affected by the number of groups by which the system is represented. An aggregation routine was included into ECOPATH II which allows for reduction of the initial number of boxes to any desired number. This routine identifies, under the constraint of no change in throughput, the pair of "boxes" which, when pooled, least reduce the ascendency of the ecosystem. As shown in Christensen and Pauly (1992b), "pairing" of boxes generally involves groups with low throughputs (at least initially) and having similar trophic levels.

Inputs Required by ECOPATH II

Primary Production (PP). Net primary production (NPP, in the currency of the model, here in $gm^{-2} \cdot year^{-1}$ WW) is not an input for ECOPATH I. However, this is a required input for ECOPATH II, in order to "(1) encourage users to obtain independent, i.e., "external" estimates of a parameter which closely correlates with a number of important characteristics of a system; (2) to allow for validation of internally generated NPP, which should be smaller than or equal to the "external" input value and more importantly; (3) to allow for the difference between observed (= external) and computed (= internal) NPP to be added to the detritus box and thus quantify a linkage important in virtually all ecosystems (i.e., the transfer of uningested, dead phytoplankton and algal biomass to the detrital pool, from where it becomes available to a variety of consumers and/or for burial or export" [Pauly et al. 1993a]).

Detritus Biomass (D). Detritus biomass is not a required input in ECOPATH I, but is needed by ECOPATH II for various computations when detritivores are included in a system, e.g., to compute the "electivity" of detritivores for detritus.

Biomass and/or Ecotrophic Efficiency. Ecotrophic efficiency (EE) is an input of ECOPATH I expressing the fraction of total production consumed by predators (a_iP_i). In ECOPATH II, ecotrophic efficiency must be either entered (when biomass is unknown) or is estimated by the program (when biomass is known and was entered). In ECOPATH II, the fraction 1-EE of production is directed toward the detritus box, from which it may be exported out of the system.

Export and/or Fisheries Catch (C). Export from a species (group) consists of catches and emigration or transport out of the system. Fisheries catch (and/or the quantity killed by fishing and discarded) is required for all exploited species. This input is needed for both versions of ECOPATH in a system of which some elements are exploited.

Production/Biomass Ratio (P/B). The P/B ratio is an input parameter required for ECOPATH I as well as ECOPATH II. As stated above, under certain conditions, the P/B ratio of a population can be set equal to instantaneous total mortality Z (or natural mortality M for an unfished stock). The P/B ratio of primary producers can be estimated either by direct methods (oxygen production, C_{14}, etc.) or if those data are not available, by indirect methods, e.g., empirical equations (Lafontaine and Peters 1986; Pauly et al. 1993a). Mann (1982) provides P/B estimates for various benthic algae and seagrasses.

Food Consumption per Unit Biomass (Q/B). The relative food consumption of a species (group) other than primary producers is required as input parameter by both versions of ECOPATH. Pauly et al. (1993a) defined Q/B as the number of times a population consumes its own weight per year. In ECOPATH I, this input corresponds to the "food required (FR)". Pauly (1986) used the symbols "Q/B" for cases when FR refers "to age-structured populations, i.e., when one must consider the fact that there are, in a natural, steady-state population of fish more young than old fish, and that the former eat (per unit weight) more than the latter" (Pauly et al. 1993a). Methods to calculate Q/B of an age-structured population are described in the "Materials and methods" section.

Diet Composition. The diet composition (DC) is also an input required by both versions of ECOPATH. Only species (groups) occurring within the system may be part of the diet[a] and, at least in ECOPATH II, some species (groups) should feed on detritus, as also happens in reality.

Unassimilated Food. Egestion and excretion refer to parts of ingestion that are not assimilated. The respective fractions can be entered as an optional input if known for a species (group). Default values of 15% and 5%, respectively, are provided by the program based on Winberg (1956).

Summary of Inputs Required for ECOPATH II:

1. one independent estimate of net primary production (NPP);
2. one independent estimate of detritus biomass (D);
3. number of species (groups) considered in the model;
4. biomass (B_i) for each species group or ecotrophic efficiency (EE) when biomass is unknown;
5. export (usually fisheries catch, including discard) for all exploited species [groups]);
6. P/B ratio (usually M_i or Z_i) for each species (group);
7. food consumption per unit biomass (Q/B) for each species (group);
8. diet composition DCij of each species (group); and
9. optional inputs: egestion and excretion (defaults 15% and 5%); the defaults were accepted here throughout.

[a]In recent version of ECOPATH, consumers may also feed on "imports," i.e., items not included in the system.

1.2. Development of the Models

Fig. 1.1 shows a flow chart of the logical development and construction of the five models of a Caribbean coral reef that are presented here.

Starting from the motivation for such a modelling effort, the first step was to formulate an objective, the second to define the size and boundaries of the system which was to be modelled. The next step was the collection and definition of the elements represented in the system. Empirical methods were used to obtain values for the key input parameters of ECOPATH II. The literature was systematically searched for data useful for the composition of a diet matrix, for the estimation of preliminary biomass values and for the computation of vital statistics by empirical methods. After a preliminary set of inputs was prepared, the elements of the system were reduced to 50 species (groups) or "boxes", using a clustering technique.

The reduced set of inputs was entered into ECOPATH II and subsequently modified until the 50-box model was balanced. The final outputs were compared with the initial inputs and discrepancies discussed.

The balanced 50-box model was then reduced to 20-box and 11-box models by two different methods of aggregation. The resulting 20- and 11-box models from both methods were compared. Based on the outputs from all models, the implications of the modelling were discussed.

The number(s) of the section(s), in which the above steps are described, is (are) given in the upper right corner of the boxes in Fig. 1.1.

1.3. Objectives

Summarizing, the main objectives of this report are:

1. to test whether it is possible to construct quantitative steady-state models of the trophic interactions in a Caribbean coral reef;
2. to assess the reliability of such models by comparison of outputs with independent quantitative information on the dynamics of Caribbean and other coral reefs;
3. to possibly identify, describe and quantify presently unknown properties (qualitative and quantitative) of coral reef ecosystems, relevant to their functioning and exploitation by fishing;
4. to identify methodological problems associated with the modelling process and propose solutions to these, e.g., on how to handle the high species diversity on coral reefs, based on various ataxonomical approaches, or on how to deal with migrating species that only spend a fraction of their time on the reef; and
5. to reveal information gaps where additional theoretical and field research is needed.

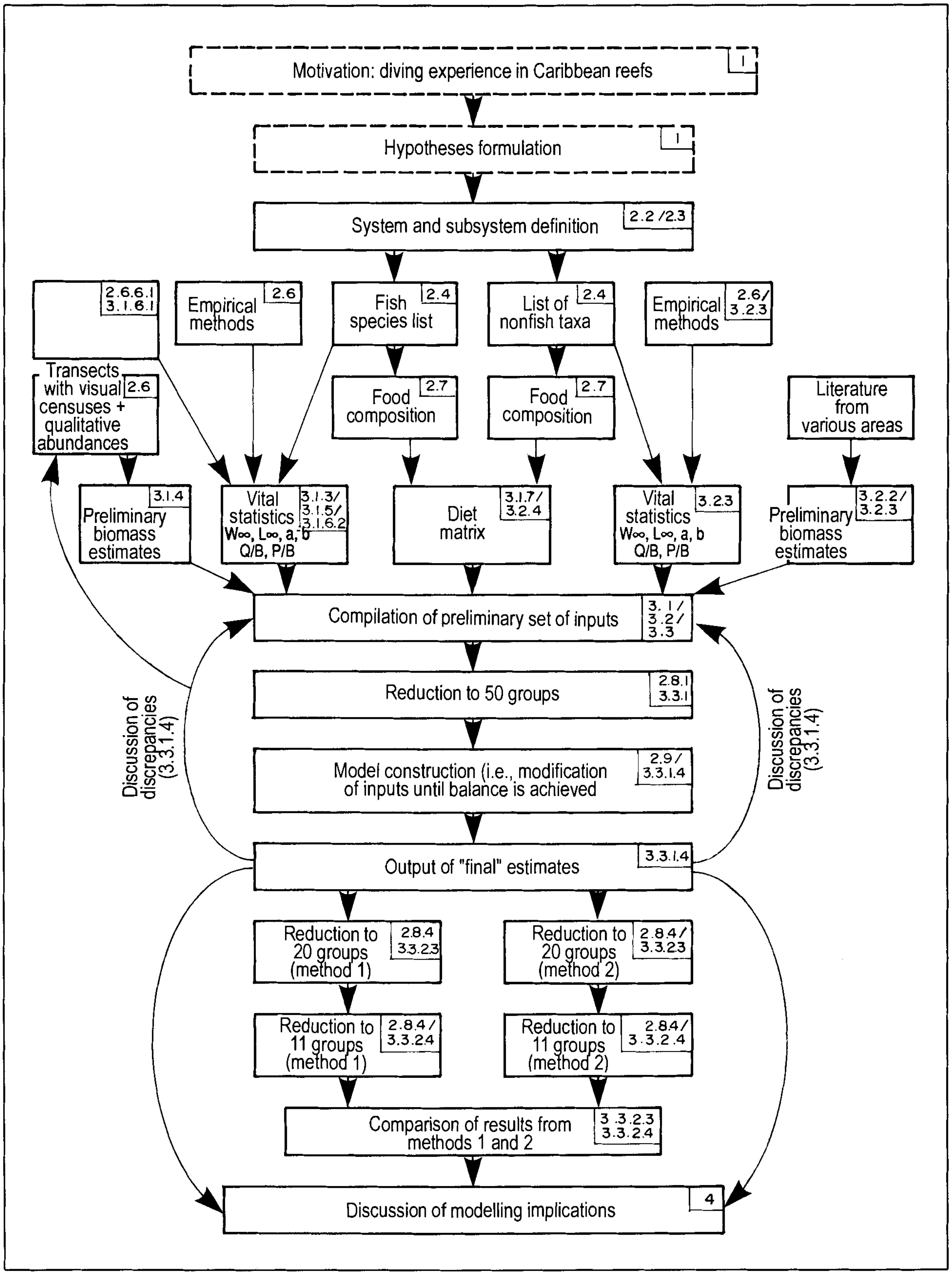

Fig. 1.1. Flow chart showing development and construction of five trophic models of a Caribbean coral reef. The numbers in the upper right corner of the boxes refer to the sections describing the steps.

2. MATERIALS AND METHODS

2.1. Sources of Data

Input data used here for the modelling of a Caribbean coral reef were obtained from published reports and papers and from parameter estimates based on multivariate statistics.

2.2. Choice of Suitable System

The decision to model a Caribbean, rather than an Indo-Pacific reef, was made on the basis of the author's personal SCUBA diving experience in the Caribbean, and because it was assumed that more literature data would be available for the former area.

Within the Caribbean, the Puerto Rico-Virgin Islands (PRVI) shelf complex appears to have been studied in greater detail than any other area, notably with regard to the food habits of fishes (see Randall 1967). Nevertheless, information from other areas had to be considered; wherever possible, data were taken from other areas of the Caribbean. When such data were lacking, literature on Indo-Pacific reefs was consulted, then that covering other tropical areas. Some literature data on various invertebrate groups were also taken from subtropical and temperate areas; in such cases, the relevant rates were always adjusted to the higher temperatures of PRVI area (see section 2.6.6).

2.3. System Boundaries and the Concept of "Subsystems"

The PRVI insular shelf extends over more than 1,000 km^2. The US Virgin Islands of St. Thomas, St. John and St. Croix are surrounded by about 200 km^2, the British Virgin Islands by 343 km^2 and Puerto Rico by 554 km^2 of shelf area. A summary description on topographical features of the PRVI shelf area may be found in Ogden and Gladfelter (1983) and in Jacobsen and Browder (1987).

The coral reefs fringing the Virgin Islands form one of several distinct ecological units that are interconnected through various components and processes. Based on our own independent literature studies, we agree with Jacobsen and Browder's (1987) concept of the shallower part of the reef consisting of distinctive, though interconnected subsystems (Fig. 2.1, Table 2.1).

Six of the seven subsystems of Jacobsen and Browder (1987) were combined here into a modelling "unit" comprising a transect from the water edge (mangrove estuaries) at 0 m depth down to the sand/mudflats at the 100-m contour with the extension of the pelagic subunit reduced to the area overlying the five demersal subunits. The shelf ("break") area below 100 m depth, which Jacobsen and Browder (1987) identified as their seventh subsystem, was not considered here, mainly because of the lack of suitable information (on, e.g., presence of nonfish taxa, abundance of species or feeding relationships), although it might be significant in both ecological and fisheries contexts.

The five demersal units were assumed to comprise each of the same area, i.e., 20% of the total area. This is a rough estimate, but the data in Table 2.1 do not suggest this to be erroneous. The inputs and outputs of biomass, production and consumption for the components of the system were all estimated for an average square meter from the five demersal subsystems and the overlaying pelagic zone.

2.4. System Components

The system was divided into two main components: fish species and nonfish taxa.

2.4.1. Fish Species

Overall, Caribbean reefs support over 500 species of fishes described in specialized texts (Bohlke and Chaplin 1968; Randall 1968, 1983). However, site-specific studies of the PRVI area reported fewer than 500 fish species: Parrish (1982) recorded 130 species on a reef off southwest Puerto Rico; Collette and Talbot (1972) recorded 107 species on a reef off St. John; Clavijo et al. (1980) listed 212 fish species that used reefs off St. Croix as "typical habitat" while adults. Kimmel (1985) identified around 200 fish species on reefs of La Parguera, Puerto Rico.

The more than 200 fish species included in Randall's (1967) study of the food habits of West Indian reef fishes were taken as scaffold for the model. This species list was completed by

Table 2.1. Areal extent of subsystems of the PRVI shelf (based on Jacobsen and Browder 1987).

Subsystem	Location	Area (km^2)
Mangrove estuaries	Puerto Rico (PR)	6.405
	Virgin Islands (VI)	n.s.
Seagrass beds	Culebra (PR)	0.433
	St. Croix (VI)	2.322
Coral reefs	Culebra (PR)	0.923
	Vieques (PR)	0.245
	St. Croix (VI)	3.584
	St. Thomas (VI)	1.901
	St. John (VI)	0.855
Algal plains	Puerto Rico	n.s.
	Virgin Islands	n.s.
Sand/mud	Puerto Rico	n.s.
	Virgin Islands	n.s.
Shelf break	PR and VI	78.000
Pelagic zone	PR and VI	10,900.000

n.s. - not stated.

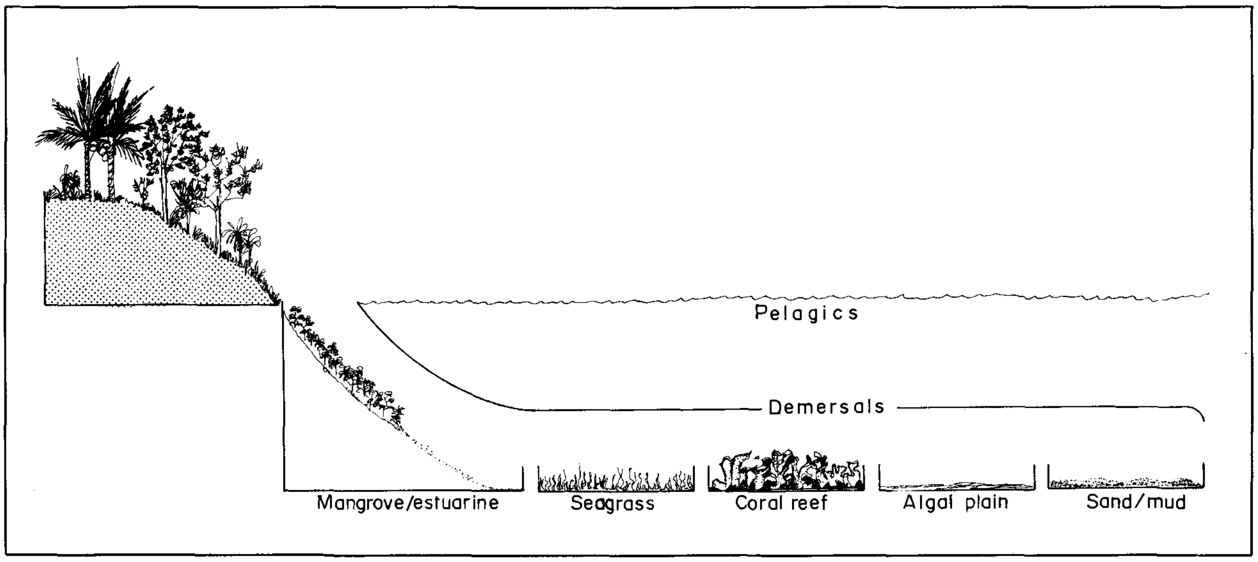

Fig. 2.1. Diagram of conceptual subsystems included in the models (modified from Jacobsen and Browder 1987).

including more fish species with affinities with coral reefs, especially sharks, from Fischer (1978). Table 2.2 lists all the fish species included in the present model.

2.4.2. Nonfish Taxa

The nonfish taxa included in the model consist mainly of groups reported by Randall from fish stomachs, as completed with information from various published sources (Table 2.3). These nonfish taxa comprise different functional groups. The energetic basis of the system is the detrital pool, with particulate organic matter (POM) and dissolved organic matter (DOM) included under the same label. This pool receives all dead organic material, excreta and egesta from the organisms in the system. Conversely, this pool serves as a food source for different detritivores of various levels of organization, e.g., bacteria, worms, crustaceans, finfish (Sorokin 1987).

Autotrophs belong to the next category of organisms. The following primary producers contribute to the reef metabolism (Mann 1982):

1. symbiotic algae, which consist of symbiotic dinoflagellates, called "zooxanthellae", and filamentous chlorophyceans (the former live inside the wall cells of the coral polyps and exchange metabolites directly with the host animal; the latter live attached to the coral skeleton and contribute roughly three times more weight than the former to total organic mass of hermatypic corals [Odum and Odum 1955]);
2. macrophytic brown and red algae;
3. coralline algae;
4. seagrasses (spermatophytes);
5. benthic diatoms; and
6. phytoplankton.

Randall (1967), in his analysis of reef fish stomachs, identified around 150 species of primary producers as food items. A variety of organisms was pooled under the label "decomposers/microfauna". The elements of this group are single-celled heterotrophic organisms such as bacteria, ciliates, foraminiferans, etc. This functional group is, like the detritus pool, of utmost importance for the entire reef metabolism. Through very high turnover rates and the ability to transform dead organic material such that it is reintroduced into the trophic cycle, the decomposer/microfauna group can be viewed as the "motor" of the reef whereas the detritus pool serves as "fuel" (note that this analogy has a problem, since some part of the "motor" is always consumed by the reef community).

As was done with "decomposers/microfauna", various organisms were pooled under the label "zooplankton" (e.g., several crustacean families, jellyfish, eggs and larvae, insects). Benthic invertebrates, sea turtles and birds form the last categories of nonfish groups.

The version of ECOPATH II used for this work did not allow the inclusion of consumers with a P/R ratio > 1.[a] Therefore the symbiotic coral-zooxanthellae-filamentous algae complex was separated into a producer component (the zooxanthellae and filamentous algae, which were grouped with the benthic autotrophs) and a consumer component (the heterotrophic part of the coral polyps).

The models presented here deal exclusively with the organic part of the system, i.e., the inorganic part, such as the skeletons of corals, foraminiferans, worms, etc., are not considered.

[a]Recent version of ECOPATH allows this.

Table 2.2. Fish species included in the ECOPATH II models of a Caribbean coral reef. Species are listed in alphabetical order of families. English and Spanish common names are from Fischer (1978).
*=not included in diet composition matrix.

Family	Species	English common name	Spanish common name
Acanthuridae	*Acanthurus bahianus* Castelnau 1855	Ocean surgeon	*Navajon pardo*
	Acanthurus chirurgus (Bloch 1787)	Doctorfish	*Navajon cirujano*
	Acanthurus coeruleus Bloch & Schneider 1801	Blue tang surgeonfish	*Navajon azul*
Albulidae	* *Albula vulpes* (Linnaeus 1758)	Bonefish	*Macabí*
Antennariidae	*Antennarius multiocellatus* (Cuvier & Valenciennes 1837)	Longlure frogfish	-
	Antennarius striatus (Cuvier 1817)	Splitlure frogfish	-
Apogonidae	*Apogon conklini* (Silvester 1915)	Freckled cardinalfish	-
	Apogon maculatus (Poey 1861)	Flamefish	-
Atherinidae	*Allanetta harringtonensis* (Goode 1877)	Reef silversides	-
	Atherinomorus stipes (Müller & Troschel 1848)	Hardhead silversides	-
Aulostomidae	*Aulostomus maculatus* Valenciennes 1842	Trumpetfish	*Trompeta*
Balistidae	* *Balistes capriscus* Gmelin 1788	Gray triggerfish	*Pejepuerco blanco*
	Balistes vetula Linnaeus 1758	Queen triggerfish	*Pejepuerco cachuo*
	Canthidermis sufflamen (Mitchill 1815)	Ocean triggerfish	-
	Melichthys niger (Bloch 1786)	Black durgon	*Calafate negro*
	* *Xanthichthys ringens* (Linnaeus 1758)	Sargassum triggerfish	-
Belonidae	* *Ablennes hians* (Valenciennes 1846)	Flat needlefish	*Agujon sable*
	Platybelone argalus argalus (LeSueur 1821)	Keeltail needlefish	*Agujon de quilla*
	Strongylura timucu (Walbaum 1792)	Timucu needlefish	*Agujon timuco*
	Tylosurus acus acus (Lacepède 1803)	Agujon needlefish	*Marao ojon*
	Tylosurus crocodilus crocodilus (Peron & LeSueur 1821)	Hound needlefish	*Marao lisero*
Blenniidae	*Entomacrodus nigricans* Gill 1859	Pearl blenny	-
	Ophioblennius atlanticus (Cuvier & Valenciennes 1836)	Redlip blenny	-
	Parablennius marmoreus (Poey 1875)	Seaweed blenny	-
	Scartella cristata (Linnaeus 1758)	Molly miller	-
Bothidae	*Bothus lunatus* (Linnaeus 1758)	Peacock flounder	*Lenguado ocelado*
	Bothus ocellatus (Agassiz 1831)	Eyed flounder	-
Carangidae	* *Alectis ciliaris* (Bloch 1788)	African pomano	*Pampano de hebra*
	Caranx bartholomaei Cuvier 1833	Yellow jack	*Cojínua amarilla*
	* *Caranx crysos* (Mitchill 1815)	Blue runner	*Cojínua negra*
	Caranx latus Agassiz 1831	Horse-eye jack	*Jurel ojon*
	* *Caranx lugubris* Poey 1860	Black jack	*Jurel negro*
	Caranx ruber (Bloch 1793)	Bar jack	*Cojínua carbonera*
	* *Decapterus macarellus* (Cuvier 1833)	Mackerel scad	*Macarela caballa*
	Decapterus punctatus (Cuvier 1829)	Round scad	*Macarela chuparaco*
	* *Elagatis bipinnulatus* (Quoy & Gaimard 1824)	Rainbow runner	*Macarela salmon*
	Oligoplites saurus (Bloch & Schneider 1801)	Atlantic leatherjack	*Zapatero sietecueros*
	Selar crumenophthalmus (Bloch 1793)	Bigeye scad	*Chicharro ojon*
	Seriola dumerili (Risso 1810)	Greater amberjack	*Medregal coronado*

continued...

Table 2.2 continued

Family	Species	English common name	Spanish common name
	* *Seriola rivoliana* Cuvier 1833	Almaco jack	*Medregal limon*
	Trachinotus falcatus (Linnaeus 1758)	Permit	*Pampano palometa*
	Trachinotus goodei Jordan & Evermann 1896	Palometa pompano	*Pampano listado*
Carcharhinidae	*Carcharhinus acronotus* (Poey 1861)	Blacknose shark	*Tiburon amarillo*
	Carcharhinus falciformis (Bibron 1839)	Silky shark	*Tiburon jaqueton*
	Carcharhinus leucas (Valenciennes 1839)	Bull shark	*Tiburon sarda*
	Carcharhinus limbatus (Valenciennes 1839)	Blacktip shark	*Tiburon macuira*
	Carcharhinus longimanus (Lesson 1830)	Oceanic whitetip shark	*Tiburon oceanico*
	Carcharhinus perezi (Poey 1876)	Caribbean reef shark	*Tiburon coralino*
	Galeocerdo cuvier (LeSueur 1822)	Tiger shark	*Tintorera, Alecrin*
	Negaprion brevirostris (Poey 1868)	Lemon shark	*Tiburon galano*
	Rhizoprionodon porosus (Poey 1861)	Caribbean sharpnose shark	*Cazon playon*
Chaetodontidae	*Chaetodon aculeatus* (Poey 1860)	Longsnout butterflyfish	-
	Chaetodon capistratus Linnaeus 1758	Foureye butterflyfish	-
	* *Chaetodon ocellatus* Bloch 1787	Spotfin butterflyfish	-
	Chaetodon sedentarius Poey 1860	Reef butterflyfish	-
	Chaetodon striatus Linnaeus 1758	Banded butterflyfish	-
Cirrithidae	*Amblycirrhitus pinos* (Mowbray 1927)	Redspotted hawkfish	-
Clinidae	*Labrisomus guppyi* Norman	Shadow blenny	-
	Labrisomus nuchipinnis (Quoy & Gaimard 1824)	Hairy blenny	-
Clupeidae	*Harengula clupeola* (Cuvier 1829)	False pilchard, f. herring	*Sardineta escamuda*
	Harengula humeralis (Cuvier 1829)	Red-ear sardine	*Sardineta de lay* **
	Jenkinsia lamprotaenia (Gosse 1851)	Dwarf herring	*Sardineta canalerita*
	Opisthonema oglinum (LeSueur 1818)	Atlantic thread herring	*Machuelo hebra atlantico*
	* *Sardinella aurita* Valenciennes 1847	Round sardinella	*Sardinela atlantica*
Congridae	*Heteroconger halis* Böhlke 1957	Garden eel	-
Dactylopteridae	*Dactylopterus volitans* (Linnaeus 1758)	Flying gurnard	*Alon*
Dasyatidae	*Dasyatis americana* Hildebrand & Schroeder 1928	Southern stingray	*Raya latigo americana*
Diodontidae	*Chilomycterus antennatus* (Cuvier 1818)	Bridled burrfish	-
	* *Chilomycterus antillarum* Jordan & Rutter 1897	Web burrfish	-
	Diodon holocanthus Linnaeus 1758	Spiny puffer	-
	Diodon hystrix Linnaeus 1758	Porcupinefish	*Pejerizo comun*
Elopidae	* *Elops saurus* Linnaeus 1776	Ladyfish	*Malacho*
Emmelichthyidae	*Inermia vittata* Poey 1861	Boga	-
Engraulidae	*Anchoa hepsetus* (Linnaeus 1758)	Striped anchovy	*Anchoa legitima*
	Anchoa lyolepis (Evermann & Marsh 1902)	Dusky anchovy	*Anchoa trompalarga*
Ephippidae	*Chaetodipterus faber* (Broussonet 1782)	Atlantic spadefish	*Paguala*
Fistulariidae	*Fistularia tabacaria* Linnaeus 1758	Cornetfish	-
Gerreidae	*Eucinostomus argenteus* Baird & Girard 1854	Silver mojarra; spotfin mojarra	*Mojarrita plateada*
	Gerres cinereus (Walbaum 1792)	Yellowfin mojarra	*Mojarra blanca*
Ginglymostomatidae	*Ginglymostoma cirratum* (Bonnaterre 1783)	Nurse shark	*Gata atlantica*
Gobiidae	* *Bathygobius soporator* (Cuvier & Valenciennes 1837)	Frillfin goby	-

continued...

Table 2.2 continued

Family		Species	English common name	Spanish common name
		Coryphopterus glaucofraenum Gill 1863	Bridled goby	-
		Gnatholepis thompsoni Jordan 1902	Goldspot goby	-
		Gobiosoma evelynae Böhlke & Robins 1968	Sharknose goby	-
Grammidae		*Gramma loreto* Poey 1868	Fairy basslet	-
		Gramma melacara Böhlke & Randall 1963	Blackcap basslet	-
Grammistidae		*Rypticus saponaceus* (Bloch & Schneider 1801)	Greater soapfish	*Jabonero*
Haemulidae		*Anisotremus surinamensis* (Bloch 1791)	Black margate	*Burro pompon*
		Anisotremus virginicus (Linnaeus 1758)	Porkfish	*Burro catalina*
		Haemulon album Cuvier 1829	White margate	*Ronco blanco*
		Haemulon aurolineatum Cuvier 1829	Tomtate grunt	*Ronco jeniguano*
	*	*Haemulon bonariense* Cuvier 1829	Black grunt	*Ronco rayado*
		Haemulon carbonarium Poey 1860	Caesar grunt	*Ronco carbonero*
		Haemulon chrysargyreum Günther 1859	Smallmouth grunt	*Ronco boquilla*
		Haemulon flavolineatum (Desmarest 1823)	French grunt	*Ronco amarillo*
		Haemulon macrostomum Günther 1859	Spanish grunt	*Ronco caco*
	*	*Haemulon melanurum* (Linnaeus 1758)	Cottonwick grunt	*Ronco mapurite*
		Haemulon parrai (Desmarest 1823)	Sailor's grunt: sailor's choice	*Ronco plateado*
		Haemulon plumieri (Lacepede 1802)	White grunt	*Ronco margariteno*
		Haemulon sciurus (Shaw 1803)	Bluestriped grunt	*Ronco catire*
	*	*Pomadasys corvinaeformis* (Steindachner 1868)	Roughneck grunt	*Corocoro gris*
	*	*Pomadasys crocro* (Cuvier 1830)	Burro grunt	*Corocoro crocro*
Hemiramphidae		*Hemiramphus balao* LeSueur 1823	Balao halfbeak	*Agujeta balaju*
		Hemiramphus brasiliensis (Linnaeus 1758)	Ballyhoo halfbeak	*Agujeta brasilena*
	*	*Hyporamphus unifasciatus* (Ranzani 1842)	Common halfbeak	*Agujeta blanca*
Holocentridae		*Holocentrus ascensionis* (Osbeck 1765)	Longjaw squirrelfish	*Candil gallito*
		Holocentrus coruscus (Poey 1860)	Reef squirrelfish	-
		Neoniphon marianus (Cuvier & Valenciennes 1829)	Squirrelfish ?	-
		Holocentrus rufus (Walbaum 1792)	Longspine squirrelfish	*Candil soldado*
		Sargocentron vexillarium (Poey 1860)	Dusky squirrelfish	-
		Myripristis jacobus Cuvier 1829	Blackbar soldierfish	*Candil colorado*
	*	*Plectyprops retrospinis* (Guichenot 1853)	Cardinal soldierfish	-
Kyphosidae		*Kyphosus incisor* (Cuvier 1831)	Yellow sea chub	*Chopa amarilla*
		Kyphosus sectatrix (Linnaeus 1758)	Bermuda sea chub	*Chopa blanca*
Labridae		*Bodianus rufus* (Linnaeus 1758)	Spanish hogfish	*Vieja colorada*
		Clepticus parrae (Bloch & Schneider 1801)	Creole wrasse	-
		Halichoeres bivittatus (Bloch 1791)	Slippery dick	-
		Halichoeres garnoti (Cuvier & Valenciennes 1839)	Yellowhead wrasse	-
		Halichoeres maculipinna (Müller & Troschel 1848)	Clown wrasse	-
		Halichoeres poeyi (Steindachner 1867)	Black-ear wrasse	-
		Halichoeres radiatus (Linnaeus 1758)	Pudding wife (wrasse)	*Doncella arco-iris*
		Xyrichtys novacula (Linnaeus 1758)	Pearly razorfish	*Doncella cuchilla*
		Xyrichtys splendens (Castelnau 1855)	Green razorfish	-
		Lachnolaimus maximus (Walbaum 1792)	Hogfish	*Doncella de pluma*

continued...

Table 2.2 continued

Family		Species	English common name	Spanish common name
		Thalassoma bifasciatum (Bloch 1791)	Bluehead	-
Lutjanidae		*Lutjanus analis* (Cuvier 1828)	Mutton snapper	*Pargo criollo*
		Lutjanus apodus (Walbaum 1792)	Schoolmaster (snapper)	*Pargo amarillo*
		Lutjanus cyanopterus (Cuvier 1828)	Cubera snapper	*Pargo cubera*
		Lutjanus griseus (Linnaeus 1758)	Gray snapper	*Pargo prieto*
		Lutjanus jocu (Bloch & Schneider 1801)	Dog snapper	*Pargo jocu*
		Lutjanus mahagoni (Cuvier 1828)	Mahagony snapper	*Pargo ojon*
		Lutjanus synagris (Linnaeus 1758)	Lane snapper	*Pargo biajaiba*
		Ocyurus chrysurus (Bloch 1791)	Yellowtail snapper	*Rabirubia*
Malacanthidae		*Malacanthus plumieri* (Bloch 1786)	Sand tilefish	*Matajuelo*
Megalopidae		*Tarpon atlanticus* (Valenciennes 1846)	Tarpon	*Tarpon*
Monacanthidae		*Aluterus schoepfii* (Walbaum 1792)	Orange filefish	*Cachua perra*
		Aluterus scripta (Osbeck 1765)	Scrawled filefish	-
		Cantherines macroceros (Hollard 1854)	Whitespotted filefish	-
		Cantherines pullus (Ranzani 1842)	Orangespotted filefish	*Lija pintada*
		Monacanthus ciliatus (Mitchill 1818)	Fringed filefish	*Lija de clavo*
	*	*Monacanthus tuckeri* Bean 1906	Slender filefish	-
	*	*Stefanolepis setifer* (Bennett 1830)	Pygmy filefish	*Lija de hebra*
Mugilidae		*Mugil curema* Valenciennes 1836	White mullet	*Lisa criolla*
Mullidae		*Mulloidichthys martinicus* (Cuvier 1829)	Yellow goatfish	*Salmonete amarillo*
		Pseudupeneus maculatus (Bloch 1793)	Spotted goatfish	*Salmonete manchado*
Muraenidae		*Echidna catenata* (Bloch 1795)	Chain moray	-
	*	*Enchelycore nigricans* (Bonnaterre 1788)	Viper moray	*Morena negra*
	*	*Gymnothorax funebris* (Ranzani 1840)	Green moray	*Morena congrio*
		Lycodontis moringa (Cuvier 1829)	Spotted moray	*Morena pintada*
		Gymnothorax vicinus (Castelnau 1855)	Purplemouth moray	*Morena amarilla*
	*	*Gymnothorax miliaris* (Kaup 1856)	Goldentail moray	*Morena dorada*
Myliobatidae		*Aetobatus narinari* (Euphrasen 1790)	Spotted eagle ray	*Chucho pintado*
Ogcocephalidae		*Ogcocephalus nasutus* (Cuvier & Valenciennes 1837)	Redbellied batfish	-
Ophichthidae		*Myrichthys breviceps* (Gronow 1854)	Sharptail eel	-
		Myrichthys ocellatus (Kaup 1856)	Goldspotted snake eel	-
		Ophichthus ophis (Linnaeus 1758)	Spotted snake eel	*Tieso pintado*
Opisthognathidae		*Opisthognatus aurifrons* (Jordan & Thompson 1905)	Yellowhead jawfish	-
	*	*Opisthognatus macrognathus* Poey 1860	Longjaw jawfish	-
		Opisthognatus maxillosus Poey 1860	Mottled jawfish	-
		Opisthognatus whitehurstii (Longley 1931)	Dusky jawfish	-
Ostraciidae		*Acanthostracion polygonius* Poey 1876	Honeycomb cowfish	-
		Acanthostracion quadricornis (Linnaeus 1758)	Scrawled cowfish	*Torito azul*
		Lactophrys trigonus (Linnaeus 1758)	Buffalo trunkfish	*Chapin bufalo*
		Lactophrys bicaudalis (Linnaeus 1758)	Spotted trunkfish	*Chapin pintado*
		Lactophrys triqueter (Linnaeus 1758)	Smooth trunkfish	*Chapin baqueta*
Pempheridae		*Pempheris schomburgki* Müller & Troschel 1848	Copper sweeper	-
	*	*Pempheris poeyi* Bean 1885	Shortfin sweeper	-

continued...

Table 2.2 continued

Family	Species	English common name	Spanish common name
Pomacanthidae	*Centropyge argi* Woods & Kanazawa 1951	Cherubfish	-
	Holacanthus ciliaris (Linnaeus 1758)	Queen angelfish	*Isabelita patale*
	Holacanthus tricolor (Bloch 1795)	Rock beauty	*Isabelita medioluto*
	Pomacanthus arcuatus (Linnaeus 1758)	Gray angelfish	*Cachama blanca*
	Pomacanthus paru (Bloch 1787)	French angelfish	*Cachama negra*
Pomacentridae	*Abudefduf saxatilis* (Linnaeus 1758)	Sergeant major	*Petaca rayada*
	Abudefduf taurus (Müller & Troschel 1848)	Night sergeant	*Petaca rezobada*
	Chromis cyanea (Poey 1860)	Blue chromis	-
	Chromis multilineata (Guichenot 1853)	Brown chromis	*Jaqueta parda*
	Microspathodon chrysurus (Cuvier & Valenciennes 1830)	Yellowtail damselfish	*Jaqueta rabo amarillo*
	Stegastes fuscus (Cuvier 1830)	Dusky damselfish	-
	Stegastes leucostictus (Müller & Troschel 1848)	Beau gregory	-
	Stegastes planifrons (Cuvier 1830)	Yellow damselfish	-
	Stegastes variabilis (Castelnau 1855)	Cocoa damselfish	-
Priacanthidae	*Priacanthus arenatus* Cuvier in Cuvier & Valenciennes 1829	Atlantic bigeye	*Catalufa toro*
	Heteropriacanthus cruentatus (Lacepède 1802)	Glasseye	*Catalufa de roca*
Rachycentridae	* *Rachycentron canadum* (Linnaeus 1766)	Cobia	*Cobie*
Scaridae	*Scarus coelestinus* Valenciennes in Cuvier & Valenciennes 1839	Midnight parrotfish	*Loro negro*
	* *Scarus coeruleus* (Bloch 1786)	Blue parrotfish	*Loro azul*
	Scarus iserti Bloch 1790	Striped parrotfish	*Loro rayado*
	Scarus guacamaia Cuvier 1831	Rainbow parrotfish	*Loro guacamayo*
	Scarus taeniopterus Desmarest 1831	Princess parrotfish	*Loro listado*
	Scarus vetula Bloch & Schneider 1801	Queen parrotfish	*Loro perico*
	Sparisoma aurofrenatum Valenciennes in Cuvier & Valenciennes 1839	Redband parrotfish	*Loro manchado*
	Sparisoma chrysopterum (Bloch & Schneider 1801)	Redtail parrotfish	*Loro verde*
	Sparisoma radians Valenciennes in Cuvier & Valenciennes 1839	Bucktooth parrotfish	-
	Sparisoma rubripinne Valenciennes in Cuvier & Valenciennes 1839	Redfin parrotfish	*Loro basto*
	Sparisoma viride (Bonnaterre 1788)	Stoplight parrotfish	*Loro viejo*
Sciaenidae	*Equetus lanceolatus* (Linnaeus 1758)	Jackknife fish	-
	Equetus punctatus (Bloch & Schneider 1801)	Spotted drum	-
	Odontoscion dentex (Cuvier 1830)	Reef croaker	*Bombache de roca*
	Pareques acuminatus (Bloch & Schneider 1801)	Cubbyu	-
Scombridae	*Euthynnus alletteratus* (Rafinesque 1810)	Little tunny	*Bacoreta*
	Scomberomorus cavalla (Cuvier 1829)	King mackerel	*Carite lucio*
	Scomberomorus regalis (Bloch 1793)	Cero	*Carite chinigua*
Scorpaenidae	*Scorpaena brasiliensis* Cuvier 1829	Barbfish	-
	Scorpaena grandicornis Cuvier 1829	Grass scorpionfish	-
	Scorpaena inermis Cuvier 1829	Mushroom scorpionfish	-
	Scorpaena plumieri Bloch 1789	Spotted scorpionfish	*Rascacio negro*
	Scorpaenodes caribbaeus Meek & Hildebrand 1928	Reef scorpionfish	-
Serranidae	*Alphestes afer* (Bloch 1793)	Mutton hamlet	*Guaseta*
	Cephalopholis cruentata Lacepède 1802	Grasby (seabass)	*Cherna enjambre*
	Cephalopholis fulva (Linnaeus 1758)	Coney (seabass)	*Cherna cabrilla*

continued...

Table 2.2 continued

Family	Species	English common name	Spanish common name
	* *Diplectrum formosum* (Linnaues 1758)	Sand seabass; sand perch	*Serrano arenero*
	Epinephelus adscensionis (Osbeck 1771)	Rock hind	*Mero cabrilla*
	Epinephelus guttatus (Linnaeus 1758)	Red hind	*Mero colorado*
	Epinephelus itajara (Lichtenstein 1822)	Giant grouper; jewfish	*Mero guasa*
	* *Epinephelus morio* (Valenciennes 1828)	Red grouper	*Mero americano*
	Epinephelus striatus (Bloch 1792)	Nassau grouper	*Cherna criolla*
	Hypoplectrus aberrans (Poey 1868)	Yellowbellied hamlet	-
	Hypoplectrus chlorurus (Valenciennes 1828)	Yellowtail hamlet	-
	Hypoplectrus nigricans (Poey 1852)	Black hamlet	-
	Hypoplectrus puella (Cuvier 1828)	Barred hamlet	-
	Mycteroperca bonaci (Poey 1861)	Black grouper	*Cuna bonaci*
	* *Mycteroperca interstitialis* (Poey 1861)	Yellowmouth grouper	*Cuna amarilla*
	* *Mycteroperca rubra* (Bloch 1793)	Comb grouper	*Cuna negra*
	Mycteroperca tigris (Valenciennes 1833)	Tiger grouper	*Cuna gata*
	Mycteroperca venenosa (Linnaeus 1758)	Yellowfin grouper	*Cuna de piedra*
	Paranthias furcifer (Valenciennes 1828)	Creole fish	*Cuna lucero*
	* *Serranus tabacarius* (Cuvier 1829)	Tobacco fish	-
	Serranus tigrinus (Bloch 1790)	Harlequin bass	-
	• *Serranus tortugarum* Longley 1935	Chalk bass	-
Sparidae	*Archosargus rhomboidalis* (Linnaeus 1758)	Western Atlantic seabream	*Sargo amarillo*
	Calamus bajonado (Bloch & Schneider 1801)	Jolthead porgy	*Pluma bajonado*
	Calamus calamus (Valenciennes 1830)	Saucereye porgy	*Pluma calamo*
	Calamus pennatula Guichenot 1868	Pluma porgy	*Pluma plumilla*
	Diplodus argentus caudimacula (Poey 1861)	Silver porgy	*Sargo fino*
Sphyraenidae	*Sphyraena barracuda* (Walbaum 1792)	Great barracuda	*Picuda barracuda*
	Sphyraena picudilla (Poey 1860)	Southern sennet	*Picuda china*
Sphyrnidae	*Sphyrna lewini* (Cuvier, Griffith & Smith 1834)	Scalloped hammerhead	*Cornuda comun*
	Sphyrna tiburo (Linnaeus 1758)	Bonnethead	*Cornuda de corona*
Synodontidae	*Synodus foetens* (Linnaeus 1766)	Galliwasp	-
	Synodus intermedius (Agassiz 18??)	Sand diver	-
	Synodus synodus (Linnaeus 1758)	Rockspear	-
Tetraodontidae	*Canthigaster rostrata* (Bloch 1782)	Sharpnose puffer	-
	Sphoeroides spengleri (Bloch 1785)	Bandtail puffer	*Tamboril collarete*
Triakidae	*Mustelus canis* (Mitchill 1815)	Smooth dogfish	*Musola dentuda*

Table 2.3. Nonfish taxa included in the ECOPATH II models of a Caribbean coral reef (from stomach content analyses of West Indian reef fishes by Randall 1967).
D = detritus, A = autotroph, I = invertebrate, R = reptile, B = bird

ID		Taxon	Remarks
D	1	Detritus	Dead particulate and dissolved organic matter
A	1	Benthic algae	See section 2.4.2 and Appendix Table 8.5.1
A	2	Spermatophytes	See Appendix Table 8.5.1
A	3	Phytoplankton	Pelagic primary producers
I	1	Microfauna	Bacteria, Foraminifera
I	2	Zooplankton	See Appendix Table 8.5.3
I	3	Sponges	See Appendix Table 8.5.2
I	4	Fire corals	Millepora, Hydrozoa (see section 2.4.2 and Appendix Table 8.5.2)
I	5	Sea fans	Gorgonacea, Octocorallia, Anthozoa (see section 2.4.2 and Appendix Table 8.5.2)
I	6	Sea anemones	Actiniaria and Zoanthidea, Hexacorallia, Anthozoa (see section 2.4.2 and Appendix Table 8.5.2)
I	7	Stony corals	Scleractinia, Octocorallia, Anthozoa (see section 2.4.2 and Appendix Table 8.5.2)
I	8	Bryozoans	See Appendix Table 8.5.2
I	9	Sipunculids	Worms (see Appendix Table 8.5.2)
I	10	Priapuloids	Worms (see Appendix Table 8.5.2)
I	11	Chitons	Mollusca (see Appendix Table 8.5.2)
I	12	Gastropods	Mollusca (see Appendix Table 8.5.2)
I	13	Bivalves	Mollusca (see Appendix Table 8.5.2)
I	14	Scaphopods	Mollusca (see Appendix Table 8.5.2)
I	15	Squids	Mollusca (see Appendix Table 8.5.2)
I	16	Octopuses	Mollusca (see Appendix Table 8.5.2)
I	17	Polychaetes	Worms (see Appendix Table 8.5.2)
I	18	Echiuroids	Worms (see Appendix Table 8.5.2)
I	19	Pycnogonids	Arthropoda, Arachnidea (see Appendix Table 8.5.2)
I	20	Barnacles	Cirripedia, Crustacea (see Appendix Table 8.5.2)
I	21	Stomatopods	Crustacea (see Appendix Table 8.5.2)
I	22	Amphipods	Crustacea (see Appendix Table 8.5.2)
I	23	Tanaids	Crustacea (see Appendix Table 8.5.2)
I	24	Isopods	Crustacea (see Appendix Table 8.5.2)
I	25	Shrimps	Natantia, Crustacea (see Appendix Table 8.5.2)
I	26	Spiny lobsters	Panuliridae, Crustacea (see Appendix Table 8.5.2)
I	27	Scyllarid lobsters	Crustacea (see Appendix Table 8.5.2)
I	28	Hermit crabs	Diogenidae, Crustacea (see Appendix Table 8.5.2)
I	29	Crabs	Reptantia, Crustacea (see Appendix Table 8.5.2)
I	30	Hemichordates	Wormlikes (see Appendix Table 8.5.2)
I	31	Starfish	Asteroidea, Echinodermata (see Appendix Table 8.5.2)
I	32	Brittle stars	Ophiuroidea, Echinodermata (see Appendix Table 8.5.2)
I	33	Sea urchins	Echinoidea, Echinodermata (see Appendix Table 8.5.2)
I	34	Sea cucumbers	Holothuroidea, Echinodermata (see Appendix Table 8.5.2)
I	35	Ascidians	Tunicata, Chordata (see Appendix Table 8.5.2)
R	1	Sea turtles	See Appendix Table 8.5.2
B	1	Sea birds	See Polovina (1984b)

A complete list of reported nonfish food items from stomachs of West Indian reef fishes is to be found in Appendix 5.1 for benthic algae and spermatophytes; in Appendix 5.2 for invertebrates and sea turtles; and in Appendix 5.3 for items that are part of the "zooplankton" group.

2.5. Fishing Activities

To simplify the modelling work and to reduce data requirements, an unexploited system was assumed. Since data from a large geographical range had to be used, especially for the nonfish taxa, the resulting model largely reflects a "virtual" system the description of which would not necessarily be improved by inclusion of fisheries catch data from a specific area. Moreover, even if this had have been attempted, it would have been extremely difficult to obtain catch data for individual species - except for certain commercial species of the Serranidae and Lutjanidae families.

The ecosystem described here can thus be seen as representing unfished areas of the PRVI shelf and may therefore be directly compared with the unexploited French Frigate Shoals reef ecosystem described by Polovina (1984a,b,c, 1985, 1986) and Polovina and Ow (1983).

2.6. Methods and Data Used for the Computation of Input Parameters Required for ECOPATH II

2.6.1. Growth Parameter Estimation

For the computation of several input parameters of ECOPATH II (e.g., Q/B, M), growth parameters had to be estimated for most of the fish and invertebrates included in the model. Growth of fish was generally assumed to follow the von Bertalanffy growth function (VBGF) expressed for growth in length as:

$$L_t = L_\infty\left(1 - e^{-K(t-t_0)}\right) \qquad \text{...2.1)}$$

where L_t is the length at age t, L_∞ the asymptotic length, K is the growth coefficient ($year^{-1}$) and t_0 the theoretical "age" at length zero (Pauly 1984). Growth in weight is defined as:

$$W_t = W_\infty\left(1 - e^{-K(t-t_0)}\right)^b \qquad \text{...2.2)}$$

where W_t is the weight at age t, W_∞ the asymptotic weight and b is the exponent of a length-weight relationship of the form:

$$W = aL^b \qquad \text{...2.3)}$$

When only one pair of L, W value was available, the value of b was set equal to 3, and the relationship was used to estimate the multiplicative factor required in equation 2.3.

$$a = W / L^3 \qquad \text{...2.4)}$$

2.6.1.1. ASYMPTOTIC SIZES

For the majority of fish species considered in the model, size-at-age or length-frequency data were not available from which L_∞ or W_∞ could be estimated. Therefore, asymptotic sizes were estimated from the reported maximum sizes (L_{max} or W_{max}) using the relationships (Pauly 1984):

$$L_{max} / 0.95 \approx L_\infty \quad \text{...2.5)}$$

$$W_{max} / 0.86 \approx W_\infty \quad \text{...2.6)}$$

2.6.1.2. GROWTH COEFFICIENT K

Estimates of the growth coefficient K of the VBGF were obtained directly from published sources or via the equation

$$\log_{10}K = \phi' - 2\log_{10}L_\infty \quad \text{...2.7)}$$

for length and

$$\log_{10}K = \phi - 0.67\log_{10}W_\infty \quad \text{...2.8)}$$

for weight. The required estimates of ϕ' and ϕ were generally obtained from the means of several values of

$$\phi' = \log_{10}K + 2\log_{10}L_\infty\text{, and} \quad \text{...2.9)}$$

$$\phi = \log_{10}K + 0.67\log_{10}W_\infty \quad \text{...2.10)}$$

where K, L_∞ and W_∞ are growth parameter estimates for various populations of the same species (Pauly 1979a; Pauly and Munro 1984; Pauly 1985). This approach which, strictly speaking, should be used only within species was used here between species (generally of the same genus) when these were similar in shape and habits.

2.6.1.3. ESTIMATION OF t_0

For all cases considered here, rough estimates of t_0 were obtained via an empirical model by Pauly (1979a) of the form:

$$\log_{10}(-t_0) \approx -0.39 - 0.28\log_{10}L_\infty - 1.04\log_{10}K \quad \text{...2.11)}$$

with L_∞ as the asymptotic length in cm (total length) and K the growth coefficient of the species considered, expressed in year^{-1}. This parameter has little influence on the estimation of Q/B (see Pauly 1986), the only use for which it was required here.

2.6.2. Habitat and Abundances

2.6.2.1. FISH SPECIES

Ecological information on feeding areas, shelter, time of activity, schooling behavior, etc., as well as information on abundance of Caribbean reef fishes were assembled from various published sources (e.g., Randall 1967, 1968; Jacobsen and Browder 1987). An attempt was made to classify information on spatial occurrence according to the subsystems defined in Fig. 2.1. Qualitative abundances were grouped applying the scale presented in Table 2.4.

Category "E" was considered here because some of the species for which growth data and/or other information were available, while not occurring in the PRVI area, do occur in other areas of the Caribbean and thus might be useful for others who might wish to construct models of other areas of the Caribbean.

Table 2.4. Qualitative abundance levels as used to estimate average density (Nm^{-2}) of fish species included in the models.[a]

Abundance level		Remarks	Nm^{-2}
V	Very abundant	Usually seen in large numbers	5.00000
A	Abundant	Usually seen in some numbers	0.50000
C	Common	Usually seen	0.05000
F	Fairly common	Seen about half of the time	0.00500
O	Occasional	Usually not seen	0.00050
R	Rare	Very unlikely	0.00005
E	Absent	(see text)	0.00000

[a]As assessed following comparison of various scales (see text).

To reexpress qualitative statements about abundances into numerical values, the following procedure was applied: A series of six published sets of numerical abundances from visual censuses and from rotenone stations carried out in the PRVI area (Jacobsen and Browder 1987) was transformed and ranked. Every list was treated separately since many fish species occurred in several lists. Furthermore, it was important to check whether the whole range of abundances was covered by the majority of the sets, and whether their respective rankings differed markedly. A parallel listing of the sets revealed, when a $\log_{10}$ scale was applied, that the whole range of abundance values (from $1.3 * 10^{-6}$ Nm^{-2} to $8.4 * 10^{-1}$ Nm^{-2}) could be covered by six levels of abundance. The last column in Table 2.4 presents an average density value in Nm^{-2} for each abundance level. This average density was computed as the mean of the corresponding subrange. Density values refer to an average·m^2 for the five subsystems considered here.

Qualitative abundances from several sources (e.g., Clavijo et al. 1980; Randall 1983; Jacobsen and Browder 1987) were transferred one level downward so they would correspond to the new scale, as suggested by a comparison of visual census figures with qualitative abundances data, for a variety of species for which both estimates were available. This transfer had the disadvantage that the qualitative definitions of the different abundance levels did not completely overlap. However, for the present application, it appeared more important to obtain a consistent scale for all data sets.

When several estimates of abundance were available for the same species, a selection was made according to three hierarchical levels:

a. data (individuals m^{-2}) from visual censuses or rotenone stations, by subsystems;
b. qualitative abundances from tables in Jacobsen and Browder (1987) based on published visual census figures; and
c. qualitative abundances derived from general descriptions of the biology of the species in question.

For species for which no indication of abundance could be found, abundance was assumed equal to the average for species with similar characteristics.

The list thus prepared, with adjusted qualitative abundances for every species and every subsystem, was used to obtain numerical values by substituting qualitative abundances by its numerical average range value in Nm^{-2}, divided by four. Then, the sum of four subsystems (seagrass beds and algal mats were combined here in one subsystem) was computed by simple addition of estimates for a species across subsystems.

2.6.2.2. NONFISH TAXA

For nonfish taxa, even rough qualitative estimates of abundance are scarce to nonexistent in coral reef systems. Although some investigations have been carried out in the PRVI reef area, they concentrated mostly on commercially exploited species, especially conchs and lobster. The limited information on abundance of nonfish taxa that were identified in the course of this work may be found in Table 3.9 in the "Results" section.

2.6.3. Biomass

2.6.3.1. FISH SPECIES

The biomass in g per m^2 wet weight ($gm^{-2}WW$) of each fish species was calculated by multiplying the average numerical abundance obtained as described above with the mean individual weight of the corresponding species. Mean individual weight (W_{mean}) was obtained through

$$W_{mean} = W_{\infty} * 0.3 * 0.86 \qquad \textbf{...2.12)}$$

with W_{∞} being asymptotic weight in gWW and assuming that the mean weight corresponds roughly to 30% of maximum weight, itself about 86% of the asymptotic weight (see equation 2.6). Note that this definition of W_{mean} implies that the bulk of the biomass is comprised by late juveniles and young adults.

2.6.3.2. NONFISH TAXA

Many of the biomass values for nonfish taxa were indicated in the corresponding references in units other than wet (=live) weight. A summary of the conversion factors used for the computation of biomass and P/B values for nonfish taxa is given in Table 2.5.

2.6.3.3. DETRITUS BIOMASS

The following empirical equation was derived by Pauly et al. (1993a, Appendix IV) to obtain rough estimates of detritus biomass (D, gCm^{-2}) as a function of primary production (PP, gCm^{-2} $year^{-1}$) and euphotic depth (E, in m):

$$\log_{10}D = -2.41 + 0.954\log_{10}PP + 0.863\log_{10}E \qquad \textbf{...2.13)}$$

Fifty-two percent of the variation (R = 0.718) in the data set was explained by equation (2.12), so the fit is not tight. However, the *biomass* of detritus (as opposed to the *flows* in and out of this box) is not an important parameter and hence the low precision of estimates for (2.13) may be acceptable here.

Table 2.5. Conversion factors used for ECOPATH II input parameter estimation of nonfish groups.

Taxon	Ratio	%[a]	Source
Organic tissue	1 kcal = 1 g WW		Steele (1974)
Organic tissue	1 g C = 10 g WW	10	Steele (1974)
Organic tissue	1gDW=4.5 gWW	20-25	Steele (1974)
Plants	1 g C = 40 kJ	-	G. Graf, IfM, Kiel (pers. comm.)
Plants	$1gCm^{-2} \cdot day^{-1} = 1gO_2m^{-2} \cdot hour^{-1}*0.3$		Connor and Adey (1977)
Primary producers	1 g C = 3.33 g DW	30[b]	G. Graf and D. Schramm, IfM, Kiel (pers. comm.)
Algae, seagrasses, phytoplankton	1 g C = 16.7 g WW	6	G. Graf and D. Schramm, IfM, Kiel (pers. comm.)
Algae, seagrasses, phytoplankton	1 g DW = 5.71 g WW	15-20	G. Graf and D. Schramm, IfM, Kiel (pers. comm.)
Foraminifera	1 g AFDW = 1.16 g WW	86.5	Odum and Odum (1955)
Animals	1 g C = 48 kJ		G. Graf, IfM, Kiel (pers. comm.)
Sponges	1 g DW = 3.33 g WW	30	D. Barthel, IfM, Kiel (pers. comm.)
Sea anemones	1 g DW = 5.88 g WW	83	Pauly et al. (1993b)
Gastropods (mean of several species)	1 g DW = 5.56 g WW	18	Pauly et al. (1993b)
Gastropods (mean of several species)	1 g DW = 18.6 kJ		Pauly et al. (1993b)
Bivalves (mean of several species)	1 g DW = 10 g WW	10	Pauly et al. (1993b)
Polychaetes (mean of several species)	1 g DW = 5 g WW	20	Pauly et al. (1993b)
Cirripedia (two species)	1 g DW = 5.3 kJ		Berry (1982)
Amphipods (one species)	1 g DW = 4 g WW	26	Pauly et al. (1993b)
Euphausids (*E. superba*)	1 g DW = 5 g WW	19	Pauly et al. (1993b)
Isopods (1 species)	1 g DW = 4 g WW	25	Pauly et al. (1993b)
Shrimps (2 species)	1 g DW = 3.8 g WW	26.7	Pauly et al. (1993b)
Small crustaceans (mean of euphausids,amphipods, isopods and shrimps)	1 g DW = 4 g WW	25	Pauly et al. (1993b)
Spiny lobster (1 species)	1 g DW = 5.55 g WW	18	Smale (1978)
Starfish (2 species)	1 g DW = 3.5 g WW	29	Pauly et al. (1993b)
Sea urchins (1 species)	1 g DW = 3.1 g WW	32	Pauly et al. (1993b)
Sea urchins (1 species)	1 kJ = 3.7 g DW		Pauly et al. (1993b)
Sea urchins (1 species)	1 kJ = 1.2 g WW		Pauly et al. (1993b)
Sea cucumbers (3 species)	1 g DW = 11.1 g WW	9	Pauly et al. (1993b)
Sea cucumbers (3 species)	1 kJ = 1.08 g WW		Pauly et al. (1993b)
Echinoderms (mean of several taxa)	1 g DW = 4 g WW	25	Pauly et al. (1993b)
Shell organics	1 g DW = 23.9 kJ		Horn (1986)

Notes:
[a]C or DW expressed as percent of WW.
[b]C or DW expressed as percent of DW.
Source: AFDW = ash free, C = carbon, DW = dry weight, WW = wet (live) weight.

2.6.4. Environmental Temperature

Mean annual temperature was determined from hydrographical charts (DHI 1969) to be 28°C for the waters around the PRVI area. An estimate of mean annual temperature was required to compute natural mortality M and food consumption (Q/B) from empirical models (see below). This value of 28°C agrees closely with temperatures indicated by Randall (1962a) for two different study sites in the US Virgin Islands.

2.6.5. Production/Biomass Ratio

Under certain conditions mentioned above, the P/B ratio is equal to total mortality Z or natural mortality M (in case of no fishing) of a population of fish or invertebrates. Given the assumption of zero fishing mortality made here, the literature was searched for published values of M (or of Z in unexploited systems).

When natural mortality (or Z) was indicated as a percentage, or as percentage survival, the estimate was transformed into an exponential rate based on:

$$N_t = N_0 * e^{-M*t} \qquad ...2.14)$$

where N_t is the number of fish in a given cohort at time t and N_0 is the initial number of fish.

In cases where no values of M for fishes or invertebrates with high metabolic rate could be found, this parameter was estimated by means of an empirical model derived by Pauly (1980), of the form

$$\log_{10}M = -0.0066-0.279\log_{10}L_\infty+0.6543\log_{10}K+0.463\log_{10}T \qquad ...2.15)$$

and

$$\log_{10}M = -0.2107-0.0824\log_{10}W_\infty+0.6757\log_{10}K+0.4687\log_{10}T \qquad ...2.16)$$

where L_∞ and W_∞ refer to asymptotic length in cm and asymptotic weight in g, respectively, K refers to $year^{-1}$ and T is the mean annual temperature in °C of the water in which the stock in question lives (i.e., 28°C, see above). Estimates of natural mortality M for clupeoid species obtained via equation (2.15) or (2.16) were corrected with M * 0.6 as suggested by Pauly (1980). In the case of the low-metabolism echinoderms (sea urchins, holothuroids), M was assumed to be lower than implied by equation (2.15) or (2.16), i.e., about equal to K (as was demonstrated to be appropriate for tropical sea urchins by Longhurst and Pauly 1987).

2.6.6. Food Consumption per Unit Biomass (Q/B)

One of the key input parameters in ECOPATH I as well as in ECOPATH II is the food consumption of a species (group). Polovina (1984a,b) called this input the "food required" (FR). Pauly (1986), instead, used the expression "food consumption per unit biomass" (Q/B) and defined it as the number of times an age-structured population of fish consumes its own weight per year. In the forthcoming, Q/B shall be used *sensu* Pauly.

Published data on food consumption of tropical reef fishes and invertebrates are scarce. Thus, Polovina (1984a,b,c), in the absence of appropriate data, used estimates of consumption by Pacific salmon for the reef fishes in the ECOPATH modelling of French Frigate Shoals, Northern Hawaiian Islands. Furthermore, all reef invertebrates, except squids, lobsters and crabs, were lumped together as "heterotrophic benthos" with one common estimate of Q/B. Menzel (1958,1960) was one of the firsts to carry out food conversion experiments on coral reef fishes using two species from Bermuda, the herbivorous *Holacanthus bermudensis* (Pomacanthidae) and the carnivorous *Epinephelus guttatus* (Serranidae) for his experiments.

To date a series of methods exists for estimating the quantity of food eaten by a fish population during a certain period of time (e.g., Bajkov 1935; Beverton and Holt 1957; Ursin 1967; Elliot and Persson 1978; Jobling 1981; Daan 1973, 1983; Andersen 1982; Armstrong et al. 1983; Durbin et al. 1983; Rice et al. 1983; Stewart et al. 1983; Majkowski and Hearns 1984; and Pennington 1984). Most of the available methods are based on combining stomach contents data obtained from the field with experimental results. These parameters then allow for the determination of transition rates for stomach contents. Such investigations require a great number of stomachs because of the generally high variabilities of stomach contents in natural fish populations. This requirement is generally difficult to meet with regard to coral reef fishes which abundances are often rather low. In addition to this, reefs are unsuited for trawl fishing for obvious reasons and, instead, fishes on reefs and in adjacent areas are caught by a wide variety of gears from traps to hook and lines. Therefore, catches and hence stomach contents are usually not representative. Fishes, when trap-caught, may consume prey usually unavailable to them. Also the mean weight of the food in the stomach of fishes caught with hook and lines, tends to be underestimated because generally "hungry" fish are caught.

Another approach to estimate the food consumption is by executing laboratory or pond feeding experiments. According to Mann (1978), extrapolations of food consumption estimates from laboratory experiments to natural conditions can be divided into direct and indirect methods. The direct methods attempt to simulate natural conditions in the laboratory by imitating environmental variables such as temperature, salinity, food type, availability of food, water movements, diel cycles, etc., as well as the growth rates of fish occurring in the field. Because of practical difficulties in meeting all of these requirements, indirect methods have evolved. Indirect estimates usually use nitrogen and/or energy budgets as a basis for the prediction of food requirements of fish under a range of conditions (Ivlev 1939, 1961; Winberg 1956; Gerking 1962). Although more assumptions than in the direct method are involved, the indirect approach leaves more space for the incorporation of the effects of environmental variables. A detailed discussion of the subject can be found in Mann (1978).

2.6.6.1. THE FOOD CONSUMPTION MODEL

As a contribution to the indirect approach, an analytical method for the estimation of Q/B has been developed by Pauly (1986) which may be applied in cases where stomach analyses from field samples cannot be carried out. The method links up estimates of gross food conversion efficiency, obtained from laboratory experiments, with field data on growth. Thus, it aims to make the best use of available data from laboratory or pond experiments without the need for extensive field sampling of stomachs. By combining experimental and field data, this model reduces the effects of two sources of bias from experimental data on food conversion: (1) experimental fish are most often given a higher ration than is available to them in nature (Windell 1978); and (2) captive fish are usually stressed and therefore have lower conversion efficiencies than in nature (Pauly 1986).

Pauly's model assumes that the population under consideration is in a steady state and that the fish (or invertebrate) grows according to the von Bertalanffy theory of growth (von Bertalanffy 1934, 1938, 1951; Pauly 1984). Note that these assumptions are also inherent to the reef ecosystem model developed here.

The model incorporates the following main features:

1. experimental data
   a. food conversion efficiencies and/or weight-specific daily ration obtained from feeding experiments; and
   b. a conversion parameter β (beta; see below for definition)
2. field data
   a. the parameters (W_∞, K and t_0) of VBGF; and
   b. an estimate of mortality (here M).

Parameter Estimation

Estimation of β (beta). Feeding experiments can be used to obtain estimates of gross conversion efficiency (K_1), which is defined for any time interval by (Ivlev 1939, 1966)

$$K_1 = \text{growth increment/food ingested} \qquad \text{...2.17)}$$

or (Paloheimo and Dickie 1966)

$$K_1 = (dw/F)dt \qquad \text{...2.18)}$$

dw/dt is the growth rate and F the food ingested. Growth increment and food ingested are expressed in the same units (e.g., g wet weight, dry weight or protein). Under stable laboratory or environmental conditions, food conversion efficiency and fish weight usually show a strong negative correlation. This can be expressed by the regression

$$\log_{10}K_1 = \log_{10}a + b\log_{10}W \qquad \text{...2.19)}$$

which leads to the conventional model

$$K_1 = aW^b \qquad \text{...2.20)}$$

(for a discussion of this model, see Jones 1976). Pauly (1986) derived the alternative model

$$K_1 = 1-(W/W_\infty)^\beta \qquad \text{...2.21)}$$

with β as the slope of a double logarithmic plot when equation (2.21) is transformed to

$$-\log_{10}(1-K_1) = \beta\log_{10}W_\infty - \beta\log_{10}W \qquad \text{...2.22)}$$

W_∞ is the weight at which $K_1 = 0$ (x-intercept), and $K_1 = 1$ when $W = 0$. W_∞ is thus defined as the weight at which dw/dt is 0, independently of the amount of food ingested. This corresponds to the definition of asymptotic weight (W_∞) in the VBGF (see above).

For cases in which the available data lead to unrealistic estimates of W_∞, equation (2.22) can be rewritten as

$$\beta = \bar{C} / \left(\log_{10} W_{\infty VBGF} - \overline{\log W}\right) \quad \text{...2.23)}$$

where $\bar{C}$ is the mean of the $-\log_{10}(1-K_1)$ values, $\overline{\log W}$ the mean of the $\log_{10}W$ values and $W_{\infty VBGF}$ an estimate of asymptotic size suitable to describe the growth of the fish in question. The same value of W_∞ can thus be used for a combined analysis of growth and food consumption.

Pauly (1986) also emphasized the appropriate choice of the regression model used. Thus when (1) the $\log_{10}W$ values are not controlled by the experimentor or (2) regression parameters are required rather than prediction of C-values, a "geometric mean" or Type II regression should be used instead of an "arithmetic mean" or Type I regression. Conversion from a Type I to a Type II regression can be performed through

$$b' = b / |r| \quad \text{...2.24)}$$

and

$$a' = \bar{C} - b'\overline{\log_{10} W} \quad \text{...2.25)}$$

where a,b are the parameters of Type I, a' and b' the parameters of Type II regression and r is the correlation coefficient linking the y (= C) and the x (= $\log_{10}W$) values (Ricker 1973).

Estimation of Food Consumption (Q/B). Food conversion efficiency as a function of age t of a given fish $K_1(t)$ can be obtained by inserting equation (2.2) into equation (2.21):

$$K_{1(t)} = 1 - \left(1 - e^{-K(t-t_0)}\right)^{b\beta} \quad \text{...2.26)}$$

where K, t_0 and β are as defined above.

The feeding rate (dq/dt) of a fish of age t can then be expressed by rewriting equation (2.17) as follows:

$$dq / dt = (dw / dt) / K_{1(t)} \quad \text{...2.27)}$$

The growth rate (dw/dt, e.g., in kg $year^{-1}$) is the first derivative of VBGF and has the form:

$$\frac{dw}{dt} = W_\infty * 3K\left(1 - e^{-K(t-t_0)}\right)^{b-1} * e^{-K(t-t_0)} \quad \text{...2.28)}$$

The cumulative food consumption (Q_c) of a fish can thus be obtained by integrating equation (2.26) from age at recruitment (t_r) to age at which the fish dies (t_{max})

$$Q_c = \int_{t_r}^{t_{max}} \left(\frac{\left(\frac{dw}{dt}\right)}{K_{1(t)}} \right) dt$$

...2.29)

By assuming exponential decrease with instantaneous total mortality Z, viz

$$N_t = N_r e^{-Z(t-t_r)}$$

...2.30)

with N_t the number of fish in the population at time t and N_r the number of recruits, the food consumption per unit biomass (Q/B) of an age-structured population can be estimated from:

$$\frac{Q}{B} = \frac{\int_{t_r}^{t_{max}} \frac{(dw/dt)\,N_t}{1-\left(1-e^{-K(t-t_0)}\right)^{b\beta}} dt}{\int_{t_r}^{t_{max}} W_{(t)} * N_t * dt}$$

...2.31)

Thus, the parameters needed for the estimation of Q/B of a fish or invertebrate population are b, ß, W_∞, Z (or M for an unfished system), K, t_0, t_r and t_{max}. The parameter b is the exponent of the length-weight relationship and can generally be set equal to 3 (see above); the parameter ß is estimated from feeding experiments; W_∞, K and t_0 are obtained from growth data, whereas t_r and t_{max} can be set more or less arbitrarily (a sensitivity analysis of the model showed only negligible effects for changes of t_r, t_{max} and t_0; see Pauly 1986).

Estimation of Maintenance Ration and Trophic Efficiency. Apart from Q/B, the above model can also be used to estimate:

1. maintenance ration (R_M);
2. trophic efficiency (E_T); and
3. respiratory and excretory losses (R_L).

Maintenance ration is defined as the amount of food necessary to maintain a given weight of a fish. R_M is usually obtained through controlled feeding experiments (Windell 1978), through starvation experiments (Jones 1976) or by measuring the oxygen consumption of a fasting animal (Ursin 1967). Pauly (1986) used the relationship between Q/B and fish weight to estimate R_M: W_∞ being defined as the weight at which all food ingested is only used for maintenance and not for growth, the ration at (or near) W_∞ can be used as estimate of R_M. In practice, R_M is obtained by extrapolating to W_∞, using a semilog plot, estimates of Q/B for two fixed weights close to W_∞, e.g., $0.90*W_\infty$ and $0.95*W_\infty$ (Pauly and Palomares 1986).

Population trophic efficiency can also be estimated from the model with

$$E_t = Z*(B/Q) \qquad \text{...2.32)}$$

where Z is total mortality (or M natural mortality for an unfished population) and B/Q the reciprocal of the output of equation (2.33). E_T expresses population production per unit food consumed. Food that has not been turned into production of biomass goes to respiratory and excretory losses; the relative amount of such losses can be calculated through

$$R_L = 1 - E_T \qquad \text{...2.33)}$$

Pauly's (1986) food consumption model was used to obtain estimates of Q/B for several macroinvertebrates (see Results section). All values of Q/B, R_m and E_T were calculated with a BASIC computer program called MAXIMS (Jarre et al. 1990).

The bulk of the Q/B estimates used for the development of the empirical model, described below, was calculated by applying published results of food conversion experiments and growth parameters of the fish stocks considered to the above described food consumption model (see Palomares 1987).

2.6.6.2. THE EMPIRICAL MODEL

Fish Species

Food consumption per unit biomass (Q/B) for the fish species included in the present models of a Caribbean coral reef was computed with an empirical model of the form:

$$\log_{10} Q/B = -0.0771 - 0.2018 \log_{10} W_\infty + 0.6121 \log_{10} T + 0.5156 \log_{10} A + 0.5471F \qquad \text{...2.34)}$$

(Palomares and Pauly 1989), where Q/B is the food consumption of an age-structured population over its mean biomass, W_∞ is the mean asymptotic (or maximum) weight (as defined by the VBGF) of the fish of a given population (live weight in g), T is the mean environmental temperature in °C, A an index of the mean activity level of the fish of a given species, derived from the shape ("aspect ratio") of its caudal fin (see below) and F is the food type, with : carnivorous = 0 and herbivorous = 1. The derivation of this model, which is modified from Palomares (1987), is given in Palomares and Pauly (1989). It is based on Q/B estimates for 33 demersal and pelagic fish stocks ranging in size from myctophids to tuna and occurring in marine waters with mean annual temperatures ranging from 10 to 28°C.

Aspect Ratio of the Caudal Fin. The aspect ratio (A) of the caudal fin is defined as the square of the height (h^2) of the caudal fin over its surface area (s) or

$$A = h^2/s \qquad \text{...2.35)}$$

(Lindsey 1978). This ratio can be used to characterize the activity level of fishes which use their caudal fin as (main) organ of propulsion. High aspect ratios indicate that the fish are fast and continuous swimmers (e.g., tunas) while low aspect ratios refer to slow and/or "burst" swimmers (e.g., groupers, see Fig. 2.2). The aspect ratio of the caudal fin is thus related to the activity level and energy requirements of the fish (Sambilay 1990). It is therefore an indirect measure for the food consumption of a fish (or a population of fish).

Based on photographs in Randall (1968) and drawings in Fischer (1978), the aspect ratios of around 230 Caribbean coral reef fish species were determined using a computerized image analyzing system. This newly available technology permits to rapidly analyze a high number of pictures, especially when combined with a special data storage program, as was the case in this study. This program was written for the present application and kindly made available by R. Froese (ICLARM). For computing Q/B, estimates of aspect ratios obtained by Randall's photographs were used and only when these were not available were values from the Food and Agriculture Organization (FAO) drawings applied. Indications of length for a variety of species were adapted from Randall (1968).

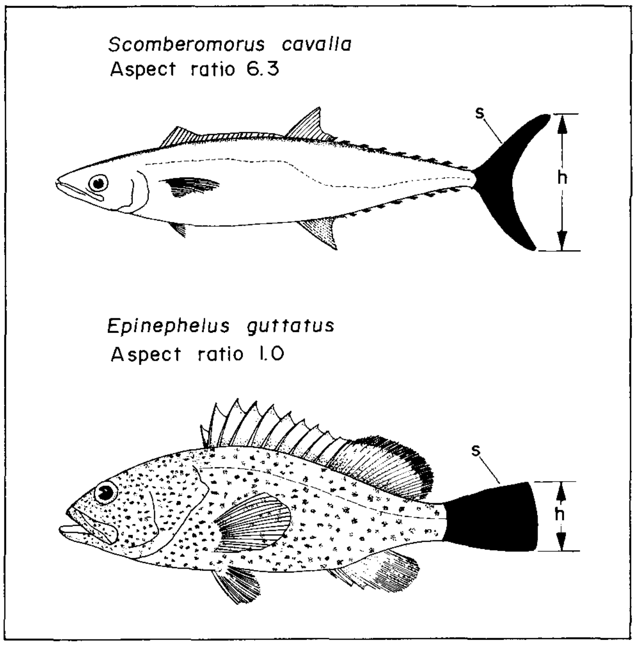

Fig. 2.2. Schematic representation of method to estimate the aspect ratio of the caudal fin of fish, given height (h) and surface area (s).

For sharks, which have heterocercal tails, and for rays, an aspect ratio of 7.0 was assumed. This value is based on the reflection that sharks and rays act as apex predators, roaming through widespread hunting grounds and thus may have an activity level similar to large scombrids and jacks, which highest aspect ratios varied between 6 and 7.

For species without well-formed caudal fins (such as moray eels), an aspect ratio of 0.7 was assumed; this corresponds to the lowest level of A among fish species with caudal fins. This assumption was made since morays and similar fishes usually spend much time hidden in crevices waiting for preys to pass by.

Food Type. The food type (F) of equation (2.34) is a dummy variable which originally took only two values: 0 for carnivorous and 1 for herbivorous fish. To be able to deal with omnivory (i.e., diets containing both animals and plants), linearity was assumed between 0 and 1, i.e., the variable F was set at values proportional to the fraction of plants in the diet when solving for Q/B.

Nonfish Taxa

The majority of estimates of Q/B for nonfish taxa were obtained by searching directly in the literature for estimates of this parameter. As pointed out above, for several taxa Q/B could be estimated through the food consumption model (Pauly 1986), i.e., via β as obtained from published estimates on food conversion or daily ration and from growth parameters.

I also attempted to estimate Q/B from data on energy metabolism, i.e., from oxygen consumption estimates. This approach yielded, for reasons not explored here, excessively high consumption estimates and was therefore abandoned.

Consumption values from the literature were adjusted to a mean annual temperature of 28°C, prevailing in the Caribbean waters around the Virgin Islands, through a reexpression of the slope associated with temperature in equation (2.34), i.e.,

$$V = (T / T')^{0.6121} \qquad \text{...2.36)}$$

V is the factor for temperature adjustment, T the temperature at PRVI (i.e., 28°C) and T' the original habitat or experimental temperature.

2.7. Diet Composition Matrix

It was known from a previous application of ECOPATH II to the Peruvian upwelling system (Jarre et al. 1991), that changes in the diet composition had a strong impact on model structure. Therefore, the diet matrix of the present modelling work was elaborated as carefully as possible for the species groups involved.

2.7.1. Fish Species

The data for the diet composition matrix DC_{ij} were obtained primarily from a study carried out in St. John, US Virgin Islands, by Randall (1967).

The results of Randall's stomach contents analyses were given in percent of volume of the different major groups of food organisms. This is roughly equivalent to relative weight and thus, approximates the relative amounts of energy extracted by consumers from various system components (MacDonald and Green 1983).

The taxonomic level of the organisms identified by Randall (1967) from fish stomachs varied from species to families and higher categories, with most of the invertebrates grouped under the higher categories. Fishes, on the other hand, were identified mostly to generic or specific level without indication of percentage volume of the single genus or species. For the construction of the DC matrix, the percentages of "fish" were divided into equal parts between all the genera and species listed as prey for the respective fish species. When fish were identified only to family or generic level, the respective percent of volume was distributed evenly over all species of the family or the genus represented in the matrix. Only 18 fish species appeared as prey but not as predators. Their share was distributed evenly over all the species of the same family or genus considered in the matrix. Species of families that were not represented in the matrix were considered as "unidentified" fish (F0). The F0 in the matrix contains also all cases where the share of fish in a diet was not identified to a lower taxonomic category.

Unidentified stomach contents were assigned to the identified parts according to the relative abundance of the latter. Eggs and larvae were assigned as "zooplankton", together with a variety of other organisms (see Appendix 8.5.3). In Randall's study, "algae and organic detritus" were listed as a combined item in many cases. Their relative contribution was divided into two equal parts. The symbiotic coral-algae complex was separated into a producer and a consumer component; when a fish species' diet included the item "corals", the corresponding percentage was divided into two shares with 60% of it for plant tissue (benthic algae) and 40% for animal tissue (corals).

Only five species of sharks, four of the family Carcharhinidae and one of the family Ginglymostomatidae were included in Randall's study. These five species were represented only by few individuals, many of which had (nearly) empty stomachs. The same was true for stomach analyses of the two species of rays included in the model. Diet for cartilaginous species was generally stated as "fish", preliminarily included into the food matrix under the label F0. Randall's list of shark species was completed by including more sharks with affinities to coral reefs of the PRVI area, based on accounts in Fischer (1978). From qualitative descriptions of the diet composition given therein, quantitative shares were estimated for each food item according to the already existing DC matrix. The item "fish" or "small fish" was most difficult to translate into quantitative information. It was assumed that, when part of the diet was stated to be "fish", every fish species in the system had the same probability of being a victim of a shark's appetite. So the generalization "feeds on fishes" was translated by distributing 100% (minus the part of the diet represented by invertebrates) into equal percentages over all fish species in the DC matrix. Excluded were (1) species larger than the one under consideration and (2) reef fish species with W_∞ < 100 g. The latter restriction was adopted based on the notion that a large animal, such as a tiger shark, weighing about half a ton, would generally not manage to extract gobies, blennies, damselfishes, etc., of 10-20 g from between the coral heads and other crevices. When the diet, or part of it, was stated to be "pelagic fish", this was divided into the pelagic species in the DC matrix. When a shark fed on "small pelagic fish" the same procedure was applied, but excluding the scombrids and large jacks from the list of possible candidates. When the food or part of it consisted of "small fish", the diet was distributed evenly over all species with W_∞ < 1,000 g. The weight limits are arbitrary. Such arbitrary limits were necessary, however, since a rigorous definition of what a "small fish" is does not exist.

The relative contribution of fish versus nonfish taxa is also arbitrary. The only restriction was the statement "feeds mainly on...". In such cases, the diet part referred to was considered to represent from 60% to 80% of the total diet.

2.7.2. Nonfish Taxa

To establish a diet matrix for the nonfish taxa, the food items of fish stomachs analyzed by Randall (1967) were listed under their corresponding taxon together with the number of fish species for which an item was stated as part of the diet (see Appendix Tables 8.5.1 and 8.5.2). Based on this listing, a search of the Aquatic Sciences and Fisheries Abstracts (ASFA) database was carried out and ca. 300 publications were selected. Since quantitative information on diet composition of coral reef invertebrates is still scarce (see also Lewis 1981), the quantitative diet composition of each taxon was estimated in many cases from qualitative or rough quantitative information and/or was transferred from ecosystems other than coral reefs.

For the construction of the DC matrix, all percentages of volume were reexpressed as fraction of one.

2.8. Aggregation of Species and Taxa

2.8.1. First Reduction

ECOPATH II, as presently implemented, allows a maximum input of 50 species groups. This restriction made it necessary to reduce the initial number of fish species (over 200) and 41 nonfish taxa into 50 species groups. The procedures used for this reduction are described below.

2.8.1.1. FISH SPECIES

A set of ecologically meaningful criteria was needed by which the fish species could be aggregated into species groups, using cluster analysis. Since I was concerned with a model of energy flow, variables which relate to flows between elements of the system had to be identified. These variables must necessarily relate to the factors which determine the food consumption of a species. Referring to the section on "Food consumption (Q/B)", these variables are: (1) size, (2) activity level and (3) type of food. These variables were parametrized as in equation (2.34), using: (1) size = asymptotic weight W_∞ in g; (2) activity level = aspect ratio A; and (3) type of food = degree of herbivory, in %. These three were treated as being of equal importance. Prior to the aggregation of fish species into species groups by cluster analysis, two of the three variables were transformed such that they evenly covered a range of values.

Asymptotic weights (originally in g wet weight) were reexpressed in logarithmic form and thus reduced to values between 0 and 6. Food type was divided by 10 and thus ranged then from 0 to 10. A value of 0 corresponded now to 100% carnivory and a value of 10-100% herbivory. Aspect ratio was not transformed since this evenly covered values between 0.7 and 7.0.

To determine whether the three variables were correlated, a factor analysis was carried out. According to Backhaus et al. (1986), prior to the execution of a cluster analysis on a given set of elements and variables, it is advisable to carry out a factor analysis to detect dependent variables and exclude them from the aggregation process. The factor analysis showed that the variables were largely independent, except for a negligible correlation between aspect ratio and size (Fig. 2.3).

Cluster analysis was performed, using the prepared matrix of 243 fish species and 3 variables. "Quadratic Euclidean distance (QED)" was selected as index of dissimilarity. By relying on the square of the distance between the variables of two elements, this index emphasizes large distances.

Three hierarchical agglomerative cluster-algorithms were applied to the matrix of input data: (1) "average linkage", (2) "centroid" and (3) "ward". All three are conservative algorithms (they have no contracting or dilating effect on the grouping process) and may be used with measures of dissimilarity (e.g., QED). "Average linkage" and "ward" are monotonous algorithms where the measure of dissimilarity (QED) increases monotonously with decreasing number of clusters. "Ward" has the exclusive feature of forming groups of similar sizes, i.e., groups with a similar number of elements. By comparison of the results (clusters) obtained by the three algorithms, "average linkage" was finally selected to be most appropriate. The species groups aggregated by this algorithm represented best the conditions in the reef, even with reference to the habitat of certain species groups (see below).

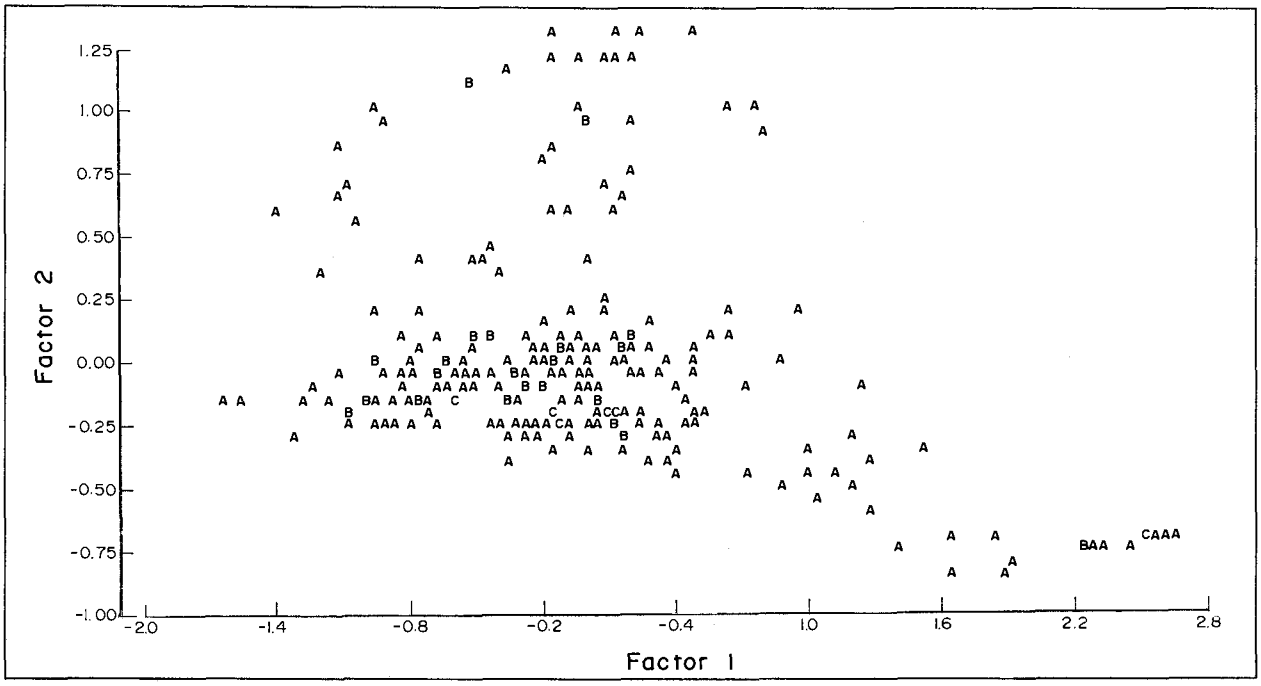

Fig. 2.3. Results of the factor analysis; relation between asymptotic weight (factor 1) and aspect ratio (factor 2).

A QED value of 1.5 was achieved when all fish species were aggregated into a single cluster. This corresponds to a cutoff level of 100%. At a cutoff level of 20% (QED = 0.3), 29 species groups were identified. Of these, 6 species, each forming a single cluster, were regarded as outliers and merged (outside the cluster analysis) with larger species groups.

An additional criterion of distinction outside the cluster analysis was applied to the prepared boxes. This criterion referred to the vertical dimension of the habitat. It was defined to be the level in the water column where a species spends most of its time. The water column was divided into two levels: demersal/off bottom and midwater/pelagic. Following this criterion, the species groups were divided into a demersal and a pelagic fraction whenever they contained species from both habitats. This division was omitted in groups of large predators because not enough information on preferred level was available, or a species could not be assigned to a distinct level. Overall, 27 fish species groups or boxes were obtained by the above-described method of aggregation.

The theoretical background for the factor analysis and cluster analyses was obtained from Backhaus et al. (1986) and Pielou (1984). The analyses were performed with the assistance of Mr. C. Klingenberg, using SAS on a VAX 750 mainframe at the Institut für Meereskunde, Kiel.

2.8.1.2. NONFISH TAXA

The aggregation of nonfish taxa could not be performed in the same manner as for fish species due to their broad taxonomic range. Values for size, activity and food type were almost entirely lacking at the species level. Activity could not be transformed into a simple parameter due to the extreme difference in lifestyle. Reduction from initially 41 to 23 groups was performed by applying the following, largely subjective aggregation criteria (in order of importance):

1. Availability of estimates of P/B and Q/B: Estimates of these two input parameters were only available for 24 of the 41 taxa. Fortunately, most of the taxa for which estimates could be obtained were definitely of great importance to reef metabolism.
2. Size: Rough indications of size for the majority of taxa were obtained from Barnes' (1963) *Invertebrate Zoology*. For some, size indications were encountered while compiling estimates of P/B and Q/B of nonfish taxa. Size was roughly scaled into four groups: small, medium, large, very large. It was assumed that, for taxa with a wide spectrum of sizes (e.g., polychaetes, gastropods), the average size contributed the bulk of biomass to the respective box.
3. Similarity of diet composition: Diet composition was reduced to six compartments: detritus, benthic producers/symbiotic algae, phytoplankton, microfauna, zooplankton, macroinvertebrates/fish.
4. Similarity of lifestyle: Sessile, semisessile, burrowing in bottom or calcareous skeletons, free living, filtering, grazing, scavenging, predatory were the categories considered.
5. Taxonomic closeness: This feature was used in cases (e.g., corals/sea anemones) where the preceding criteria were not applicable or did not allow a decision because, e.g., the lifestyles were too different, as in the case of sessile or slow-moving organisms which had no adequate group to be pooled with in terms of sizes or diet compositions.

2.8.2. Weighting Within Species Groups

To obtain a reasonable distribution of food percentages within the species groups, these had to be weighted by considering throughput of every species belonging to the respective group. A weighting factor (WF) was computed for every species through

$$WF = W_{mean} * AB * Q / B \qquad ...2.37)$$

where W_{mean} is as defined for equation (2.12) above, AB is the abundance of a species in Nm^{-2} and Q/B the annual food consumption per unit biomass.

2.8.3. Combining Species Groups

Single fish species and nonfish taxa were combined into the respective groups according to the results of the aggregation procedure.

2.8.3.1. P/B RATIO AND FOOD CONSUMPTION (Q/B)

A group estimate of P/B ratio and Q/B was obtained from the median of the respective parameter for each group of estimates for single species or taxon.

2.8.3.2. DIET COMPOSITION MATRIX

For the condensation of the DC matrix, groups had to be combined vertically (columns) and horizontally (rows). All columns and rows belonging to one group were summed up. Thus, each row in the reduced DC matrix represented a predator group and each column a prey group. To bring the sum of a row back to unity (all values had formerly been multiplied by the corresponding weighting factor, see above), each value in a row was divided by the sum of the row:

$$d_{(ij)} = \frac{d_{(ij)}}{\sum_{k=1}^{n} d_{(ik)}} \quad \text{...2.38)}$$

where d_{ij} is the weighted jth value of species group i, k is the number of columns and d_{ij}' the resulting part of 1.0 in column j of group i. This procedure was carried out for each species group and each level of aggregation.

2.8.4. Second Reduction of Species Groups

The initial 50-box model was still rather difficult to handle and visualize. For this reason, and also to find out whether information on the energy flow is lost when the system is further aggregated, the number of boxes was further reduced. Models with an equal number of boxes generated by two different methods of reduction were also compared.

2.8.4.1. METHOD 1: CLUSTER ANALYSIS + INTUITION

Fish Groups

The fish groups were further reduced by increasing the average distance (expressed by the dissimilarity index QED) between clusters. Two additional cutoff levels of 40% and 50% were selected. After separating the "pelagic-midwater" from the "demersal-off bottom" species, two sets with nine, respectively, four fish species groups were obtained. Combining groups was achieved by computing a mean (weighted by biomass) for the three key input parameters. The DC values were computed as weighted means (by throughput = biomass * consumption) from the groups of which they consisted.

Nonfish Groups

The nonfish groups were again difficult to reduce, especially because no standardized criterion could be identified for lumping nonfish groups with each other and with fish groups, a necessary procedure when reducing the boxes of the system (<20). Based on diet composition, size and lifestyle, boxes were combined intuitively with each other as well as with fish groups. Results of this "intuitive guesswork" (Ulanowicz 1986) were contrasted with those of the objective aggregation routine included in ECOPATH II, described in the Introduction and summarized in Section 2.8.4.2. The resulting total number of boxes including all fish species and nonfish taxa was 20 and 11, respectively.

2.8.4.2. METHOD 2: ECOPATH II AGGREGATION ROUTINE

As described in the Introduction, the ECOPATH II program (Pauly and Christensen 1993) includes an aggregation routine, based on Ulanowicz (1986), which allows the stepwise reduction of the number of boxes in a model from a highest possible number of 50 to any small number (after the initial system is balanced). Boxes are linked pairwise such that ascendency (a measure of the information content of a system, see Introduction) is reduced as little as possible. With this aggregation routine, the boxes of the present coral reef system were reduced pairwise until the 50 initial boxes of the system were reduced to 10. The intermediate models with the box numbers corresponding to those obtained by method 1 were used to compare models resulting from both methods.

2.9. ECOPATH II Parameter Estimation Routine

The databases for the 50-, 20- and 11-box models obtained by method 1 were fed into the ECOPATH II program, and the ecotrophic efficiency (EE) for each box was computed. Then, the original input values of the 50-box model were gradually modified, until all components (boxes) showed an EE<1. Starting from the balanced 50-box model, the ECOPATH II aggregation routine (method 2) was then used to compute the parameter values for each aggregation step (this involved automatical transformation of the diet matrix) such that every new model resulting from a further reduction of boxes was again balanced.

Besides estimation of EE, ECOPATH II was used to compute the estimates for each box of the parameters of the "master equation" (see Introduction). With the estimates for food intake, predation mortality (= production (P) * EE), flow to detritus and assimilation (A) (all in $gm^{-2} \cdot year^{-1}$), an energy balance for every box could be calculated. Furthermore, ECOPATH II calculated trophic level, omnivory index, gross efficiency, net efficiency, R/A ratio and P/R ratio for each box of the system. Based on the diet composition matrix, ECOPATH II computed, finally, for each predator, the food intake in $gm^{-2} \cdot year^{-1}$, Ivlev's electivity index and the standardized forage ratio of each prey group (see Introduction).

2.10. Whole System Properties

In the Introduction, the various features of ECOPATH II were presented. Besides the ability to produce a balanced system, the program offers several routines for the computation of various whole system properties useful for comparing different ecosystems or models of the same ecosystem.

These summary statistics are: sum of all production, sum of all imports, sum of all respiratory flows, sum of flows into detritus, total system throughput, throughput cycled, Finn's cycling index and net primary production necessary to support the system.

The "network flow indices" routine enabled the computation of ascendency, overhead and capacity for distinctive sources (inputs, internal and dissipations) of the system. The same routine computed flows and transfer efficiencies within the system subsequent to dividing it into discrete trophic levels. Finally, the routine called "mixed trophic impacts" allowed the computation of a predator - prey matrix in which the impact of an increase in biomass for a predator group is shown for all prey groups.

2.11. Graphical Representation of Models

The graphical representation of the box models followed suggestions made on this topic by Jarre et al. (1989) and Pauly and Christensen (1993). Thus, the surface area of each box was drawn so as to be proportional to the logarithm of the biomass in that box. Also, care was taken to arrange the boxes along the ordinate (trophic level) such that they did not overlap and enough space was left to draw the arrows representing the flows. Furthermore, the boxes were arranged along the abscissa so as to minimize crossovers of arrows. Whenever possible, flows were combined to reduce the number of arrows between boxes. About 80-90% of flows into a box from the components of the system were included into the graphical representations of the models, the rest was omitted for clarity. The complete sets of flows for each box are shown in Appendix 8.8.

3. RESULTS

3.1. Fish Species

3.1.1 Ecology

The available information on the spatial distribution of coral reef fish species in the Puerto Rico - Virgin Islands (PRVI) area are summarized, by subsystem, in Table 3.1. While the majority of species live within the coral reef, a number of others use the reef only as shelter and forage in the adjacent areas, such as the seagrass beds and the algal flats. These species contribute to reef metabolism mainly by means of their excreted and egested matters (feces). Several species use mangrove areas and estuaries as nursery for their offspring. These few examples show that in terms of energy flow, the subsystems cannot really be separated from each other (see also Ogden and Gladfelter 1983).

The resident coral reef fishes and the regular visitors to reefs show a very high species diversity, whereas the pelagic or oceanic fishes that are only indirectly related to reef metabolism (through their foraging activity or release of excreta) contribute relatively few species.

However, Table 3.1 is only a first attempt to group into compartments what is, in reality, a gradient with smooth transitions.

3.1.2. Fisheries and Management

The fisheries in the PRVI reef area consist mainly of small-scale, commercial fishing, and the rest of recreational fishing (and perhaps some subsistence fishing). The Caribbean Fisheries Management Council (CFMC 1985) estimates that 22% of total landings originate from the recreational sector in the US Virgin Islands. In the shallow-water reef fisheries, it is estimated that recreational landings contribute 13% of total landings. The overwhelming part of domestic requirements of fish products in the PRVI area (Puerto Rico, 85%; US Virgin Islands, over 60%) is covered by imports. Table 3.2 gives the number of fishers and vessels comprising the commercial fisheries in the PRVI area.

Fish traps are by far the most important fishing gear in terms of units as well as yield in the PRVI area. The second most important gear is the handline. Table 3.3 gives the relative importance of the different gear in the fisheries of Puerto Rico and the US Virgin Islands. A local annual fisheries production of around 3,000 t for Puerto Rico and 1,700 t for the US Virgin Islands is indicated (Table 3.3).

The CFMC reports the following 10 species as important in PRVI: Nassau grouper (*Epinephelus striatus*), red hind (*E. guttatus*), coney (*Cephalopholis fulva*), lane snapper (*Lutjanus synagris*), mutton snapper (*L. analis*), yellowtail snapper (*Ocyurus chrysurus*), white grunt (*Haemulon plümieri*), queen triggerfish (*Balistes vetula*), spotted goatfish (*Pseudupeneus

Table 3.1. Spatial distribution of Caribbean reef fishes (with emphasis on the Virgin Islands and notes on their ecology).

F=foraging, H=home, Cl=cleaner, y=young, 1=bottom, 2=well above bottom, 3=midwater, 4=pelagic; + = reported to occur in subsystem.
VA=very abundant, A=abundant, C=common, F=fairly common, O=occasional, R=rare, E=absent.
R=resident, V=regular visitor, T=transient.
W=wide range from shallow to deep; V=very shallow, surface to 2 m; SH=shallow, 1-15 m; D=deep, below 15 m; ++=upper depth limit SH.
* = from tables in Boulon (1986b); type of length not stated, therefore total length is assumed; average size of species estimated during census on reef; species with an estimate are of commercial importance in the Virgin Islands Biosphere Reserve; values in brackets were recorded for genus or family.

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Acanthuridae	*Acanthurus bahianus*	HF1y	HF1	F1			SH		O	V	(11.4)	
	Acanthurus chirurgus	HF1y	HF1	F1			W		O		(11.4)	
	Acanthurus coeruleus	HF1y	HF1	+			SH		C	R	(11.4)	More closely related to coral reefs than above species.
Albulidae	*Albula vulpes*				HF1		SH		S			Food: worms, molluscs, crabs, shrimps, squid (FAO 1977).
Antennariidae	*Antennarius multiocellatus*		HF1				SH		S			Most common of family on West Indian reefs; commercially unimportant.
	Antennarius striatus		HF1	HF1	HF1				O			In different habitats; commercially unimportant.
Apogonidae	*Apogon binotatus*		HF1							R		
	Apogon conklini		HF1				SH		C	R		
	Apogon maculatus		HF1				W		C	R		Largest and most common inshore cardinal fish of West Indies (WI).
	Apogon pigmentaria		HF1							R		
	Apogon quadrisquamatus		HF1							R		
	Apogon townsendi		HF1							R		
	Apogon xenus		HF1							R		
Atherinidae	*Allanetta harringtonensis*		HF3	HF3	HF3				O			Widely used as bait. Important forage for commercial fishes.
	Atherinomorus stipes		HF3	HF3	HF3				O			See above. Most common inshore of family in WI.
Aulostomidae	*Aulostomus maculatus*		HF2	F2			A		O			Clear water.
Balistidae	*Balistes capriscus*		HF1	HF1	HF1		W	50	S			
	Balistes vetula		HF1	HF1	HF1		W	100	O		27.9	
	Canthidermis sufflamen					HF4	W		S			Rare inshore,but common on offshore reefs, near dropoffs to clear water.
	Melichthys niger		HF2			HF2	W	30	O			Outer coral reefs with clear water.
	Xanthichthys ringens		HF1	HF3y		HF1	D	>35	O			One of most abundant WI reef fishes in >35m, above rare; young in floating *Sargassum* .
Belonidae	*Ablennes hians*					HF4	V		S			Inshore occurrence around islands.
	Platybelone argalus	HF4	HF4	HF4	HF4	HF4			F			Frequently found in inshore waters.
	Strongylura marina	HF4			HF3				E			Coastal areas and mangrove-lined lagoons.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Acanthuridae	*Acanthurus bahianus*	HF1y	HF1	F1			SH		O	V	(11.4)	
	Strongylura timucu		HF3		HF3				F			Inshore species, often in mangrove sloughs, enters fresh waters.
	Tylosurus acus					HF4			O			More offshore than *T.crocodilus* but also in coastal waters.
	Tylosurus crocodilus				HF4	HF4			O			Largest of Belonidae; occurs more inshore than above species.
Blenniidae	*Entomacrodus nigricans*		HF1				++		F	R		Inshore species, bottom-bound.
	Hypleurochilus sp.		HF1									
	Ophioblennius atlanticus		HF1				SH		A			One of most abundant fishes on WI reefs (0.65 individuals m^{-2} based on Randall 1968).
	Parablennius marmoreus		HF1				++		F			
	Scartella cristata		HF1				++		O			Rocky areas close to shore.
Bothidae	*Bothus lunatus*	HF1	HF1	+	HF1		0	65	F			Also in mangrove areas.
	Bothus ocellatus		HF1	+	HF1		SH		O			
	Paralichthys tropicus				HF1		++	183	F			
Carangidae	*Alectis ciliaris*					HF2	W	>60	O			Solitary openwater species.
	Caranx bartholomaei					H2F1	W		O			Solitary or in small groups; uncommon in inshore waters.
	Caranx crysos		F1			HF3	W		O		27.9	Large schools; sometimes feeding on coral reefs.
	Caranx hippos					HF3			S			Rare in clearwater reef areas.
	Caranx latus	HF2	HF2			HF3	W		O			Small groups of small fishes over inshore reefs; larger fish, more offshore.
	Caranx lugubris					HF3	24	>65	S	T	25.4	Free clear water.
	Caranx ruber	HF2	HF2				SH		C	V-T	22.8	Most common jack in WI; foraging and cleaning on reef.
	Decapterus macarellus					F4	W		S			Occasionally over outer reef areas; zooplanktonfeeder.
	Decapterus punctatus		F2,3			F4	W	90	O			Occasionally over outer reef areas; zooplanktonfeeder.
	Elagatis bipinnulatus		F3			F4	W		S			Pelagic, but occasionally nearshore, also over reefs.
	Oligoplites saurus	HF3,4			HF3,4				C			Small groups near surface; more turbid than clear waters.
	Selar crumenophthalmus	HF2,3	F2		HF2,3		SH		O			Schooling fish over shallow reefs or in turbid waters.
	Selene vomer		HF1		HF1		++					Small milling schools.
	Seriola dumerili		F1,4			HF2,4	W	360	S		53.3	Most common of genus in tropical West Atlantic.
	Seriola rivoliana		F1				W		S			Rare in shallow waters.
	Trachinotus falcatus		F1,4	F1,4	F1,4		V	>35	O			Rare in WI.
	Trachinotus goodei		HF1		HF1		++		O			Surf zone and clear waters along sandy beaches; schooling.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Carcharhinidae	*Carcharhinus acronotus*		HF		HF				S			Feeds on small fishes.
	Carcharhinus falciformis		+	+	+	+	W	>500	S			Feeds on fishes, squids, crabs.
	Carcharhinus leucas			HF1,4	HF1,4		W		S			Feeds on fishes (mackerels, tunas, smaller sharks, rays); invertebrates (crabs, shrimps, sea urchins); and carrion.
	Carcharhinus limbatus		HF4	HF4	HF4	HF4	W		S			Aggregating; feeds on small schooling fishes, rays, squids.
	Carcharhinus longimanus		HF4	HF4	HF4	HF4			S			Females aggregate; feeds on fishes (scombrids, carangids), squids, portunid crabs, turtles, carrion.
	Carcharhinus perezi (*springeri*)		HF1	HF1	HF1		30		O			Probably most common member of genus in inshore water of WI islands; feeds on fishes including rays.
	Galeocerdo cuvieri		HF3	HF3	HF3	HF3	W		O			Coastal as well as offshore waters, near the surface; feeds on fishes (also sharks, rays), turtles, seabirds, squids, conchs, crabs, carrion.
	Negaprion brevirostris	HF1	HF1	HF1	HF1		W		O			Common inshore species entering also brackish and even fresh water.
	Rhizoprionodon porosus		HF1	HF1	HF1	HF1	W	>500	O			Primarily a coastal species, but also found in offshore waters.
Chaetodontidae	*Chaetodon aculeatus*		HF1				D	>100	S			Rare in shallow water, most common of family from 30 m depth.
	Chaetodon capistratus		HF1				SH		C			Most common of family in WI reefs.
	Chaetodon ocellatus		HF1				W		S			
	Chaetodon sedentarius		HF1				W		S			Found in deeper water than others of family.
	Chaetodon striatus		HF1				SH		O			
Centropomidae	*Centropomus undecimalis*										30.4	
Cirrhitidae	*Amblycirrhitus pinos*		HF1				W		S-O	R		

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Clinidae	*Acanthemblemaria spinosa*		HF1							R		
	Emblemariopsis leptocirris		HF1							R		
	Enneanectes altivelis		HF1							R		
	Labrisomus guppyi		HF1				++		C			
	Labrisomus haitiensis		HF1							R		
	Labrisomus kalisherae		HF1				++		F			
	Labrisomus nuchipinnis		HF1				++		C			Largest and most abundant inshore clinid fish in WI.
	Pseudemblemaria signifera		HF1							R		
	Starksia hassi		HF1							R		
	Starksia lepicoelia		HF1							R		
Clupeidae	*Harengula clupeola*		HF4	HF4	HF4		++		VA			Pelagic, in coastal waters, estuaries and lagoons; schooling.
	Harengula humeralis	HF4	HF4	HF4	HF4		++		VA		10.1	Pelagic, in coastal waters, estuaries and lagoons; schooling.
	Jenkinsia lamprotaenia	HF4	HF4	HF4	HF4		++		VA	V	*	Often extremely abundant; forms large schools near the surface.
	Opisthonema oglinum		HF4	HF4	HF4		++		C			Pelagic, in coastal waters,often forming compact schools.
	Sardinella aurita		HF4	HF4	HF4		++		C			Pelagic, in coastal waters, often forming compact circular schools; feeds on plankton.
Congridae	*Heteroconger halis*				HF1		++	50	F			Burrowed in sand near reefs; zooplankton feeder.
Dactylopteridae	*Dactylopterus volitans*				HF1		++		O			No commercial interest.
Dasyatidae	*Dasyatis americana*		+		HF1		++		F			Most common of genus in WI,regular visitor to reefs.
	Urolophus jamaicensis											
Diodontidae	*Chilomycterus antennatus*	HF1	+	HF1			W		S-O			Relatively rare; most often taken from seagrass beds.
	Chilomycterus antillarum		+	+			W	30	S			
	Diodon holocanthus	HF1	HF1		HF1		SH		O-C			More often in muddy habitats (mangroves) than on reefs.
	Diodon hystrix		HF1				SH	30	O			Most frequent of family.
Echeneidae	*Echeneis naucrates*		HF						O			Attached sometimes to larger reef fishes, sometimes solitary in reef.
	Remora remora		HF						O			Attached sometimes to larger reef fishes, sometimes solitary in reef.
Elopidae	*Elops saurus*		HF		HF		++		O			Common in WI in shallow brackish lagoons.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Emmelichthyidae	*Emmelichthyops atlanticus*		HF2				3	50	F	R		Small aggregations above coral heads.
	Inermia vittata					HF3	D		C			Slender schooling fish in clear blue waters.
Engraulidae	*Anchoa hepsetus*		HF3	HF3	HF3		++	>70	A			Forms large schools; feeds on small zooplankton and zoobenthos.
	Anchoa lyolepis			HF3	HF3		++	>55	A			Forms large, compact schools; on sandy beaches and mangrove lagoons.
Ephippidae	*Chaetodipterus faber*		HF2				W		S		22.8	Schooling.
Fistulariidae	*Fistularia tabacaria*		+	HF1			SH		S-O			
Gerreidae	*Eucinostomus argenteus*				HF1		++		C		(20.3)	
	Gerres cinereus		HF1		HF1		++		C		(20.3)	Also in brackish environments.
Ginglymostomatidae	*Ginglymostoma cirratum*		HF1	+	HF1		W		O			Most common reef shark in WI; feeds mostly on invertebrates (shrimps, crabs, lobsters, squids, other molluscs, sea urchins); also on small fish.
Gobiidae	*Bathygobius soporator*	HF1	HF1		HF1		0		S-O			Most common shore fish of tropical America.
	Coryphopterus dicrus		HF1							R		
	Coryphopterus eidolon		HF1							R		
	Coryphopterus glaucofraenum		HF1	HF1	HF1		W	27	O	R		Most common goby of WI reefs.
	Coryphopterus personatus		HF1							R		
	Coryphopterus thrix		HF1							R		
	Gnatholepis thompsoni		HF1		HF1			33	C	R		
	Gobiosoma evelynae		HF1				SH		F	R		
	Gobiosoma horsti		HF1				SH		F	R		
	Gobiosoma saucrum		HF1							R		
	Lythrypnus elasson		HF1							R		
	Lythrypnus nesiotes		HF1							R		
	Lythrypnus sp.		HF1							R		
	Quisquilius hipoliti		HF1							R		
	Risor ruber		HF1							R		
Grammidae (Serranidae)	*Gramma loreto*		HF1				W	70	O			Cleaner; common in caves or beneath ledges; highly prized aquarium fish.
	Gramma melacara		HF1				10	70	O			Bahamas and Belize, rare in <30 m, very common on reef fronts in <50 m in the Bahamas.
Grammistidae (Serranidae)	*Rypticus saponaceus*		+		+		SH	50	O			
	Rypticus subbifrenatus		+				SH			R		

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*		HF1	F1	F1		SH		S-O			Very shallow water, one of the largest grunts.
	Anisotremus virginicus		HF1Cy				SH		S		17.7	Common in Florida Keys.
	Haemulon album		H1	F1	F1	H1	SH	30	O		25.4	Largest of genus; clear water; active at night; good food fish.
	Haemulon aurolineatum	+	H1	F1	F1	H1	W	25	O	R	10.6	Smallest and most common of family.
	Haemulon bonariense	+	HF1	HF1	HF1		SH		S			Abundant in southern Caribbean, also found in mangrove-lined lagoons.
	Haemulon boschmae		HF1				V	100	S			Forms loose aggregates.
	Haemulon carbonarium		+	HF1	HF1		W	25	S		12.7	Forms schools around coral reefs in clear water.
	Haemulon chrysargyreum		H1	F1,3	F1,3		W	25	O		11.4	Small schools hiding in caves by day.
	Haemulon flavolineatum	HF1y	HF1	HF1			W	25	C	R	11.4	Most common grunt on WI reefs; one of most abundant species in WI; commonly in schools.
	Haemulon macrostomum		HF1	HF1			W		S		13.9	Clear water.
	Haemulon melanurum		HF1	HF1			W		S			Clear water; schooling.
	Haemulon parrai		HF1	HF1		HF1	W	30	S		19.0	More common in continental waters; schooling.
	Haemulon plumieri	HF1	HF1	HF1	HF1		W	35	O		15.2	Common reef fish.
	Haemulon sciurus	HF1	HF1	HF1			W	30	O		17.7	One of most common and most colorful WI grunts.
	Haemulon steindachneri		+		HF1		0	25	E			Mainly sandy and rubble bottom, occasionally coral reefs; schooling.
	Haemulon striatum					HF1		100	S			Prefers deeper water than other species of genus.
	Orthopristis chrysoptera		+		HF1		++					Only occasionally on reefs.
	Orthopristis poeyi		+		HF1		++					Cuba only.
	Orthopristis ruber	HF1	+		HF1		++	70				Southern Caribbean; also in brackish water.
	Pomadasys corvinaeformis		HF1		HF1		++		S			Cuba is northern limit of distribution.
	Pomadasys crocro	HF1			HF1		++		S			Also quite common in brackish, mangrove-lined lagoons; anadromous.
Hemiramphidae	*Hemiramphus balao*		+	HF4	HF4				F			Inshore surface dwelling fish forming sizeable schools.
	Hemiramphus brasiliensis		+	HF4	HF4		V		O			Inshore surface dwelling fish forming sizeable schools.
	Hyporamphus unifasciatus		+	HF4	HF4				O			Inshore surface schooling species, frequently entering estuaries.
Holocentridae	*Holocentrus ascensionis*	+	H1	F1	F1	H1	SH	30	O		(13.7)	Nocturnal.
	Holocentrus coruscus	+	H1	F1	F1	H1	SH	30	O	R	(13.7)	Nocturnal.
	Holocentrus rufus	+	H1	F1	F1	H1	W	32	C	V	(13.7)	Nocturnal; more abundant on well-developed reefs than *H. ascensionis*.
	Myripristis jacobus	+	HF1			HF1	SH	25	O	R	(13.7)	Nocturnal; aggregating around coral reefs.
	Neoniphon marianus	+	H1	F1	F1	H1	W	70	O	R	(13.7)	Rare in shallow water, maybe most common of family in 35-70 m depth; nocturnal.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
	Plectrypops retrospinis		HF1				W		S		(13.7)	Nocturnal; secretive.
	Sargocentron vexillarium	+	H1	F1	F1	H1	SH		O		(13.7)	Most common inshore squirrelfish in WI.
Kyphosidae	*Kyphosus incisor*		HF1	HF1			SH		O		(25.4)	Sometimes in floating *Sargassum* weed.
	Kyphosus sectatrix		HF1	HF1	HF1		SH		O		(25.4)	Young commonly found in floating *Sargassum* weed.
Labridae	*Bodianus rufus*		HF1				W	35	O		20.3	Moderately large.
	Clepticus parrae		HF3	F3	F3		W		O			Reef for shelter, feeding in midwater on zooplankton.
	Halichoeres bivittatus		+	HF1	HF1		SH		O	V		Most common of genus.
	Halichoeres garnoti		HF1		HF1		W		S	V		Not uncommon.
	Halichoeres maculipinna		HF1				SH		O	T		
	Halichoeres poeyi		+	HF1			SH		C			
	Halichoeres radiatus		HF1	HF1	HF1		SH	50	O			Largest of genus and second largest of family in WI.
	Lachnolaimus maximus		HF1	HF1	HF1		SH		S			Largest tropical wrasse, open areas near reefs (gorgonians).
	Thalassoma bifasciatum		HF1				SH		C	R		One of most abundant WI reef fishes.
	Xyrichtys novacula				HF1		1	90	F			
	Xyrichtys splendens				HF1		SH		O			Smaller than *X. novacula*.
Lutjanidae	*Apsilus dentatus*		HF2					120-180				Mainly rocky bottoms; young may be found near surface.
	Lutjanus analis		+	HF2	+		W		O		55.8	More open water over vegetated sand bottom; forms small aggregations.
	Lutjanus apodus	HF2	HF2	HF2	HF2		SH		C		19.0	Most common of family on WI coral reefs; forms aggregations by day.
	Lutjanus buccanella		HF2		HF2		++	150	E			Young in 35-50 m; adults between 80-150 m.
	Lutjanus campechanus		HF2				10	190	E			Mainly in 30-130 m; juveniles in shallow waters and over sand or mud.
	Lutjanus cyanopterus	HF2y	HF2		HF2		W	40	S	T		Large near rocks and reefs; small often on mangrove-lined coasts; least common of shallow water species of WI.
	Lutjanus griseus	HF2	HF2	HF2	HF2	HF2	W	180	S-O		26.6	Various habitats (rock-mangrove).
	Lutjanus jocu	HF2y	HF2		HF2y		W		O		20.3	Adults in reefs; young in estuaries and coastal waters.
	Lutjanus mahagoni	HF2y	HF2	+	+		SH		O		15.2	Coral reef species in clear water.
	Lutjanus synagris		HF2	HF2	HF2		W	400	F			Forms large aggregations, especially during the spawning period.

continued. .

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
	Lutjanus vivanus					HF2	++	>200	S			Very common between 90 and 140 m, near shelf edge; not a real reef species.
	Ocyurus chrysurus	HF2	HF2	HF2y			10	70	C	V-T	17.7	One of the most common and active shallow-water reef fishes of the Caribbean.
Malacanthidae	*Malacanthus plumieri*		+		HF1		10-50	153	O			Sand and rubble near reefs; only shallow-water species of family in West Atlantic.
Megalopidae	*Tarpon atlanticus*	HF							O			
Monacanthidae	*Aluterus monoceros*											
	Aluterus schoepfii		+	HF1,3	HF1,3		++	50	F			
	Aluterus scripta		+	HF1			SH		S			
	Cantherines macrocerus		+				SH		S			
	Cantherines pullus		+				SH	50	O			Most common filefish in WI.
	Monacanthus ciliatus		HF1	HF1	HF1		SH	50	O			Fish of vegetated areas.
	Monacanthus tuckeri		+				SH		O	V		Smallest of WI filefishes.
	Stephanolepis setifer			HF2	HF2		++	80	O			
Mugilidae	*Mugil curema*	HF			HF3		++		O		25.4	Typical in murky waters (estuaries, mangroves, lagoons) but also in clear waters close to the surface.
Mullidae	*Mulloidichthys martinicus*	+	H1	HF1y	HF1		SH		O		16.5	Solitary or in small groups.
	Pseudupeneus maculatus	+	H1	HF1y	HF1		SH	50	O	V	13.7	Solitary, young in seagrass beds.
Muraenidae	*Enchelycore nigricans*		HF1				SH	>12	S			Mainly in very shallow water.
	Echidna catenata		HF1				SH		S			Very shallow water beneath rocks; feeds mainly on crabs.
	Gymnothorax funebris	HF1	HF1		HF1		SH	5	O			Also in mangroves.
	Gymnothorax vicinus		HF1	HF1			SH		O			Secretive.
	Gymnothorax miliaris		HF1				SH	50	S	R		Secretive.
	Lycodontis moringa		HF1				SH	50	O	V		Most common moray in shallow water in WI.
Myliobatidae	*Aetobatus narinari*		HF3	HF3	HF3		SH		S			Coastal surface waters; visitor to reefs; solitary or large schools; feeds on bivalves (cockles, oysters), snails, shrimps, worms, cephalopods, small fish.
Ogcocephalidae	*Ogcocephalus nasutus*		+	HF1	HF1		++		O			Occasionally on reefs.
Ophichthidae	*Myrichthys breviceps*		+	HF1	HF1		SH		O			May be observed in reefs; burrowing in mud or sand.

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Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
	Myrichthys ocellatus		+				SH		O			Feeds primarily on crabs; burrowing in mud or sand.
	Ophichtus ophis			HF1			SH	50	F			Burrowing in mud or sand.
Opisthognathidae	*Opisthognathus aurifrons*		HF1				++		F			
	Opistognathus macrognathus		HF1				++		S			
	Opistognathus maxillosus		HF1				++		O-F			Most common of family.
	Opisthognathus whitehurstii		HF1				++		O			
Ostraciidae	*Acanthostracion polygonius*		HF1				W		S		(17.7)	Least common trunk fish in WI.
	Acanthostracion quadricornis			HF1			SH	80	O		(17.7)	
	Lactophrys bicaudalis		HF1	HF1			SH	50	S		(17.7)	
	Lactophrys trigonus			HF1			SH	50	S-O		(17.7)	Largest of genus.
	Lactophrys triqueter		HF1	F1	F1		SH	50	O	R	(17.7)	
Pempheridae	*Pempheris schomburgki*		H1F2				SH		O			Nocturnal.
	Pempheris poeyi		H1F2						O			Nocturnal.
Pomacanthidae	*Centropyge argi*		HF1				D	>30	O			Not common in shallow water, moderately common in 30 m depth.
	Holacanthus ciliaris		HF1				SH		O	R	(20.3)	
	Holacanthus tricolor		HF1				SH		O		15.2	Clear reef areas.
	Pomacanthus arcuatus	+	HF1				SH		O	T	27.9	Usually in pairs.
	Pomacanthus paru		HF1				SH		O		(20.3)	Young are often cleaners.
Pomacentridae	*Abudefduf saxatilis*		HF1				SH	<15	O			
	Abudefduf taurus		HF1	HF1			++	<5	O			Largest of WI pomacentrids.
	Chromis cyanea		H1F3				W		O	R		
	Chromis multilineata		H1F3				W	>40	O	R		
	Microspathodon chrysurus		HF1				SH	7-10	O			Second in size to *A. taurus;* one of most common *reef* fishes in WI.
	Pomacentrus partitus		HF1						O	R		
	Stegastes fuscus		+				SH		C			One of most abundant of all fish.
	Stegastes leucostictus		+				SH		C			Very common.
	Stegastes planifrons		+				SH		S	R		Abundant.
	Stegastes variabilis		+				SH		O	R		Abundant.
Priacanthidae	*Heteropriacanthus cruentatus*		HF2				SH	-	S			Nocturnal, solitary.
	Priacanthus arenatus		HF2				SH	75	O			Nocturnal, occurs in small aggregations.
Rachycentridae	*Rachycentron canadum*		HF3			HF3	W		S			Clear water reef areas; mainly pelagic.
Scaridae	*Cryptotomus roseus*			+	+		8	60			(13.7)	
	Nicholsina usta			+			++	83			(13.7)	
	Scarus coelestinus		H1	F1			SH	<20	F		(13.7)	Second largest after *S. guacamaia*.
	Scarus coeruleus		+	+			SH		O		(13.7)	

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
	Scarus guacamaia	HF1y	HF1	F1			W		O-F		(13.7)	Adults mainly on reefs, young often in mangrove areas.
	Scarus iserti		HF1	F1			SH		F	V	(13.7)	Most common of genus in WI and smallest of genus in Atlantic.
	Scarus taeniopterus		HF1				W		O	T	(13.7)	
	Scarus vetula		HF1	HF1			SH		A	R	(13.7)	One of the most common scarids in WI reefs.
	Sparisoma aurofrenatum		HF1	HF1	+		W		F	V	(13.7)	Young mainly in seagrass beds.
	Sparisoma chrysopterum		HF1	HF1	+		SH		F		(13.7)	Second in abundance to *S. radians* in WI reefs.
	Sparisoma radians			HF1			SH		O		(13.7)	Smallest of genus.
	Sparisoma rubripinne		HF1	HF1			SH		F		(13.7)	Most common of genus in inshore portions of WI reefs.
	Sparisoma viride		HF1	HF1			SH		C	V	(13.7)	Young in vegetated areas.
Sciaenidae	*Equetus lanceolatus*		H1F2		+		SH		O			Found in deeper water than other members of genus.
	Equetus punctatus		HF				SH		S			Largest of genus in WI; secretive by day in reefs and usually solitary.
	Odontoscion dentex	+	H1F2		F2		SH		O			Nocturnal, hides in caves by day.
	Pareques acuminatus		HF				SH		O			Small groups; hides under rock ledges by day.
Scombridae	*Euthynnus aletteratus*					F4	W		O			Green shelf waters, forms compact schools.
	Scomberomorus cavalla		F1,3		F1,3	F1,3	W		O		81.2	Largest of genus, midwater but often near bottom.
	Scomberomorus maculatus										38.1	
	Scomberomorus regalis		HF				W		O	T		Most common member of genus; clear inshore waters.
Scorpaenidae	*Scorpaena brasiliensis*		HF1		HF1		++	100	F			
	Scorpaena grandicornis			HF1			SH		S-O			
	Scorpaena inermis		HF1	HF1			W		S			
	Scorpaena plumieri		HF1				SH		O			Largest and most common of genus on shallow WI reefs.
	Scorpaenodes caribbaeus		HF1				SH		O			Common inshore fish but rarely seen.
Serranidae	*Alphestes afer*		HF1	HF1			SH		S-O		17.7	Much more common in seagrass beds than on reefs.
	Cephalopholis cruentata		HF1				W	>70	O	R	19.0	Most abundant on reefs with ledges and caves.
	Cephalopholis fulva		HF1				W	40	O		19.0	One of the most common groupers on WI reefs.
	Dermatolepis inermis		HF1						O			Secretive.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
	Diplectrum formosum				HF1		1	50	S			At the bases of reefs, known in WI only from Cuba and islands of the southern Caribbean.
	Epinephelus adscensionis		HF1				SH	>30	O			Most common in shallow water on rocky bottom.
	Epinephelus guttatus		HF1				W		O		17.7	Most common of genus in WI.
	Epinephelus itajara		HF1		HF1		++		O			Largest of family.
	Epinephelus morio		HF1				5	150	S			Abundant in Florida and Gulf of Mexico.
	Epinephelus striatus		HF1	HF1			SH	90	O	R	31.7	One of the most important commerciel fishes of WI; young in seagrass beds.
	Hypoplectrus aberrans		HF1				SH		O			
	Hypoplectrus chlorurus		HF1				SH		O			
	Hypoplectrus nigricans		HF1				SH		O			Largest of genus.
	Hypoplectrus puella		HF1				SH		C	R		Most common of genus in WI.
	Mycteroperca bonaci		HF1				W		S		29.2	Rare in Virgin Islands and Puerto Rico, common in the Bahamas, Cuba, Florida Keys and southern Caribbean.
	Mycteroperca cidi		HF1		HF1y		W	>20	E			Common inshore species at coast of Venezuela and offshore islands, juveniles over sand, larger >20 m depth.
	Mycteroperca interstitialis	HF1	HF1		HF1y		W	>55	S			Small- and middle-sized individuals occur in mangrove-lined lagoons.
	Mycteroperca microlepis		HF1	HF1			48	80	E			Depth refers to catch on Campeche Bank.
	Mycteroperca phenax		HF1				64	90	E			Depth refers to catch on Campeche Bank.
	Mycteroperca rubra	HF1y	HF1		HF1y				S			Rare in the north, common to the south; also common (especially young) in mangrove-lined lagoons.
	Mycteroperca tigris		HF1				W	>30	O		30.4	
	Mycteroperca venenosa		HF1				W	>80	S			Most common species of genus generally in WI.
	Paranthias furcifer					H2F3	D	70	S			Feeds on zooplankton in midwater, forms small schools.
	Serranus dewegeri		HF1	HF1y			++		E			Southern Caribbean; one of the most abundant inshore fishes of rocky bottom around islands off Venezuela.
	Serranus tabacarius		HF1				5	>20	O			
	Serranus tigrinus		HF1				W		S			Most common species of genus on WI reefs but nowhere abundant.
	Serranus tortugarum		+		HF1				O			Small groups, hovering over a patch of coral rubble or an old conch shell.

continued...

Table 3.1 continued

Family	Species	Mangroves/ estuaries	Coral reefs	Seagrass beds/ algal mats	Sand and mudflats	Offshore reef	Average depth/ upper limit	Depth limit (m)	Abundance	Type	Average size* (cm)	Remarks
Sparidae	*Archosargus rhomboidalis*	HF1	+	HF1			++		S-O		7.6	Rare on coral reefs; more common near mangroves and on vegetated areas.
	Calamus bajonado		HF1	HF1	HF1		6	45	S		(17.7)	Largest of genus; clear water; large adults usually solitary.
	Calamus calamus		HF1	HF1y	HF1y		6	75	O		(17.7)	
	Calamus penna		+	+			3	87	S		(17.7)	
	Calamus pennatula		HF1	HF1	HF1		W,Sy	85	S-O	T	(17.7)	Most common of genus in WI; young in shallower waters.
	Diplodus caudimacula		HF1		HF1		++		O		(17.7)	Shallow, calm waters; young may form aggregations.
Sphyraenidae	*Sphyraena barracuda*	HF3y	HF3	HF3y	HF3y	HF3	W		O		76.2	Openwater species; young in aggregations, larger, solitary over reefs.
	Sphyraena picudilla		HF2	HF2	HF2		W		S			Small schooling species, mainly over seagrass beds; uncommon in VI.
Sphyrnidae	*Sphyrna lewini*		+	+	+	+	W		S			Young occur mostly in coastal waters; feed on pelagic fish (including smaller sharks and rays), squids, crabs, sting rays.
	Sphyrna tiburo		HF1		HF1		10-25	80	O			Often preyed upon by larger sharks; feeds on crabs and shrimps, less on clams, octopus and small fishes.
Syngnathidae	*Syngnathus* sp.		+							R		
Synodontidae	*Synodus foetens*				HF1		++		O			Not a reef fish.
	Synodus intermedius		HF1		HF1		++		F	V		Largest and most common of family in WI.
	Synodus synodus				HF1		++		O			
Tetraodontidae	*Canthigaster rostrata*		HF1	HF1			W		O-C	R		
	Sphoeroides spengleri		HF1	HF1	HF1		SH	30	O			Solitary.
	Sphoeroides testudineus	HF1			HF1		++		S			One of most common species in mangrove areas and estuarine coastlines; may form huge aggregates.
Triakidae	*Mustelus canis*		+	+	HF1		W	>150	S			Coastal waters, occasionally in fresh water; on muddy bottom; feeds on crabs, lobsters, small fish and molluscs.

Table 3.2. Number of fishers and vessels in Puerto Rico and U.S. Virgin Islands 1970-1981 (reproduced from Table 6 in CFMC 1985).

Year	Number of fishers: Puerto Rico	Number of fishers: Virgin Islands	Number of vessels: Puerto Rico	Number of vessels: Virgin Islands
1970	1,082	400	869	-
1971	994	-	811	-
1972	968	-	797	-
1973	927	-	785	-
1974	1,182	-	835	-
1975	1,230	450	902	-
1976	-	509	-	-
1977	1,368	846	1,036	-
1978	1,442	265	1,073	231
1979	-	281	-	223
1980	1,447	355	1,084	237
1981	-	397	-	-
1982	1,872	578	1,449	-

-:Data not available.

Table 3.3. Relative importance of the different gear in the fisheries of the PRVI area (adapted from Table 5 in CFMC 1985).

Gear/ product	Number of units	Puerto Rico (1980) Catch (t)	Puerto Rico (1980) %[a]	US Virgin Islands (1979-1980) Catch (t)	US Virgin Islands (1979-1980) %[a]
Fish trap	12,586	1,268	42.0	1,098	66.0
Lobster pot	2,252	29	1.0	109	6.5
Fishnet	-	-	-	215	13.0
Beach seine	238	249	8.2	-	-
Gillnet	870	264	8.7	-	-
Castnet	827	19	0.6	-	-
Hookfish	-	-	-	147	8.8
Handline	2,391	635	21.0	-	-
Troll line	2,057	209	6.9	-	-
Trotline	331	11	0.4	-	-
Spear	341	168	5.6	20	1.2
Hand	-	170	5.6	-	-
Hand lobster	-	-	-	11	0.7
Conch	-	-	-	57	3.4
Whelk	-	-	-	6	0.4
Total	-	3,022	100.0	1,663	100.0

[a]Percent of total catch from all gears.

maculatus) and yellow goatfish (*Mulloidichthys martinicus*). Based on biostatistical surveys, Jacobsen and Browder (1987) calculated that these 10 species contribute approximately 40% to Virgin Islands landings, by weight, and 45% to Puerto Rico landings. Table 3.4 gives the average annual catch per trap for Puerto Rico for three years. The landings per year were divided by the total number of traps assuming that the number of hauls remained constant. There was a decline in catch/effort for all the families listed.

Boulon (1986a) listed fish species and invertebrates of commercial importance in the Virgin Islands Biosphere Reserve (Table 3.1). The only catch data available on over 50 individual species are reported in Boulon and Clavijo (1986) based on a study of three commercial fishpot fishers on St. John, US Virgin Islands, from January to June 1984.

Table 3.5. Estimated asymptotic length (L_∞) and weight (W_∞) of Caribbean reef fishes.

Family	Species	L_∞ (cm)		Source	W_∞ (g)	Source
Acanthuridae	*Acanthurus bahianus*	25	FL	Pauly (1978)	288	Randall (1962, 1967, 1968)
	Acanthurus chirurgus	33	FL	Pauly (1978)	820	Munro (1983)
	Acanthurus coeruleus	32	FL	Pauly (1978)	983	Munro (1983)
Albulidae	*Albula vulpes*	82		Beebe and Tee-Van (1928)	7,150	Beebe and Tee-Van (1928), Randall (1962, 1967, 1968)
Antennariidae	*Antennarius multiocellatus*	15	(-)	Randall (1962, 1967, 1968)	70	*
	Antennarius striatus	15	/	Figuereido and Menezes (1977); Randall (1962, 1967, 1968)	70	*
Apogonidae	*Apogon conklini*	5	SL/	Randall (1962, 1967, 1968)	3.3	Smith and Tyler (1972)
	Apogon maculatus	10	/	Randall (1962, 1967, 1968)	37	Smith and Tyler (1972)
Atherinidae	*Allanetta harringtonensis*	8	/	Randall (1962, 1967, 1968)	11	Beebe and Tee-Van (1928)
	Atherinomorus stipes	9	+	Randall (1962, 1967, 1968)	16	Beebe and Tee-Van (1928)
Aulostomidae	*Aulostomus maculatus*	76	/	Randall (1962, 1967, 1968)	777	Beebe and Tee-Van (1928)
Balistidae	*Balistes capriscus*	31		Johnson and Solomon (1984); Randall (1962, 1967, 1968)	611	Polovina and Ralston (1987)
	Balistes vetula	45	FL	Munro (1983); Randall (1962, 1967, 1968)	2,586	Randall (1962, 1967, 1968)
	Canthidermis sufflamen	56	+	Randall (1962, 1967, 1968)	4,783	Munro (1983)
	Melichthys niger	36		Randall (1962, 1967, 1968)	960	*
	Xanthichthys ringens	25		Randall (1962, 1967, 1968)	320	*
Belonidae	*Ablennes hians*	87		Fischer (1978)	751	Beebe and Tee-Van (1928)
	Platybelone argalus argalus	51	/	Randall (1962, 1967, 1968)	150	*
	Strongylura marina	64		Fischer (1978)	300	*
	Strongylura timucu	46	/	Randall (1962, 1967, 1968)	110	*
	Tylosurus acus	135	SL	Fischer (1978)	2,800	*
	Tylosurus crocodilus	107	SL	Fischer (1978)	1,400	*
Blenniidae	*Entomacrodus nigricans*	8.5		Randall (1962, 1967, 1968)	13	*
	Ophioblennius atlanticus	12	/	Randall (1962, 1967, 1968)	35	*
	Parablennius marmoreus	8		Randall (1962, 1967, 1968)	10	*
	Scartella cristata	11		Randall (1962, 1967, 1968)	27	*
Bothidae	*Bothus lunatus*	46	/	Randall (1962, 1967, 1968)	3,000	*
	Bothus ocellatus	18		Randall (1962, 1967, 1968)	180	*
	Paralichthys tropicus	54	%	Randall (1962, 1967, 1968)	5,000	*
Carangidae	*Alectis ciliaris*	91	TL/	Randall (1962, 1967, 1968)	10,700	Randall (1962, 1967, 1968)
	Caranx bartholomaei	81	TL	Munro (1983)	9,862	Munro (1983)
	Caranx crysos	58	TL	Munro (1983); Randall (1962, 1967, 1968)	2,314	Munro (1983)
	Caranx hippos	95	TL	Munro (1983)	8,490	Randall (1962, 1967, 1968)
	Caranx latus	80	%	Randall (1962, 1967, 1968)	6,250	Randall (1962, 1967, 1968)
	Caranx lugubris	80	%	Randall (1962, 1967, 1968)	6,554	Randall (1962, 1967, 1968)
	Caranx ruber	56	%	Randall (1962, 1967, 1968)	3,160	Munro (1983)
	Decapterus macarellus	35	SL	Fischer (1978)	750	*
	Decapterus punctatus	32		Beebe and Tee-Van (1928)	573	Beebe and Tee-Van (1928)
	Elagatis bipinnulatus	107	FL	Fischer (1978)	10,500	Fischer (1978)
	Oligoplites saurus	31	FL%	Fischer (1978)	334%	Fischer (1978)
	Selar crumenophthalmus	40	TL	Figuereido and Menezes (1977); Randall (1962, 1967, 1968)	1,240	Beebe and Tee-Van (1928)
	Selene vomer	50	TL	Figuereido and Menezes (1977)	1,400	*
	Seriola dumerili	194		Randall (1962, 1967, 1968)	80,000	Figuereido and Menezes (1977); Fischer (1978); Randall (1962, 1967, 1968)
	Seriola rivoliana	97		Fischer (1978)	24,000	Fischer (1978); Randall (1962, 1967, 1968)
	Trachinotus falcatus	105	FL	Fischer (1978)	36,000	Fischer (1978)
	Trachinotus goodei	50		Figuereido and Menezes (1977); Fischer (1978); Randall (1962, 1967, 1968)	3,900	*
Carcharhinidae	*Carcharhinus acronotus*	200	L_{max}	Fischer (1978)	90,000	*
	Carcharhinus falciformis	350	L_{max}	Fischer (1978)	350,000	*
	Carcharhinus leucas	350	L_{max}	Fischer (1978)	350,000	Clark and von Schmidt (1965)
	Carcharhinus limbatus	247	L_{max}	Fischer (1978)	116,000	Clark and von Schmidt (1965)
	Carcharhinus longimanus	350	L_{max}	Fischer (1978)	350,000	*
	Carcharhinus perezi	230	L_{max}	Fischer (1978)	100,000	*
	Galeocerdo cuvier	457		Pauly (1978)	672,000	Clark and von Schmidt (1965)
	Negaprion brevirostris	284		Pauly and Palomares (1986)	110,000	Collette and Nauen (1983)
	Rhizoprionodon porosus	107		Randall (1962, 1967, 1968)	5,020	Randall (1962, 1967, 1968)
Chaetodontidae	*Chaetodon aculeatus*	9.5	%	Randall (1962, 1967, 1968)	19	Munro (1983)
	Chaetodon capistratus	14.2		Munro (1983)	120	*
	Chaetodon ocellatus	16.8		Munro (1983)	200	*
	Chaetodon sedentarius	14.7	%	Randall (1962, 1967, 1968)	130	*
	Chaetodon striatus	15.8		Munro (1983)	164	Beebe and Tee-Van (1928)

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Table 3.5 continued

Family	Species	L_∞ (cm)		Source	W_∞ (g)	Source
Cirrhitidae	*Amblycirrhitus pinos*	8	(SL)	Beebe and Tee-Van (1928)	15	Smith and Tyler (1972)
Clinidae	*Labrisomus nuchipinnis*	20		Randall (1962, 1967, 1968)	137	Smith and Tyler (1972)
Clupeidae	*Harengula clupeola*	18	%	Figuereido and Menezes (1977)	240	*
	Harengula humeralis	22		Randall (1962, 1967, 1968)	440	*
	Jenkinsia lamprotaenia	6.8	%	Fischer (1978)	13	*
	Opisthonema oglinum	26	%	Fischer (1978)	730	Beebe and Tee-Van (1928)
Congridae	*Heteroconger halis*	48		Randall (1962, 1967, 1968)	150	*
Coryphaenidae	*Coryphaena hippurus*	151		Pauly and Palomares (1986)	147,000	Pauly and Palomares (1986)
Dactylopteridae	*Dactylopterus volitans*	45	+	Fischer (1978)	1,825	Beebe and Tee-Van (1928); Figuereido and Menezes (1977)
Dasyatidae	*Dasyatis americana*	300		Fischer (1978)	122,000	*
	Urolophus jamaicensis	76		Randall (1962, 1967, 1968)		
Diodontidae	*Chilomycterus antennatus*	26.3	%	Randall (1962, 1967, 1968)	1,420	Beebe and Tee-Van (1928)
	Chilomycterus antillarum	26.3	%	Randall (1962, 1967, 1968)	1,420	*
	Diodon holocanthus	51		Randall (1962, 1967, 1968)	11,300	*
	Diodon hystrix	60	%	Randall (1962, 1967, 1968)	18,446	Beebe and Tee-Van (1928)
Echeneidae	*Echeneis naucrates*	85	%	Randall (1962, 1967, 1968)	2,080	Randall (1962, 1967, 1968)
	Remora remora	79		Randall (1962, 1967, 1968)	1,700	*
Elopidae	*Elops saurus*	47		Pauly (1978)	444	Beebe and Tee-Van (1928)
Emmelichthyidae	*Inermia vittata*	23	(SL)/	Randall (1962, 1967, 1968)	282	Smith and Tyler (1972)
Engraulidae	*Anchoa hepsetus*	15		Fischer (1978)	50	Beebe and Tee-Van (1928);
	Anchoa lyolepis	8		Fischer (1978); Randall (1962, 1967, 1968)	8	Figuereido and Menezes (1977)
	Anchoa mitchilli	10		Fischer (1978)	15	*
	Anchoa parva	6		Fischer (1978)	3	*
Ephippidae	*Chaetodipterus faber*	90		Fischer (1978); Randall (1962, 1967, 1968)	9,000	Beebe and Tee-Van (1928); Randall (1962, 1967, 1968)
Exocoetidae	*Exocoetus volitans*	18	/	Fischer (1978)	90	*
Fistulariidae	*Fistularia tabacaria*	183		Randall (1962, 1967, 1968)	10,800	*
Gerreidae	*Eucinostomus argenteus*	30	%	Figuereido and Menezes (1977)	290	*
	Eucinostomus lefroyi					
	Gerres cinereus	40		Beebe and Tee-Van (1928); Fischer (1978); Randall (1962, 1967, 1968)	690	Randall (1962, 1967, 1968)
Ginglymostomatidae	*Ginglymostoma cirratum*	430		Fischer (1978)	500,000	Figuereido and Menezes (1977)
Gobiidae	*Bathygobius soporator*	15		Randall (1962, 1967, 1968)	70	*
	Coryphopterus glaucofraenum	8	(SL)	Randall (1962, 1967, 1968)	10.5	Smith and Tyler (1972)
	Gnatholepis thompsoni	6	SL/	Randall (1962, 1967, 1968)	4.1	Smith and Tyler (1972)
	Gobiosoma evelynae	5	(SL)	Randall (1962, 1967, 1968)	2.2	Smith and Tyler (1972)
	Gobiosoma horsti	5	(SL)	Randall (1962, 1967, 1968)	3.1	Smith and Tyler (1972)
Grammidae (Serranidae)	*Gramma loreto*	8	+	Randall (1962, 1967, 1968)	15	*
	Gramma melacara	10	-	Randall (1962, 1967, 1968)	30	*
	Rypticus saponaceus	29.5	(SL%)	Randall (1962, 1967, 1968)	685	Smith and Tyler (1972)
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*	63	TL%	Randall (1962, 1967, 1968)	4,770 %	Randall (1962, 1967, 1968)
	Anisotremus virginicus	30	/	Randall (1962, 1967, 1968)	850	Munro (1983)
	Haemulon album	65	FL	Pauly (1980)	5,300	Munro (1983)
	Haemulon aurolineatum	23	FL	Munro (1983)	188	Munro (1983)
	Haemulon bonariense	30	FL	Munro (1983)	385	Munro (1983)
	Haemulon boschmae	19	/	Fischer (1978); Randall (1962, 1967, 1968)		
	Haemulon carbonarium	38	%	Randall (1962, 1967, 1968)	861	Munro (1983)
	Haemulon chrysargyreum	24	%	Randall (1962, 1967, 1968)	251	Munro (1983)
	Haemulon flavolineatum	27	/	Randall (1962, 1967, 1968)	480	Munro (1983)
	Haemulon macrostomum	45	%	Randall (1962, 1967, 1968)	1,795	Randall (1962, 1967, 1968)
	Haemulon melanurum	30	FL	Munro (1983)	427	Munro (1983)
	Haemulon parrai	41		Randall (1962, 1967, 1968)	1,265	*
	Haemulon plumieri	42		Munro (1983)	1,360	Munro (1983)
	Haemulon sciurus	41	%	Randall (1962, 1967, 1968)	1,185	Randall (1962, 1967, 1968)
	Haemulon steindachneri	27		Randall (1962, 1967, 1968)	360	*
	Haemulon striatum	28		Randall (1962, 1967, 1968)	400	*
	Orthopristis chrysoptera	46		Darcy (1983); Fischer (1978)	900	Darcy (1983)
	Orthopristis poeyi	24		Fischer (1978)	130	*
	Orthopristis ruber	33		Randall (1962, 1967, 1968)	330	*

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Table 3.5 continued

Family	Species	L∞ (cm)		Source	W∞ (g)	Source
	Pomadasys corvinaeformis	25		Fischer (1978)	386	Beebe and Tee-Van (1928)
	Pomadasys crocro	33		Figuereido and Menezes (1977)	890	*
Hemiramphidae	*Hemiramphus balao*	40		Fischer (1978)	614	Berkeley and Houde (1978)
	Hemiramphus brasiliensis	32.5		Pauly and Murphy (1982)	298	Berkeley and Houde (1978)
	Hyporamphus unifasciatus	27		Fischer (1978)	167	Beebe and Tee-Van (1928)
Holocentridae	*Holocentrus ascensionis*	37	TL%	Randall (1962, 1967, 1968)	838	Munro (1983)
	Holocentrus coruscus	13		Randall (1962, 1967, 1968)	57	Beebe and Tee-Van (1928)
	Holocentrus rufus	32		Fischer (1978); Randall (1962, 1967, 1968)	583	Munro (1983)
	Myripristis jacobus	23	%	Randall (1962, 1967, 1968)	397	Beebe and Tee-Van (1928)
	Neoniphon marianus	19	%	Randall (1962, 1967, 1968)	163	Beebe and Tee-Van (1928)
	Plectrypops retrospinis	13		Randall (1962, 1967, 1968)	57	*
	Sargocentron vexillarium	18	-	Randall (1962, 1967, 1968)	181	Beebe and Tee-Van (1928)
Kyphosidae	*Kyphosus incisor*	70	%	Randall (1962, 1967, 1968)	6,122	Randall (1962, 1967, 1968)
	Kyphosus sectatrix	80	%	Randall (1962, 1967, 1968)	9,139	Randall (1962, 1967, 1968)
Labridae	*Bodianus rufus*	40		Fischer (1978); Randall (1962, 1967, 1968)	1,560	Beebe and Tee-Van (1928)
	Clepticus parrae	25		Randall (1962, 1967, 1968)	447	Beebe and Tee-Van (1928)
	Halichoeres bivittatus	23	%	Randall (1962, 1967, 1968)	230	*
	Halichoeres garnoti	19		Randall (1962, 1967, 1968)	132	Beebe and Tee-Van (1928)
	Halichoeres maculipinna	11		Randall (1962, 1967, 1968)	25	*
	Halichoeres poeyi	20		Randall (1962, 1967, 1968)	150	*
	Halichoeres radiatus	46		Randall (1962, 1967, 1968)	2,283	Beebe and Tee-Van (1928)
	Lachnolaimus maximus	86	%	Randall (1962, 1967, 1968)	7,728	Randall (1962, 1967, 1968)
	Thalassoma bifasciatum	17		Pauly (1978)	97	Beebe and Tee-Van (1928)
	Xyrichtys novacula	23	%	Randall (1962, 1967, 1968)	230	*
	Xyrichtys splendens	14		Randall (1962, 1967, 1968)	50	*
Lutjanidae	*Apsilus dentatus*	65	TLf	Pauly (1980)	4,000	Pauly (1980)
		67	TLm	Pauly (1980)	4,500	Pauly (1980)
	Lutjanus analis	74	FL%	Randall (1962, 1967, 1968)	5,511	Randall (1962, 1967, 1968)
	Lutjanus apodus	59	FL%	Randall (1962, 1967, 1968)	3,502	Randall (1962, 1967, 1968)
	Lutjanus buccanella	60	TLf	Pauly (1980)	3,200	Pauly (1980)
		53	TLm	Pauly (1980)	1,890	Pauly (1980)
	Lutjanus campechanus	95	TL	Polovina and Ralston (1987)	18,000	Beebe and Tee-Van (1928)
	Lutjanus cyanopterus	160		Fischer (1978)	70,000	Randall (1962, 1967, 1968)
	Lutjanus griseus	55		Pauly (1978)	1,590	Beebe and Tee-Van (1928)
	Lutjanus jocu	83	%	Randall (1962, 1967, 1968)	13,380	Randall (1962, 1967, 1968)
	Lutjanus mahagoni	40	%	Randall (1962, 1967, 1968)	980	*
	Lutjanus synagris	43	FL%	Munro (1983)	1,213	Munro (1983)
	Lutjanus vivanus	70	FL	Munro (1983)	4,700	*
	Ocyurus chrysurus	75	TL%	Randall (1962, 1967, 1968)	3,570	Munro (1983)
	Pristipomoides macrophthalmus	37	FL%m	Munro (1983)		
	Rhomboplites aurorubens	63		Polovina and Ralston (1987)		
Malacanthidae	*Malacanthus plumieri*	61	/	Randall (1962, 1967, 1968)	1,126	Randall (1962, 1967, 1968)
Megalopidae	*Tarpon atlanticus*	250		Fischer (1978)	160,000	Beebe and Tee-Van (1928); Randall (1962, 1967, 1968)
Monacanthidae	*Aluterus monoceros*	61	+	Randall (1962, 1967, 1968)	2,500	*
	Aluterus schoepfii	51	/	Randall (1962, 1967, 1968)	1,892	Beebe and Tee-Van (1928)
	Aluterus scripta	76	%	Randall (1962, 1967, 1968)	2,941	Randall (1962, 1967, 1968)
	Cantherines macrocerus	44	%	Randall (1962, 1967, 1968)	2,700	*
	Cantherines pullus	19	mean	Randall (1962, 1967, 1968)	220	Beebe and Tee-Van (1928)
	Monacanthus ciliatus	20		Fischer (1978)	448	Beebe and Tee-Van (1928)
	Monacanthus tuckeri	10	%	Randall (1962, 1967, 1968)	24	Smith and Tyler (1972)
	Stephanolepis setifer	19	%	Randall (1962, 1967, 1968)	220	*
Mugilidae	*Mugil curema*	38		Randall (1962, 1967, 1968)	767	Beebe and Tee-Van (1928)
Mullidae	*Mulloidichthys martinicus*	35	mean	Pauly (1980)	440	Munro (1983)
	Pseudupeneus maculatus	28	/	Munro (1983); Randall (1962, 1967, 1968)	393	Munro (1983)
Muraenidae	*Enchelycore nigricans*	100		Fischer (1978)	900	*
	Echidna catenata	71		Randall (1962, 1967, 1968)	600	*
	Gymnothorax funebris	190		Fischer (1978); Randall (1962, 1967, 1968)	12,000	Randall (1962, 1967, 1968)
	Gymnothorax miliaris	50		Figuereido and Menezes (1977); Fischer (1987); Randall (1962, 1967, 1968)	201	Smith and Tyler (1972)
	Gymnothorax vicinus	122	/	Fischer (1978); Randall (1962, 1967, 1968)	3,000	*
	Lycodontis moringa	100		Fischer (1978); Smith and Tyler (1972)	950 mean	Beebe and Tee-Van (1928); Smith and Tyler (1972)
Myliobatidae	*Aetobatus narinari*	370	Len	Fischer (1978)	230,000	Figuereido and Menezes (1977)
		280	Wid	Fischer (1978)		

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Table 3.5 continued

Family	Species	L∞ (cm)		Source	W∞ (g)	Source
Ogcocephalidae	*Ogcocephalus nasutus*	28	/	Randall (1962, 1967, 1968)	641	Beebe and Tee-Van (1928)
Ophichthidae	*Myrichthys breviceps*	91	+	Randall (1962, 1967, 1968)	640	*
	Myrichthys ocellatus	91	/	Randall (1962, 1967, 1968)	640	*
	Ophichtus ophis	135		Randall (1962, 1967, 1968)	2,091	Randall (1962, 1967, 1968)
Opisthognathidae	*Opisthognathus aurifrons*	10	-	Randall (1962, 1967, 1968)	30	*
	Opistognathus macrognathus	20	-	Randall (1962, 1967, 1968)	240	*
	Opistognathus maxillosus	13	/	Randall (1962, 1967, 1968)	65	*
	Opisthognathus whitehurstii	8		Randall (1962, 1967, 1968)	15	*
Ostraciidae	*Acanthostracion polygonius*	41	%	Randall (1962, 1967, 1968)	2,200	*
	Acanthostracion quadricornis	46	/	Randall (1962, 1967, 1968)	3,050	*
	Lactophrys bicaudalis	45		Fischer (1978)	5,572	Beebe and Tee-Van (1928)
	Lactophrys trigonus	46	+	Randall (1962, 1967, 1968)	3,052	Beebe and Tee-Van (1928)
	Lactophrys triqueter	30		Fischer (1978); Randall (1962, 1967, 1968)	1,394 1,755	Beebe and Tee-Van (1928) Smith and Tyler (1972)
Pempheridae	*Pempheris schomburgki*	15		Randall (1962, 1967, 1968)	100	*
	Pempheris poeyi	10	/	Randall (1962, 1967, 1968)	30	*
Pomacanthidae	*Centropyge argi*	7		Randall (1962, 1967, 1968)	10	*
	Holacanthus ciliaris	46		Randall (1962, 1967, 1968)	1,988	Randall (1962, 1967, 1968)
	Holacanthus tricolor	36	%	Munro (1983)	1,306	Munro (1983)
	Pomacanthus arcuatus	60		Fischer (1978); Munro (1983); Randall (1962, 1967, 1968)	12,407	Beebe and Tee-Van (1928)
	Pomacanthus paru	43	%	Randall (1962, 1967, 1968)	2,769	Munro (1983)
Pomacentridae	*Abudefduf saxatilis*	20		Fischer (1978)	483	Beebe and Tee-Van (1928)
	Abudefduf taurus	25		Fischer (1978)	900	*
	Chromis cyanea	13	/	Beebe and Tee-Van (1928); Randall (1962, 1967, 1968)	93	Beebe and Tee-Van (1928)
	Chromis multilineata	20	SL	Fischer (1978)	339	Smith and Tyler (1972)
	Microspathodon chrysurus	20		Fischer (1978)	412	Beebe and Tee-Van (1928)
	Stegastes fuscus	15	/	Randall (1962, 1967, 1968)	168	Beebe and Tee-Van (1928)
	Stegastes leucostictus	10		Randall (1962, 1967, 1968)	50	*
	Stegastes planifrons	11	TL	Pauly (1978)	68	Smith and Tyler (1972)
	Stegastes variabilis	10	+	Randall (1962, 1967, 1968)	54	Smith and Tyler (1972)
Pomatomidae	*Pomatomus saltator*	115		Pauly (1978)		
Priacanthidae	*Heteropriacanthus cruentatus*	30		Randall (1962, 1967, 1968)	700	*
	Priacanthus arenatus	40		Fischer (1978); Randall (1962, 1967, 1968)	1,653	Beebe and Tee-Van (1928)
Rachycentridae	*Rachycentron canadum*	160		Pauly (1978)	33,400	Randall (1962, 1967, 1968)
Scaridae	*Cryptotomus roseus*	13	( )	Randall (1962, 1967, 1968)		
	Nicholsina usta	31	%	Randall (1962, 1967, 1968)		
	Scarus coelestinus	80	%	Randall (1962, 1967, 1968)	8,556	Randall (1962, 1967, 1968)
	Scarus coeruleus	62		Pauly (1978)	3,720	Randall (1962, 1967, 1968)
	Scarus guacamaia	99	%	Randall (1962, 1967, 1968)	23,000	Randall (1962, 1967, 1968)
	Scarus iserti	20	FL	Munro (1983)	141	Munro (1983)
	Scarus taeniopterus	35	FL	Munro (1983)	1,102	Beebe and Tee-Van (1928)
	Scarus vetula	54	SL%	Randall (1962, 1967, 1968)	5,558	Smith and Tyler (1972)
	Sparisoma aurofrenatum	26	FL	Munro (1983)	324	Munro (1983)
	Sparisoma chrysopterum	42	FL	Fischer (1978); Pauly (1978); Randall (1962, 1967, 1968)	1,510	Munro (1983)
	Sparisoma radians	20	%	Randall (1962, 1967, 1968)	150	*
	Sparisoma rubripinne	46.5		Pauly (1978)	2,734	Randall (1962, 1967, 1968)
	Sparisoma viride	50	FL	Munro (1983)	2,430	Munro (1983)
Sciaenidae	*Equetus lanceolatus*	25		Figuereido and Menezes (1977)	325	Beebe and Tee-Van (1928)
	Equetus punctatus	28	%	Randall (1962, 1967, 1968)	460	Beebe and Tee-Van (1928)
	Odontoscion dentex	25		Figuereido and Menezes (1977)	318	Beebe and Tee-Van (1928)
	Pareques acuminatus	24	mean	Figuereido and Menezes (1977); Randall (1962, 1967, 1968)	280	*
Scombridae	*Auxis rochei*	50	FL	Fischer (1978)	1,800	*
	Auxis thazard	50	FL	Fischer (1978)	1,840	Beebe and Tee-Van (1928)
	Euthynnus aletterafus	93	FL	Collette and Nauen (1983)	12,200	Collette and Nauen (1983)
	Scomberomorus cavalla	137	FL	Pauly (1978)	34,285	Collette and Nauen (1983)
	Scomberomorus maculatus	77	FL	Collette and Nauen (1983)	4,800	Collette and Nauen (1983)
	Scomberomorus regalis	83.5	FL	Collette and Nauen (1983)	4,900	Collette and Nauen (1983)
	Thunnus atlanticus	90		Pauly (1978)		
Scorpaenidae	*Scorpaena brasiliensis*	36	/	Randall (1962, 1967, 1968)	1,600	Beebe and Tee-Van (1928)
	Scorpaena grandicornis	18	/	Randall (1962, 1967, 1968)	212	Beebe and Tee-Van (1928)
	Scorpaena inermis	>7		Randall (1962, 1967, 1968)	10	*
	Scorpaena plumieri	43	/	Randall (1962, 1967, 1968)	4,330	Beebe and Tee-Van (1928)
	Scorpaenodes caribbaeus	13	/	Randall (1962, 1967, 1968)	80	*

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Table 3.5 continued

Family	Species	L_∞ (cm)		Source	W_∞ (g)	Source
Serranidae	*Alphestes afer*	33		Fischer (1978)	1,202	Beebe and Tee-Van (1928); Figuereido and Meneses (1977)
	Cephalopholis cruentata	34		Munro (1983)	691	Munro (1983)
	Cephalopholis fulva	34		Munro (1983)	640	Munro (1983)
	Dermatolepis inermis	85	%	Randall (1962, 1967, 1968)	10,513	Randall (1962, 1967, 1968)
	Diplectrum formosum	31		Fischer (1978); Pauly (1978); Randall (1962, 1967, 1968)	550	*
	Epinephelus adscensionis	50	%	Randall (1962, 1967, 1968)	1,981	Randall (1962, 1967, 1968)
	Epinephelus guttatus	58	%	Randall (1962, 1967, 1968)	2,919	Munro (1983)
	*Epinephelus itajara**	228	%	Randall (1962, 1967, 1968)	381,644	Randall (1962, 1967, 1968)
	Epinephelus morio	71		Fischer (1978)	5,010	Randall (1962, 1967, 1968)
	Epinephelus striatus	100		Pauly (1978); Polovina and Ralston (1987)	23,800	Randall (1962, 1967, 1968)
	Hypoplectrus aberrans	12		Randall (1962, 1967, 1968)	50	*
	Hypoplectrus chlorurus	13		Randall (1962, 1967, 1968)	64	*
	Hypoplectrus nigricans	15		Randall (1962, 1967, 1968)	90	*
	Hypoplectrus puella	13	SL	Randall (1962, 1967, 1968)	64	Randall (1962, 1967, 1968)
	Mycteroperca bonaci	120		Polovina and Ralston (1987)	90,000	Figuereido and Menezes (1977)
	Mycteroperca cidi	114		Randall (1962, 1967, 1968)	77,000	*
	Mycteroperca interstitialis	70		Figuereido and Menezes (1977); Randall (1962, 1967, 1968)	4,000	Figuereido and Menezes (1977)
	Mycteroperca microlepis	110	mean	Pauly (1978); Polovina and Ralston (1987)	70,000	*
	Mycteroperca phenax	72	+	Polovina and Ralston (1987)	43,700	Fischer (1978)
	Mycteroperca rubra	70		Randall (1962, 1967, 1968)	10,719	Fischer (1978)
	Mycteroperca tigris	102		Fischer (1978); Randall (1962, 1967, 1968)	17,043	Randall (1962, 1967, 1968)
	Mycteroperca venenosa	86	FL	Munro (1983); Polovina and Ralston (1987)	12,270	Randall (1962, 1967, 1968)
	Paranthias furcifer	37		Polovina and Ralston (1987)	1,100	Beebe and Tee-Van (1928)
	Serranus dewegeri	32		Randall (1962, 1967, 1968)	700	*
	Serranus tabacarius	18		Randall (1962, 1967, 1968)	141	Beebe and Tee-Van (1928)
	Serranus tigrinus	10		Randall (1962, 1967, 1968)	21	Beebe and Tee-Van (1928)
	Serranus tortugarum	8		Randall (1962, 1967, 1968)	12	*
Sparidae	*Archosargus rhomboidalis*	35		Figuereido and Menezes (1977)	1,200	*
	Calamus bajonado	64		Beebe and Tee-Van (1928)	4,500	Beebe and Tee-Van (1928)
	Calamus calamus	38	mean	Beebe and Tee-Van (1928); Fischer (1978); Randall (1962, 1967, 1968)	1,541	Beebe and Tee-Van (1928)
	Calamus penna	50	%	Figuereido and Menezes (1977)	2,000	*
	Calamus pennatula	39	%	Randall (1962, 1967, 1968)	1,700	*
	Diplodus caudimacula	28		Fischer (1978)	600	*
Sphyraenidae	*Sphyraena barracuda*	178		Pauly (1978); Randall (1962, 1967, 1968)	57,800	Randall (1962, 1967, 1968)
	Sphyraena picudilla	50		Fischer (1978)	1,300	*
Sphyrnidae	*Sphyrna mokarran*	550		Figuereido and Menezes (1977); Randall (1962, 1967, 1968)	711,000 mean	Figuereido and Menezes (1977); Randall (1962, 1967, 1968)
	Sphyrna lewini	420		Fischer (1978)	400,853	Figuereido and Menezes (1977); Randall (1962, 1967, 1968)
	Sphyrna tiburo	150		Fischer (1978)	18,000	*
Synodontidae	*Synodus intermedius*	46		Randall (1962, 1967, 1968)	1,103	Beebe and Tee-Van (1928)
	Synodus foetens	46		Randall (1962, 1967, 1968)	1,100	*
	Synodus synodus	33		Randall (1962, 1967, 1968)	400	*
Tetraodontidae	*Canthigaster rostrata*	11	(SL)	Randall (1962, 1967, 1968)	82	Smith and Tyler (1972)
	Sphoeroides spengleri	15		Fischer (1978)	92	Beebe and Tee-Van (1928)
	Sphoeroides testudineus	30		Fischer (1978)		
Triakidae	*Mustelus canis*	150	/	Fischer (1978)	15,000	*

Symbols:
FL = fork length.
SL = standard length.
TL = total length.
Len = length.
Wid = width.
f = female.
m = male.
mean = mean from several sources or several values in one source
/ = approximate asymptotic size.
+ = rather more than recorded size.
- = rather less than recorded size.
( ) = 'reported' to reach the recorded size.
% = L_{max}/W_{max} transformed into L/W by equation (2.5)/(2.6).
* = calculated with mean 'a' from similarly sized species of genus or family.

Table 3.6. Estimated average biomass of fish species in Virgin Islands reef environments.

Family	Species	Average weight (g/ind.)	Average density (Nm^{-2})	Average biomass (gm^{-2})
Acanthuridae	*Acanthurus bahianus*	74	3.75E-02	2.7750
	Acanthurus chirurgus	212	1.5E-02	3.1800
	Acanthurus coeruleus	254	2.5E-02	6.3500
Albulidae	*Albula vulpes*	1,845	1.25E-05	0.0231
Antennariidae	*Antennarius multiocellatus*	18	1.25E-05	0.0002
	Antennarius striatus	18	1.25E-04	0.0023
Apogonidae	*Apogon conklini*	1	1.26E-02	0.0126
	Apogon maculatus	10	1.25E-03	0.0125
Atherinidae	*Allanetta harringtonensis*	3	1.25E-01	0.3754
	Atherinomorus stipes	4	1.25E-01	0.5000
Aulostomidae	*Aulostomus maculatus*	200	2.5E-03	0.5000
Balistidae	*Balistes capriscus*	158	1.25E-05	0.0020
	Balistes vetula	667	1.38E-03	0.9171
	Canthidermis sufflamen	1,234	1.25E-05	0.0154
	Melichthys niger	248	1.25E-04	0.0310
	Xanthichthys ringens	83	1.25E-04	0.0104
Belonidae	*Ablennes hians*	194	1.25E-05	0.0024
	Platybelone argalus	39	1.25E-03	0.0488
	Strongylura timucu	28	1.25E-03	0.0350
	Tylosurus acus	722	1.25E-04	0.0903
	Tylosurus crocodilus	361	1.25E-03	0.4513
Blenniidae	*Entomacrodus nigricans*	3	1.25E-03	0.0038
	Ophioblennius atlanticus	9	1.25E-03	0.0113
	Parablennius marmoreus	3	1.25E-03	0.0038
	Scartella cristata	7	1.25E-04	0.0009
Bothidae	*Bothus lunatus*	774	1.25E-04	0.0968
	Bothus ocellatus	46	1.25E-05	0.0006
Carangidae	*Alectis ciliaris*	2,761	1.25E-05	0.0345
	Caranx bartholomaei	2,544	1.25E-04	0.3180
	Caranx crysos (fusus)	597	1.38E-04	0.0821
	Caranx latus	1,613	2.5E-04	0.4033
	Caranx lugubris	1,691	1.25E-05	0.0211
	Caranx ruber	815	3.88E-02	31.5813
	Decapterus macarellus	194	1.25E-05	0.0024
	Decapterus punctatus	148	1.25E-04	0.0185
	Elagatis bipinnulatus	2,709	1.25E-05	0.0339
	Oligoplites saurus	86	1.25E-02	1.0750
	Selar crumenophthalmus	320	1.25E-04	0.0400
	Seriola dumerili	20,640	1.25E-05	0.2580
	Seriola rivoliana	6,192	1.25E-05	0.0774
	Trachinotus falcatus	9,288	1.25E-05	0.1161
	Trachinotus goodei	1,006	1.25E-04	0.1258
Carcharhinidae	*Carcharhinus acronotus*	23,220	1.25E-05	0.2903
	Carcharhinus falciformis	90,300	1.25E-05	1.1288
	Carcharhinus leucas	90,300	1.25E-05	1.1288
	Carcharhinus limbatus	29,928	1.25E-05	0.3741
	Carcharhinus longimanus	90,300	1.25E-05	1.1288
	Carcharhinus perezi	25,800	1.25E-04	3.2250
	Galeocerdo cuvieri	173,376	1.25E-04	21.6720

continued...

Table 3.6 continued

Family	Species	Average weight (g/ind.)	Average density (Nm^{-2})	Average biomass (gm^{-2})
	Negaprion brevirostris	28,380	1.25E-04	3.5475
	Rhizoprionodon porosus	1,295	1.25E-04	0.1619
Chaetodontidae	*Chaetodon aculeatus*	5	1.25E-05	0.0001
	Chaetodon capistratus	31	2.5E-03	0.0775
	Chaetodon ocellatus	52	1.25E-05	0.0007
	Chaetodon sedentarius	34	1.25E-05	0.0004
	Chaetodon striatus	42	1.25E-05	0.0005
Cirrhitidae	*Amblycirrhitus pinos*	4	1.38E-04	0.0006
Clinidae	*Labrisomus guppyi*	35	1.25E-02	0.4375
	Labrisomus nuchipinnis	35	1.25E-02	0.4375
Clupeidae	*Harengula clupeola*	62	1.25E-01	7.7500
	Harengula humeralis	114	1.39E-01	15.8175
	Jenkinsia lamprotaenia	3	1.39E+00	4.1625
	Opisthomema oglinum	188	1.25E-02	2.3500
	Sardinella aurita	258	1.25E-02	3.2250
Congridae	*Heteroconger halis*	39	1.25E-02	0.4875
Dactylopteridae	*Dactylopterus volitans*	471	1.25E-02	5.8875
Dasyatidae	*Dasyatis americana*	31,476	1.25E-03	39.3450
Diodontidae	*Chilomycterus antennatus*	366	1.38E-04	0.0503
	Chilomycterus antillarum	366	1.25E-05	0.0046
	Diodon holocanthus	2,915	1.25E-02	36.4739
	Diodon hystrix	4,759	1.25E-04	0.5949
Elopidae	*Elops saurus*	115	1.25E-04	0.0144
Emmelichthyidae	*Inermia vittata*	73	1.25E-02	0.9125
Engraulidae	*Anchoa hepsetus*	13	1.25E-03	0.0163
	Anchoa lyolepis	2	1.25E-03	0.0025
Ephippidae	*Chaetodipterus faber*	2,322	2.5E-04	0.5805
Fistulariidae	*Fistularia tabacaria*	2,786	1.25E-04	0.3483
Gerreidae	*Eucinostomus argenteus*	75	1.25E-02	0.9394
	Gerres cinereus	178	1.39E-02	2.4698
Ginglymostomatidae	*Ginglymostoma cirratum*	129,000	1.25E-04	16.1250
Gobiidae	*Bathygobius soporator*	18	1.38E-04	0.0025
	Coryphopterus glaucofraenum	3	2.5E-02	0.0750
	Gnatholepis thompsoni	1	1.26E-02	0.0126
	Gobiosoma evelynae	0.6	1.25E-01	0.0751
	Gobiosoma horsti	0.8	1.25E-01	0.1001
Grammidae	*Gramma loreto*	4	1.25E-03	0.0050
	Gramma melacara	8	1.25E-04	0.0010
Grammistidae	*Rypticus saponaceus*	177	1.25E-02	2.2147
Haemulidae	*Anisotremus surinamensis*	1,231	1.38E-04	0.1693
	Anisotremus virginicus	219	1.38E-04	0.0301
	Haemulon album	1,367	2.63E-04	0.3588

continued...

Table 3.6 continued

Family	Species	Average weight (g/ind.)	Average density (Nm^{-2})	Average biomass (gm^{-2})
	Haemulon aurolineatum	49	1.26E-02	0.6186
	Haemulon bonariense	99	1.25E-05	0.0012
	Haemulon carbonarium	222	1.25E-04	0.0278
	Haemulon chrysargyreum	65	1.38E-03	0.0894
	Haemulon flavolineatum	124	1.5E-01	18.6000
	Haemulon macrostomum	463	1.25E-05	0.0058
	Haemulon melanurum	110	1.25E-05	0.0014
	Haemulon parrai	326	1.25E-03	0.4075
	Haemulon plumieri	351	1.51E-02	5.3089
	Haemulon sciurus	306	3.88E-03	1.1858
	Pomadasys corvinaeformis	100	1.25E-05	0.0013
	Pomadasys crocro	230	1.25E-05	0.0029
Hemiramphidae	*Hemiramphus balao*	158	1.25E-03	0.1975
	Hemiramphus brasiliensis	77	1.25E-04	0.0096
	Hyporamphus unifasciatus	43	1.25E-04	0.0054
Holocentridae	*Holocentrus ascensionis*	216	2.53E-03	0.5454
	Holocentrus coruscus	15	1.51E-03	0.0227
	Holocentrus rufus	150	1.39E-02	2.0831
	Myripristis jacobus	102	3.88E-04	0.0395
	Neoniphon marianus	42	2.63E-04	0.0110
	Plectrypops retrospinis	15	1.5E-03	0.0225
	Sargocentron vexillarium	47	1.4E-03	0.0658
Kyphosidae	*Kyphosus incisor*	1,579	1.38E-03	2.1711
	Kyphosus sectatrix	2,358	2.5E-03	5.8950
Labridae	*Bodianus rufus*	402	2.5E-04	0.1005
	Clepticus parrae	115	1.25E-02	1.4375
	Halichoeres bivittatus	59	1.38E-02	0.8113
	Halichoeres garnoti	34	1.25E-03	0.0425
	Halichoeres maculipinna	6	1.25E-03	0.0075
	Halichoeres poeyi	39	1.26E-02	0.4924
	Halichoeres radiatus	589	1.25E-04	0.0736
	Lachnolaimus maximus	1,994	1.25E-05	0.0249
	Thalassoma bifasciatum	25	2.5E-02	0.6250
	Xyrichtys novacula	59	1.25E-02	0.7375
	Xyrichtys splendens	13	1.25E-02	0.1625
Lutjanidae	*Lutjanus analis*	1,422	2.63E-04	0.3733
	Lutjanus apodus	904	1.5E-02	13.5600
	Lutjanus cyanopterus	18,060	1.25E-05	0.2258
	Lutjanus griseus	410	1.5E-02	6.1500
	Lutjanus jocu	3,452	1.25E-04	0.4315
	Lutjanus mahagoni	253	1.5E-02	3.7950
	Lutjanus synagris	313	2.5E-03	0.7825
	Ocyurus chrysurus	921	2.75E-02	25.3275
Malacanthidae	*Malacanthus plumieri*	291	1.28E-02	3.7103
Megalopidae	*Tarpon atlanticus*	41,280	1.38E-04	5.6760
Monacanthidae	*Aluterus schoepfii*	488	1.25E-03	0.6100
	Aluterus scripta	759	1.25E-05	0.0095
	Cantherines macrocerus	697	1.25E-05	0.0087
	Cantherines pullus	57	1.25E-04	0.0071
	Monacanthus ciliatus	116	1.25E-02	1.4500
	Monacanthus tuckeri	6	1.26E-03	0.0076
	Stephanolepis setifer	57	1.25E-04	0.0071

continued...

Table 3.6 continued

Family	Species	Average weight (g/ind.)	Average density (Nm^{-2})	Average biomass (gm^{-2})
Mugilidae	*Mugil curema*	198	1.38E-04	0.0272
Mullidae	*Mulloidichthys martinicus*	114	1.5E-02	1.7100
	Pseudupeneus maculatus	101	5.E-03	0.5050
Muraenidae	*Echidna catenata*	155	1.25E-05	0.0019
	Enchelycore nigricans	232	1.25E-05	0.0029
	Gymnothorax funebris	3,096	1.25E-04	0.3870
	Gymnothorax miliaris	52	1.25E-05	0.0007
	Gymnothorax vicinus	774	1.25E-04	0.0968
	Lycodontis moringa	245	1.25E-05	0.0031
Myliobatidae	*Aetobatus narinari*	59,340	1.25E-05	0.7418
Ogcocephalidae	*Ogcocephalus nasutus*	165	1.25E-04	0.0206
Ophichthidae	*Myrichthys breviceps*	165	1.25E-05	0.0021
	Myrichthys ocellatus	165	1.25E-05	0.0021
	Ophichthus ophis	540	1.25E-03	0.6750
Opisthognathidae	*Opisthognathus aurifrons*	8	1.25E-03	0.0100
	Opistognathus macrognathus	62	1.25E-05	0.0008
	Opistognathus maxillosus	17	6.25E-04	0.0106
	Opisthognathus whitehurstii	4	1.25E-03	0.0050
Ostraciidae	*Acanthostracion polygonius*	568	1.28E-03	0.7242
	Acanthostracion quadricornis	787	1.5E-04	0.1181
	Lactophrys bicaudalis	1,438	1.5E-04	0.2157
	Lactophrys trigonus	787	1.28E-03	1.0034
	Lactophrys triqueter	360	2.51E-03	0.9045
Pempheridae	*Pempheris poeyi*	8	1.25E-04	0.0010
	Pempheris schomburgki	26	1.25E-03	0.0325
Pomacanthidae	*Centropyge argi*	3	1.25E-04	0.0004
	Holacanthus ciliaris	513	1.28E-02	6.5407
	Holacanthus tricolor	337	2.5E-04	0.0843
	Pomacanthus arcuatus	3,201	2.51E-03	8.0425
	Pomacanthus paru	714	2.5E-04	0.1785
Pomacentridae	*Abudefduf saxatilis*	125	1.25E-03	0.1563
	Abudefduf taurus	232	1.25E-04	0.0290
	Chromis cyanea	24	1.25E-02	0.3000
	Chromis multilineata	87	1.25E-02	1.0875
	Microspathodon chrysurus	106	1.25E-02	1.3250
	Stegastes fuscus	43	1.26E-01	5.4288
	Stegastes leucostictus	13	1.25E-02	0.1625
	Stegastes planifrons	18	1.25E-02	0.2250
	Stegastes variabilis	14	1.25E-02	0.1750
Priacanthidae	*Heteropriacanthus cruentatus*	181	1.25E-04	0.0226
	Priacanthus arenatus	426	1.25E-04	0.0533
Rachycentridae	*Rachycentron canadum*	8,617	1.25E-05	0.1077
Scaridae	*Scarus coelestinus*	2,207	1.25E-04	0.2759
	Scarus coeruleus	960	1.25E-04	0.1200
	Scarus guacamaia	5,934	1.26E-02	74.9168
	Scarus iserti	36	2.5E-03	0.0900
	Scarus taeniopterus	284	1.25E-04	0.0355
	Scarus vetula	1,434	1.38E-02	19.7175

continued...

Table 3.6 continued

Family	Species	Average weight (g/ind.)	Average density (Nm^{-2})	Average biomass (gm^{-2})
	Sparisoma aurofrenatum	84	1.25E-03	0.1050
	Sparisoma chrysopterum	390	1.38E-02	5.3625
	Sparisoma radians	39	1.25E-01	4.8799
	Sparisoma rubripinne	705	1.25E-03	0.8813
	Sparisoma viride	627	1.38E-03	0.8621
Sciaenidae	*Equetus lanceolatus*	84	1.25E-04	0.0105
	Equetus punctatus	119	1.25E-04	0.0149
	Odontoscion dentex	82	2.5E-04	0.0205
	Paregues acuminatus	72	1.25E-05	0.0009
Scombridae	*Euthynnus aletteratus*	3,148	1.25E-04	0.3935
	Scomberomorus cavalla	8,846	1.38E-04	1.2163
	Scomberomorus regalis	1,264	1.38E-03	1.7380
Scorpaenidae	*Scorpaena brasiliensis*	413	1.25E-03	0.5163
	Scorpaena grandicornis	55	6.25E-05	0.0034
	Scorpaena inermis	3	1.25E-03	0.0038
	Scorpaena plumieri	1,117	1.38E-04	0.1536
	Scorpaenodes caribbaeus	21	1.25E-04	0.0026
Serranidae	*Alphestes afer*	310	6.25E-05	0.0194
	Cephalopholis cruentata	178	1.25E-04	0.0223
	Cephalopholis fulva	165	1.38E-03	0.2269
	Diplectrum formosum	142	1.25E-05	0.0018
	Epinephelus adscensionis	511	2.5E-04	0.1278
	Epinephelus guttatus	753	2.5E-03	1.8825
	Epinephelus itajara	98,464	1.25E-04	12.3080
	Epinephelus morio	1,293	1.25E-05	0.0162
	Epinephelus striatus	6,140	2.5E-04	1.5350
	Hypoplectrus aberrans	13	1.25E-04	0.0016
	Hypoplectrus chlorurus	17	1.25E-05	0.0002
	Hypoplectrus nigricans	23	1.25E-04	0.0029
	Hypoplectrus puella	17	1.25E-03	0.0213
	Mycteroperca bonaci	23,220	2.5E-04	5.8050
	Mycteroperca interstitialis	1,032	1.25E-05	0.0129
	Mycteroperca rubra	2,766	1.25E-05	0.0346
	Mycteroperca tigris	4,397	1.25E-04	0.5496
	Mycteroperca venenosa	3,166	1.25E-05	0.0396
	Paranthias furcifer	284	1.25E-05	0.0036
	Serranus tabacarius	36	1.25E-05	0.0005
	Serranus tigrinus	5	1.38E-03	0.0069
	Serranus tortugarum	3	1.25E-04	0.0004
Sparidae	*Archosargus rhomboidalis*	310	1.5E-04	0.0465
	Calamus bajonado	1,161	2.5E-05	0.0290
	Calamus calamus	398	2.5E-04	0.0995
	Calamus pennatula	439	1.38E-04	0.0604
	Diplodus caudimacula	155	1.38E-04	0.0213
Sphyraenidae	*Sphyraena barracuda*	14,912	1.5E-03	22.3680
	Sphyraena picudilla	335	1.25E-05	0.0042
Sphyrnidae	*Sphyrna lewini*	103,420	1.25E-05	1.2928
	Sphyrna tiburo	4,644	1.25E-04	0.5805
Synodontidae	*Synodus foetens*	284	1.25E-04	0.0355
	Synodus intermedius	285	1.38E-03	0.3919
	Synodus synodus	103	1.25E-03	0.1288
Tetraodontidae	*Canthigaster rostrata*	21	1.26E-02	0.2651
	Sphoeroides spengleri	24	1.39E-03	0.0333
Triakidae	*Mustelus canis*	3,870	1.25E-05	0.0484

Table 3.7. Estimated growth parameters and natural mortality (M) of Caribbean reef fishes; mean environmental temperature = 28°C.

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
Acanthuridae	*Acanthurus bahianus*	VI	25 FL	0.383	1.00 *	Pauly (1981)*
		Jamaica	28 FL	0.500	2.20 >	Nicholson and Hartsuijker (1982)
		Jamaica	30 FL	0.180	0.58 *	Nicholson and Hartsuijker (1982)
	Acanthurus chirurgus	VI	33 FL	0.254	0.71 *	Pauly (1978)
	Acanthurus coeruleus	VI	32 FL	0.247	0.70 *	Pauly (1978)
		Jamaica	30 Fl	0.500	2.35 >	Nicholson and Hartsuijker (1982)
		Jamaica	28 FL	0.220	0.68 *	Nicholson and Hartsuijker (1982)
Apogonidae	*Apogon conklini*		5 SL/	9.111	12.50 **	Pauly (1978)
	Apogon cyanosoma	Red Sea	9.4	2.904	4.96 *	Pauly (1978)
	Apogon maculatus		10 /	2.278	4.16 **	Pauly (1978)
Atherinidae	*Allanetta harringtonensis*		8 /	1.855	3.87 **	Pauly (1978)
	Atherinomorus stipes		9 +	1.466	3.21 **	Pauly (1978)
Balistidae	*Balistes capriscus*	Gulf of Mexico	31	0.383	0.94 *	Johnson and Salomon (1984)
	Balistes vetula	Jamaica	45 FL	0.570	2.60	Munro (1983)
		Jamaica	54 FL	0.125	0.39 *	Nicholson and Hartsuijker (1982)
		VI	60 TL	0.230	0.56 *	Pauly (1978)
Blenniidae	*Parablennius marmoreus*		8		2.53	Eyberg (1984); annual P/B ratio for the respective genera
	Scartella cristata		11		2.84	Eyberg (1984); annual P/B ratio for the respective genera
Bothidae	*Bothus lunatus*		46 /	0.321	0.75 **	Pauly (1978)
	Bothus ocellatus		18	2.101	3.35 **	Pauly (1978)
Carangidae	*Caranx ruber*	Jamaica	53	0.235	0.59 *	Nicholson and Hartsuijker (1982)
		Jamaica	56	0.240	1.40	Munro (1983)
		Jamaica	57	0.240	1.51	Pauly (1980)
	Decapterus macarellus		35 SL	0.397	0.93 **	Pauly (1978)
	Decapterus punctatus	Red Sea	32	0.318	0.83 *	Pauly (1978)
	Seriola dumerili		194	0.118	0.26 **	Pauly (1978)
	Seriola rivoliana		97	0.473	0.79 **	Pauly (1978)
Carcharhinidae	*Carcharhinus acronotus*		200			
			168	0.159	0.33 *	Pauly (1978)
	Carcharhinus leucas		350			
			305	0.125	0.24 *	Pauly (1978)
	Carcharhinus limbatus		247			
			228	0.139	0.28 *	Pauly (1978)

continued...

Table 3.7 continued

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
	Galeocerdo cuvier		457	0.106	0.19 *	Pauly (1978)
	Negaprion brevirostris		320 +	0.132	0.25 *	Pauly (1978)
	Prionace glauca		383	0.110	0.21 *	Pauly (1978)
Chaetodontidae	*Chaetodon aculeatus*		9.5	1.957	3.82 **	Ralston (1976); daily K * 365; ϕ' for *Chaetodon miliaris*
	Chaetodon capistratus		14.2	0.876	2.02 **	Ralston (1976); daily K * 365; ϕ' for *Chaetodon miliaris*
	Chaetodon ocellatus		16.8	0.626	1.55 **	Ralston (1976); daily K * 365; ϕ' for *Chaetodon miliaris*
	Chaetodon sedentarius		14.7	0.817	1.91 **	Ralston (1976); daily K * 365; ϕ' for *Chaetodon miliaris*
	Chaetodon striatus		15.8	0.708	1.70 **	Ralston (1976); daily K * 365; ϕ' for *Chaetodon miliaris*
Clupeidae	*Harengula clupeola*		18	0.627	0.91 **	Hubold and Mazzetti (1982); ϕ' computed from *Harengula jaguana*
	Harengula humeralis		22	0.420	0.66 **	Hubold and Mazzetti (1982); ϕ' computed from *Harengula jaguana*
	Sardinella aurita		29	0.488	0.68 **	Pauly (1978)
	Sardinella brasiliensis				0.74	Saccardo (1983)
Coryphaenidae	*Coryphaena hippurus*	Florida	135	0.620	0.86 *	Pauly (1978)
		Florida	167	0.530	0.73 *	Pauly (1978)
		mean	151	0.575		
Elopidae	*Elops saurus*	Cuba	47	0.240	0.62 *	Pauly (1978)
Engraulidae	*Anchoa hepsetus*		15	0.585	1.53 **	Pauly (1978)
	Anchoa lyolepis		8	2.055	4.14 **	Pauly (1978)
	Anchoa naso	Ecuador	8.6	1.780	3.69 *	Pauly (1978)
Ginglymostomatidae	*Ginglymostoma cirratum*		430	0.141	0.24 *	Pauly (1978)
Gobiidae	*Bathygobius soporator*		15	0.223	0.81 **	Pauly (1978)
	Coryphopterus glaucofraenum		8 (SL)	0.785	2.20 **	Pauly (1978)
	Gnatholepis thompsoni		6 SL/	1.395	3.48 **	Pauly (1978)
	Gobiosoma evelynae		5 (SL)	1.103	3.14 **	Pauly (1978)
	Gobiosoma horsti		5 (SL)	1.103	3.14 **	Pauly (1978)
	Gobiosoma robustum	Florida	3.6	2.006	5.09 *	Pauly (1978)
		Florida	6	0.813	2.44 *	Pauly (1978)
Haemulidae (Pomadasyidae)	*Haemulon album*	Jamaica	68	0.200	0.79	Munro (1983)
		Jamaica	75	0.200	0.79	Pauly (1980)
	Haemulon aurolineatum	Jamaica	23 FL	0.350	2.37 >	Nicholson and Hartsuijker (1982)
	Haemulon flavolineatum	Jamaica	27 /	0.185	0.90 >	Nicholson and Hartsuijker (1982)
	Haemulon plumieri	Jamaica	42 FL	0.345	1.77	Munro (1983), Pauly (1980)
		Jamaica	42 FL	0.260	0.67 *	Nicholson and Hartsuijker (1982)

continued...

Table 3.7 continued

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
		Jamaica	46 FL	0.150	0.46 *	Nicholson and Hartsuijker (1982)
	Haemulon sciurus	Jamaica	41 FL	0.260	0.68 *	Munro (1983)
Hemiramphidae	*Hemiramphus brasiliensis*	Florida	32.5	0.587	1.23 *	Pauly and Murphy (1982)
Holocentridae	*Holocentrus ascensionis*	Jamaica	30	1.180	4.32	Munro (1983)
		Jamaica	30	0.260	0.74 *	Nicholson and Hartsuijker (1982)
		Jamaica	31	0.235	0.69 *	Nicholson and Hartsuijker (1982)
	Holocentrus coruscus		13	1.973	3.52 **	Pauly (1978)
	Holocentrus diadama	Red Sea	17	1.129	2.27 *	Pauly (1978)
	Holocentrus rufus	Jamaica	23	0.940	4.56	Munro (1983)
	Neoniphon marianus		19	0.924	1.93 **	Pauly (1978)
		Jamaica	23	0.290	0.86 *	Nicholson and Hartsuijker (1982)
	Sargocentron vexillarium		18 -	1.029	2.10 **	Pauly (1978)
Labridae	*Thalassoma bifasciatum*	Florida	17	0.750	1.73 *	Pauly (1978)
Lutjanidae	*Apsilus dentatus*	Jamaica	65 f	0.300	0.83	Pauly (1980)
		Jamaica	67 m	0.650	1.90	Pauly (1980)
	Lutjanus analis		74 FL	0.120	0.20	Bannerot et al.(1987)
		Cuba	81 TL	0.116	0.33 *	Pozo (1979)
		Florida	86 TL	0.153	0.39 *	Polovina and Ralston (1987)
	Lutjanus apodus	Jamaica	63 TL	0.180	0.54	Pauly (1980)
	Lutjanus buccanella	Jamaica	53 TL	0.700	2.24	Pauly (1980)
		Jamaica	60	0.350	1.83	Pauly (1980)
	Lutjanus campechanus	mean	95 TL	0.150	0.37 *	Polovina and Ralston (1987)
	Lutjanus griseus	Cuba	51 FL	0.240	0.61 *	Baez et al. (1980)
		Florida	55 FLm	0.167	0.47 *	Pauly (1978)
	Lutjanus synagris	Cuba	42 FL	0.268	0.69 *	Pauly (1978)
		Florida	50 TL	0.134	0.42 *	Polovina and Ralston (1987)
		Ceara	50	0.231	0.59 *	Pauly (1978)
	Ocyurus chrysurus	Jamaica	75 TL	0.250	0.60	Munro (1983)
		Southern Florida	45 FL	0.279	0.69 *	Johnson and Attramadal (1983)
		Jamaica	60 FL	0.250	0.60	Munro (1983)
		Jamaica	60 FL	0.250	0.62	Pauly (1980)
			69 TL	0.160	0.20	Bannerot et al. (1987)
	Rhomboplites aurorubens		63	0.198	0.50 *	Polovina and Ralston (1987)
Malacanthidae	*Malacanthus plumieri*		61 /	0.147	0.42 **	Pauly (1978)

continued...

Table 3.7 continued

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
	Lutjanus synagris	Cuba	42 FL	0.268	0.69 *	Pauly (1978)
		Florida	50 TL	0.134	0.42 *	Polovina and Ralston (1987)
		Ceara	50	0.231	0.59 *	Pauly (1978)
	Ocyurus chrysurus	Jamaica	75 TL	0.250	0.60	Munro (1983)
		Southern Florida	45 FL	0.279	0.69 *	Johnson and Attramadal (1983)
		Jamaica	60 FL	0.250	0.60	Munro (1983)
		Jamaica	60 FL	0.250	0.62	Pauly (1980)
			69 TL	0.160	0.20	Bannerot et al. (1987)
	Rhomboplites aurorubens		63	0.198	0.50 *	Polovina and Ralston (1987)
Malacanthidae	*Malacanthus plumieri*		61 /	0.147	0.42 **	Pauly (1978)
Megalopidae	*Tarpon atlanticus*	Ceara	263.3 FLf	0.065	0.16 *	Ferreira de Menezes and Pinto Paiva (1966)
		Ceara	206.2 FLm	0.084	0.21 *	Ferreira de Menezes and Pinto Paiva (1966)
Mugilidae	*Mugil curema*		38	0.341	0.83 **	Pauly (1978)
			53	0.1	0.34 *	Alvarez-Lajonchere (1981)
Mullidae	*Mulloidichthys martinicus*	Jamaica	30	0.400	0.98 *	Nicholson and Hartsuijker (1982)
		Jamaica	33	0.190	0.59 *	Nicholson and Hartsuijker (1982)
		Jamaica	35	0.400	1.70	Munro (1983)
	Pseudupeneus maculatus	Jamaica	25 f	0.350	0.95	Munro (1983)
		Jamaica	27 m	0.700	1.89	Munro (1983)
		Jamaica	29	0.270	0.77 *	Nicholson and Hartsuijker (1983)
Pomacanthidae	*Holacanthus ciliaris*		46	0.136	0.43 **	Pauly (1986, Table 2; ϕ for *Holacanthus bermudensis*)
	Holacanthus tricolor		36	0.180	0.55 **	Pauly (1986, Table 2; ϕ for *Holacanthus bermudensis*)
	Pomacanthus arcuatus	Jamaica	41	0.230	0.63 *	Nicholson and Hartsuijker (1983)
		Jamaica	47	0.214	0.57 *	Pauly (1978)
		Jamaica	60		1.78 >	Munro (1983)
	Pomacanthus paru		43	0.231	0.62 **	Based on ϕ' of *Pomacanthus arcuatus*
Pomacentridae	*Stegastes fuscus*		15 /		1.60	Meekan (1988); mortality of 24%/month for *Pomacentrus* sp. modified into an annual exponential rate
	Stegastes leucostictus		10		1.60	Meekan (1988); mortality of 24%/month for *Pomacentrus* sp.
	Stegastes planifrons		10.2 f	0.580	1.69 *	Pauly (1981)
			11.6 m	0.330	1.13 *	Pauly (1981)
	Stegastes variabilis		10 +		1.60	Meekan (1988); mortality of 24%/month for *Pomacentrus* sp. modified into an annual exponential rate

continued...

Table 3.7 continued

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
Pomatomidae	*Pomatomus saltator*	Cape Cod, Gulf of Maine	115	0.135	0.33 *	Pauly (1978)
Rachycentridae	*Rachycentron canadum*	Chesapeake Bay	134	0.210	0.42 *	Pauly (1978)
			160	0.200	0.39 *	Pauly (1978)
Scaridae	*Scarus coeruleus*	VI	61.5	0.325	0.70 *	Pauly (1978)
	Scarus guacamaia	VI	80	0.293	0.61 *	Pauly (1978)
	Scarus taeniopterus	Jamaica	35 FL		1.59 >	Munro (1983)
		Jamaica	31 FL	0.305	0.81 *	Nicholson and Hartsuijker (1982)
	Scarus vetula	VI	53 SL	0.599	1.09 *	Pauly (1978)
	Sparisoma aurofrenatum	Jamaica	26 FL	0.350	0.94 *	Nicholson and Hartsuijker (1982)
	Sparisoma chrysopterum	VI	42 FL	0.782	1.38 *	Pauly (1978)
	Sparisoma rubripinne	VI	46.5	0.584	1.11 *	Pauly (1978)
Scombridae	*Scomberomorus cavalla*	Ceara	116	0.180	0.40 *	Pauly (1978)
		Ceara	137	0.150	0.34 *	Pauly (1978)
	Scomberomorus maculatus	Florida	77 FL	0.356	0.70 *	Pauly (1978)
	Scomberomorus regalis		83.5 FL	0.303	0.61 **	Pauly (1978)
	Thunnus atlanticus	Cuba	78	0.330	0.67	Pauly (1978)
		Florida	90	0.216	0.48 *	Pauly (1978)
Scorpaenidae	*Scorpaena brasiliensis*		36 /	0.197	0.59 **	Pauly (1978)
	Scorpaena grandicornis		18 /	0.788	1.76 **	Pauly (1978)
	Scorpaena guttata	California	35	0.389	0.92 *	Pauly (1978)
	Scorpaena plumieri		43 /	0.138	0.44 **	Pauly (1978)
	Scorpaenodes caribbaeus		13 /			
Serranidae	*Cephalopholis cruentata*	Jamaica	34	0.340	0.85 *	Polovina and Ralston (1987)
		Curaçao	42	0.130	0.43 *	Polovina and Ralston (1987)
	Cephalopholis fulva	Jamaica	34	0.630	1.95	Munro (1983)
		Jamaica	34	0.630	0.55	Pauly (1980)
		Jamaica	34	0.440	1.01 *	Nicholson and Hartsuijker (1982)
		Jamaica	37.5	0.175	0.54 *	Nicholson and Hartsuijker (1982)
	Diplectrum formosum	Florida	31	0.287	0.78 *	Pauly (1978)
	Epinephelus guttatus	Jamaica	52 TL	0.240	0.68	Munro (1983)
		Jamaica	53 TL	0.480	0.94 *	Computed with ELEFAN, based on length-frequency data in Munro (1983)
	Epinephelus morio	Florida	67	0.179	0.46 *	Polovina and Ralston (1987)
		Mexico	93	0.113	0.31 *	Polovina and Ralston (1987)
	Epinephelus striatus	Jamaica	90	0.090	0.24	Munro (1983)
		VI	97	0.183	0.36	Polovina and Ralston (1987)
		VI	110	0.224	0.47 *	Pauly (1978)

continued...

Table 3.7 continued

Family	Species	Origin	L_∞ (cm)	K $year^{-1}$	M $year^{-1}$	Source[a]
	Mycteroperca bonaci		120	0.160	0.37 *	Polovina and Ralston (1987)
	Mycteroperca microlepis	Florida	101 TL	0.156	0.38 *	Polovina and Ralston (1987)
		Florida	124 TL	0.124	0.31 *	Pauly (1978)
	Mycteroperca phenax	Florida	72 TL	0.166	0.43 *	Polovina and Ralston (1987)
	Mycteroperca venenosa	Jamaica	86	0.170	0.42	Munro (1983)
		Jamaica	86	0.100	0.30 *	Polovina and Ralston (1987)
	Paranthias furcifer	Gulf of Mexico	37	0.220	0.63 *	Polovina and Ralston (1987)
	Serranus tabacarius		18	0.086	0.41 **	Bouain (1983); mean ϕ' computed from three species of
	Serranus tigrinus		10	0.279	1.05 **	Bouain (1983); mean ϕ' computed from three species of genus
	Serranus tortugarum		8	0.436	1.50 **	Bouain (1983); mean ϕ' computed from three species of genus
Sphyraenidae	*Sphyraena barracuda*	Florida	156 f	0.113	0.27 *	Pauly (1978)
		Florida	178 m	0.087	0.22 *	Pauly (1978)
Sphyrnidae	*Sphyrna tiburo*		150	0.11	0.27 *	Pauly (1978)
Triakidae	*Mustelus canis*		150	0.138	0.31 *	Pauly (1978)

[a]For values of M and/or K [when M was computed by equations (2.9), (2.10) and (2.15)].

Symbols:
FL = fork length.
SL = standard length.
TL = total length.
f = female.
m = male.
VI = Virgin Islands.
* = computed with equation (2.15).
** = computed via ϕ or ϕ' [equations (2.9) or (2.10)] and equation (2.15).
> = M/K divided by K or K_{mean} from other source.
/ = approximate asymptotic size.
+ = rather more than the recorded size.
- = rather less than the recorded size.
() = 'reported' to reach the recorded size.

Table 3.8. Estimated food consumption of Caribbean reef fishes. Q/B values represent mean population consumption of the corresponding species; mean environmental temperature = 28°C.

Family	Species	Food type	Aspect ratio	W_∞ (g)	Q/B (%BWD)	Q/B ($year^{-1}$)
Acanthuridae	*Acanthurus bahianus*	0.89	2.18	288	9.42	34.38
	Acanthurus chirurgus	0.88	1.78	820	6.78	23.87
	Acanthurus coeruleus	0.88	1.86	983	6.68	24.38
Antennariidae	*Antennarius multiocellatus*	0	1.22	70	3.03	11.06
	Antennarius striatus	0	0.80	70	2.43	8.87
Apogonidae	*Apogon conklini*	0	1.72	3.3	6.69	24.42
	Apogon maculatus	0	1.53	37	3.87	14.13
Atherinidae	*Allanetta harringtonensis*	0	1.71	11	5.24	19.12
	Atherinomorus stipes	0	1.88	16	5.10	18.60
Aulostomidae	*Aulostomus maculatus*	0	1.70	777	2.21	8.06
Balistidae	*Balistes capriscus*	0.50 *	2.44	611	5.25	19.16
	Balistes vetula	0.12	1.98	2,586	2.18	7.96
	Canthidermis sufflamen	0.25	1.71	4,783	2.10	7.67
	Melichthys niger	0.75	2.30	960	6.36	23.21
Belonidae	*Platybelone argalus argalus*	0	2.65	150	3.87	14.12
	Strongylura timucu	0	1.69	110	3.26	11.91
	Tylosurus crocodilus	0	3.11	1,400	2.68	9.78
Blenniidae	*Entomacrodus nigricans*	0.84	1.02	13	11.16	40.72
	Ophioblennius atlanticus	0.87	0.92	35	9.01	32.88
	Parablennius marmoreus	0.69	1.26	10	10.87	39.67
	Scartella cristata	0.87	1.18	27	10.76	39.29
Bothidae	*Bothus lunatus*	0	1.11	3,000	1.35	4.94
	Bothus ocellatus	0	1.51	180	2.79	10.19
Carangidae	*Alectis ciliaris*	0 *	4.82	10,700	2.23	8.13
	Caranx bartholomaei	0	4.06	9,862	2.07	7.56
	Caranx crysos (fusus)	0	4.19	2,314	2.82	10.31
	Caranx hippos	0 *	3.76	8,490	2.05	7.50
	Caranx latus	0	4.48	6,250	2.39	8.72
	Caranx lugubris	0	5.48	6,554	2.63	9.59
	Caranx ruber	0	4.52	3,160	2.76	10.06
	Decapterus macarellus	0	3.80	750	3.37	12.30
	Decapterus punctatus	0	3.66	573	3.49	12.73
	Oligoplites saurus	0	3.12	334	3.58	13.08
	Selar crumenophthalmus	0	3.54	1,240	2.93	10.70
	Seriola dumerili	0	4.49	80,000	1.43	5.22
	Trachinotus falcatus	0	3.88	36,000	1.56	5.69
	Trachinotus goodei	0	5.01	3,900	2.79	10.18
Carcharhinidae	*Carcharhinus acronotus*	0	7 *	90,000	1.76	6.41
	Carcharhinus falciformis	0	7 *	350,000	1.34	4.87
	Carcharhinus leucas	0	7 *	350,000	1.34	4.87
	Carcharinus leucas	0	3.85 S	350,000	0.98	3.58
	Carcharhinus limbatus	0	7 *	116,000	1.67	6.09
	Carcharhinus longimanus	0	7 *	350,000	1.34	4.87
	Carcharhinus perezi	0	7 *	100,000	1.72	6.28
	Galeocerdo cuvier	0	7 *	672,000	1.17	4.27
	Negaprion brevirostris	0	7 *	110,000	1.69	6.16
	Negaprion brevirostris	0	1.56 S	110,000	0.78	2.84
	Rhizoprionodon porosus	0	7 *	5,020	3.15	11.48
Chaetodontidae	*Chaetodon aculeatus*	0	1.85	19	4.88	17.82
	Chaetodon capistratus	0	2.53	120	3.95	14.42

continued...

Table 3.8 continued

Family	Species	Food type		Aspect ratio		W_∞ (g)	Q/B (%BWD)	Q/B $(year^{-1})$
	Chaetodon sedentarius	0		2.29		130	3.70	13.51
	Chaetodon striatus	0		2.37		164	3.59	13.09
Cirrhitidae	*Amblycirrhitus pinos*	0		1.52		15	4.62	16.86
Clinidae	*Labrisomus nuchipinnis*	0		1.29		137	2.72	9.93
Clupeidae	*Harengula clupeola*	0		2.65		240	3.52	12.85
	Harengula humeralis	0.03		2.90		440	3.39	12.37
	Jenkinsia lamprotaenia	0		2.19		13	5.74	20.95
	Opisthonema oglinum	0		3.13		730	3.06	11.18
Dactylopteridae	*Dactylopterus volitans*	0		1.60		1,825	1.80	6.57
Dasyatidae	*Dasyatis americana*	0		7	*	122,000	1.65	6.03
Diodontidae	*Chilomycterus antennatus*	0		1.40		1,420	1.77	6.46
	Diodon holocanthus	0		1.37		11,300	1.15	4.20
	Diodon hystrix	0		1.09		18,446	0.93	3.38
Echeneidae	*Echeneis naucrates*	0		1.10		2,080	1.45	5.29
	Remora remora	0		1.60		1,700	1.83	6.68
Elopidae	*Elops saurus*	0	*	3.41		444	3.54	12.92
Emmelichthyidae	*Inermia vittata*	0		2.92		282	3.58	13.07
Engraulidae	*Anchoa lyolepis*	1	*	1.77		8	19.99	72.96
Ephippidae	*Chaetodipterus faber*	0.07		3.11		9,000	2.01	7.34
Fistulariidae	*Fistularia tabacaria*	0		1.70		10,800	1.30	4.75
Gerreidae	*Eucinostomus argenteus*	0		1.94		290	2.89	10.55
	Gerres cinereus	0		3.91		690	3.48	12.69
Ginglymostomatidae	*Ginglymostoma cirratum*	0		7	*	500,000	1.24	4.54
	Ginglymostoma cirratum	0		0.76	S	500,000	0.40	1.44
Gobiidae	*Coryphopterus glaucofraenum*	0.44		1.11		10.5	7.35	26.83
	Gnatholepis thompsoni	0.65		0.96		4.1	10.72	39.13
	Gobiosoma evelynae	0		0.79		2.2	4.85	17.70
Grammidae (Serranidae)	*Gramma loreto*	0		1.13		15	3.97	14.49
	Gramma melacara	0		1.36		30	3.80	13.87
Grammistidae (Serranidae)	*Rypticus saponaceus*	0		1.37		685	2.03	7.41
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*	0		2.66		4,770	1.93	7.04
	Anisotremus virginicus	0		2.84		850	2.82	10.31
	Haemulon album	0		2.77		5,300	1.93	7.04
	Haemulon aurolineatum	0		2.44		188	3.55	12.95
	Haemulon bonariense	0	*	2.45		385	3.07	11.22
	Haemulon carbonarium	0		2.84		861	2.82	10.29
	Haemulon chrysargyreum	0		2.59		251	3.45	12.58
	Haemulon flavolineatum	0		2.46		480	2.94	10.75
	Haemulon macrostomum	0		2.69		1,795	2.36	8.63
	Haemulon melanurum	0	*	1.79		427	2.56	9.34
	Haemulon parrai	0		2.53		1,265	2.46	8.98
	Haemulon plumieri	0		2.86		1,360	2.58	9.42
	Haemulon sciurus	0		2.45		1,185	2.45	8.94

continued...

Table 3.8 continued

Family	Species	Food type		Aspect ratio		W_∞ (g)	Q/B (%BWD)	Q/B ($year^{-1}$)
	Haemulon steindachneri	0	*	2.02		360	2.82	10.29
	Haemulon striatum	0	*	1.83		400	2.62	9.58
	Orthopristis chrysoptera	0	*	2.46		900	2.59	9.47
	Orthopristis ruber	0	*	2.46		330	3.17	11.58
Hemiramphidae	*Hemiramphus balao*	0		2.73		614	2.96	10.79
	Hemiramphus brasiliensis	0.81		3.23		298	10.36	37.80
Holocentridae	*Holocentrus ascensionis*	0		2.64		838	2.73	9.97
	Holocentrus coruscus	0		3.03		57	5.05	18.42
	Holocentrus rufus	0		2.23		583	2.69	9.82
	Myripristis jacobus	0		2.46		397	3.06	11.16
	Neoniphon marianus	0		3.02		163	4.07	14.86
	Plectrypops retrospinis	0		1.73		57	3.77	13.77
	Sargocentron vexillarium	0		2.65		181	3.73	13.60
Kyphosidae	*Kyphosus incisor*	1		2.83		6,122	6.68	24.37
	Kyphosus sectatrix	1		2.90		9,139	6.23	22.76
Labridae	*Bodianus rufus*	0		1.20		1,560	1.60	5.85
	Clepticus parrae	0		1.84		447	2.58	9.40
	Halichoeres bivittatus	0		1.27		230	2.43	8.88
	Halichoeres garnoti	0		1.44		132	2.90	10.59
	Halichoeres maculipinna	0		1.25		25	3.77	13.77
	Halichoeres poeyi	0		1.19		150	2.56	9.35
	Halichoeres radiatus	0		1.58		2,283	1.71	6.25
	Lachnolaimus maximus	0		1.51		7,728	1.31	4.78
	Thalassoma bifasciatum	0		1.07		97	2.65	9.66
	Xyrichtys novacula	0		1.48		230	2.63	9.60
	Xyrichtys splendens	0		1.48		50	3.58	13.06
Lutjanidae	*Lutjanus analis*	0		2.06		5,511	1.64	5.99
	Lutjanus apodus	0		2.00		3,502	1.77	6.46
	Lutjanus campechanus	0	*	1.41		18,000	1.06	3.88
	Lutjanus cyanopterus	0		2.18		70,000	1.01	3.69
	Lutjanus griseus	0		2.06		1,590	2.11	7.70
	Lutjanus jocu	0		2.08		13,380	1.38	5.04
	Lutjanus mahagoni	0		2.05		980	2.32	8.47
	Lutjanus synagris	0		1.97		1,213	2.18	7.95
	Ocyurus chrysurus	0		2.96		3,570	2.16	7.89
Malacanthidae	*Malacanthus plumieri*	0		1.42		1,126	1.87	6.82
Megalopidae	*Tarpon atlanticus*	0		2.96		160,000	1.00	3.66
Monacanthidae	*Aluterus monoceros*	0.50	*	1.70		2,500	3.28	11.96
	Aluterus schoepfii	0.99		0.72		1,892	4.13	15.09
	Aluterus scripta	0.43		0.72		2,941	1.86	6.79
	Cantherines macrocerus	0.29		1.46		2,700	2.29	8.35
	Cantherines pullus	0.42		1.47		220	4.48	16.37
	Monacanthus ciliatus	0.34		1.24		448	3.21	11.73
	Monacanthus tuckeri	0.31		1.37		24	5.90	21.53
Mugilidae	*Mugil curema*	1		2.72		767	9.95	36.33
Mullidae	*Mulloidichthys martinicus*	0		2.26		440	2.87	10.48
	Pseudupeneus maculatus	0		2.30		393	2.96	10.80
Muraenidae	*Enchelycore nigricans*	0		0.7	*	900	1.36	4.95
	Echidna catenata	0		0.7	*	600	1.47	5.38
	Gymnothorax funebris	0		0.7	*	12,000	0.80	2.94
	Gymnothorax miliaris	0		0.7	*	201	1.84	6.70

continued...

Table 3.8 continued

Family	Species	Food type	Aspect ratio	W_∞ (g)	Q/B (%BWD)	Q/B ($year^{-1}$)
	Gymnothorax vicinus	0	0.7 *	3,000	1.06	3.89
	Lycodontis moringa	0	0.7 *	950	1.34	4.90
Myliobatidae	*Aetobatus narinari*	0	7 *	230,000	1.45	5.31
Ophichthidae	*Myrichthys breviceps*	0	0.7 *	640	1.45	5.31
	Myrichthys ocellatus	0	0.7 *	640	1.45	5.31
	Ophichtus ophis	0	0.7 *	2,091	1.14	4.18
Opisthognathidae	*Opisthognathus aurifrons*	0	0.84	30	2.96	10.81
	Opistognathus macrognathus	0	1.14	240	2.28	8.33
	Opisthognathus whitehurstii	0	0.82	65	2.51	9.15
	Opistognathus maxillosus	0	0.76	15	3.24	11.81
Ostraciidae	*Acanthostracion polygonius*	0	1.17	2,200	1.47	5.38
	Acanthostracion quadricornis	0.1	1.14	3,050	1.55	5.65
	Lactophrys bicaudalis	0.15	1.23	5,572	1.52	5.55
	Lactophrys trigonus	0.08	1.87	3,052	1.95	7.11
	Lactophrys triqueter	0.02	1.98	1,394	2.18	7.96
Pempheridae	*Pempheris schomburgki*	0	2.28	100	3.89	14.19
Pomacanthidae	*Centropyge argi*	0.75	1.44	10	12.57	45.90
	Holacanthus ciliaris	0.02	1.29	1,988	1.63	5.95
	Holacanthus tricolor	0.01	1.65	1,306	1.99	7.26
	Pomacanthus arcuatus	0.08	2.89	12,407	1.84	6.72
	Pomacanthus paru VI	0.13	1.81	2,769	2.08	7.59
	Pomacanthus paru Jamaica	0.13	1.81	2,229	2.17	7.92
Pomacentridae	*Abudefduf saxatilis*	0.09	2.98	483	3.64	13.28
	Abudefduf taurus	0.94	2.01	900	7.64	27.88
	Chromis cyanea	0	1.79	93	3.49	12.72
	Chromis multilineata	0	1.79	339	2.68	9.78
	Microspathodon chrysurus	0.78	1.88	412	7.06	25.77
	Stegastes fuscus	0.51	1.83	168	5.94	21.67
	Stegastes leucostictus	0.2	1.31	50	4.32	15.77
	Stegastes planifrons	0.25	1.37	68	4.43	16.16
	Stegastes variabilis	0.45	1.54	54	6.34	23.13
Priacanthidae	*Heteropriacanthus cruentatus*	0	1.79	700	2.32	8.46
	Priacanthus arenatus	0	1.83	1,653	1.97	7.20
Rachycentridae	*Rachycentron canadum*	0	1.56	33,400	0.99	3.62
Scaridae	*Scarus coelestinus*	0.99	1.06	8,556	3.71	13.53
	Scarus coeruleus	1 *	1.48	3,720	5.28	19.27
	Scarus guacamaia	1	1.19	23,000	3.27	11.95
	Scarus iserti	1 *	1.44	141	10.09	36.82
	Scarus taeniopterus	0.99	1.09	1,102	5.70	20.82
	Scarus vetula	0.97	1.05	5,558	3.94	14.37
	Sparisoma aurofrenatum	0.99	1.33	324	8.07	29.47
	Sparisoma chrysopterum	1	1.44	1,510	6.25	22.82
	Sparisoma radians	1	1.26	150	9.28	33.88
	Sparisoma rubripinne	1	1.51	2,734	5.69	20.77
	Sparisoma viride	1	1.43	2,430	5.66	20.66
Sciaenidae	*Equetus lanceolatus*	0	0.97	325	1.98	7.21
	Equetus punctatus	0	1.25	460	2.10	7.66
	Odontoscion dentex	0	1.68	318	2.63	9.59
	Pareques acuminatus	0	1.34	280	2.40	8.77
Scombridae	*Euthynnus aletteratus*	0	6.29	12,200	2.49	9.08
	Scomberomorus cavalla	0	6.31	34,285	2.02	7.39

continued...

Table 3.8 continued

Family	Species	Food type		Aspect ratio		W_∞ (g)	Q/B (%BWD)	Q/B ($year^{-1}$)
	Scomberomorus maculatus	0	*	4.87		4,800	2.63	9.61
	Scomberomorus regalis	0		6.16		4,900	2.96	10.80
Scorpaenidae	*Scorpaena brasiliensis*	0		1.03		1,600	1.47	5.37
	Scorpaena grandicomis	0		1.03		212	2.22	8.09
	Scorpaena plumieri	0		1.00		4,330	1.19	4.33
Serranidae	*Alphestes afer*	0		1.20		1,202	1.69	6.17
	Cephalopholis cruentata	0		1.23		691	1.91	6.99
	Cephalopholis fulva	0		1.47		640	2.13	7.78
	Dermatolepis inermis	0	*	1.51		10,513	1.23	4.49
	Diplectrum formosum	0	*	1.49		550	2.21	8.08
	Epinephelus adscensionis	0		1.53		1,981	1.73	6.33
	Epinephelus guttatus	0		1.03		2,919	1.31	4.77
	Epinephelus itajara	0		1.28		381,644	0.55	1.99
	Epinephelus morio	0		1.46		5,010	1.40	5.12
	Epinephelus striatus	0		1.57		23,800	1.06	3.88
	Hypoplectrus aberrans	0		1.84		50	4.01	14.62
	Hypoplectrus chlorurus	0		1.53		64	3.46	12.64
	Hypoplectrus nigricans	0		1.77		90	3.48	12.70
	Hypoplectrus puella	0		1.58		64	3.52	12.86
	Mycteroperca bonaci	0		1.22		90,000	0.71	2.60
	Mycteroperca cidi	0	*	1.13		77,000	0.71	2.58
	Mycteroperca interstitialis	0		1.29		4,000	1.38	5.03
	Mycteroperca phenax	0	*	1.36		43,700	0.87	3.18
	Mycteroperca rubra	0	*	1.20		10,719	1.09	3.97
	Mycteroperca tigris	0		1.81		17,043	1.22	4.46
	Mycteroperca venenosa	0		1.08		12,270	1.00	3.66
	Paranthias furcifer	0		2.27		1,100	2.39	8.73
	Serranus dewegeri	0		1.40		700	2.04	7.45
	Serranus tabacarius	0		1.24		141	2.65	9.67
	Serranus tigrinus	0		1.45		21	4.21	15.37
	Serranus tortugarum	0		1.58		12	4.94	18.03
Sparidae	*Archosargus rhomboidalis*	0.83		2.47		1,200	6.98	25.46
	Calamus bajonado	0		3.04		4,500	2.09	7.63
	Calamus calamus	0		3.18		1,541	2.66	9.70
	Calamus penna	0		3.11		2,000	2.49	9.10
	Calamus pennatula	0		3.04		1,700	2.55	9.29
	Diplodus caudimacula	0.8		2.92		600	8.43	30.76
Sphyraenidae	*Sphyraena barracuda*	0		1.61		57,800	0.90	3.28
	Sphyraena picudilla	0		2.62		1,300	2.49	9.08
Sphyrnidae	*Sphyrna lewini*	0		7	*	400,853	1.30	4.74
	Sphyrna tiburo	0		7	*	18,000	2.43	8.87
	Sphyma tiburo	0		1.63	S	18,000	1.15	4.18
Synodontidae	*Synodus intermedius*	0		2.38		1,103	2.45	8.94
	Synodus foetens	0		2.65		1,100	2.59	9.45
	Synodus synodus	0		2.38		400	3.01	10.98
Tetraodontidae	*Canthigaster rostrata*	0.18		1.52		82	4.12	15.04
	Sphoeroides spengleri	0.08		1.57		92	3.60	13.16
Triakidae	*Mustelus canis*	0		7	*	15,000	2.52	9.20

Symbols: * = assumed value.
VI = Virgin Islands.
S = aspect ratio from Table 1 in Pauly et al. (1993).

3.2. Nonfish Taxa

3.2.1. Ecology, Fisheries and Management

Although I assumed a coral reef ecosystem without fishing activities, which was realistic when Randall investigated food habits of West Indian reef fishes in 1967, some information on fisheries and management were included here to give an idea of later developments.

Boulon (1986b) gave a short description of spatial occurrence of the three commercially most important invertebrates in the Virgin Islands Biosphere Reserve:

> Adults of *Strombus gigas*, the queen conch, are found from grass and mud-bottom mangrove embayments out to deep (10 m+) algal plains. They are most often found in beds of seagrass (*Thalassia testudinum, Syringodium filiforme*, or a mixture of both), but are also found on sand flats. Juvenile conch are generally found in shallower water and in areas of less dense seagrass. Young conch may be restricted in their movements in thick beds of seagrass.
>
> *Cittarium pica*, the West Indian topshell, is primarily found in rocky, coastal habitats, from slightly above the water level to several feet below. They appear to prefer coasts that are subject to at least some wave action. The smaller individuals tend to be found higher up in the habitat range of this species with larger, mature individuals being found in deeper (1-2 m) subtidal bedrock or upper fore-reef zones.
>
> *Panulirus argus*, the spiny lobster, appears to be most abundant near reef-grassflat boundaries. Juveniles were found in mangroves and *Thalassia* habitats. In the reef habitat, lobsters are primarily found in dense grass beds (?) where they spend the daylight hours. At night, they forage for food either on the reef or on adjacent algal plains.

Mahon (1987) gave a summary on ecology, fisheries and management of "shared fishery resources of the Lesser Antilles region". The only invertebrates discussed therein are queen conch and spiny lobster; the former is stated to be "the second most valuable resource in the Caribbean as a whole", while "conch stocks throughout the Caribbean region are considered to be fully or overexploited".

In Puerto Rico, all conch production is consumed locally. The west coast dominates the fisheries with landings averaging 68.2 t during the early and mid-1970s, and increasing to 189 t in 1982. Price per pound rose from US$0.5 in 1975 to US$1.37 in 1984, with a total worth for the latter year of $628,350, thus, making conch one of the country's most commercially important species.[a]

Inshore populations were noticeably reduced by the mid-1970s, when fishing pressure on deepwater areas increased. In the population off La Parguera, Puerto Rico, fishing mortality is estimated to be 68% (F = 0.4 $year^{-1}$). The conch fishery is classified as "overfished".

A directed, commercial conch fishery exists on St. Croix, US Virgin Islands. St. Thomas and St. John are less fished because conch occur deeper and farther from shore. In 1982, 9.7 $conch \cdot ha^{-1}$ and $1.58 * 10^6$ individuals were estimated for St. Thomas/St. John, and 7.6 $conch \cdot ha^{-1}$ and $0.26 * 10^6$ individuals for St. Croix. Primary fishing grounds for conch in the US Virgin Islands are the west and northwest coasts of St. Croix and the south shelf on St. Thomas. The conch resources in the US Virgin Islands are classified as "overfished".

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[a]All monetary figures are in US$, unless otherwise stated.

Queen conch are harvested primarily by free and scuba diving. The regulations that have been enacted or proposed to reduce fishing pressure include: a minimum size limit on shell length (e.g., 18 cm), shell diameter, lip thickness or meat weight (e.g., 225 g market weight), seasonal closures, total closures, prohibitions on the use of scuba and on export.

In Puerto Rico, total spiny lobster landings decreased from 133.58 t in 1983 to 112.62 t in 1985, and the market value decreased from $1.04 * 10^{-6}$ to $0.92 *$10^{-6}$. For 1985-1986, approximately 20% of lobsters sampled were less than 76 mm carapace length (CL) as compared to 16% for 1984-1985. Regulations include a minimum CL of 89 mm; no capture of berried females; prohibition on the use of spears, hooks and drugs, poisons or explosives; and the use of degradable panels on lobster traps.

In the US Virgin Islands, estimated domestic landings were 22.7 t in 1975; this rose to 74 t in 1979, but the 1982 estimate was 45.4 t. Only 50% of lobster catches are assumed to be reported, which hinders reliable determination of stock size. Depletion of spiny lobster stocks is indicated by declining average size and the necessity for fishers to travel longer distances to the fishing grounds. Regulations are the same as for Puerto Rico.

Indications on the commercial importance of other nonfish taxa, such as shrimps and turtles, were not found. Indications on their ecology, however, were found in general zoology textbooks and in the references assembled for construction of their diet composition matrix (see below).

3.2.2. Abundance and Mean Individual Weight

While assembling the ECOPATH II input parameters for nonfish taxa, a number of estimates of abundance and weight per individual could be identified (Table 3.9).

3.2.3. Biomass, P/B Ratio and Food Consumption

Table 3.10 shows the complete database of the three ECOPATH II key input parameters for the 41 nonfish taxa originating from stomach contents records of West Indian reef fishes (Randall 1967). Following is a brief description on the origin of every range or single value, in form of 135 numbered "statements":[b]

1. To assess total system net primary productivity (NPP), a selection of published values of coral reef gross and net PP was compiled from various sources (Table 3.11). Emphasis was put on information from the Caribbean Sea. Available values for distinct parts of the community were related to their corresponding subsystem(s) (mangrove, seagrass bed, sand flat, coral reef, algal plain). A mean NPP (in $gCm^{-2}year^{-1}$) was computed for every subsystem and from these again a mean total system NPP of ca. 1,200 $gCm^{-2}year^{-1}$ (= 20,000 $gm^{-2}year^{-1}$WW, conversion: carbon = 6% of WW) was obtained. Compared to overall NPP for coral reefs worldwide (e.g., in Lewis 1981 and Hatcher 1990, see Table PP), the value obtained by the above-described procedure for a Virgin Islands reef system seemed high. This value, however, was strongly influenced by the high NPP estimates reported for parts of the algal community by Connor and Adey (1977) for the Virgin Islands. The uncertainty of the estimate of total system NPP is critical since this value is a direct measure of the carrying capacity of the system. The reliability of this parameter has a strong impact on the degree of similarity in terms of size (biomass) between the real system and the model.

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[b]The number corresponding to each statement may also be found in Table 3.10.

Table 3.9. Abundance (Nm^{-2}) and mean individual live weight (g) of some nonfish taxa from Caribbean reefs and other areas.

Nonfish group	Abundance (Nm^{-2})	Source	Mean weight (gWW/I)	Source
Sponges	0.76	Beets and Lewand (1986)[b]	86-184	Wilkinson (1987)[m]
			7.50	Wilkinson (1987)[l]
Sea fans (Gorgonacea) (Octocorallia, Anthozoa)	0.26	Beets and Lewand (1986)[b]	-	
Sea anemones (Actiniaria, Zoanthidea, Hexacorallia and Anthozoa)	7.26	Beets and Lewand (1986)[b]	-	
Gastropods	3.01	Beets and Lewand (1986)[b]	-	
Bivalves	0.12	Beets and Lewand (1986)[b]	-	
Octopuses	0.01	Beets and Lewand (1986)[b]	2,800	Guerra (1979)[e]
Polychaetes	1.54	Beets and Lewand (1986)[b]	0.006	Naim and Amoureux (1982)[h]
Amphipods	516	Berry (1982)[c]	0.005	Berry (1982)[c]
Isopods (fish parasites)			0.14	Schwinghamer et al. (1986, Table 1)[j]
Shrimps	1.25	Beets and Lewand (1986)[b]	-	
Spiny lobsters	0.02	Beets and Lewand (1986)[b]	58.7	Munro (1983)[f]
			217	Munro (1983)[g]
Scyllarid lobsters	1.35	Beets and Lewand (1986)[b]	-	
Crabs	0.54	Beets and Lewand (1986)[b]	-	
Ophiuroids	2.5	Beets and Lewand (1986)[b]	-	
Echinoids	2.1	Bak et al. (1984)[a]	57	Sambilay et al. (1990)[i]
	3.3	Beets and Lewand (1986)[b]	-	
	2.6-7	Weil et al. (1984)[k]	-	
Holothurians	15	Berry (1982)[d]	4	Berry (1982)[d]
Ascidians (Tunicata)	0.69	Beets and Lewand (1986)[b]		

Sources:

[a]From Table 1 in Bak et al. (1984), an average density of 2.1 individuals per m^2 was computed for *Diadema antillarum* in Curaçao, Netherlands Antilles.

[b]Beets and Lewand (1986, Tables 1-4) indicated density values (individuals m^{-2}) for five phototransects of a US Virgin Islands reef area. The area covered was 0.5 m on either side of the transect line. Values in Table DMWNFG represented means for five transects.

[c]Berry (1982,in Table 1) reported a mean density for amphipods (several species) on the ORI reef, Natal province, South Africa, of 516 individuals per m^2 ; live weight is 1-3.5 gm^{-2} (conversion: DW=25% of WW). Mean weight per individual is 4.5 mg.

[d]Berry (1982), in Table 1, gave a mean density of 15 individuals per m^2 and a biomass equivalent to 55.1 kJm^{-2} for holothurians on the ORI reef, Natal province, South Africa. 1 kJ corresponds to 1.08 g WW; mean individual live weight is 3.96 g.

[e]Guerra (1979) gave growth estimates for *Octopus vulgaris* (in the Mediterranean) which yielded a W_∞ of 10,850 g. W_{mean} was computed from equation (2.12).

[f]Munro (1983) recorded a mean live weight of 58.7 g for individual *Panulirus guttatus* around Jamaica.

[g]Munro (1983) reported a biomass of 63-119 $kgkm^{-2}$ and a density of 290-550 individuals per km^2 for *P. argus* in Jamaican waters. Hence, mean individual live weight is 217 g.

[h]Naim and Amoureux (1982) gave a maximum polychaete density of 1,900 individuals m^{-2} = 11 gm^{-2} for a coral reef in Moorea, French Polynesia. Mean weight per individual is 5.8 mg.

[i]Pauly et al. (1993b) for Caribbean *D. antillarum.*

[j]Schwinghamer et al. (1986, Table 1).

[k]Weil et al. (1984); mean density of *D. antillarum* for several coral reefs in Venezuela.

[l]Wilkinson (1987, Table 1) indicated density values for Caribbean reef sponges of 7.37 individuals m^{-2} (0.5 km distance from land) and 7.60 individuals m^{-2} (5 km distance from land).

[m]With density and biomass values from Table 1 in Wilkinson (1987), a range of mean weight of 86-184 g/individual was calculated for Caribbean reef sponges.

Table 3.10. Database of ECOPATH II key input parameters of nonfish groups for Caribbean coral reef models; Q/B = annual consumption/ unit biomass, P/B = production/biomass ratio.

Net primary production (NPP) of overall system: 20,000 (15,000-25,000) g $m^{-2}year^{-1}$WW(see text statement no. 1).
Export of benthic producers from system: 480 $gm^{-2}year^{-1}$WW(see text statement no. 2).

ID	Nonfish group	Biomass (gm^{-2}WW)	Source (TSN)	Q/B ($year^{-1}$)	Source (TSN)	P/B ($year^{-1}$)	Source (TSN)
D 1	Detritus, POM, DOM	2,000	3	-	-	-	-
A 1	Epilithic and endolithic algae	360	4	-	-	30.8	5
	Reef turf algae	109	6	-	-		
	Benthic fleshy algae	6,000	7	-	-		
	Macroalgae	415	8	-	-		
	Benthic algae	2,800	9	-	-		
		55-164	10	-	-		
	Spermatophytes	163	11	-	-	12.8	12
						13.25	13
						20.1	12
	Benthic autotrophs (excluding symbionts)	1,500	14	-	-	13.5	15
A 2	Symbiotic algae (zooxanthellae, filaments)	730	16			9.3	17
						10.2	18
						16.6	19
	Benthic autotrophs	3,500-4,000	20	-	-	12.5	21
						13	22
A 3	Phytoplankton	0.102	23	-	-	70	26
		11.7-83	24	-	-		
		73	25	-	-		
I 1	Bacterioplankton	2-5	27	1,043	28	267	29
						313	30
	Benthic bacteria	0.1	31	7,300	33	155	34
		0.2-1.732					
	Foraminifera	1	35	30	36	10	37
	Decomposers/microfauna	5.5	38	2,190	39	220	40
I 2	Zooplankton	5-30	41	50	42	40	26
				280	26		
I 3	Sponges	30.5	43	4.02	45	1.7	46
		507-1,049	44				
I 4	Fire corals (Millepora, Hydrozoa)						
I 5	Sea fans (Gorgonacea) (Octocorallia, Anthozoa)	14	47	3	+52	0.08	48
				15	+52		
I 6	Sea anemones (Actiniaria and Zoanthidea, Hexacorallia, Anthozoa)	1.3	49	3	+52		
			15	+52			
I 7	Stony corals (Scleractinia) (Octocorallia, Anthozoa)	21-57	50	3	+52		
				15	+52		
	Corals	187	51	3	52	0.37	53
				15	52	1.8	53
I 8	Bryozoans	9.2	54				
I 9	Sipunculid worms	4.5	55				
		7.5-11.5	56				
I 10	Priapuloids						
I 11	Chitons	18	57	7.2	59	0.26	60
		30	57	16.2	59	0.42	60
		61	58				
I 12	Gastropods	39	61	4.7	62	0.1	66
				7.7	63	2.5	67
				15.7	64	2.1-5.9	68
				56.4	65		
I 13	Bivalves	60-170	69	9	70	1.35	73
				9.5	71	2.23	68
				29.1	72	3.8	74
I 14	Scaphopods						
	Molluscs (excluding Cephalopods)	47-143	75				
		396	76				
I 15	Squids			16.6	77	0.9-1.6	79
				20.8	78		
I 16	Octopuses	28	80	6.76	81	1.09	82
						3.06	83
I 17	Polychaetes	1.9	84	24.2	89	2.48	68
		11	85	99	90	5.8	89
		10	86				
		20	87				
		34	88				
I 18	Echiuroids						
I 19	Pycnogonids						

continued...

Table 3.10 continued

ID		Nonfish group	Biomass (gm^{-2}WW)	Source (TSN)	Q/B ($year^{-1}$)	Source (TSN)	P/B ($year^{-1}$)	Source (TSN)
I	20	Barnacles	35-83	91				
I	21	Stomatopods						
I	22	Amphipods	1.1-3.5	92	33.4	93	2.41	68
					125.5	94		
					164	95		
I	23	Tanaids			33.4	93		
I	24	Isopods (fish parasites)			33.4	93	2.4	68
		Small crustaceans	0.16	96			1.4-3.9	68
I	25	Shrimps	0.25-0.52	97	26.9	99	0.9-1.6	100
			3.8	98			1.8-2.8	101
I	26	Spiny lobsters	0.09	102	7.4	103	0.35	104
							0.45	105
							1.03	106
I	27	Scyllarid lobsters						
I	28	Hermit crabs	0.1-0.2	107				
I	29	Crabs	2.3-4.9	108	10.6	109	0.73	110
					17.4	109	1.61	111
		Lobsters and crabs	3.31	26	8.2	26	0.52	26
		Crustaceans	2.5-5.6	112				
			161	113				
I	30	Hemichordates						
I	31	Asteroids	14-25	114	3.24	115	0.49	116
I	32	Ophiuroids	1-3	117				
I	33	Echinoids	67	118	2.81	122	0.8	68
			40-148	119			2	123
			120	120				
			148-211	121				
I	34	Holothurians	23-44	124	3.36	126	0.29	127
			59	125				
		Echinoderms	140-200	128				
			1,053	129				
I	35	Ascidians (Tunicata)	35	130	9-49	132	2.3	133
			744	131	24	132		
R	1	Sea turtles	0.015	26	2.8	134	0.15	26
					3.5	26		
					11.5	135		
B	1	Sea birds	0.015	26	80	26	5.4	26

Symbols:
A = autotrophs.
B = birds.
D = detritus.
I = invertebrates.
R = reptiles.
TSN = text statement number.
* = assumed value.

Table 3.11. Primary productivity of coral reefs and components; GPP = gross primary production, NPP = net primary production, P/R = production/respiration ratio.

Community component	Geographical location	GPP[a]	NPP[a]	P/R	Source
Overall system	Tropics	840-2,190[c]	-3.7-62	1H	Hatcher (1990, Fig.1)
Overall system	Tropics	-	200-1,000		Lewis (1981)
Overall system	Tropics	-	1,200	>1	Lewis (1981, Table 1); median of reefs with P/R >1
Overall system	Puerto Rico, El Mario reefs	4,450	350	1.1	Odum et al. (1959)
Fore reef	Tropics	730-2,555[c]	-365-1,862	0.5-5.5	Hatcher (1990, Fig.1)
Reef flat - reef crest	Tropics	730-2,555[c]	110-548	1-4	Hatcher (1990, Fig.1)
Reef flat - back reef	Tropics	949-14,500[c]	621-9,855	0.7-3.2	Hatcher (1990, Fig.1)
Sand sheet and shallow patch reefs	Tropics	329-4,709[c]	-183-1,241	0.7-1.4	Hatcher (1990, Fig.1)
Water over algal plains, seagrass meadows	Tropics	3.65-730[c]	-475-511	0.1-1.4	Hatcher (1990, Fig.1)
Surface pelagic waters	Virgin Islands	-	20-267	-	Jacobsen and Browder (1987); mean from Table 51
Lagoon	Joyuda Lagoon, Puerto Rico	1,260[c]	475	1.6	Owen and Tilly (1985)
Lagoon	British West Indies, Bimini	319	114	-	Odum and Hoskin (1958)
Corals	Tropics	281-3,723[c]	2.9-14.6[b]	0.5-5	Hatcher (1990, Fig.1)
Gorgonacea	Florida	2,080	533	3.9	Kanwisher and Wainwright (1967)
Scleractinia	Florida	2,385	769	3.1	Kanwisher and Wainwright (1967)
Acropora palmata	Virgin Islands	485-1,405[c]	197-708	1.7-2	Rogers and Salesky (1981)
A. palmata	Virgin Islands	880	551-672	2-2.5	Gladfelter et al. (1977)
Benthic algae	PRVI area	-	110	-	Stanhope (1980)
Coralline algae	Tropics	292-1,022[c]	0.22-4.27[b]	1-5.4	Hatcher (1990, Fig.1)
Corallinaceae	Curaçao	890	370	1.7	Wanders (1976a)
Algal turfs	Tropics	329-4,417[c]	6.2-102.2[b]	1.2-6.7	Hatcher (1990, Fig.1)
Algal turfs	Virgin Islands	-	213.5[c]	-	Rogers and Salesky (1981)
Reef turf algae	PRVI area	-	274	-	Carpenter (1985)
Macroalgae - reef flat	Tropics	840-14,381[c]	9.13-4.31[b]	1.2-6.3	Hatcher (1990, Fig.1)
Macroalgae - lagoon	Tropics	-1,460[c]	0.073-14.6[b]	1.9-2.8	Hatcher (1990, Fig.1)
Macroscopic algae	Virgin Islands	-	2,010	-	Rogers and Salesky (1981)
Microalgae	Tropics	29-1,351[c]	?-132.5[b]	1.1-10.3	Hatcher (1990, Fig.1)
Fleshy and filamentous algae	Curaçao	712	452	2.7	Wanders (1976a)
Fleshy and filamentous algae	Virgin Islands	10,950	6,278	2.3	Connor and Adey (1977)
Algal	Virgin Islands	2,486-4,139	1,577-2,321	2.4	Connor and Adey (1977)
Sargassum platycarpum	Curaçao	3,840	2,550	2.9	Wanders (1976b)
Halimeda	Jamaica	1,460	839	2.3	Hillis-Colinvaux (1974)
Seagrass	Tropics	1,095-5,480	1.5-3.2[b]	1.5-2.5	Hatcher (1990, Fig.1)
Turtle grassbed	Florida, Long Keys	3,880	1,140	1.4	Odum (1957)
Turtle grassbed	Puerto Rico, West La Gata reef	980	-310	0.8	Odum et al. (1959)
Turtle grassbed	Puerto Rico, Isla Magueyes	1,350	-150	0.9	Odum et al. (1959)
Thalassia	Barbados	-	368	-	Patriquin (1973)
Thalassia	Cuba	-	585	-	Buesa (1974)
Thalassia	Florida	-	534-712	-	Odum (1957)
Thalassia	Jamaica	-	704	-	Greenway (1974)
Thalassia	Puerto Rico	-	800	-	Burkholder et al. (1959)

[a]($gCm^{-2} \cdot year^{-1}$).
[b]($gCg \cdot year^{-1}DW$).
[c]Values adjusted to annual production.

2. From Table 2 in Zieman et al. (1979), total export of primary producers from Virgin Islands seagrass meadows was calculated as follows:

Item	Unit	Value
Combined surface and bedload export	(g day^{-1} DW)	162,000.000
Export area	(m^2)	620,000.000
Daily export	(g $m^{-2}day^{-1}$ DW)	0.261
Annual export	(g $m^{-2}year^{-1}$ DW)	95.370
Export in live weight	(g $m^{-2}year^{-1}$ WW)	477.000

Conversion: DW = 17.5% of WW.

Annual export of benthic producers amounted to around 480 g live weight m^{-2}.

3. Detritus standing stock was calculated by applying equation (2.13). A gross PP of 3,000 $gCm^{-2}year^{-1}$ (mean from overall system values in Table PP) and an approximate euphotic depth of 40 m (personal observation) yielded a detritus standing stock of 195 gCm^{-2} which was around 2,000 gm^{-2}WW. Conversion: C = 10% of WW for organic material.

4. 21.5 gCm^{-2} was the average algal biomass (mean of highest and lowest value) from Fig. 5 in Klumpp and McKinnon (1989) for an epilithic algal community (EAC) on Davis Reef, Great Barrier Reef, Australia. Conversion: C=6% of WW.

5. In Klumpp and McKinnon (1989), the range of gross production of the above (no. 4) EAC was 1.705-2.511 $gCm^{-2}day^{-1}$ for the reef flat and 1.114-1.716 $gCm^{-2}day^{-1}$ for the reef slope. An average annual production of 662 gCm^{-2} was calculated (highest + lowest value/2) which resulted in a P/B ratio of 30.8 when divided by an average biomass of 21.5 gCm^{-2} (see no. 4).

6. Carpenter (1985) reported a biomass of 19.0 gm^{-2}DW for reef turf algae in the PRVI area. Live weight was 109 gm^{-2} with a conversion of 17.5%.

7. A biomass of 1,022.1 gm^{-2}DW was obtained for benthic fleshy algae on a Caribbean *Porites furcata* reef from Table 2 in Glynn (1973). Conversion: 17.5% of WW.

8. Biomass for macroalgae was derived from a value of 71.27 gm^{-2}DW in Table 3 in Dominguez and Alcolado (1990) for macroalgae in the Gulf of Batabanó, Cuba. Conversion: DW = 17.5% of WW.

9. From Tables 8-12 in Odum and Odum (1955), an average biomass for benthic algae (excluding symbiotic algae in corals) of 490 gm^{-2}DW was calculated. Conversion: DW = 17.5% of WW.

10. Stanhope (1980) gave a biomass of 4.3-11.7 gm^{-2}DW for benthic algae associated with coral reefs in the PRVI area. Converted into live weight, the biomass was 55-164 gm^{-2} (DW = 17.5% of WW).

11. A mean standing crop of 142 gm^{-2}DW was assessed by Gonzalez-Liboy (1979) for turtle grassbeds (*Thalassia testudineum*) for seven sites off La Parguera, Puerto Rico. DW-WW relationship was assumed to be 17.5%. This live weight was only valid for one subsystem, so the calculated value of 811 g was divided by 5. This procedure was applied in cases where the distribution of an organism was clearly limited to a specific subsystem.

12. Zieman et al. (1979, in Table 1) indicated a daily production of 2.7 gm^{-2}DW and a standing crop of 77 gm^{-2}DW for a turtle grassbed (*Thalassia testudineum*) in the US Virgin Islands, which resulted in an annual P/B ratio of 12.8. Production and standing crop for the seagrass *Syringodium filiforme* were 0.32 $gm^{-2}day^{-1}$DW and 5.8 gm^{-2}DW, respectively, which yielded an annual P/B ratio of 20.1.

13. A mean daily turnover (= P/B * 100) of 3.63% was assessed by Gonzalez-Liboy (1979) for the above turtle grassbeds. Annual turnover (= P/B) was thus 13.25 (3.63 * 3.65).

14. A mean standing crop of 1,513 gm^{-2}WW for benthic autotrophs, excluding symbiotic algae (zooxanthellae and filamentous algae), was estimated from biomass values of different components described in nos. 4, 6, 7, 8, 9, 10 and 11.

15. A weighted (by biomass) mean annual P/B ratio of 13.5 for benthic autotrophs was estimated from nos. 5, 12 and 13, and an assumed annual P/B ratio of 12.5 for benthic algae, benthic fleshy algae and macroalgae (see no. 21).

16. From Table 4 in Odum and Odum (1955), an average dry weight for symbiotic algae (zooxanthellae and filaments) of 0.063 gcm^{-2} was obtained. Conversion DW-WW was 17.5%. Since the calculated live weight of 3,600 gm^{-2} was only valid for the reef zone, and few or no corals grow in the other subsystems included in the model, the value was divided by 5. The resulting biomass of 720 gm^{-2}WW was increased to 730 gm^{-2}WW to account for zooxanthellae biomass in foraminiferans (see no. 35).

17. A PP for corals of 281-3,723 $gCm^{-2}year^{-1}$ was read off Fig. 1 in Hatcher (1990). A mean production of 33,366 $gm^{-2}year^{-1}$WW (conversion: C = 6% of WW) and a biomass of 3,600 gm^{-2}WW for symbionts resulted in an annual P/B of 9.3.

18. From Kanwisher and Wainwright (1967), an average gross primary productivity of 2,200 $gCm^{-2}year^{-1}$ was obtained for Gorgonacea (sea fans) and Scleractinia (stony corals). Applying a conversion of C = 6% of WW and a symbiont biomass of 3,600 gm^{-2}WW, the resulting P/B ratio was 10.2 $year^{-1}$.

19. Production of zooxanthellae was indicated with 10 $kcalm^{-2}day^{-1}$ in Fig. 2 in Sorokin (1987) which is 3,650 $gm^{-2}year^{-1}$WW. When zooxanthellae biomass is around 220 gm^{-2}WW (Odum and Odum 1955, Table 4; conversion DW = 17.5% of WW), annual P/B is 16.6.

20. Odum and Odum (1955) estimated a mean standing stock of benthic producers of 703 gm^{-2}DW with a low standard deviation, i.e., the biomass seemed to be evenly distributed over the reef regardless of species composition. A conversion of DW = 17.5% WW resulted in a live weight biomass of ca. 3,500-4,000 gm^{-2} for benthic autotrophs.

21. Odum and Odum (1955) indicated an annual ratio of 12.5 for gross PP to standing stock of benthic autotrophs for the Eniwetok atoll reef.

22. Weighted (by biomass) mean annual P/B ratio for benthic autotrophs and symbiotic algae was 13.0.

23. Chlorophyll-*a* concentrations per depth range of pelagic waters in Great Cruz Bay, St. John, Virgin Islands, were given in Table 52 in Jacobsen and Browder (1987). The median was 0.37 mgChl.-am^{-2}. A conversion factor of Chl.-*a* to phytoplankton carbon of 6% was determined from Table 1 and Fig. 5 in Knoppers and Opitz (1984). Assuming a conversion of 6% for carbon: WW resulted in a biomass of 0.102 gm^{-2}WW for phytoplankton.

24. Margalef (1971) gave a phytoplankton biomass range of 0.7-5.0 g Cm^{-2} for the northeastern Caribbean. This, transformed into wet weight, yielded a range of 11.7-83 g (Carbon = 6% of WW).

25. Jones (1963) indicated a phytoplankton production of 307 gCm^{-2} $year^{-1}$ = 5,117 gm^{-2} $year^{-1}$WW (conversion C = 6% of WW) for a Florida patch reef. Assuming a P/B ratio of 70 (Polovina 1984b) yielded a biomass of 73 gm^{-2}WW.

26. All estimates with this source number in Table 3.10 were adopted from Polovina (1984b).

27. Sorokin (1987) reported 0.2-0.5 gm^{-3} as range for bacterioplankton biomass. An assumed mean water depth of 10 m resulted in a value of 2-5 gm^{-2} bacterioplankton standing stock.

28. A daily consumption of 10 $kcalm^{-2}$ was read off Fig. 2 in Sorokin (1987) for bacterioplankton. A conversion of 1 kcal = 1 g live weight and a biomass of 2-5 gm^{-2} yielded a daily consumption of 286% of body weight (% $BWday^{-1}$) and an annual Q/B of 1,043.

29. Lewis (1981, Table 3b) presented values for production and biomass of bacteria in the water column above various coral reefs. From these values, a mean annual P/B ratio of 267 can be calculated.

30. Production of bacterioplankton was 3 $kcalm^{-2}day^{-1}$ in Fig. 2 in Sorokin (1987). Divided by a biomass of 3.5 gm^{-2}, this resulted in an annual P/B ratio of 313 (1 kcal = 1 gWW).

31. Odum and Odum (1955) calculated a biomass of 0.1 gm^{-2} for bacteria on reef substrates.

32. Sorokin (1987) gave a biomass range of 0.2-1.7 gm^{-2} for benthic bacteria as an average for coral reefs.

33. Sorokin (1987), in Fig. 2, gave a ration of 20 $kcalm^{-2}day^{-1}$ = 20 gm^{-2}WW for demersal microflora on coral reefs. Based on an average biomass of 1 gm^{-2} (0.2-1.7 gm^{-2}, no. 32), the annual consumption was 7,300 *BW.

34. From Table 3a in Lewis (1981), a mean annual P/B ratio of 155 was calculated for bacteria in coral sediments.

35. A value for organic tissue of foraminiferans was obtained as follows:

a. 31.4 g was the mean foraminiferan biomass of a four-year sampling period in the Gulf of Batabanó, Cuba (based on Table 4 in Gomez et al. 1980).

b. Odum and Odum (1955, Table 12) reported an ash-free DW of 48 gm^{-2} for foraminifera and an AFDW:WW conversion of 86.5% for this component of the decomposers on the Eniwetok reef atoll, South Pacific. Thus foraminiferan wet weight was 55.5 gm^{-2}.

c. From Table 2 in Glynn (1973), a biomass of 135.6 gm^{-2}DW was obtained for foraminiferans on a Caribbean *P. furcata* reef. A conversion of 86.5% (Odum and Odum 1955) yielded a live weight of 157 gm^{-2}.

d. A mean foraminiferan biomass of 81 gm^{-2}WW was computed from a, b and c. Odum and Odum (1955) gave a loss on ignition for foraminiferans of 13.5% per individual. Organic tissue of foraminiferans is assumed to approximately represent the difference between dry weight and wet weight, so that the main component of dry biomass consists of the calcareous skeleton. Like coral polyps, foraminiferans, in Caribbean coral reefs, cover their metabolic requirements largely through the activity of symbiotic microalgae (zooxanthellae). These autotroph organisms are assumed to represent 80-90% of the organic tissue of foraminiferans (Prof. Röttger, Department of Microbiology, University Kiel, pers. comm.). Hence, isolated organic tissue of foraminiferans was reduced to 1 gm^{-2}WW.

36. Annual P/B ratio of foraminiferans (no. 37) is about ten times the P/B ratio of corals. Their functioning as an ecological unit resembles that of corals: both have a calcareous skeleton and symbiotic zooxanthellae which supply a considerable part of the ration - ca. 40% of photosynthesis C_{14} is transferred to the animal (Drits et al. 1987). Considering the much smaller size of foraminiferans and therefore a higher metabolism, I assumed their Q/B to be at least ten times that of corals. Hence, annual consumption should not be < 30 *BW.

37. Hallock (1981) reported carbonate turnover rates for foraminiferans of 11-16 times per year for Palau, Western Caroline Islands and of 7-11 times for Hawaii due to slower growth rates and the absence of the family Calcarinidae. Species composition of Caribbean reef foraminiferans was not known; an average annual P/B ratio of 10 was assumed.

38. Sum of foraminifera (1 gm^{-2}), benthic bacteria (0.9 gm^{-2}) and bacterioplankton (3.5 gm^{-2})

39. Consumption, computed via the combined daily ration of 30 $kcalm^{-2}day^{-1}$, for bacterioplankton and demersal decomposers (Fig. 2 in Sorokin 1987) was 556% * 3.65 = 2,028* $year^{-2}$BW based on a wet biomass of 5.4 gm^{-2} and a conversion of 1 kcal = 1 gWW.

40. Mean weighted (by biomass) annual P/B ratio for microfauna (bacterioplankton, benthic microflora and foraminifera) was 220.

41. Sorokin (1987) reported a range of 0.5-3 gm^{-3} for zooplankton biomass on coral reefs; based on an assumed average water depth of 10 m, the biomass was thus 5-30 gm^{-2}.

42. Sorokin (1987) in Fig. 2 gave a consumption of 2.5 $kcalm^{-2}day^{-1}$ for reef zooplankton. For an average biomass of 18 gm^{-2}, daily consumption was 13.9% BW and annual Q/B was 50.1.

43. Glynn (1973, in Table 2) reported a sponge biomass of 11.8 gm^{-2}DW for a *P. furcata* reef in the Caribbean. A conversion of DW = 30% of WW yielded a wet biomass for sponges of 39.3 gm^{-2}. A 22.5% wet mass was subtracted for inorganic skeletal material (D. Barthel, IfM, Kiel, pers. comm.). The organic weight was 30.5 gm^{-2}.

44. Wilkinson (1987, in Table 1) gave a biomass value of 1,353.8 gm^{-2}WW (0.5 km distance from land) and 654.2 gm^{-2} (5 km distance from land) for sponge populations around St. Croix, US Virgin Islands. Subtracting 22.5% for inorganic skeletal material yielded a range of organic wet weight of 507-1,049 gm^{-2}.

45. Wilkinson (1987) reported a consumption of 0.084 $gCm^{-2}day^{-1}$ for a Great Barrier Reef sponge biomass of 98.3 gm^{-2}WW = 76.2 gm^{-2} of organic wet weight. A conversion of carbon to live weight of 10% yielded a daily sponge consumption of 1.1% BW. Thus, sponges consumed 4.02 times their body weight per year. This value might underestimate consumption of Caribbean sponge populations. Sponges in the Pacific show a much higher infestation with autotrophic symbionts (Cyanophyceae) than species in the tropical Atlantic; metabolites of these symbionts are consumed directly by the sponge host, as those of symbiotic zooxanthellae by the coral polyp (see Wilkinson 1987).

46. Weight-at-age data for the Caribbean sponge *Pseudoceratina crassa* were read off Fig. 1 in Wilkinson and Cheshire (1988). The slope of a semilogarithmic plot from these data yielded an annual production rate of 2.97, indicating that an individual would treble its initial biomass in one year. When assuming a low natural mortality of 10% $year^{-1}$ and exponential growth, an annual P/B ratio of 1.7 can be obtained as a crude preliminary estimate.

47. A biomass value of 16.52 gm^{-2}DW was adopted from Table 12 in Alcolado (1990) for calculating a gorgonian standing stock. Dry weight was converted to live weight (22.5%) and yielded 73.4 gm^{-2}. From this value, 5% was subtracted for zooxanthellae biomass (see Table 4 in Odum and Odum 1955). The resulting animal biomass was divided by 5 to account for its occurrence in only one subsystem.

48. Yoshioka and Yoshioka (1990) reported an average annual survival rate of 92% for gorgonians at La Parguera, Puerto Rico. From this value, an exponential rate of total mortality Z = M = 0.08 $year^{-1}$ can be computed. This corresponds to an estimate of P/B (see Allen 1971).

49. Glynn (1973) in Table 2 gave a biomass of 1.1 gm^{-2}DW for zoanthids on a Caribbean *P. furcata* reef. With a conversion of DW = 17% of WW, the live biomass was 6.5 gm^{-2}. Divided by 5 to account for the subsystems' effect led to a live weight of sea anemones of 1.3 gm^{-2}.

50. A weight range of 60.1-160 gm^{-2}DW for stony corals was taken from Fig. 8 in Martínez-Estalella and Alcolado (1990a). This value originated from a coral reef area near the Isla de la Juventud at the southern margin of the Gulf of Batabanó, Cuba. Conversion of DW = 22.5% of WW resulted in a live weight of 267-711 gm^{-2}. Martinez-Estalella and Alcolado (1990a) did not mention if their coral biomass values were reduced for plant material (symbiotic zooxanthellae and filamentous algae). If not, the stony coral animal live weight decreased to 107-285 gm^{-2} (animal tissue ca. 40% of plant tissue, subpolyp zone not included; see Odum and Odum 1955, Table 4). Accounting for the subsystem effect, the final animal biomass for stony corals was 21.4-57 gm^{-2}WW.

51. Odum and Odum (1955, in Table 4) gave a biomass of animal tissue in corals of 0.021 gcm^{-2}DW = 933.3 gm^{-2}WW (DW = 22.5% of WW). Accounting for the subsystems effect, the live weight of corals for the representative area in the models was 933.3/5 = 187 gm^{-2}.

52. Sorokin (1987, his Fig. 2) gave a consumption value from reef system components (excluding supply by symbiotic algae) of 8.2 $kcalm^{-2}day^{-1}$ for coral polyps and sea anemones, and 1 kcal was assumed to equal 1 gWW. A biomass of 1,000 gm^{-2} for stony corals (calcareous skeleton and symbionts excluded) and sea anemones (see nos. 49 and 51) yielded a daily consumption of 0.825% BW and an annual Q/B of 3.0. When consumption was based on an average biomass of 200 gm^{-2} (no. 50), the annual consumption increased to 15 *BW.

53. Production of coral polyps and sea anemones was given as 1 $kcalm^{-2}day^{-1}$ in Fig. 2 of Sorokin (1987). This value yielded an annual P/B ratio of 0.365 based on a biomass of 1,000 gm^{-2}WW and 1.825 with a biomass of 200 gm^{-2}WW (conversion 1kcal = 1 gWW).

54. Dahl (1973) in Table 2 gave a live weight of 2.3 g for 0.25 m^2 of a coral reef and sand habitat in Puerto Rico.

55. Glynn (1973) in Table 1 gave a sipunculid dry weight of 0.9 gm^{-2} for a Caribbean *P. furcata* reef area. Applying a conversion factor for polychaetes (DW = 20% of WW) yielded a live biomass of 4.5gm^{-2}.

56. Berry (1982), in Table 1, gave for polychaetes a dry biomass range of 1.5-2.3 gm^{-2}DW which was a live weight of 7.5-11.5 gm^{-2}WW when a conversion of DW = 20% of WW was applied.

57. Horn (1986), in Table 4, gave an average dry biomass of 3.3 gm^{-2} and 5.4 gm^{-2} (sum of somatic tissue and shell organics) for two populations of *Chiton pelliserpentis* on a New Zealand high- and lowshore habitat. A conversion of DW = 18% of WW (mean of several gastropod species; for chitons, no value was available) yielded an average live biomass of 18.4 gm^{-2} (highshore) and 30.2 gm^{-2} (lowshore).

58. Based on values in Glynn (1973), an average dry biomass of 55 gm^{-2} was computed for chitons from two reef-boring polyplacophores (*Chiton tuberculatus*, Florida reef, 41 gm^{-2} and *Acanthopleura granulata*, Puerto Rico reef, 69 gm^{-2}). A live biomass of 306 gm^{-2} was obtained by an 18% DW:WW conversion for gastropods. This occurred in only one subsystem, so the average live weight was 61.1 gm^{-2}.

59. In Table 7, Horn (1986) gave an average consumption of 471 (highshore) and 1,521 (lowshore) $kJm^{-2}year^{-1}$ for *Chiton pelliserpentis*. If 18.6 kJ corresponded to 1 gDW of somatic tissue and 23.9 kJ to 1 gDW of shell organics, annual consumption for chitons was: highshore, 7.2 * BW and lowshore, 16.2 * BW (average biomass: highshore, 3.3 gm^{-2}DW and 5.4 gm^{-2}DW, lowshore; see no. 57). Both values are rather low for an herbivorous animal.

60. Horn (1986) gave an annual mortality rate of 22.9% for highshore and 34.3% for lowshore chitons. These values were transformed into exponential rates of natural mortality M = 0.26 and 0.42 $year^{-1}$, respectively; M was set equal to P/B (Allen 1971).

61. A dry biomass of 60-80 g 10m^{-2} for gastropods from Fig. 19 in Martínez-Estalella and Alcolado (1990b) was converted into live biomass = 38.9 gm^{-2} with a conversion of DW = 18% of WW.

62. Huebner and Edwards (1981) gave a daily feeding rate of 1.28% BW for the gastropod *Polinices duplicatus*. The annual rate was 1.28 * 3.65 = 4.7 * BW.

63. Riddle et al. (1990) in Table 5 gave a consumption for infaunal gastropods (>2.0 mm) from Davies Reef Lagoon, Great Barrier Reef, Australia, of 277 kJm^{-2}year^{-1}. Biomass was indicated with 0.748 gCm^{-2}. Q/B was then 7.7 year^{-1} (conversion: 1 gC = 48 kJ).

64. Deslous-Paoli et al. (1985) gave an energy budget for the gastropod *Crepidula fornicata* in the basin of Marennes-Oleron, France: average biomass for an individual representative of the population was equivalent to 1.87 kJ and the annual consumption was 20.08 kJ per individual. Q/B was thus 10.74 year^{-1}. Adjusted for temperature (V = 1.465 when T'= 15°C), the consumption increased to Q/B = 15.7 year^{-1}.

65. From Table 3 in Carefoot (1970), gross conversion efficiencies (K_1) for two seahares (*Aplysia dactylomela* and *A. juliana*), fed on various species of algae, were computed. A mean value of b = 0.0204 (see Pauly 1986) and an annual consumption of 56.4 *BW was computed using growth parameters for the seahare *Dolabella auricularia* from Pauly and Calumpong (1984): W_∞ = 490 g, K = 0.9 year^{-1}, t_0 = -0.23 year^{-1} and b = 3. Natural mortality M = 1.6 was estimated through equation (2.15). The computations were executed with the MAXIMS software.

66. Berg and Olsen (1989) gave an average natural mortality rate M of 0.1 year^{-1} for the abundant queen conch (*Strombus gigas*) in the PRVI area; this was set equal P/B.

67. Riddle et al. (1990, in Table 5) gave a P/B ratio for gastropods (>2 mm, mean weight = 50.5 mg/l) of 2.5 year^{-1}.

68. All estimates of P/B ratio with this statement number in Table 3.10 were obtained from Table 1 in Schwinghamer et al. (1986). Each P/B ratio in Table 3.10 represented the average of all estimates listed for a taxon in Schwinghamer et al. (1986); their P/B ratios were assembled from temperate and boreal areas.

69. A dry biomass of 60.1-170 g 10m^{-2} for bivalves from Fig. 20 in Martínez-Estalella and Alcolado (1990b) was converted to a live biomass of 60-170 gm^{-2} with a conversion of DW = 10% of WW.

70. Salzwedel (1980) gave an energy budget for an "average" *Tellina fabula* population in the German Bight, North Sea, of mean biomass = 60 kJm^{-2} and consumption = 290 kJm^{-2}year^{-1}, at a temperature of about 10°C. Annual Q/B for *T. fabula* was thus 4.8. This value was adjusted for temperature to a consumption of 9.5 year^{-1}*BW with a factor of 1.88. (T = 28°C, T' = 10°C).

71. Riddle et al. (1990, in Table 5) gave a consumption for infaunal bivalves (>2.0 mm) from Davies Reef Lagoon, Great Barrier Reef, Australia, of 657 kJm^{-2}year^{-1}. Biomass was indicated with 1.443 gCm^{-2}. Annual Q/B was then 9.5 (conversion: 1 gC = 48 kJ).

72. The daily rations for three species of bivalves (*Mytilus edulis*, *Modiolus modiolus* and *Arctica islandica*) were calculated as follows: filtration rates were determined from equations in Moehlenberg and Riisgard (1979) and multiplied by an average organic content of 0.16 mgl^{-1} of seawater. The parameter b and Q/B values were computed with MAXIMS (Jarre et al. 1990). The growth constant K was obtained from Appendix 4 in Vakily (1992). W_{max} in the filtration experiments of Moehlenberg and Riisgard were assumed to be 86% of W_∞ of the three species. M was assumed to equal K, as is commonly done in bivalves. The average annual Q/B of the three species was adjusted for temperature. Table 3.12a/b shows the parameters used for the computation of annual Q/B for bivalves.

Table 3.12a. Parameters used to estimate annual Q/B of some bivalves.

Parameter/species	*Mytilus edulis*		*Modiolus modiolus*		*Arctica islandica*	
Size (gDW)	0.011	1.361	0.058	1.555	0.011	1.310
Volume filtered (l day^{-1})	9.1	219.1	17.0	200.5	8.1	157.5
Daily ration ($gDWday^{-1}$)	0.0015	0.0351	0.0027	0.0321	0.0013	0.0252
Daily ration (%)	13.3	2.6	4.7	2.1	11.8	1.9
W_∞ (gWW)	15.8		18.1		15.2	
K = M ($year^{-1}$)	0.36		0.08		0.02	
b	3		3		3	
β	0.02		0.009		0.0012	

Table 3.12b. Consumption of some bivalves.

Species	Q/B (% BWD)	Q/B ($year^{-1}$)
Mytilus edulis	5.8	21.0
Modiolus modiolus	2.8	10.4
Arctica islandica	5.3	19.3
Mean	4.6	16.9
Adjusted (V = 1.724)	7.9	29.1

73. In Salzwedel (1980), biomass for *T. fabula* in the German Bight was 60 kJm^{-2} and production was 81 $kJm^{-2}year^{-1}$. The resulting P/B ratio was 1.35 $year^{-1}$.

74. Berry (1982, in Table 1) gave a biomass equivalent of 6,702.5 kJm^{-2} for organic tissue of a *Perna perna* population on the Oceanographic Research Institute (ORI) Reef, Natal Province, South Africa. Production was 25,458 $kJm^{-2}year^{-1}$. Annual P/B was thus 3.8.

75. A dry biomass of 66-200 g $10m^2$ for molluscs from Fig. 18 in Martínez-Estalella and Alcolado (1990b) was converted to a live biomass of 47-143 gm^{-2}. A mean conversion for gastropods and bivalves of DW = 14% of WW was applied.

76. Glynn (1973) in Table 2 gave a dry biomass of 59.4 gm^{-2} for molluscs on a Caribbean *P. furcata* reef. This corresponded to a live biomass of 424.3 gm^{-2} when DW = 14% of WW.

77. Pauly et al. (1993b) estimated an average daily consumption of 4.56% BW for squids as an ecological group. Annual Q/B was thus 16.6.

78. Abolmasova (1985) reported a daily consumption of 13.8-5.7% of body weight from feeding experiments with captive squid *Sthenoteuthis oualaniensis* of 20-70 g body weight. Experimental temperature was 29-30°C. The value of 5.7% was assumed to pertain to a 70 g animal and used to calculate an annual consumption of 20.8 * BW for tropical squids.

79. From Table 10.6 in Longhurst and Pauly (1987) and Table 8 in Pauly et al. (1993b), various annual rates of natural mortality M for squids were obtained:

Species	M($year^{-1}$)	Source
Loligo duvauceli	1.50	Longhurst and Pauly (1987)
Sepioteuthis lessoniana	1.10	Longhurst and Pauly (1987)
Loligo duvauceli and *Loligo opalescens*	1.58	Pauly et al. (1993b)
Sepioteuthis lessoniana and *Illex illecebrosus*	0.85	Pauly et al. (1993b)

M was assumed to equal P/B, therefore, a range of 0.85-1.58 $year^{-1}$ was accepted for squids.

80. From Beets and Lewand (1986), an octopus density for a Virgin Island reef area of 0.01 individuals m^{-2} (mean of Tables 1-4) was obtained. From growth estimates in Guerra (1979) and from equation (2.12), a medium-sized individual of *Octopus vulgaris* was calculated to weigh 2,800 g. The resulting live biomass was 28 gm^{-2}WW.

81. Two species of octopus (*O. vulgaris* and *O. briareus*) were identified as prey items of fish diets on West Indian reefs (see Appendix Table 8.5.2). For *O. vulgaris*, annual population consumption was computed as follows: From Table 3 in Smale and Buchan (1981), estimates for gross conversion efficiency (K_1) and b were obtained for females and males separately (see Table 3.13a). With MAXIMS (Jarre et al. 1990), annual Q/B was then computed using growth parameters from Guerra (1979) (Table 3.13b). Age at size 0 (t_0) and natural mortality M were obtained from equations (2.11) and (2.16), respectively. Annual Q/B was then adjusted for temperature (Table 3.13c).

82. From growth parameters in Guerra (1979), an annual natural mortality rate M of 1.09 was calculated for *O. vulgaris* (W_∞ = 10,850 g, K = 0.72 year^{-1}, T = 28°C). M was assumed to equal P/B.

83. Buchan and Smale (1981) gave an annual P/B ratio of 3.33 for female and 2.78 for male *O. vulgaris* on the ORI Reef, Natal Province, South Africa. The mean was 3.06 year^{-1}.

84. Lewis (1981) calculated an average biomass of 0.19 gCm^{-2} (= 1.9 gm^{-2}WW) for polychaetes in coral clumps on reefs in the Bahamas and off South Florida from data in Vittor and Johnson (1977).

85. Naim and Amoureux (1982) gave a maximum polychaete density of 1,900 individuals = 11 gm^{-2} for a coral reef in Moorea, French Polynesia.

Table 3.13a. Conversion efficiencies of *O. vulgaris* (Smale and Buchan, 1981 modified).

No. ind.	Days	Diet	Initial weight (g)	Final weight (g)	Mean weight (g)	Change in weight (g)	Food intake (g)	K_1	β
Females									
1	84	R+M	74	1,013	544	939	3,481	0.2698	0.1051
2	77	M	77	744	411	667	2,644	0.2523	0.0888
3	97	M	80	1,292	686	1,212	6,236	0.1944	0.0783
4	70	R+M	146	1,129	638	983	2,810	0.3498	0.1519
5	194	R+M	197	4,353	2,275	4,156	8,741	0.4755	0.4131
6	138	R+M	238	4,332	2,285	4,094	8,398	0.4875	0.4291
7	81	R+M	247	1,646	947	1,399	3,939	0.3552	0.1799
8	53	R+M	282	1,728	1,005	1,446	2,490	0.5807	0.3653
9	55	R+M	350	866	608	516	1,493	0.3456	0.1474
10	58	R+M	351	1,251	801	900	2,377	0.3786	0.1826
11	25	M	497	881	689	384	1,718	0.2235	0.0918
12	196	R+M	545	4,542	2,544	3,997	9,903	0.4036	0.3563
13	31	M	580	1,113	847	533	1,910	0.2791	0.1283
14	98	R+M	952	3,111	2,032	2,159	5,620	0.3842	0.2894
Mean females									0.2148
Males									
1	83	M	13	277	145	214	908	0.2357	0.0623
2	278	R+M	284	5,685	2,985	5,401	9,062	0.5960	0.7023
3	91	R+M	291	1,815	1,053	1,524	2,764	0.5514	0.3437
4	94	R+M	320	1,709	1,015	1,389	3,435	0.4044	0.2187
5	158	R+M	393	2,259	1,326	1,866	5,988	0.3116	0.1776
6	127	R+M	486	1,480	983	994	4,149	0.2396	0.1141
7	139	M	528	1,768	1,148	1,240	5,413	0.2291	0.1158
8	36	M	540	1,142	841	602	1,715	0.3510	0.1691
9	112	M	542	1,100	821	558	3,207	0.1740	0.0741
10	106	M	635	1,492	1,064	857	3,562	0.2406	0.1185
11	112	M	889	1,680	1,285	791	4,455	0.1776	0.0917
Mean males									0.1989
Mean of all values									0.2078

M = mussels, R = rock lobster.

Table 3.13b. Parameters used to estimate consumption of *O. vulgaris*.

Parameter (unit)		Source
L_∞ (cm)	30	Guerra (1979)
W_∞ (g)	10,850	Guerra (1979)
W_{max} (g)	4,000	Largest individual of Smale and Buchan (1981)
W_r (g)	1	Set value
K ($year^{-1}$)	0.72	Guerra (1979)
t_0 ($year^{-1}$)	-0.22	Equation (2.11)
b	2.987	Guerra (1979)
β	0.2078	Table 3.13a
M ($year^{-1}$)	1.09	Equation (2.16)
T (°C)	28	DHI (1967)
T' (°C)	23	Smale and Buchan (1981)
V	1.128	Pauly et al. (1993b)

Table 3.13c. Consumption and maintenance ration of *O. vulgaris* at 28°C.

Temperature	Q/B (% BWD)	R_m (% BWD)	Q/B ($year^{-1}$)	R_m (*BWyear^{-1})
23°C	1.6415	0.9528	5.9916	3.4778
28°C	1.85	1.08	6.76	3.92

86. Ibarzábal (1990, in Fig. 15) gave a biomass value of > 2 gm^{-2}DW for polychaetes in an area near the Isla de la Juventud, Cuba. Applying a conversion of DW = 20% of WW, the minimum live weight was 10 gm^{-2}.

87. Kohn and Lloyd (1973) estimated biomass of polychaetes on coral reefs in the Eastern Indian Ocean of 2-6 gm^{-2}DW (ca. 20 gm^{-2}WW).

88. Glynn (1973, in Table 2) gave a dry biomass of 6.7 gm^{-2} for polychaetes in a Caribbean *P. furcata* reef area. Allowing for DW = 20% of WW yielded a live weight of 33.5 gm^{-2}.

89. Riddle et al. (1990, in Table 5) reported the following consumption rates and P/B ratios for polychaetes in Davies Reef Lagoon, Great Barrier Reef, Australia:

Feeding type	Size	Biomass ($mgCm^{-2}$)	Consumption ($kJm^{-2}year^{-1}$)	P/B ($year^{-1}$)	Q/B[a] ($year^{-1}$)
Macrophagous	> 2 mm	124	73	2.6	12.3
	0.5-2mm	71	126	10.3	40.0
Microphagous	> 2 mm	217	157	3.3	15.1
	0.5-2mm	224	373	8.5	34.7

[a]Consumption/48/biomass (1gC = 48 kJ).

A weighted (by biomass) mean annual Q/B of 24.2 with a P/B ratio of 5.8 could thus be calculated for polychaetes as an ecological group.

90. From Table 1 in Pamatmat and Findlay (1983), a mean daily ration for the polychaete *Capitella capitata* of 27% BW was determined. Annual Q/B for animals of 45-167 mgWW was 99.

91. Berry (1982, in Table 1) gave a dry biomass range for two species of Cirripedia on the ORI Reef, Natal Province, South Africa, of 8.74 to 20.46 gm^{-2} (calcareous shells excluded). Allowing for a conversion DW = 25% of WW (mean for various small crustaceans) resulted in a live biomass range of 35.4-82.8 gm^{-2}.

92. Berry (1982, in Table 1) gave a dry biomass range for amphipods (several species) of 0.28-0.92 gm^{-2} which corresponded to a live biomass of 1.1-3.5 gm^{-2} (conversion 1:4).

93. Riddle et al. (1990, in Table 5) gave a biomass of 0.086 gCm^{-2} and a consumption of 69 $kJm^{-2}year^{-1}$ for crustaceans in Davies Reef Lagoon, Great Barrier Reef, Australia, of 5.32 mg (>2 mm length) mean body weight. Annual Q/B was thus 16.7. Consumption for crustaceans of a mean weight of 0.072 mg (0.5-2 mm length) was 46.3*BW $year^{-1}$ (249 $kJm^{-2}year^{-1}$/48/0.112 gCm^{-2}). Weighted (by biomass) mean annual Q/B of small crustaceans was then 33.4.

94. Applying an equation by Cammen (1980):

$$C = 0.381 * W^{0.742} \qquad \textbf{...3.3)}$$

where C = daily ingestion rate in $mgday^{-1}$DW, W = body weight in mgDW, for deposit feeders and detritivores yielded a daily ingestion rate of 0.515 mg = 34.3% BW for amphipods of mean individual dry body weight of 1.5 mg (Berry 1982). Annual Q/B was 125.25.

95. Hargrave (1985) gave an average daily consumption rate of 30-60% BW for lysianassid amphipods (size not given) of the Nares Abyssal Plain (5,830 m depth) in the northwest Atlantic Ocean, where temperature (not given) can be presumed to be very low. A mean consumption rate of 45% BW yielded an annual Q/B of 164. This already high estimate of Q/B was not adjusted to the higher temperature of waters around PRVI.

96. Odum and Odum (1955, p. 309) gave a biomass value for "microcrustacea" in algal encrusting mats of 0.022 gm^{-2}DW which is 0.17 gm^{-2}WW (wet volume assumed to have a specific density of 1). The authors did not comment on species composition and size of this ecological group.

97. In Fig. 32 in Martínez-Iglesias and Alcolado (1990), a dry biomass range of 66-140 g 100m^{-2} was indicated for decapod crustaceans in the Gulf of Batabanó, Cuba, north of the Isla de la Juventud. In Fig. 34 (same source), it was shown that penaeidean and caridean shrimps comprise an average 10% of the decapod biomass of the samples taken during the study. Allowing for DW = 26.7% of WW yielded a shrimp wet biomass of 0.25-0.52 gm^{-2}.

98. Odum and Odum (1955, in Table 8, quadrat A), gave a dry biomass for predominantly herbivorous gammarids and other small crustacean of 4.7 gm^{-2}. A mean live biomass of 18.8 gm^{-2} was computed with DW = 25% of WW. This ecological group was not listed for quadrats B,C,D and E by Odum and Odum (1955, Tables 9-12); hence, the average reef area contained 18.8/5 = 3.76 gm^{-2}WW.

99. Pauly et al. (1993b) computed a daily consumption of 7.93% BW for "shrimps" as an ecological group; annual Q/B was thus 26.9.

100. Pauly et al. (1993b) estimated a natural mortality rate for *Metapenaeus monoceros* of M = 1.6 $year^{-1}$ and for *Penaeus monodon* of M = 0.9 $year^{-1}$. M was assumed to equal P/B. Hence, an annual range of P/B for shrimps of 0.9-1.6 was obtained.

101. Garcia (1985), in Table 1, gave estimates of annual natural mortality M (= P/B) for fully exploited penaeid shrimp stocks in the Gulf of Mexico of 1.8-2.8 $year^{-1}$. Penaeids comprised ca. 25% of occurrence of "shrimps" in West Indian fish stomachs analyzed by Randall (1967). M was set equal P/B.

102. Munro (1983) reported a biomass of 63-119 $kgkm^{-2}$ = 0.063-0.119 gm^{-2} for *Panulirus argus* in Jamaican waters.

103. Food consumption for spiny lobsters was computed as follows: Table 3.14a shows food conversions and corresponding weights for *Panulirus homarus*, read off Fig. 17 in Smale (1978) for an experimental temperature of 28°C. Dry weight was converted into wet weight with

DW = 18% of WW. These data were used to estimate b through equation (2.23), applying a mean W_∞ of 833 gWW from females and males (see Table 3.14b). From growth parameters in Table 3.14b, the annual consumption (Table 3.14c) of spiny lobster was computed with MAXIMS (Jarre et al. 1990).

104. Malkov (1978) gave a natural mortality estimate M of 0.35 $year^{-1}$ for *P. argus* in Cuban waters.

105. Buesa (1969) reported an annual natural mortality of 56-78% for *P. argus* in Cuban waters; from this, a mean exponential rate of M = 0.45 $year^{-1}$ was computed; M was assumed to equal P/B.

Table 3.14a. Food conversions of *P. homarus* (Smale 1978, Fig. 17, 28°C).

DW(g)	K_1*100	WW(g)	$Log_{10}WW$	K_1	$-Log_{10}(1-K_1)$
1.5	31.3	8.33	0.920818	0.313	0.163043
3.8	19.8	21.11	1.324511	0.198	0.095825
5.7	14.0	31.67	1.500602	0.140	0.065501
7.2	12.2	40.00	1.602059	0.122	0.056500
11.2	17.2	62.22	1.793945	0.172	0.081969
13.1	15.4	72.78	1.861998	0.154	0.072629
14.9	10.9	82.78	1.917913	0.109	0.050122
16.8	9.2	93.33	1.970036	0.092	0.041914
18.3	9.9	101.67	2.007178	0.099	0.045275
26.2	16.7	145.56	2.163028	0.167	0.079354
27.9	9.0	155.00	2.190331	0.090	0.040958
31.2	8.7	173.33	2.238882	0.087	0.039529
32.8	1.8	182.22	2.260601	0.018	0.007888
33.9	5.0	188.33	2.274927	0.050	0.022276
35.1	5.9	195.00	2.290034	0.059	0.026410
36.4	4.0	202.22	2.305828	0.040	0.017728
37.5	2.0	208.33	2.318758	0.020	0.008773
Mean			1.937732		0.053865

Table 3.14b. Parameters used to estimate consumption of *P. homarus*.

Parameter	(unit)	Female	Male	Source
Cl_∞	(mm)	94.2	120.0	Smale (1978)
Cl_{max}	(mm)	76.0	81.0	Smale (1978, Table 3)
a		0.00069	0.00126	Munro (1983,for *P. guttatus*)
b		3.01	2.85	Munro (1983,for *P. guttatus*)
W_∞	(g)	604.0	1,062.0	-
W_{max}	(g)	316.0	346.0	-
W_r	(g)	1.0	1.0	Set value
K	($year^{-1}$)	0.337	0.177	Smale (1978, K (day^{-1})*365)
t_0		0.15	-0.01	Equation (2.11)
M	($year^{-1}$)	0.7	0.7	Mean of nos. 95, 96 and 97
β		0.05484	0.05484	See text

Table 3.14c. Consumption and maintenance ration of *P. homarus*.

Sex	Q/B (% BWD)	R_m (% BWD)	Q/B ($year^{-1}$)	R_m (*BW$year^{-1}$)
Female	2.4138	1.6773	8.8105	6.1222
Male	1.6173	0.9305	5.9031	3.3963
F + M	2.02	1.30	7.36	4.76

106. Munro (1983, in Table 16.2) estimated M for female and male *P. argus* from unexploited parts of Pedro Bank, Jamaica, to be 0.81 and 1.25 $year^{-1}$, respectively. Hence, mean P/B for *P. argus* was 1.03 $year^{-1}$.

107. A biomass range of 66-149 g $100m^{-2}$DW for decapod crustaceans was read off Fig. 32 in Martínez-Iglesias and Alcolado (1990). Fig. 34 (same source) indicated a percentage of anomuran biomass of 3.2. Allowing for a DW/WW conversion of 1:4 yielded a live biomass for hermit crabs of 0.09-0.18 gm^{-2}.

108. Brachyuran biomass in Martínez-Iglesias and Alcolado (1990) was 87.2% of decapod biomass (Fig. 34). A dry biomass range of 66-140 g$100m^{-2}$ (Fig. 32) and a conversion DW/WW of 1:4 resulted in a live biomass for crabs of 2.3-4.9 gm^{-2}.

109. Consumption for the majid crab *Mithrax spinosissimus* was estimated as follows: From Tables 2 and 4 in Wilber and Wilber (1989), length increments ($\delta l/\delta t$) in relation to CL of *M. spinosissimus* were prepared for a "forced" Gulland and Holt plot (Pauly 1984). An asymptotic carapace width (CW) of 150 mm (Munro 1983: for *M. spinosissimus* around Jamaica) was used as "external" $CL(_\infty)$. The slope of the plot yielded an estimate of K = 0.00087 day^{-1}, i.e., K = 0.32 $year^{-1}$. Estimates of daily ration for *M. spinosissimus* were read off Fig. 1 in Winfree and Weinstein (1989). Two different kinds of diets were provided which yielded two differing values for β and hence of consumption. Table 3.15a shows the data used for the estimation of Q/B of *M. spinosissimus*. Table 3.15b presents the population consumption computed using MAXIMS (Jarre et al. 1990).

110. Based on W_∞ = 1,326 g for female and 2,820 g for male *M. spinosissimus*, a value of K = 0.32 $year^{-1}$ (see no. 109) and a mean environmental temperature of 28°C, values of M of 0.75 for females and 0.71 for males were computed from equation (2.16). Mean P/B for *M. spinosissimus* was thus 0.73 $year^{-1}$.

111. Erhardt and Restrepo (1989) reported a natural mortality rate M of 1.60 $year^{-1}$ for the Florida stone crab *Menippe mercenaria* (Majidae). Majid crabs comprised ca. 30% of occurrence of crab species in West Indian fish stomachs analyzed by Randall (1967).

112. A biomass range of 66-140 g $100m^{-2}$DW for decapod crustaceans in the Gulf of Batabanó, Cuba, was obtained from Fig. 32 in Martínez-Iglesias and Alcolado (1990). Allowing for a DW/WW conversion of 1:4 yielded a live biomass of 2.6-5.6 gm^{-2}.

113. Glynn (1973), in Table 2, gave a dry biomass for crustaceans on a Caribbean *P. furcata* reef of 40.3 gm^{-2}. When an average conversion of 25% is applied, live biomass was 161.2 gm^{-2}.

114. A biomass range of 41-71 g $10m^{-2}$DW for asteroids in the Gulf of Batabanó, Cuba, was obtained from Fig. 38A in Corvea et al. (1990). Live weight of starfish was 14.1-24.5 gm^{-2} when DW is 29% of WW.

Table 3.15a. Parameters used to estimate consumption of *M. spinosissimus*.

Parameter	(unit)	Female	Male	Source
CW_{max}	(mm)	154	175	Munro (1983)
a		0.00028	0.00018	Munro (1983)
b		3.0515	3.1654	Munro (1983)
W_r	(g)	651	727	Munro (1983)
W_{max}	(g)	1,140	2,425	Munro (1983)
W_∞	(g)	1,326	2,820	Equation (2.6)
K	($year^{-1}$)	0.32	0.32	See text
t_0	($year^{-1}$)	0.32	0.31	Equation (2.11)
M	($year^{-1}$)	0.75	0.71	Equation (2.16)
β_1		0.0179	0.0223	Computed with MAXIMS
β_2		0.0285	0.0385	Computed with MAXIMS

1 diet: wild reef algae; 2 diet: fish - *Gracilaria* sp. - *Ulva* sp.

Table 3.15b. Consumption of a Caribbean population of *M. spinosissimus*.

Sex		Q/B (% BWD)	Q/B ($year^{-1}$)
Female	1	5.2372	19.1157
Male	1	4.2936	15.6715
Female	2	3.2977	12.0366
Male	2	2.5036	9.1318
F + M	1	4.765	17.394
F + M	2	2.901	10.587

1 and 2: see above.

115. From data in Wurzian (1984) on *Astropecten aranciacus* in the Northern Adriatic Sea, a rough estimate of food consumption for starfish was computed as follows: density of *A. aranciacus* was 3.67 individuals 100 m^{-2}; this was 0.037 individuals m^{-2}. Ingestion was 9.5 $kJm^{-2}year^{-1}$ A mean radius (R) of 12.3 cm was computed from R-frequency data in Fig. 1 (same source) and converted to a live weight of 130 g applying the equation in Fig. 2:

$$WW = 0.1609 * R^{2.8293} \quad \text{...3.4)}$$

where WW is wet weight in g and R is the radius of the starfish. With a density of 0.037 individuals m^{-2} and an individual weight of 130 g, an average live biomass of 4.76 gm^{-2} was computed. Ingestion was converted into wet weight with 1 kJ = 1.2 gWW (conversion for sea urchins) to 11.37 $gm^{-2}year^{-1}$. Hence, annual food consumption for an average individual of *A. aranciacus* was 2.39 *BW. Adjusted for temperature, annual Q/B increased to 3.24 (V = 1.36; T'= 17°C: mean annual temperature for the Northern Adriatic was determined from charts in KNMI 1957).

116. Production of *A. aranciacus* in the Northern Adriatic was indicated with 1.958 $kJm^{-2}year^{-1}$ (Wurzian 1984). Converted to live weight, production was 2.35 $gm^{-2}year^{-1}$. Based on an average biomass of 4.76 gm^{-2}WW (see no. 115), the annual P/B ratio was 0.49.

117. A biomass range of 2-6 g10m^{-2} DW for ophiuroids in the Gulf of Batabanó, Cuba, was obtained from Fig. 41A in Corvea et al. (1990). Live weight of ophiuroids was 0.7-2.1 g when DW is 29% of WW.

118. McClanahan (1988), in Table 1, gave density and biomass values for three species of sea urchins on a Kenyan coral reef. Mean biomass was 67.4 gm^{-2}WW.

119. A biomass range of 127-472 g10m^{-2} DW for echinoids in the Gulf of Batabanó, Cuba, was obtained from Fig. 39A in Corvea et al. (1990). Live weight of sea urchins was thus 39.7-147.5 gm^{-2} based on a conversion DW/WW of 32%.

120. From Table 1 in Bak et al. (1984), an average density of 2.1 individuals m^2 was computed for *Diadema antillarum* in Curaçao, Netherlands Antilles. Pauly et al. (1993b) computed an average weight per individual of the same species of 57 gWW. Based on these values, the biomass was 119.7 gm^{-2}. *D. antillarum* is the most common sea urchin in PRVI reef areas.

121. Weil et al. (1984) reported a mean *D. antillarum* density of 2.6-3.7 individuals m^2 for several coral reefs in Venezuela. Based on an average individual weight of 57 g (see no. 120), the mean biomass range was 148.2-210.9 gm^{-2}WW.

122. Pauly et al. (1993b) estimated food consumptions for various species of sea urchins. When abundance of the respective genera in stomach analyses of reef fishes was considered (Randall 1967, see Appendix 8.5.2), the weighted mean consumption for sea urchins as an ecological group is 0.77% BWD or 2.81 * $BWyear^{-1}$.

123. Hawkins (1985) gave a P/B estimate of 2.0 $year^{-1}$ for the sea urchin *D. antillarum* in Barbados.

124. A biomass range of 21-40 g 10m^{-2}DW for holothurians in the Gulf of Batabanó, Cuba, was obtained from Fig. 40A in Corvea et al. (1990). Live weight of sea cucumbers was 23.3-44.4 gm^{-2} when DW is 9% of WW.

125. Berry (1982), in Table 1, gave a caloric equivalent of biomass of 55.1 kJm^{-2} for a holothurian species on the ORI Reef, Natal Province, South Africa. Allowing for a conversion of 1 kJ = 1.08 gWW, the live biomass was 59.4 gm^{-2}.

126. Pauly et al. (1993b) estimated the consumption of several species of tropical holothurians from published data. From this source, consumption estimates for *Holothuria* sp. (Q/B = 0.77% BWD) and *Opheodesoma spectabilis* (Q/B = 1.07% BWD) were used to compute an average consumption of 3.36 * $BWyear^{-1}$ for the ecological group "holothurians" of the present Caribbean reef model.

127. In Pauly et al. (1993b), estimates of the growth constant K ($year^{-1}$) were given for various species of holothurians. The mean annual K of species similar to those occurring in the PRVI area was 0.29, assumed to equal M (= P/B).

128. Corvea et al. (1990, in Fig. 36) gave a dry biomass range for echinoderms in the Gulf of Batabanó, Cuba, of 351-500 $g10m^{-2}$. This corresponded to a live weight of 140.4-200 gm^{-2}.

129. Glynn (1973, in Table 2) gave a dry biomass for echinoderms on a Caribbean *P. furcata* reef of 263.3 gm^{-2}. This corresponded to a live weight of 1,053.2 gm^{-2}.

130. Dahl (1973, in Table 1) gave a wet biomass of 8.8 g 0.25m^{-2} which corresponded to 35.2 gm^{-2} for tunicates on a Puerto Rican algal plain.

131. Berry (1982, in Table 1) gave a biomass of 148.8 gm^{-2}DW (flesh only) for the ascidian *Pyura stolonifera* on the ORI Reef, Natal Province, South Africa. Allowing for DW = 20% of WW (organic tissue) yielded a live weight of 744 gm^{-2}.

132. Consumption of ascidians (sessile tunicates) was estimated as follows: Mullin (1983) provided equations to compute filtering rates of the planktonic living salp *Thalia democratica* on phytoplankton and bacteria. Benthic tunicates also filter phytoplankton and microfauna (besides zooplankton and detritus particles); hence, the suggested filtering rates were assumed to be valid also for sessile ascidians. From stomach analyses of West Indian reef fishes (Randall 1967) and from a collection of Caribbean reef invertebrates and plants (Colin 1978), species composition and rough estimates of abundance were obtained. Meinkoth (1981) provided information on size of solitary and colonial ascidians. Weight estimates were obtained by computing the volume of a cylinder whose height corresponded to the length of an individual ascidian and whose radius corresponded to its width/2, and by setting the specific weight of the cylinder equal to that of water (1 cm^3 = 1 g). Body carbon of ascidians was computed via the equations in Mullin (1983):

for solitaries $C = 1.03*L^{1.775}$ **...3.5)**

for aggregates $C = 0.515*L^{2.1}$ **...3.6)**

where carbon is organic carbon content of body in mg and L is body length in mm. Mullin (1983) reported median total particulate organic carbon in his experimental filtering media as 142 μgCl^{-1} (range 69-200 μgCl^{-1}). I assumed from diet composition percentages for ascidians (see Appendix Table 8.6.2) that 60% of the volume filtered (VF) was grazed at rates for bacteria and 40% at rates for phytoplankton. The VF of every food item was computed by multiplying the corresponding grazing rates with the body carbon of the respective species. The consumption of a food item was obtained by dividing the total organic carbon content (142 μgl^{-1}) into the respective percentages (60% for bacteria, 40% for phytoplankton) and by then multiplying the shares by VF. Rations per hour were converted into consumption of % of body weight applying mean carbon-weight (C/W) ratios of 0.0112% for solitary and 0.0013% for colonial species. The range of consumption values included in Table 3.10 does not report the results for the colonial species as they are unrealistically low. An average annual Q/B of 24 is the median for solitary species. Table 3.16 shows the data used for the estimation of food consumption for ascidians as an ecological group in the present Caribbean reef model.

133. Berry (1982), in Table 1, gave a caloric equivalent of biomass of 2,300 kJm^{-2} for organic tissue of the detritivorous ascidian *Pyura stolonifera* on the ORI Reef, Natal Province, South Africa. Production of organic tissue was given as 5,213 $kJm^{-2}year^{-1}$. Hence, the P/B ratio was 2.3 $year^{-1}$.

134. U. Richter (Hagenbecks Tierpark, Hamburg) reported the following personal observations: (a) juvenile *Emydura albertinii* (marine turtle, New Guinea, piscivorous) of 65 g live weight consumed around 0.5 g fish or shellfish flesh per day which was 0.77% BWD and 2.8*$BWyear^{-1}$, (b) a "giant turtle" (species name not available) of 300 kg consumed around 2 kg of plant food per day which was 0.67% BWD or 2.5*$BWyear^{-1}$. These values of turtle consumption were somewhat lower than that of 3.5*$BWyear^{-1}$ estimated by Polovina (1984b) in his coral reef model of French Frigate Shoals, Hawaii. The low values are surprising since, in the first case, we deal with a very young organism with high metabolic requirements. In the second case, the consumption rate appears to be low for an herbivorous animal. However, annual P/B ratio was also very low (0.15).

135. From Fig. 1 in Nuitja and Uchida (1982), maximum daily growth for juvenile loggerhead turtles (*Caretta caretta*) was obtained for a feeding rate of 3.1% BW. It is not known if the growth potential is reached at that feeding rate. This feeding rate yielded an annual consumption estimate for juvenile carnivorous loggerhead turtles of 11.5*BW. Experimental temperature was 20.5°C. For this turtle, the amount of food required to maintain basal metabolism was less for higher temperatures than for lower ones (see Nuitja and Uchida 1982). Therefore, the Q/B estimate was not corrected for temperature.

The estimates presented in points 1-135 were summarized; a range and an average input value were determined for each of the three input parameters and for each taxon for which estimates were available (Table 3.17).

3.2.4. Diet Composition Matrix

In the diet composition (DC) matrix of nonfish taxa (Appendix Table 8.6.2), constituents are listed in rough systematical order. The matrix was assembled from a wide variety of sources (see "Materials and methods" section). The references on which the matrix was based are listed in Appendix Table 8.6.3 by author(s) and year of publication.

3.3. The Models

3.3.1. The 50-Box Model

3.3.1.1. AGGREGATION OF FISH SPECIES

The results from the cluster analysis, aggregating 243 fish species stepwise into 1 species group, are depicted in Fig. 3.1. This dendrogram includes the names of fish species combined into the respective clusters. The first cutoff level at a quadratic Euclidean distance (QED) of 0.3 (20% of the total 1.5) yielded 29 fish species groups (see "Materials and methods" section).

Overall, the cluster analysis produced a distinct separation among carnivorous, omnivorous and herbivorous species. Furthermore, apex predators, such as large sharks and rays, as well

Table 3.16. Food consumption of ascidians (class: Tunicata).

Species	N	Type	Height L(mm)	Width (mm)	Volume[a] (cm^3)	W (g)	C-Body (μg)	C/W-ratio (%)	GR-bact ($ml_{\mu}gC^{-1}h^{-1}$)	GR Phyto ($ml_{\mu}gC^{-1}h^{-1}$)
Ascidia nigra	2	Is	102	60	288.4	288.4	3,785	0.001312	5.646[b]	8.998[d]
Boltenia echinata	1	I	25	35	24.1	24.1	312	0.001294	1.425[b]	2.056[d]
B. ovifera	1	I	76	51	155.3	155.3	2,245	0.001445	4.233[b]	6.606[d]
B. villosa	1	I	41	32	33.0	33.0	751	0.002275	2.313[b]	3.456[d]
Clavelina huntsmani	?	I	51	10	4.0	4.0	1,106	0.027651	2.864[b]	4.346[d]
Clavelina picta	?	I	19	6	0.5	0.5	192	0.038340	1.090[b]	1.541[d]
Didemnum albidum	2	C	3	102	24.5	24.5	5	0.000021	0.248[c]	0.314[e]
D. carnulentum	2	C	3	121	34.5	34.5	5	0.000014	0.248[c]	0.314[e]
Distaplia stylifer	?	C	16	19	4.5	4.5	174	0.003865	0.742[c]	1.061[e]
Ecteinascidia turbinata	1	I	25	10	2.0	2.0	312	0.015600	1.425[b]	2.056[d]
Polycarpa obtecta	1	Is	51	44	77.5	77.5	1,106	0.001425	2.864[b]	4.346[d]

I = individuals, Is = solitary individuals, C = colonies.

Species	VFbact (mlh^{-1})	VFphyto (mlh^{-1})	Cons. B. (μgh^{-1})	Cons. P. (μgh^{-1})	Q/B-bac ($\%BCh^{-1}$)	Q/B-phy ($\%BCh^{-1}$)	Q/B ($\%BCh^{-1}$)	Q/B ($\%BCday^{-1}$)	Q/B (%BWD)	Q/B ($year^{-1}$)
Ascidia nigra	21,372.33	34,058.91	1,816.65	1,941.36	47.99	51.29	49.64	1,191.34	13.31	48.57
Boltenia echinata	444.73	641.38	37.80	36.56	12.12	11.72	11.92	285.98	3.19	11.66
B. ovifera	9,504.47	14,833.16	807.88	845.49	35.98	37.66	36.82	883.63	9.87	36.03
B. villosa	1,736.90	2,549.48	147.64	147.89	19.66	19.70	19.68	472.33	5.28	19.26
Clavelina huntsmani	3,168.22	4,806.41	269.30	273.97	24.35	24.77	24.56	589.41	6.58	24.03
Clavelina picta	208.86	295.40	17.75	16.48	9.26	8.78	9.02	216.53	2.42	8.83
Didemnum albidum	1.28	1.62	0.11	0.09	2.11	1.79	1.95	46.78	0.06	0.22
D. carnulentum	1.28	1.62	0.11	0.09	2.11	1.79	1.95	46.78	0.06	0.22
Distaplia stylifer	129.04	184.62	10.97	10.52	6.31	6.05	6.18	148.25	0.19	0.70
Ecteinascidia turbinata	444.73	641.38	37.8	36.56	12.12	11.72	11.92	285.98	3.19	11.66
Polycarpa obtecta	3,168.22	4,806.41	269.30	273.97	24.35	24.77	24.56	589.41	6.58	24.03
Annual consumption of ascidians (median of all values except colonies).										24.00

[a]Volume of cylinder: $\pi \cdot r^2 \cdot h$ ($r = W/2$).
[b]Grazing rate for solitaries on bacteria: $0.061*L^{0.979}$.
[c]Grazing rate for aggregates on bacteria: $0.121*L^{0.654}$.
[d]Grazing rate for solitaries on phytoplankton: $0.07*L^{1.05}$.
[e]Grazing rate for aggregates on phytoplankton: $0.141*L^{0.728}$.

Table 3.17. Key input parameters of 41 nonfish groups for Caribbean coral reef models; average values = mean of two values or median of > two values; P/B = production/biomass ratio, Q/B = annual consumption per unit biomass.

Net primary production (PP) of overall system: 20,000 $g \cdot m^{-2} \cdot year^{-1}$ WW.
Export of benthic producers from system: 480 $g \cdot m^{-2} \cdot year^{-1}$ WW.

ID		Nonfish group	Range of biomass ($g \cdot m^{-2}$ WW)	Average biomass ($g \cdot m^{-2}$ WW)	Range of P/B ($year^{-1}$)	Average P/B ($year^{-1}$)	Range of Q/B ($year^{-1}$)	Average Q/B ($year^{-1}$)
D	1	Detritus, POM, DOM	1,000-3,000	2,000.000				
A	1	Benthic autotrophs (excluding symbionts)	109-3,300	1,500.000	12.8-30.8	13.25		
A	2	Symbiotic algae		730.000	9.3-16.6	10.20		
A	3	Phytoplankton	0.1-83	42.000		70.00		
I	1	Decomposers/microfauna	3.1-7.7	5.400	170-220	195.00	1,900-2,200	2,050.00
I	2	Zooplankton	5-30	17.500		40.00	50-280	165.00
I	3	Sponges	30.5-1,049	800.000		1.70	4.02	
I	4	Fire corals					3-15	9.00
I	5	Sea fans		14.000		0.08	3-15	9.00
I	6	Sea anemones		1.300			3-15	9.00
I	7	Stony corals	21-57	39.000			3-15	9.00
		Corals		187.000	0.37-1.8	1.09	3-15	9.00
I	8	Bryozoans		9.200				
I	9	Sipunculid worms	4.5-11.5	7.000				
I	10	Priapuloids						
I	11	Chitons	18-61	36.000	0.26-0.42	0.34	7.2-16.2	11.70
I	12	Gastropods		39.000	0.1-5.9	2.50	4.7-56.4	14.00
I	13	Bivalves	60-170	115.000	1.35-3.8	2.23	9-29.1	9.50
I	14	Scaphopods						
		Shelled molluscs	47-396	246.000				
I	15	Squids			0.9-1.6	1.25	16.6-20.8	18.70
I	16	Octopuses		28.000	1.09-3.06	2.08		6.76
I	17	Polychaetes	1.9-34	11.000	2.48-5.8	4.14	24.2-99	61.60
I	18	Echiuroids						
I	19	Pycnogonids						
I	20	Barnacles	35-83	59.000				
I	21	Stomatopods						
I	22	Amphipods	1.1-3.5	2.300		2.41	33.4-164	125.50
I	23	Tanaids						125.50
I	24	Isopods (fish parasites)				2.40		125.50
		Small crustaceans		0.160	1.4-3.9	2.65		
I	25	Shrimps	0.25-3.8	2.100	0.9-2.8	1.80		26.90
I	26	Spiny lobsters		0.090	0.35-1.03	0.45		7.40
I	27	Scyllarid lobsters						
I	28	Hermit crabs	0.1-0.2	0.150				
I	29	Crabs	2.3-4.9	3.600	0.73-1.61	1.17	10.6-17.4	14.00
		Lobsters and crabs		3.310		0.52		8.20
		Crustaceans	2.5-161	82.500				
I	30	Hemichordates						
I	31	Asteroids	14-25	19.500		0.49		3.24
I	32	Ophiuroids	1-3	2.000				
I	33	Echinoids	40-211	107.000	0.8-2	1.40		2.81
I	34	Holothurians	23-59	46.200		0.29		3.36
		Echinoderms	140-1,053	612.000				
I	35	Ascidians (Tunicata)	35-744	390.000		2.30	9-49	24.00
R	1	Sea turtles		0.015		0.15	2.8-11.5	3.50
B	1	Sea birds		0.015		5.40		80.00

D = detritus, A = autotroph, I = invertebrate, R = reptile, B = bird.

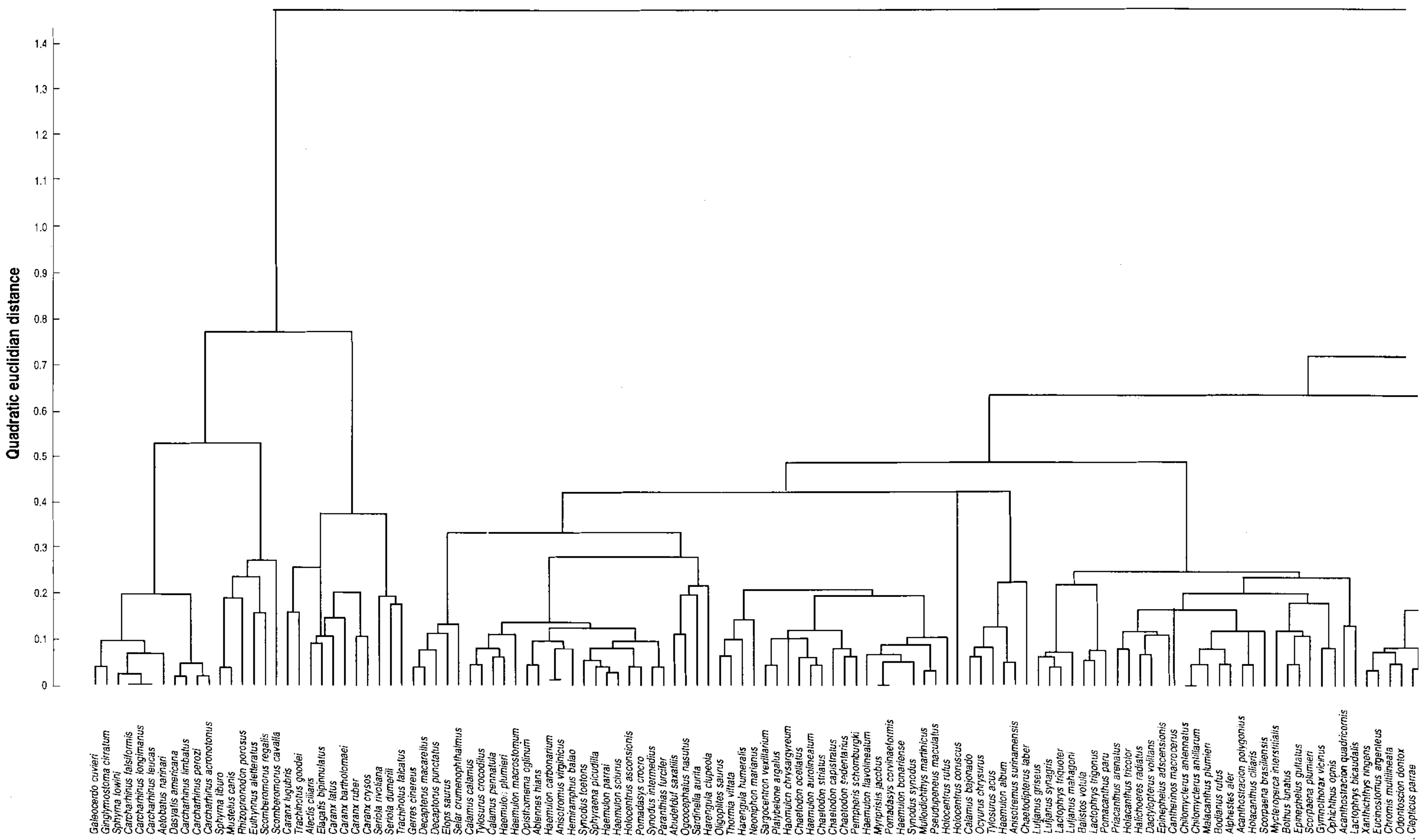
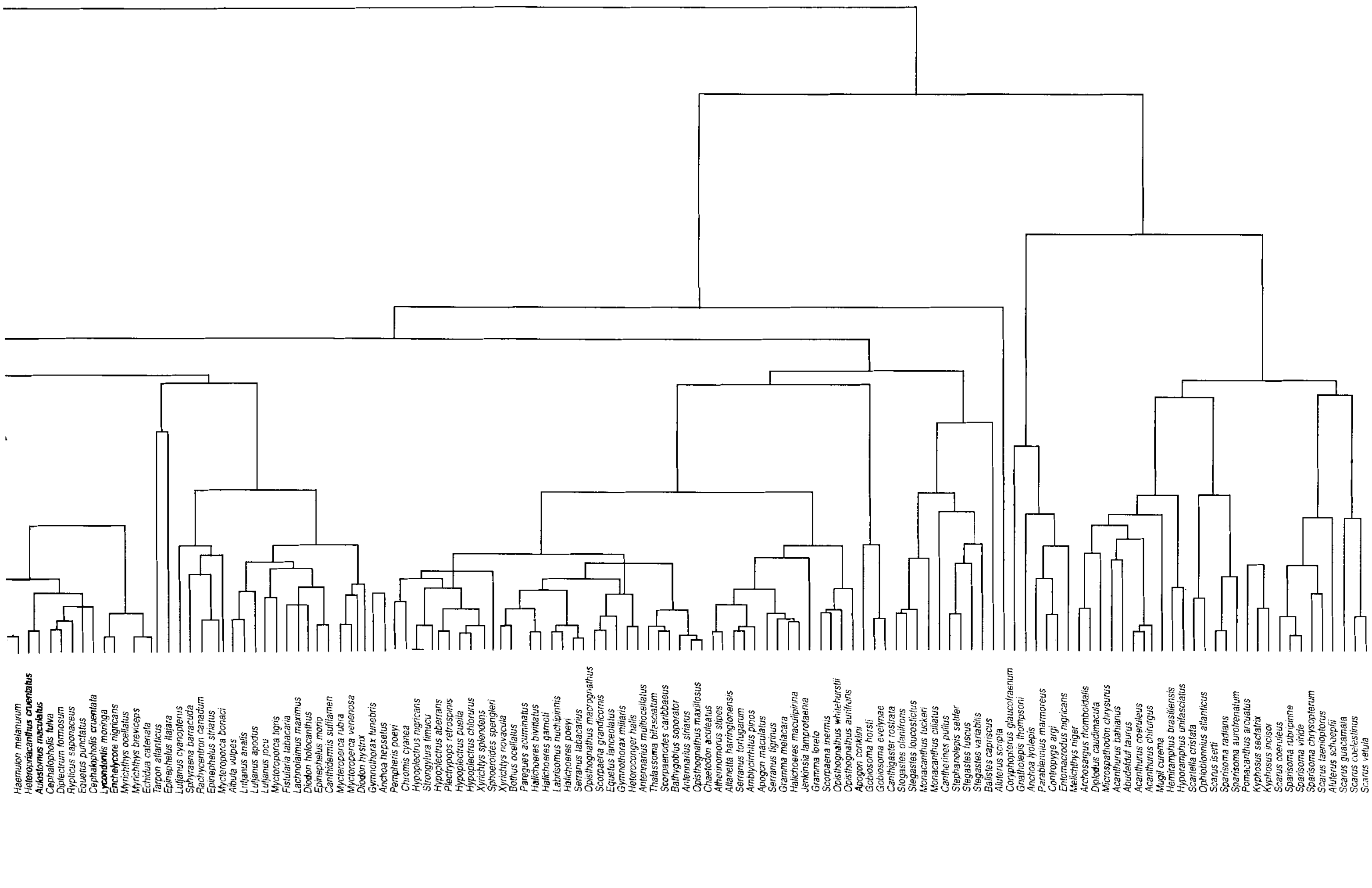


Fig. 3.1. Graphical representation of the results of the cluster-analysis showing the reduction from 243 fish species to 1 species group.



Haemulon melanurum
Heteropriacanthus cruentatus
Aulostomus maculatus
Cephalopholis fulva
Diplectrum formosum
Rypticus saponaceus
Equetus punctatus
Cephalopholis cruentata
Lycondontis moringa
Enchelycore nigricans
Myrichthys ocellatus
Myrichthys breviceps
Echidua catenata
Tarpon atlanticus
Epinephelus itajara
Lutjanus cyanopterus
Sphyraena barracuda
Rachycentron canadum
Epinephelus striatus
Mycteroperca bonaci
Albula vulpes
Lutjanus analis
Lutjanus apodus
Lutjanus jocu
Mycteroperca tigris
Fistularia tabacaria
Lachnolaimus maximus
Diodon holocanthus
Epinephelus morio
Canthidermis sufflamen
Mycteroperca rubra
Mycteroperca venenosa
Diodon hystrix
Gymnothorax funebris
Anchoa hepsetus
Pempheris poeyi
Chromis cyanea
Hypoplectrus nigricans
Strongylura timucu
Hypoplectrus aberrans
Plectrypops retrospinis
Hypoplectrus puella
Hypoplectrus chlorurus
Xyrichtys splendens
Sphoeroides spengleri
Xyrichtys novacula
Bothus ocellatus
Paregues acuminatus
Halichoeres bivittatus
Halichoeres garnoti
Labrisomus nuchipinnis
Halichoeres poeyi
Serranus tabacarius
Opisthognathus macrognathus
Scorpaena grandicornis
Equetus lanceolatus
Gymnothorax miliaris
Heteroconger halis
Antennarius multiocellatus
Thalassoma bifasciatum
Scorpaenodes caribbaeus
Bathygobius soporator
Antennarius striatus
Opisthognathus maxillosus
Chaetodon aculeatus
Atherinomorus stipes
Allanetta harringtonensis
Serranus tortugarum
Amblycirrhitus pinos
Apogon maculatus
Serranus tigrinus
Gramma melacara
Halichoeres maculipinna
Jenkinsia lamprotaenia
Gramma loreto
Scorpaena inermis
Opisthognathus whitehurstii
Opisthognathus aurifrons
Apogon conklini
Gobiosoma horsti
Gobiosoma evelynae
Canthigaster rostrata
Stegastes planifrons
Stegastes leucostictus
Monacanthus tuckeri
Monacanthus ciliatus
Cantherines pullus
Stephanolepis setifer
Stegastes fuscus
Stegastes variabilis
Balistes capriscus
Aluterus scripta
Coryphopterus glaucofraenum
Gnatholepis thompsoni
Anchoa lyolepis
Parablennius marmoreus
Centropyge argi
Entomacrodus nigricans
Melichthys niger
Archosargus rhomboidalis
Diplodus caudimacula
Microspathodon chrysurus
Acanthurus bahianus
Abudefduf taurus
Acanthurus coeruleus
Acanthurus chirurgus
Mugil curema
Hemiramphus brasiliensis
Hyporamphus unifasciatus
Scartella cristata
Ophioblennius atlanticus
Scarus iserti
Sparisoma radians
Sparisoma aurofrenatum
Pomacanthus arcuatus
Kyphosus sectatrix
Kyphosus incisor
Scarus coeruleus
Sparisoma rubripinne
Sparisoma viride
Sparisoma chrysopterum
Scarus taeniopterus
Aluterus schoepfii
Scarus guacamaia
Scarus coelestinus
Scarus vetula

as scombrids and large jacks were jointly aggregated into clusters due to their high aspect ratio and high asymptotic weight. The vast majority of (predominantly) carnivorous reef species and small pelagics were clustered according to the resulting mixture of asymptotic weight and aspect ratio. These basic features of aggregation were observed as well by the results of the "centroid" agglomeration algorithm. The "centroid" algorithm produced more single species clusters than "average linkage", an undesirable feature for the present application. Besides, "average linkage" and "centroid" differed in several cases in the way they combined omnivorous species with carnivores or herbivores. Slight differences could also be observed for species with intermediate sizes and aspect ratios. Since the reef fish community can be viewed as an assemblage of species with smooth gradations in terms of size, activity and even DC than a set of separate compartments (see above), it is not surprising that species with intermediate parameter values were grouped differently by two different aggregation algorithms. What was surprising, rather, was that the results from both methods were largely compatible.

3.3.1.2. ASSEMBLAGE CHARACTERISTICS OF FISH SPECIES GROUPS

Table 3.18 presents the characteristics of 27 fish species groups which resulted from a further treatment of the 29 fish species groups from the cluster analysis. These 27 groups are part of the 50-box model, which was completed by adding 23 nonfish groups. An extended version of Table 3.18, where the species are only grouped but not condensed may be found in Appendix Table 8.7.1.

3.3.1.3. INPUT VALUES

Tables 3.19 and 3.20 present the estimates of the three key parameters: biomass, P/B ratio and Q/B, which served as input values for the groups of the 50-box model. The model was balanced based on these inputs and the corresponding food matrix, presented in Table 3.21, with all ecotrophic efficiencies (EEs) < 1 and input NPP > output NPP.

3.3.1.4. MODIFICATION STRATEGY OF INPUT VALUES

The inputs were ranked intuitively according to the accuracy of the methods by which the respective inputs were obtained (see "Materials and methods"). The biomass values of fish and nonfish groups were considered to be the least accurate of all inputs. The P/B and Q/B values of nonfish groups were considered to be less accurate than those of fish groups. The diet matrix of nonfish groups was considered less accurate than that of fish groups. Within the fish groups, the DCs of large, wide-ranging top predators, like sharks, scombrids and jacks, were considered less accurate than that of the other fish groups. The inputs were gradually modified following the above sequence of accuracy.

3.3.1.5. PARAMETER ESTIMATION

Output values

In Table 3.22, the changes of the three key input parameters necessary to balance the 50-box model are documented together with the resulting change in ecotrophic efficiency. Table 3.23 documents necessary changes within the diet composition matrix. Table 3.24 shows

Table 3.18. Characteristics of 27 fish species groups defined by cluster analysis.
L_∞, W_∞ = asymptotic length/live weight.
H = habitat (a feature not included in cluster analysis), P = pelagic, D = demersal.

Group no.	Fish species group	No. of species	Range of L_∞ (cm)	Range of W_∞ (g)	Average aspect ratio[a]	Average food type[a]	H	Most important species in group (by biomass)
1	Large sharks/rays, carnivorous	13	200-457	90,000-672,000	7	0	P/D	*Dasyatis americana* *Galeocerdo cuvier*
2	Sharks/scombrids, carnivorous	6	83.5-150	4,900-34,300	6.65	0	P/D	*Scomberomorus regalis* *Scomberomorus cavalla*
3	Large jacks, carnivorous	3	97-194	24,000-80,000	4.5	0	P/D	*Seriola dumerili* *Trachinotus falcatus*
4	Intermediate jacks, carnivorous	8	56-107	2,300-10,700	4.5	0	P/D	*Caranx ruber* *Caranx latus*
5	Small jacks, carnivorous	4	32-47	444-1,240	3.6	0	P/D	*Selar crumenophtalmus* *Decapterus punctatus*
6	Intermediate reef fish, carnivorous 1	12	45-90	2,586-12,407	2.45	0	D	*Ocyurus chrysurus* *Lutjanus apodus*
7[b]	Large to intermediate schooling fish, pelagic	11	18-135	150-2,800	3.0	0	P	*Harengula humeralis* *Harengula clupeola*
8	Intermediate reef fish, carnivorous 2	39	13-55	57-1,795	2.5	0	D	*Haemulon flavolineatum* *Lutjanus griseus*
9	Hemiramphidae, herbivorous	2	27-32.5	167-298	3.1	0.8	P	*Hemiramphus brasiliensis* *Hyporamphus unifasciatus*
10	Kyphosidae, herbivorous	2	70-80	6,122-9,139	2.85	1	D	*Kyphosus sectatrix* *Kyphosus incisor*
11	Intermediate reef fish, herbivorous	10	20-38	288-1,200	2.25	0.85	D	*Acanthurus coeruleus* *Acanthurus chirurgus*
12	Large reef fish, carnivorous	13	51-190	7,728-70,000	1.6	0	D	*Diodon holocanthus* *Sphyraena barracuda*
13	Intermediate reef fish, carnivorous 3	36	20-135	290-5,010	1.4	0	D	*Dactylopterus volitans* *Malacanthus plumieri*
14	Small reef fish, carnivorous 1	29	10-50	30-325	1.3	0	D	*Halichoeres bivittatus* *Xyrichtys novacula*
15[b]	Small schooling fish, pelagic	4	6.8-48	11-110	1.8	0	P	*Jenkinsia lamprotaenia* *Atherinomorus stipes*
16	Engraulidae, herbivorous	2	8-15	8-50	1.9	0.7	P	*Anchoa hepsetus* *Anchoa lyolepis*
17	Small reef fish, carnivorous 2	12	5-11	3.3-37	1.43	0	D	*Apogon conklini* *Apogon maculatus*
19	Intermediate reef fish, carnivorous 4	7	36-76	1,306-5,572	1.3	0.1	D	*Holacanthus ciliaris* *Lactophrys bicaudalis*
20	Small reef fish, omnivorous 1	5	10-20	54-448	1.5	0.4	D	*Stegastes fuscus* *Monacanthus ciliatus*
21	Small reef fish, omnivorous 2	4	10-11	24-82	1.35	0.2	D	*Canthigaster rostrata* *Stegastes planifrons*
22	Small reef fish, omnivorous 3	5	7-8.5	4.1-13	1.1	0.7	D	*Coryphopterus glaucofraenum* *Gnatholepis thompsoni*
23	Large Scaridae, herbivorous	3	54-99	5,558-23,000	1.1	1	D	*Scarus guacamaia* *Scarus vetula*
24	Intermediate Scaridae, herbivorous	6	35-62	1,102-3,720	1.4	1	D	*Sparisoma chrysopterum* *Sparisoma rubripinne*
25	Small Scaridae, herbivorous	3	20-26	141-324	1.3	1	D	*Sparisoma radians* *Sparisoma aurofrenatum*
26	Blenniidae, herbivorous	2	11-12	27-35	1.05	0.9	D	*Ophioblennius atlanticus* *Scartella cristata*
27	Small Gobiidae, carnivorous	2	5	2.2-3.1	0.8	0	D	*Gobiosoma horsti* *Gobiosoma evelynae*

[a] Median of species-specific values.
[b] Grouped by habitat "midwater-pelagic" outside cluster-analysis.

Table 3.19. Key input parameters of 27 fish species groups prepared for a 50- box model of a Caribbean coral reef; average values = mean of 2 values or median of > 2 values.

Group no.	Fish species group	No. of species	Biomass (g·m⁻² WW)	Average P/B (year⁻¹)	Average Q/B (year⁻¹)
1	Large sharks/rays, carnivorous	13	95.676	0.240	4.900
2	Sharks/scombrids, carnivorous	6	4.139	0.340	9.150
3	Large jacks, carnivorous	3	0.452	0.525	5.700
4	Intermediate jacks, carnivorous	8	32.600	1.170	9.150
5	Small jacks, carnivorous	4	0.075	0.830	12.500
6	Intermediate reef fish, carnivorous 1	12	50.400	0.580	6.850
7[a]	Large-intermediate schooling fish, pelagic	11	31.920	0.680	12.400
8	Intermediate reef fish, carnivorous 2	39	46.376	1.265	10.300
9	Hemiramphidae, herbivorous	2	0.015	1.230	39.100
10	Kyphosidae, herbivorous	2	8.066	0.600[b]	23.600
11	Intermediate reef fish, herbivorous	10	13.787	0.710	25.650
12	Large reef fish, carnivorous	13	63.121	0.380	3.900
13	Intermediate reef fish, carnivorous 3	36	20.713	0.640	6.400
14	Small reef fish, carnivorous 1	29	4.652	1.665	9.800
15[a]	Small schooling fish, pelagic	4	5.073	3.540	18.850
16	Engraulidae, herbivorous	2	0.019	2.835	43.400
17	Small reef fish, carnivorous 2	12	0.065	3.820	14.650
18	Large groupers, carnivorous	2	18.113	0.370	2.300
19	Intermediate reef fish, carnivorous 4	7	7.156	0.550	6.000
20	Small reef fish, omnivorous 1	5	7.068	1.600	16.400
21	Small reef fish, omnivorous 2	4	0.660	1.505	16.000
22	Small reef fish, omnivorous 3	5	0.096	2.530	39.700
23	Large Scaridae, herbivorous	3	94.910	0.850	13.500
24	Intermediate Scaridae, herbivorous	6	7.871	1.155	20.750
25	Small Scaridae, herbivorous	3	5.075	0.940	33.900
26	Blenniidae, herbivorous	2	0.012	2.840	36.100
27	Small Gobiidae, carnivorous	2	0.175	3.140	17.450

[a]Grouped by habitat "midwater-pelagic" outside cluster analysis.
[b]Assumed value, estimated from groups with similar ecology.

Table 3.20. Key input parameters of 23 nonfish groups prepared for a 50-box model of a Caribbean coral reef; average values = mean of 2 values or median of > 2 values.
NPP of overall system: 20,000 (15,000-25,000) $g \cdot m^{-2} \cdot year^{-1}$ WW.
Export of benthic producers from system: 480 $g \cdot m^{-2} \cdot year^{-1}$ WW.

	Nonfish group	Range of biomass (g·m⁻² WW)	Average biomass (g·m⁻² WW)	Range of P/B (year⁻¹)	Average P/B (year⁻¹)	Range of Q/B (year⁻¹)	Average Q/B (year⁻¹)
1	Sea birds		0.015		5.40		80.00
2	Squids		*1.000	0.9-1.6	1.25	16.6-20.8	18.70
3	Sea turtles		0.015		0.15	2.8-11.5	3.50
4	Octopuses		28.000	1.09-3.06	2.08		6.76
5	Lobsters		1.090	0.35-1.03	0.45		7.40
6	Crabs	2.3-4.9	3.600	0.73-1.61	1.17	10.6-17.4	14.00
7	Shrimps/hermit crabs/ stomatopods	0.1-3.8	3.250	0.9-2.8	1.80		26.90
8	Small benthic arthropods	4.1-6.1	5.300	2.4-2.41	2.40	33.4-164	125.50
9	Asteroids	14-25	19.500		0.49		3.24
10	Echinoids	40-211	107.000	0.8-2	1.40		2.81
11	Gastropods		39.000	0.1-5.9	2.50	4.7-56.4	14.00
12	Chitons/scaphopods	19-62	37.000	0.26-0.42	0.34	7.2-16.2	11.70
13	Polychaetes/priapuloids/ ophiuroids	3.9-38	14.000	2.48-5.8	4.14	24.2-99	61.60
14	Holothuroids/sipunculids/ echiuroids/hemichordates	29.5-72.5	55.200		0.29		3.36
15	Bivalves	60-170	115.000	1.35-3.8	2.23	9-29.1	9.50
16	Ascidians/barnacles/ bryozoans	79-836	458.000		2.30	9-49	24.00
17	Sponges	30.5-1,049	800.000		1.70		4.02
18	Corals/sea anemones	54-188	121.000	0.37-1.8	1.09	3-15	9.00
19	Zooplankton	5-30	17.500		40.00	50-280	165.00
20	Decomposers/microfauna	3.1-7.7	5.400	170-220	195.00	1,900-2,200	2,050.00
21	Phytoplankton	0.1-73	26.000		70.00	-	-
22	Benthic autotrophs	840-4,030	2,230.000	12.8-30.8	13.25	-	-
23	Detritus, POM, DOM	1,000-3,000	2,000.000	-	-	-	-

* An arbitrary minimum biomass of 1 $g \cdot m^{-2}$ has been assigned to all taxa for which an estimate was lacking.

Table 3.21 . Diet composition matrix prepared for the construction of a 50-box model of a Caribbean coral reef.

Group no.	Predator group	No. of original groups or species	Prey group 1	2	3	4	5	6	7	8	9	10	11
1	Large sharks/rays, carnivorous	13	0.049	0.017	0.003	0.007	0.004	0.009	0.019	0.054	0.002	0.002	0.042
2	Sharks/scombrids, carnivorous	6	-	0.013	-	0.031	0.031	0.015	0.176	0.04	0.115	-	0.016
3	Large jacks, carnivorous	3(2)[b]	-	-	-	0.134	-	0.135	-	0.223	-	-	0.044
4	Intermediate jacks, carnivorous	8(4)	-	-	-	-	-	0.001	0.056	0.11	-	-	0.107
5	Small jacks, carnivorous	4(2)	-	-	-	0.002	0.001	-	0.014	-	-	-	0.02
6	Intermediate reef fish, carnivorous 1	13(12)	-	-	-	-	-	0.001	-	0.009	-	-	-
7[a]	Large to intermediate schooling fish, pelagic	11(9)	-	-	-	-	-	-	0.003	-	-	-	0.006
8	Intermediate reef fish, carnivorous 2	39(35)	-	-	-	0.001	-	-	0.001	0.04	-	-	-
9	Hemiramphidae, herbivorous	2(1)	-	-	-	-	-	-	-	-	-	-	-
10	Kyphosidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
11	Intermediate reef fish, herbivorous	10(9)	-	-	-	-	-	-	-	-	-	-	-
12	Large reef fish, carnivorous	13(10)	-	-	0.004	0.024	0.02	0.019	0.043	0.058	-	-	0.019
13	Intermediate reef fish, carnivorous 3	36(29)	-	-	-	-	0.001	-	0.002	0.021	-	-	0.005
14	Small reef fish, carnivorous 1	29(23)	-	-	-	-	-	-	0.002	0.002	0.002	-	-
15[a]	Small schooling fish, pelagic	4	-	-	-	-	-	-	-	-	-	-	-
16	Engraulidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
17	Small reef fish, carnivorous 2	12(11)	-	-	-	-	-	-	-	0.002	-	-	0.001
18	Large groupers, carnivorous	2	0.041	-	-	-	-	-	-	0.191	-	-	-
19	Intermediate reef fish, carnivorous 4	7	-	-	-	-	-	-	-	-	-	-	-
20	Small reef fish, omnivorous 1	5(4)	-	-	-	-	-	-	0.003	0.003	0.003	-	-
21	Small reef fish, omnivorous 2	4(3)	-	-	-	-	-	-	-	-	-	-	-
22	Small reef fish, omnivorous 3	5	-	-	-	-	-	-	-	-	-	-	-
23	Large Scaridae, herbivorous	3	-	-	-	-	-	-	-	-	-	-	-
24	Intermediate Scaridae, herbivorous	6(5)	-	-	-	-	-	-	-	-	-	-	-
25	Small Scaridae, herbivorous	3	-	-	-	-	-	-	-	-	-	-	-
26	Blenniidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
27	Small Gobiidae, carnivorous	2(1)	-	-	-	-	-	-	-	-	-	-	-
28	Sea birds	1	-	0.02	0.01	0.06	0.03	0.01	0.28	0.04	0.1	-	0.01
29	Squids	1	-	-	-	-	-	-	0.12	-	0.03	-	-
30	Sea turtles	1	-	-	-	-	-	-	-	-	-	-	-
31	Octopuses	1	-	-	-	-	-	-	-	0.002	-	-	0.002
32	Lobsters	2	-	-	-	-	-	-	-	-	-	-	-
33	Crabs	1	-	-	-	-	-	-	-	-	-	-	-
34	Shrimps/hermit crabs/stomatopods	3	-	-	-	-	-	-	-	0.01	-	-	-
35	Amphipods/isopods/tanaids/pycnogonids	4	-	-	-	-	0.005	-	0.01	0.03	0.005	-	0.01
36	Asteroids	1	-	-	-	-	-	-	-	-	-	-	-
37	Echinoids	1	-	-	-	-	-	-	-	-	-	-	-
38	Gastropods	1	-	-	-	-	-	-	-	-	-	-	-
39	Chitons/scaphopods	2	-	-	-	-	-	-	-	-	-	-	-
40	Polychaetes/priapuloids/ophiuroids	3	-	-	-	-	-	-	-	-	-	-	-
41	Holothuroids/sipunculids/echiuroids/hemichordates	4	-	-	-	-	-	-	-	-	-	-	-
42	Bivalves	1	-	-	-	-	-	-	-	-	-	-	-
43	Ascidians/barnacles/bryozoans	3	-	-	-	-	-	-	-	-	-	-	-
44	Sponges	1	-	-	-	-	-	-	-	-	-	-	-
45	Sea anemones/corals	4	-	-	-	-	-	-	-	-	-	-	-
46	Zooplankton	1	-	-	-	-	-	-	-	-	-	-	-
47	Microfauna	1	-	-	-	-	-	-	-	-	-	-	-
48	Phytoplankton	1	-	-	-	-	-	-	-	-	-	-	-
49	Benthic autotrophs	2	-	-	-	-	-	-	-	-	-	-	-
50	Detritus, POM, DOM	1	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 3.21 continued

Group no.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	0.009	0.067	0.043	0.049	0.028	0.03	0.001	0.006	0.007	0.004	0.001	0.002	0.004	0.006	0.003	-
2	0.014	0.084	0.061	0.136	0.04	0.009	-	-	0.003	0.001	-	-	0.001	0.002	0.001	-
3	-	0.134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	0.11	0.107	0.001	-	-	0.053	0.053	0.053	0.016	0.073	0.122	0.053	-
5	-	-	-	0.006	0.019	-	-	-	-	-	-	-	-	-	-	-
6	-	0.057	0.009	0.062	-	0.003	-	-	0.02	-	-	0.006	0.008	0.016	-	-
7[a]	-	-	-	0.047	0.006	-	-	-	-	-	-	-	-	-	-	-
8	0.001	0.001	-	0.067	0.002	0.001	-	-	-	-	-	-	-	-	-	-
9	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0.017	0.021	0.002	0.059	0.001	-	-	-	0.006	0.017	-	0.006	0.008	0.006	0.001	-
13	-	0.009	0.068	0.002	0.002	0.005	-	-	0.006	0.001	0.015	0.002	0.002	0.001	0.002	0.007
14	-	-	0.005	0.002	0.002	0.002	-	-	0.002	0.002	0.006	-	-	0.002	0.006	0.002
15[a]	-	-	-	0.002	0.002	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	0.012	-	-	0.001	-	-	0.001	-	0.004	-	-	-	0.001	0.002
18	0.232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	0.008	0.004	0.004	0.004	-	-	0.004	0.004	0.004	-	-	0.004	0.004	0.004
21	-	-	0.003	0.003	0.003	0.003	-	-	-	0.003	0.003	-	-	-	0.003	0.002
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	0.005	0.03	0.025	0.2	0.1	0.008	-	0.005	0.005	0.003	-	0.002	0.005	0.002	-	-
29	-	-	-	0.12	0.03	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	0 001	0.003	0.007	-	-	0.001	-	-	0.002	0.002	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	0.013	-	-	0.007	-	-	-	-	-	-	-	-	-	-
34	-	-	0.01	-	0.01	0.005	-	-	-	-	-	-	-	-	-	-
35	0.01	0.03	0.02	0.005	-	0.01	-	-	0.005	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 3.21 continued

Group no.	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1	0.01	0.021	0.02	0.003	0.015	0.109	0.059	-	-	0.008	0.015	0.006	0.082	0.11	0.058	-
2	-	0.034	-	0.045	0.005	0.036	0.069	-	-	-	0.008	0.001	0.006	-	0.007	-
3	-	-	-	-	-	0.013	0.02	-	-	0.082	0.158	-	-	-	0.057	-
4	-	0.014	-	-	-	0.004	0.041	-	-	-	0.004	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	0.005	-	0.014	-	0.189	0.072	-	0.001	0.018	0.017	-	0.006	0.003	0.01	0.017
7[a]	-	-	-	-	-	-	0.007	-	-	-	-	-	0.195	-	-	-
8	-	-	-	0.021	0.001	0.232	0.091	0.031	-	0.023	0.035	0.033	0.255	0.096	0.043	0.001
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	0.004	-	-	-	0.001	-	0.002	-	-	-
12	-	0.001	-	0.009	0.002	0.032	0.03	-	-	0.076	0.43	-	-	-	0.083	-
13	-	-	-	0.015	-	0.259	0.202	0.042	-	0.006	0.004	0.01	0.072	0.021	0.023	0.01
14	-	-	-	-	-	0.189	0.056	0.042	-	0.051	0.144	0.04	0.112	0.008	0.06	-
15[a]	-	-	-	-	-	-	-	0.015	-	-	-	-	-	-	-	0.006
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	0.004	-	0.063	0.23	0.123	-	-	0.005	0.002	0.079	0.001	0.002	-
18	-	-	0.035	-	0.426	0.075	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	0.001	0.002	-	0.002	0.003	-	-	0.006	0.006	-	0.023
20	-	-	-	-	-	0.025	0.024	0.056	-	-	0.038	-	0.071	-	0.008	0.002
21	-	-	-	-	-	0.07	0.057	0.051	0.021	0.021	0.035	-	0.129	0.005	0.023	0.012
22	-	-	-	-	-	-	-	0.008	-	-	-	-	0.083	-	0.071	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	0.001	-	-	-	-	-
27	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	0.3	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
30	-	-	-	-	0.06	0.025	0.04	-	0.02	0.02	0.025	-	-	-	0.02	0.02
31	-	-	-	0.01	-	0.035	0.03	-	-	-	0.83	0.01	0.005	-	0.06	-
32	-	-	-	-	-	-	-	-	-	-	0.15	-	0.1	-	0.5	-
33	-	-	-	-	-	0.04	0.07	0.01	-	0.002	0.08	-	0.004	0.001	0.03	0.003
34	-	0.015	-	0.02	0.015	0.005	0.065	0.23	0.005	0.005	0.095	0.02	0.12	0.005	0.125	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
36	-	-	-	-	-	0.02	-	-	0.12	0.02	0.2	0.01	0.06	0.01	0.09	0.005
37	-	-	-	-	-	-	-	-	0.01	0.01	-	-	0.01	0.01	0.01	-
38	-	-	-	-	0.004	0.002	0.006	0.006	-	-	0.04	0.06	0.1	0.018	0.03	0.048
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
40	-	-	-	-	-	-	-	0.04	-	-	0.01	-	0.095	-	0.01	0.01
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 3.21 continued

Group no.	44	45	46	47	48	49	50	Sum
1	-	-	-	-	-	-	0.016	1
2	-	-	-	-	-	-	-	1
3	-	-	-	-	-	-	-	1
4	-	-	0.022	-	-	-	-	1
5	-	-	0.938	-	-	-	-	1
6	0.111	0.01	0.318	-	-	0.018	-	1
7[a]	-	-	0.722	-	-	0.014	-	1
8	0.001	0.004	0.018	-	-	0.001	-	1
9	-	-	-	-	-	0.8	-	1
10	-	-	-	-	-	1	-	1
11	-	-	0.002	-	-	0.533	0.458	1
12	-	-	0.006	-	-	-	-	1
13	0.004	0.003	0.173	-	-	0.005	-	1
14	-	-	0.26	-	-	0.001	-	1
15[a]	-	-	0.972	0.003	-	-	-	1
16	-	-	0.2	-	0.7	-	0.1	1
17	-	-	0.467	-	-	-	-	1
18	-	-	-	-	-	-	-	1
19	0.921	0.007	0.001	-	-	0.028	-	1
20	0.001	0.032	0.134	-	-	0.297	0.259	1
21	0.065	0.118	0.109	0.005	-	0.18	0.076	1
22	-	-	0.252	-	-	0.294	0.292	1
23	0.002	0.001	-	-	-	0.997	-	1
24	0.001	-	-	-	-	0.999	-	1
25	-	-	-	-	-	1	-	1
26	-	-	0.005	-	-	0.497	0.497	1
27	-	-	-	-	-	-	-	1
28	-	-	0.05	-	-	-	-	1
29	-	-	0.3	-	-	-	-	1
30	0.34	0.016	-	-	-	0.414	-	1
31	-	-	-	-	-	-	-	1
32	-	-	-	-	-	0.15	0.1	1
33	0.02	0.016	0.04	0.03	0.03	0.574	0.03	1
34	-	-	0.15	0.055	-	0.005	0.03	1
35	0.03	0.058	0.1	0.08	-	0.447	0.125	1
36	0.005	0.012	-	0.04	-	0.058	0.35	1
37	0.05	0.08	-	-	-	0.82	-	1
38	0.04	0.018	-	0.064	-	0.364	0.2	1
39	0.02	0.008	-	0.42	-	0.512	-	1
40	0.025	0.02	0.11	0.095	0.15	0.15	0.285	1
41	-	-	-	0.2	0.015	0.125	0.66	1
42	-	-	-	0.12	0.16	-	0.72	1
43	-	-	0.225	0.2	0.235	-	0.34	1
44	-	-	-	0.001	-	-	0.999	1
45	-	-	0.15	0.1	-	0.65	0.1	1
46	-	-	-	0.75	0.2	-	0.05	1
47	-	-	-	-	-	0.05	0.95	1
48	-	-	-	-	-	-	-	0
49	-	-	-	-	-	-	-	0
50	-	-	-	-	-	-	-	0

[a]Grouped by habitat "midwater-pelagic" outside cluster analysis.
[b]Value outside parentheses: no. of species indicated by cluster analysis.
Value inside parentheses: no. of species with DC values available in DC matrix.

Table 3.22. Results of the ECOPATH II parameter estimation for the construction of a 50-box model of a Caribbean coral reef. Original inputs which had to be modified are shown in parentheses.
P/B = annual production/biomass ratio; Q/B = annual consumption /unit biomass; EE = ecotrophic efficiency.

Group no.	Species group	Biomass ($g \cdot m^{-2}$)		Biomass change (%)	P/B ($year^{-1}$)		P/B change (%)	Q/B ($year^{-1}$)		Q/B change (%)	Start EE	End EE
1	Large sharks/rays, carnivorous	0.300	(95.676)	- 99.7	0.240		-	4.90		-	1.053	0.320
2	Sharks/scombrids, carnivorous	0.414	(4.139)	- 90	0.340		-	9.15		-	6.030	0.626
3	Large jacks, carnivorous	0.181	(0.452)	- 60	0.525		-	5.70		-	10.120	0.604
4	Intermediate jacks, carnivorous	1.630	(32.600)	- 95	1.170		-	9.15		-	0.295	0.411
5	Small jacks, carnivorous	1.000	(0.075)	+ 1,233	0.830		-	12.50		-	184.200	0.725
6	Intermediate reef fish, carnivorous 1	3.024	(50.400)	- 94	0.580		-	6.85		-	0.358	0.776
7	Large to intermediate schooling fish, pelagic	11.172	(31.920)	- 65	0.680		-	12.40		-	2.510	0.953
8	Intermediate reef fish, carnivorous 2	6.493	(46.376)	- 86	1.265		-	10.30		-	2.201	0.933
9	Hemiramphidae, herbivorous	1.125	(0.015)	+7,400	1.230		-	39.10		-	527.800	0.888
10	Kyphosidae, herbivorous	2.420	(8.066)	- 70	0.600		-	23.60		-	0.194	0.587
11	Intermediate reef fish, herbivorous	9.651	(13.787)	- 30	0.710		-	25.65		-	6.855	0.672
12	Large reef fish, carnivorous	2.525	(63.121)	- 96	0.380		-	3.90		-	1.081	0.692
13	Intermediate reef fish, carnivorous 3	7.250	(20.713)	- 65	0.640		-	6.40		-	6.187	0.825
14	Small reef fish, carnivorous 1	4.419	(4.652)	- 5	1.665		-	9.80		-	6.774	0.955
15	Small schooling fish, pelagic	10.146	(5.073)	+ 100	3.540		-	18.85		-	8.600	0.793
16	Engraulidae, herbivorous	3.325	(0.019)	+ 17,400	2.835		-	43.40		-	979.300	0.791
17	Small reef fish, carnivorous 2	1.300	(0.065)	+ 1,900	3.820		-	14.65		-	101.100	0.884
18	Large groupers, carnivorous	0.725	(18.113)	- 96	0.370		-	2.30		-	0.070	0.510
19	Intermediate reef fish, carnivorous 4	1.431	(7.156)	- 80	0.550		-	6.00		-	0.716	0.739
20	Small reef fish, omnivorous 1	3.534	(7.068)	- 50	1.600		-	16.40		-	2.887	0.711
21	Small reef fish, omnivorous 2	0.990	(0.660)	+ 50	1.505		-	16.00		-	23.160	0.932
22	Small reef fish, omnivorous 3	0.960	(0.096)	+ 900	2.530		-	39.70		-	78.390	0.866
23	Large Scaridae, herbivorous	18.982	(94.910)	- 80	0.850		-	13.50		-	0.118	0.336
24	Intermediate Scaridae, herbivorous	5.510	(7.871)	- 30	1.155		-	20.75		-	3.156	0.607
25	Small Scaridae, herbivorous	5.075		-	0.940		-	33.90		-	9.864	0.735
26	Blenniidae, herbivorous	0.600	(0.012)	+ 4,900	2.840		-	36.10		-	543.800	0.854
27	Small Gobiidae, carnivorous	0.175		-	3.140		-	17.45		-	2.740	0.939
28	Sea birds	0.017	(0.015)[b]	+ 20	5.400		-	80.00		-	57.870	0.320
29	Squids	1.500	(1.000)[b]	+ 50	1.300	(1.25)[a]	+ 4	17.5	(18.70)[a]	- 6	19.360	0.894
30	Sea turtles	0.500	(0.015)[b]	+ 1,900	0.150		-	3.50		-	4,815.000	0.876
31	Octopuses	8.400	(28.000)[b]	- 70	1.900	(2.08)[a]	- 9	6.76		-	0.443	0.849
32	Lobsters	3.270	(1.090)[b]	+ 200	1.000	(0.45)[a]	+ 22	7.40		-	60.010	0.960
33	Crabs	19.000	(3.600)[c]	+ 428	1.600	(1.17)[a]	+ 37	14.00		-	70.960	0.938
34	Shrimps/hermit crabs/stomatopods	10.000	(3.250)[c]	+ 208	2.800	(1.80)[a]	+ 56	26.90		-	30.240	0.949
35	Amphipods/isopods/tanaids/ pycnogonids	13.250	(5.300)[c]	+ 150	5.000	(2.40)[c]	+ 108	125.50		-	7.147	0.927
36	Asteroids	25.000	(19.500)[a]	+ 28	0.490		-	3.24		-	1.222	0.963
37	Echinoids	100.000	(107.000)[a]	- 6	1.100	(1.40)[a]	- 21	3.70	(2.81)[b]	+ 32	0.321	0.648
38	Gastropods	46.800	(39.000)[b]	+ 20	2.800	(2.50)[a]	+ 12	14.00		-	3.727	0.974

continued...

Table 3.22 continued
Original inputs which had to be modified are shown in parentheses.
P/B = annual production/biomass ratio; Q/B = annual consumption /unit biomass; EE = ecotrophic efficiency.

Group no.	Species group	Biomass ($g \cdot m^{-2}$)		Biomass change (%)	P/B ($year^{-1}$)		P/B change (%)	Q/B ($year^{-1}$)		Q/B change (%)	Start EE	End EE
39	Chitons/scaphopods	62.000	(37.000)[a]	+ 68	0.360	(0.34)[a]	+ 6	11.70		-	4.674	0.911
40	Polychaetes/priapuloids/ophiuroids	33.000	(14.000)[a]	+ 136	5.200	(4.14)[a]	+ 26	61.60		-	7.265	0.919
41	Holothuroids/sipunculids/ echiuroids/hemichordates	66.240	(55.200)[a]	+ 20	0.310	(0.29)[b]	+ 7	3.36		-	7.239	0.916
42	Bivalves	109.250	(115.000)[a]	- 5	2.230		-	9.50		-	0.549	0.913
43	Ascidians/barnacles/bryozoans	137.400	(458.000)[a]	- 70	2.300		-	20.00	(24.00)[a]	- 17	0.072	0.798
44	Sponges	800.000		-	1.50	(1.70)[b]	- 25	5.00	(4.02)[b]	+ 24	0.095	0.249
45	Corals/sea anemones	121.000		-	1.090		-	9.00		-	0.817	0.977
46	Zooplankton	32.000	(17.500)[c]	+ 83	40.000		-	165.00		-	4.825	0.921
47	Decomposers/microfauna	15.000	(5.400)[c]	+ 178	280.00	(195.00)[c]	+ 44	1,900.00	(2,050.00)[a]	- 7	4.754	0.979
48	Phytoplankton	40.000	(42.000)[a]	- 5	70.000		-	-			1.906	0.740
49	Benthic autotrophs	1,300.000	(2,230.000)[a]	- 42	13.250		-	-			0.167	0.360
50	Detritus, POM, DOM	2,000.000		-	-	-		-		-	-	-

[a]Within available range.
[b]No range available.
[c]Out of available range.

Table 3. 23. Results of the ECOPATH II parameter estimation for the construction of a 50-box model of a Caribbean coral reef diet composition matrix. Values in parentheses refer to original inputs that were **modified** during the parameter estimation routine.

Group no.	Predator group	No. of original groups or species	Prey group 1	2	3	4	5	6	7	8	9	10	11
1	Large sharks/rays, carnivorous	13	0.01	0.01	0.003	0.05	0.004	0.1	0.01	0.01	0.002	0.06	0.052
			(0.049)	(0.017)		(0.007)		(0.009)	(0.019)	(0.054)		(0.002)	(0.042)
2	Sharks/scombrids, carnivorous	6	-	0.01	-	0.034	0.05	0.015	0.176	0.04	0.115	0.02	0.02
				(0.013)		(0.031)	(0.031)					(-)	(0.016)
3	Large jacks, carnivorous	3(2)	-	-	-	0.15	-	0.2	-	0.16	-	-	0.044
						(0.134)		(0.135)		(0.223)			
4	Intermediate jacks, carnivorous	8(4)	-	-	-	-	-	0.001	0.056	0.11	-	0.015	0.107
5	Small jacks, carnivorous	4(2)	-	-	-	0.002	0.001	-	0.014	-	-	-	0.02
6	Intermediate reef fish, carnivorous 1	13(12)	-	-	-	-	-	0.001	-	0.009	-	0.003	0.004
												(-)	(-)
7	Large to intermediate schooling fish, pelagic	11(9)	-	-	-	-	-	-	0.003	-	-	-	0.01
													(0.006)
8	Intermediate reef fish, carnivorous 2	39(35)	-	-	-	0.001	-	-	0.001	0.02	-	0.003	0.004
										(0.040)		(-)	(-)
9	Hemiramphidae, herbivorous	2(1)	-	-	-	-	-	-	-	-	-	-	-
10	Kyphosidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
11	Intermediate reef fish, herbivorous	10(9)	-	-	-	-	-	-	-	-	-	-	-
12	Large reef fish, carnivorous	13(10)	-	-	0.004	0.024	0.02	0.03	0.04	0.04	-	0.003	0.023
								(0.019)	(0.043)	(0.058)	-		(0.019)
13	Intermediate reef fish, carnivorous 3	36(29)	-	-	-	-	0.003	0.01	0.002	0.01	-	0.003	0.009
						(-)	(0.001)	(-)	(-)	(0.020)	(-)	(-)	(0.005)
14	Small reef fish, carnivorous 1	29(23)	-	-	-	-	-	-	0.002	0.002	0.002	-	-
15	Small schooling fish, pelagic	4	-	-	-	-	-	-	-	-	-	-	-
16	Engraulidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
17	Small reef fish, carnivorous 2	12(11)	-	-	-	-	-	-	-	0.002	-	-	0.001
18	Large groupers, carnivorous	2	0.005	0.005	-	0.01	0.01	0.085	-	0.09	-	0.02	0.02
			(0.041)	(-)		(-)	(-)	(-)		(0.191)		(-)	(-)
19	Intermediate reef fish, carnivorous 4	7	-	-	-	-	-	-	-	-	-	-	-
20	Small reef fish, omnivorous 1	5(4)	-	-	-	-	-	-	0.003	0.003	0.003	-	-
21	Small reef fish, omnivorous 2	4(3)	-	-	-	-	-	-	-	-	-	-	-
22	Small reef fish, omnivorous 3	5	-	-	-	-	-	-	-	-	-	-	-
23	Large Scaridae, herbivorous	3	-	-	-	-	-	-	-	-	-	-	-
24	Intermediate Scaridae, herbivorous	6(5)	-	-	-	-	-	-	-	-	-	-	-
25	Small Scaridae, herbivorous	3	-	-	-	-	-	-	-	-	-	-	-
26	Blenniidae, herbivorous	2	-	-	-	-	-	-	-	-	-	-	-
27	Small Gobiidae, carnivorous	2(1)	-	-	-	-	-	-	-	-	-	-	-
28	Sea birds	1	-	0.02	0.01	0.06	0.03	0.01	0.28	0.04	0.1	-	0.01
29	Squids	1	-	-	-	-	-	-	0.15	-	0.015	-	-
									(0.120)		(0.030)		
30	Sea turtles	1	-	-	-	-	-	-	-	-	-	-	-
31	Octopuses	1	-	-	-	-	-	-	-	0.002	-	-	0.002
32	Lobsters	2	-	-	-	-	-	-	-	-	-	-	-
33	Crabs	1	-	-	-	-	-	-	-	-	-	-	-
34	Shrimps/hermit crabs/ stomatopods	3	-	-	-	-	-	-	-	0.01	-	-	-
35	Amphipods/isopods/tanaids/pycnogonids	4	-	-	-	-	-	-	-	-	-	-	-
							(0.005)		(0.010)	(0.030)	(0.005)		(0.010)
36	Asteroids	1	-	-	-	-	-	-	-	-	-	-	-
37	Echinoids	1	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 3. 23 continued

Group no.	Predator group	No. of original groups or species	Prey group 1	2	3	4	5	6	7	8	9	10	11
38	Gastropods	1	-	-	-	-	-	-	-	-	-	-	-
39	Chitons/scaphopods	2	-	-	-	-	-	-	-	-	-	-	-
40	Polychaetes/priapuloids/ophiuroids	3	-	-	-	-	-	-	-	-	-	-	-
41	Holothuroids/sipunculids/echiuroids/hemichordates	4	-	-	-	-	-	-	-	-	-	-	-
42	Bivalves	1	-	-	-	-	-	-	-	-	-	-	-
43	Ascidians/barnacles/bryozoans	3	-	-	-	-	-	-	-	-	-	-	-
44	Sponges	1	-	-	-	-	-	-	-	-	-	-	-
45	Sea anemones/corals	4	-	-	-	-	-	-	-	-	-	-	-
46	Zooplankton	1	-	-	-	-	-	-	-	-	-	-	-
47	Microfauna	1	-	-	-	-	-	-	-	-	-	-	-
48	Phytoplankton	1	-	-	-	-	-	-	-	-	-	-	-
49	Benthic autotrophs	2	-	-	-	-	-	-	-	-	-	-	-
50	Contribution to detritus	1	-	-	-	-	-	-	0.001	0.001	-	0.001	0.002

continued...

Table 3.23 continued

Group no.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	0.03 (0.009)	0.025 (0.067)	0.02 (0.043)	0.049	0.028	0.006 (0.030)	0.093 (0.001)	0.02 (0.006)	0.025 (0.007)	0.004	0.001	0.025 (0.002)	0.002 (0.004)	0.001 (0.006)	- (0.003)	-
2	0.014	0.084	0.02 (0.061)	0.136	0.04	0.02 (0.009)	-	0.006 (-)	0.014 (0.003)	0.001	-	0.03 (-)	0.001	0.002	0.001	-
3	-	0.124 (0.134)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	0.11	0.107	0.001	-	0.005 (-)	0.053	0.053	0.053	0.016	0.073	0.122	0.053	-
5	-	-	-	0.006	0.019	-	-	-	-	-	-	-	-	-	-	-
6	-	0.057	0.005 (0.009)	0.062	-	0.003	- -	0.003	0.02	-	-	0.03 (0.006)	0.016 (0.008)	0.016	-	-
7	-	-	-	0.047	0.006	-	-	-	-	-	-	-	-	-	-	-
8	0.001	0.015 (0.001)	-	0.067	0.002	0.001	- -	0.003 (-)	-	-	-	0.02 (-)	0.03 (-)	0.01 (-)	-	-
9	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	0.005 (0.017)	0.04 (0.021)	0.001 (0.002)	0.059	0.001	-	-	0.003 -	0.017 (0.006)	0.006 (0.017)	-	0.01 (0.006)	0.01 (0.008)	0.008 (0.006)	0.001	-
13	-	0.012 (0.009)	0.01 (0.068)	0.002	0.002	0.01 (0.005)	-	0.003 (-)	0.04 (0.006)	0.001	0.015	0.055 (0.002)	0.007 (0.002)	0.006 (0.001)	0.002	0.004 (0.007)
14	-	-	0.003 (0.005)	0.002	0.002	0.002	-	-	0.005 (0.002)	0.002	0.006	-	-	0.002	0.006	0.002
15	-	-	-	0.002	0.002	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	0.008 (0.012)	-	-	0.003 (0.001)	-	-	0.001	-	0.004	-	-	-	0.001	0.002
18	0.232	-	-	-	-	-	-	0.01 (-)	-	-	-	0.248 (-)	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	0.004 (0.008)	0.004	0.004	0.004	-	-	0.006 (0.004)	0.004	0.004	-	-	0.004	0.004	0.003 (0.004)
21	-	-	0.003	0.003	0.003	0.003	-	-	-	0.003	0.003	-	-	-	0.003	0.002
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	0.005	0.03	0.025	0.2	0.1	0.008	-	0.005	0.005	0.003	-	0.002	0.005	0.002	-	-
29	-	-	-	0.13 (0.120)	0.03	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 3.23 continued

Group no.	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	0.001	0.003	0.007	-	-	0.001	-	-	0.002	0.002	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	0.01	-	-	0.007	-	-	-	-	-	-	-	-	-	-
			(0.013)													
34	-	-	0.01	-	0.01	0.005	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	(0.010)	(0.030)	(0.020)	(0.005)		(0.010)			(0.005)							
36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	0.002	0.001	-	-	-	0.001	-	-	0.003	0.001	0.002	-	-

continued...

Table 3.23 continued

Group no.	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
1	0.02	0.005	0.005	0.02	0.005	0.05	0.05	-	-	0.008	0.01	-	0.05	0.05	0.067	-
	(0.010)	(0.021)	(0.020)	(0.003)	(0.015)	(0.109)	(0.059)				(0.015)	(0.006)	(0.082)	(0.110)	(0.058)	
2	-	0.01	-	0.045	0.005	0.02	0.05	-	-	-	0.008	-	0.006	-	0.007	-
	-	(0.034)				(0.036)	(0.069)					(0.001)				
3	-	-	-	-	-	0.01	0.015	-	-	0.082	0.158	-	-	-	0.057	-
						(0.013)	(0.020)									
4	-	0.004	-	-	-	0.004	0.031	-	-	-	0.004	- .	-	-	-	-
		(0.014)					(0.041)									
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	0.001	-	0.014	-	0.09	0.03	-	0.001	0.05	0.017	-	0.006	0.003	0.01	0.06
		(0.005)				(0.189)	(0.072)			(0.018)						(0.017)
7	-	-	-	-	-	-	0.004	-	-	-	-	-	0.12	-	-	-
							(0.007)						(0.195)			
8	-	-	-	0.05	0.001	0.1	0.02	0.031	-	0.1	0.035	0.02	0.18	0.06	0.073	0.05
				(0.021)		(0.232)	(0.091)			(0.023)		(0.033)	(0.255)	(0.096)	(0.043)	(0.001)
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	0.004	-	-	-	0.001	-	0.002	-	-	-
12	-	0.001	-	0.009	0.002	0.032	0.03	-	-	0.1	0.4	-	-	-	0.075	-
										(0.076)	(0.430)				(0.083)	
13	-	-	-	0.03	-	0.15	0.1	0.042	-	0.06	0.004	0.01	0.05	0.01	0.023	0.04
				(0.015)		(0.259)	(0.202)			(0.006)			(0.072)	(0.021)		(0.01)
14	-	-	-	-	-	0.1	0.04	0.042	-	0.11	0.144	0.04	0.1	0.008	0.06	-
						(0.189)	(0.056)			(0.051)			(0.112)			
15	-	-	-	-	-	-	-	0.01	-	-	-	-	-	-	-	0.03
								(0.015)								(0.006)
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	0.02	-	0.063	0.15	0.1	-	-	0.005	0.002	0.079	0.001	0.03	-
				(0.004)			(0.230)	(0.123)							(0.002)	
18	-	-	0.035	-	0.16	0.07	-	-	-	-	-	-	-	-	-	-
					(0.426)	(0.075)										
19	-	-	-	-	-	0.001	0.002	-	0.002	0.003	-	-	0.006	0.006	-	0.023
20	-	-	-	-	-	0.01	0.01	0.056	-	-	0.038	-	0.05	-	0.02	0.02
						(0.025)	(0.024)						(0.071)		(0.008)	(0.002)
21	-	-	-	-	-	0.05	0.04	0.035	0.021	0.05	0.035	-	0.1	0.005	0.027	0.02
						(0.070)	(0.057)	(0.051)		(0.021)			(0.129)		(0.023)	(0.012)
22	-	-	-	-	-	-	-	0.008	-	-	-	-	0.05	-	0.071	-
													(0.083)			
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-	-	-	0.001	-	-	-	-	-
27	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	-	0.01	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
							(0.300)									

continued...

Table 3.23 continued

Group no.	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
30	-	-	-	-	0.06	0.025	0.04	-	0.02	0.02	0.025	-	-	-	0.02	0.02
31	-	-	-	0.02 (0.010)	-	0.025 (0.035)	0.02 (0.030)	-	-	-	0.5 (0.830)	0.01	0.005	-	0.4 (0.060)	-
32	-	-	-	-	-	-	-	-	-	-	0.15	-	0.05 (0.100)	-	0.5	-
33	-	-	-	-	-	0.005 (0.040)	0.01 (0.070)	0.005 (0.010)	-	0.05 (0.002)	0.05 (0.080)	-	0.004	0.001	0.05 (0.030)	0.02 (0.003)
34	-	0.005 (0.015)	-	0.025 (0.020)	0.005 (0.015)	0.002 (0.005)	0.002 (0.065)	0.04 (0.230)	0.01 (0.005)	0.11 (0.005)	0.08 (0.095)	0.01 (0.020)	0.05 (0.120)	0.005	0.212 (0.125)	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05 (0.020)
36	-	-	-	-	-	0.01 (0.02)	-	-	0.08 (0.120)	0.07 (0.020)	0.135 (0.200)	0.005 (0.010)	0.03 (0.060)	0.005 (0.010)	0.145 (0.090)	0.02 (0.005)
37	-	-	-	-	-	-	-	-	0.006 (0.010)	0.015 (0.010)	-	-	0.004 (0.010)	0.005 (0.010)	0.01	-
38	-	-	-	-	0.002 (0.004)	0.002	0.004 (0.006)	0.006	-	-	0.02 (0.040)	0.02 (0.060)	0.05 (0.100)	0.015 (0.018)	0.04 (0.030)	0.058 (0.048)
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
40	-	-	-	-	-	-	-	0.015 (0.040)	-	-	0.01	-	0.03 (0.095)	-	0.03 (0.010)	0.04 (0.010)
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	-	-	-	0.001	-	0.002	0.002	0.015	0.001	0.005	0.006	0.006	0.018	0.002	0.01	0.026

continued...

Table 3.23 continued

Group no.	44	45	46	47	48	49	50	*Sum*
1	-	-	-	-	-	-	0.02 (0.016)	1
2	-	-	-	-	-	-	-	1
3	-	-	-	-	-	-	-	1
4	-	-	0.022	-	-	-	-	1
5	-	-	0.938	-	-	-	-	1
6	0.2 (0.111)	0.01	0.25 (0.318)	-	-	0.029 (0.018)	-	1
7	-	-	0.722	-	-	0.088 (0.014)	-	1
8	0.07 (0.001)	0.004	0.018	-	-	0.01 (0.001)	-	1
9	-	-	-	-	-	0.8	-	1
10	-	-	-	-	-	1	-	1
11	-	-	0.002	-	-	0.533	0.458	1
12	-	-	0.006	-	-	-	-	1
13	0.07 (0.004)	0.003	0.15 (0.173)	-	-	0.052 (0.005)	-	1
14	-	-	0.26	-	-	0.058 (0.001)	-	1
15	-	-	0.95 (0.972)	0.006 (0.003)	-	-	-	1
16	-	-	0.2	-	0.7	-	0.1	1
17	-	-	0.5 (0.467)	-	-	0.028 (-)	-	1
18	-	-	-	-	-	-	-	1
19	0.921	0.007	0.001	-	-	0.028	-	1
20	0.02 (0.001)	0.02 (0.032)	0.1 (0.134)	-	-	0.326 (0.297)	0.28 (0.259)	1
21	0.08 (0.065)	0.1 (0.118)	0.109	0.005	-	0.2 (0.180)	0.1 (0.076)	1
22	-	-	0.2 (0.252)	-	-	0.335 (0.294)	0.336 (0.292)	1
23	0.002	0.001	-	-	-	0.997	-	1
24	0.001	-	-	-	-	0.999	-	1
25	-	-	-	-	-	1	-	1
26	-	-	0.005	-	-	0.497	0.497	1
27	-	-	-	-	-	-	-	1
28	-	-	0.05	-	-	-	-	1
29	-	-	0.565 (0.300)	-	-	-	-	1

continued...

Table 3.23 continued

Group no.	44	45	46	47	48	49	50	Sum
30	0.34	0.016	-	-	-	0.414	-	1
31	-	-	-	-	-	-	-	1
32	-	-	-	-	-	0.18	0.12	1
						(0.150)	(0.100)	
33	0.05	0.01	0.03	0.03	0.02	0.6	0.048	1
	(0.020)	(0.016)	(0.040)		(0.030)	(0.574)	(0.030)	
34	-	-	0.15	0.055	-	0.084	0.12	1
						(0.005)	(0.030)	
35	0.06	0.04	0.04	0.04	-	0.6	0.17	1
	(0.030)	(0.058)	(0.100)	(0.080)		(0.447)	(0.125)	
36	0.02	0.012	-	0.02	-	0.088	0.36	1
	(0.005)			(0.040)		(0.058)	(0.350)	
37	0.05	0.05	-	-	-	0.86	-	1
		(0.080)				(0.820)		
38	0.04	0.015	-	0.03	-	0.4	0.298	1
		(0.018)		(0.064)		(0.364)	(0.200)	
39	0.02	0.008	-	0.3	-	0.632	-	1
				(0.42)		(0.512)		
40	0.05	0.01	0.05	0.05	0.1	0.245	0.37	1
	(0.025)	(0.020)	(0.110)	(0.095)	(0.150)	(0.150)	(0.285)	
41	-	-	-	0.1	0.01	0.13	0.76	1
				(0.200)	(0.015)	(0.125)	(0.660)	
42	-	-	-	0.1	0.15	-	0.75	1
				(0.120)	(0.160)		(0.720)	
43	-	-	0.15	0.1	0.2	-	0.55	1
			(0.225)	(0.200)	(0.235)		(0.340)	
44	-	-	-	0.001	-	-	0.999	1
45	-	-	0.15	0.1	-	0.65	0.1	1
46	-	-	-	0.6	0.2	-	0.2	1
				(0.750)			(0.050)	
47	-	-	-	-	-	0.05	0.95	1
48	-	-	-	-	-	-	(1)	(1)
49	-	-	-	-	-	-	(1)	(1)
50	0.073	0.01	0.05	0.25	0.033	0.475	-	(1)

Table 3.24. Results of the ECOPATH II parameter estimation for the construction of a 50-box model of a Caribbean coral reef. Additional parameters. Import to detritus: 475 $g \cdot m^{-2}$, other imports to boxes are 0; catches for all boxes are 0. Excretion = 5% and egestion = 15% (default values) of the food intake of each box.

Group no.	Species group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Net production ($g \cdot m^{-2} \cdot year^{-1}$)	Trophic level
1	Large sharks/rays, carnivorous	1.47	1.104	0.023	0.343	1.176	0.072	3.920
2	Sharks/scombrids, carnivorous	3.79	2.890	0.088	0.810	3.030	0.141	4.155
3	Large jacks, carnivorous	1.03	0.730	0.057	0.244	0.825	0.094	4.050
4	Intermediate jacks, carnivorous	14.91	10.024	0.784	4.106	11.932	1.908	3.630
5	Small jacks, carnivorous	12.50	9.170	0.601	2.729	10.000	0.829	3.600
6	Intermediate reef fish, carnivorous 1	20.71	14.818	1.361	4.536	16.572	1.754	3.480
7	Large intermediate schooling fish, pelagic	138.53	103.229	7.240	28.064	110.826	7.597	3.470
8	Intermediate reef fish, carnivorous 2	66.88	45.289	7.660	13.929	53.502	8.210	3.440
9	Hemiramphidae, herbivorous	43.99	33.806	1.229	8.952	35.190	1.384	2.520
10	Kyphosidae, herbivorous	57.11	44.238	0.853	12.022	45.690	1.453	2.000
11	Intermediate reef fish, herbivorous	247.55	191.186	4.603	51.759	198.038	6.850	2.020
12	Large reef fish, carnivorous	9.85	6.919	0.664	2.265	7.878	0.960	3.660
13	Intermediate reef fish, carnivorous 3	46.40	32.480	3.829	10.091	37.120	4.641	3.440
14	Small reef fish, carnivorous 1	43.31	27.287	7.026	8.993	34.645	7.357	3.355
15	Small schooling fish, pelagic	191.25	117.085	28.483	45.684	153.002	35.918	3.595
16	Engraulidae, herbivorous	144.31	106.018	7.456	30.832	115.444	9.426	2.320
17	Small reef fish, carnivorous 2	19.04	10.270	4.390	4.385	15.236	4.966	3.570
18	Large groupers, carnivorous	1.67	1.066	0.137	0.465	1.334	0.269	3.890
19	Intermediate reef fish, omnivorous	8.59	6.082	0.582	1.923	6.869	0.788	2.990
20	Small reef fish, omnivorous 1	57.96	40.712	4.022	13.224	46.366	5.657	2.580
21	Small reef fish, omnivorous 2	15.84	11.182	1.389	3.269	12.672	1.490	2.980
22	Small reef fish, omnivorous 3	38.11	28.061	2.103	7.948	30.490	2.428	2.480
23	Large Scaridae, herbivorous	256.26	188.871	5.415	61.971	205.006	16.116	2.000
24	Intermediate Scaridae, herbivorous	114.33	85.102	3.863	25.367	91.466	6.364	2.000
25	Small Scaridae, herbivorous	172.04	132.863	3.507	35.672	137.634	4.771	2.000
26	Blenniidae, herbivorous	21.66	15.624	1.455	4.581	17.328	1.704	2.010
27	Small Gobiidae, carnivorous	3.05	1 894	0.516	0.644	2.443	0.550	3.285
28	Sea birds	1.36	0.996	0.029	0.334	1.088	0.091	4.240
29	Squids	26.25	19.050	1.743	5.457	21.000	1.950	3.910
30	Sea turtles	1.75	1.325	0.066	0.359	1.400	0.075	2.730
31	Octopuses	56.78	29.467	13.556	13.761	45.427	15.967	3.310
32	Lobsters	24.20	16.088	3.140	4.970	19.359	3.271	2.820
33	Crabs	266.00	182.400	28.526	55.074	212.800	30.412	2.430
34	Shrimps/hermit crabs/stomatopods	269.00	187.200	26.561	55.239	215.200	27.988	3.085
35	Amphipods/isopods/tanaids/pycnogonids	1,662.88	1,264.050	61.417	337.408	1,330.300	66.254	2.285
36	Asteroids	81.00	52.550	11.796	16.654	64.800	12.249	2.710
37	Echinoids	370.00	186.000	71.315	112.685	296.000	110.054	2.170
38	Gastropods	655.20	393.120	127.695	134.385	524.160	131.104	2.370
39	Chitons/scaphopods	725.40	558.000	20.339	147.061	580.320	22.326	2.380

continued...

Table 3.24 continued

Group no.	Species group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Net production ($g \cdot m^{-2} \cdot year^{-1}$)	Trophic level
40	Polychaetes/priapuloids/ophiuroids	2,032.80	1,454.640	157.634	420.526	1,626.240	171.528	2.350
41	Holothuroids/sipunculids/ echiuroids/hemichordates	222.57	157.519	18.803	46.245	178.053	20.527	2.100
42	Bivalves	1,037.88	586.672	222.354	228.849	830.300	243.542	2.100
43	Ascidians/barnacles/bryozoans	2,748.00	1,882.380	252.302	613.318	2,198.400	316.168	2.340
44	Sponges	4,000.00	2,000.000	299.177	1,700.823	3,200.000	1,201.514	2.000
45	Sea anemones/corals	1,089.00	739.310	128.803	220.887	871.200	131.835	2.340
46	Zooplankton	5,280.00	2,944.000	1,179.004	1,156.996	4,224.000	1,280.135	2.600
47	Microfauna	28,500.00	18,600.000	4,112.797	5,787.203	22,800.000	4,201.018	2.000
48	Phytoplankton	-	-	2,073.120	726.880	-	2,801.514	1.000
49	Benthic autotrophs	-	-	6,201.429	11,023.570	-	-	1.000
50	Detritus, POM, DOM	-	-	-	-	-	-	1.000

[a]($g \cdot m^{-2} \cdot year^{-1}$ WW).

continued...

Table 3.24 continued.

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
1	0.5950	0.049	0.058	0.939	0.065
2	0.3031	0.037	0.044	0.954	0.049
3	0.3684	0.092	0.108	0.885	0.129
4	0.3988	0.128	0.151	0.840	0.190
5	0.0280	0.066	0.078	0.917	0.090
6	0.3076	0.085	0.100	0.894	0.118
7	0.2702	0.055	0.065	0.931	0.074
8	0.2505	0.123	0.144	0.846	0.181
9	1.0773	0.031	0.037	0.961	0.041
10	0.0000	0.025	0.030	0.968	0.033
11	0.0263	0.028	0.033	0.965	0.036
12	0.3181	0.097	0.115	0.878	0.139
13	0.2831	0.100	0.118	0.875	0.143
14	0.1704	0.170	0.200	0.788	0.270
15	0.0086	0.188	0.221	0.765	0.307
16	0.4096	0.065	0.077	0.918	0.089
17	0.1515	0.261	0.307	0.674	0.484
18	0.4604	0.161	0.189	0.799	0.252
19	0.0362	0.092	0.108	0.885	0.129
20	0.5494	0.098	0.115	0.878	0.139
21	0.4694	0.094	0.111	0.882	0.133
22	0.4761	0.064	0.075	0.920	0.087
23	0.0038	0.063	0.074	0.921	0.085
24	0.0010	0.056	0.065	0.930	0.075
25	0.0000	0.028	0.033	0.965	0.036

continued...

Table 3.24 continued.

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
26	0.0146	0.079	0.093	0.902	0.109
27	0.0000	0.180	0.212	0.775	0.290
28	0.2708	0.067	0.078	0.915	0.091
29	0.1887	0.074	0.087	0.907	0.102
30	0.4528	0.043	0.051	0.946	0.057
31	0.0709	0.281	0.331	0.649	0.542
32	0.3011	0.135	0.159	0.831	0.203
33	0.4187	0.114	0.135	0.857	0.167
34	0.4034	0.104	0.122	0.870	0.150
35	0.2831	0.040	0.047	0.950	0.052
36	0.4394	0.151	0.178	0.811	0.233
37	0.1756	0.297	0.350	0.628	0.592
38	0.3337	0.200	0.235	0.750	0.333
39	0.2585	0.031	0.036	0.962	0.040
40	0.3277	0.084	0.099	0.894	0.118
41	0.0900	0.092	0.109	0.885	0.130
42	0.0900	0.235	0.276	0.707	0.415
43	0.3684	0.115	0.135	0.856	0.168
44	0.0010	0.300	0.353	0.625	0.601
45	0.3684	0.121	0.142	0.849	0.178
46	0.2400	0.242	0.285	0.697	0.435
47	0.0000	0.147	0.173	0.816	0.226
48	0.0000	-	-	-	-
49	0.0000	-	-	-	-
50	0.3669	-	-	-	-

additional parameters and ratios computed by ECOPATH II for the balanced 50-box model. These outputs permit to estimate flow rates (in $gm^{-2}year^{-1}$) in and out of each box of the system.

Modifications Required to Balance the 50-Box Model

The input value of net PP had to be modified slightly, from 20,000 $gm^{-2}year^{-1}$ to 20,500 $gm^{-2}year^{-1}$. This was still well within the established range of NPP estimates (15,000-25,000 $gm^{-2}year^{-1}$).

The strongest changes were applied to the biomass estimates since they were considered to be least accurate of all input values. The biomass of detritus was left unchanged, as well as biomass of phytoplankton, whereas that of benthic primary producers had to be lowered by 42% from 2,230 to 1,300 gm^{-2}. This value was still within the range estimated for an average m^2 from five subsystems.

It was observed during the balancing process that the input biomass values of fish groups were generally too high, while those of the majority of nonfish taxa were too low. This was especially true for strongly carnivorous groups. Another aspect of the initial biomass estimates of fish groups was that values for large predators were too high, while those for small ones were too low.

The density estimates for fishes, which are generally based on visual censuses, appeared to have provided unrealistically high abundances for groups of large predatory fish. For example, the biomass of large sharks and rays had to be decreased from 96 gm^{-2} to 0.3 gm^{-2}, a change of 99.7%. Obviously, the density estimates for relatively rare, but large and wide-ranging predators depended strongly on their presence during a census. This point will be discussed in more detail below.

The majority of biomass values for sharks and rays was computed via qualitative indications of density. Since a common definition in terms of numbers does not exist for qualitative indications of abundance, it is quite possible that expressions such as "abundant" or "common" refer to a comparison between species of the same ecological group, so that, e.g., nurse sharks are abundant on the reef compared to tiger sharks but that this abundance has nothing in common with the expression "abundant" used, e.g., for doctorfish, parrotfish, etc., or even small pelagics such as dwarf herring or sardine.

Densities of small and/or cryptic reef fish species are obviously strongly underestimated by visual census techniques. Thus, for example "Blenniidae" had to be raised from 0.012 gm^{-2} to 0.6 gm^{-2}, a change of biomass of 4,900%.

The density of small schooling pelagic fish was also strongly underestimated. Thus, for example, the initial estimate of the biomass of Engraulidae had to be raised from 0.019 gm^{-2} to 3.325 gm^{-2} (17,400% change). This can be explained by the fact that only the highest density level obtained from visual censuses for reef fishes was assigned to small schooling pelagics. In all censuses in which small pelagics were explicitly included, they were stated as "too numerous to count". Still higher levels of abundance might have to be added to the ones presented in "Materials and methods" in order to properly account for densities of small pelagics.

Groups of large to intermediate herbivorous reef fish (e.g., families Scaridae or Kyphosidae) showed generally low EEs. Their input biomasses were reduced in line with reduction of biomass of 60-99% performed on groups containing similarly sized carnivorous species. An 80% reduction of biomass is the average for fishes of this size range. The biomass of large herbivorous reef fish could have been reduced further to raise their EE, but there was no good reason to do so, except that the relatively high EE of benthic autotrophs would have slightly decreased.

The biomass values of nonfish groups had to be raised because of the diet preferences of fish groups. Conspicuous was the discrepancy between "offer" and "demand" in crustaceans, which were the most difficult groups to balance. This is because these groups feed on a relatively high trophic level and their consumption is rather high (up to 125 times their body weight per year). This makes it difficult to raise their biomass without serious implications for the whole system.

Initial biomasses of crustaceans were generally too low to satisfy the food requirements of the fish groups. Two opposite tendencies might be responsible for this discrepancy: (1) the comparably high percentages of crustaceans in the diet composition of fish groups might be an artefact, i.e., due to the high amount of undigestible exoskeletons, the percentage of crustaceans in the food of fishes might be overestimated; and (2) the biomass estimates for crustaceans are derived mainly from the Gulf of Batabanó, Cuba, from an area characterized by sand and mud. The combined biomass estimates for crustaceans from this area, of 5-10 gm^{-2}WW, do not compare well with an overall estimate of crustacean biomass of around 160 gm^{-2}WW recorded by Glynn (1973) for a Caribbean *Porites furcata* reef (see also Table 3.17).

The effect of erroneous biomass estimates on weighting factors within species groups is, on the other hand, of minor importance since these groups are composed of species with similar ecological features; the above problems concerning the input biomasses are thus valid for all species of a group.

After the biomasses, the strongest modifications were performed on the DC matrix, particularly of elasmobranchs and on invertebrates. This was not unexpected, since these parts of the matrix were most heterogenous in the first place. Raising the biomass of crustaceans was not enough to correct for the unrealistically high initial EE values for these groups. Thus, the diet of groups which fed on crustaceans was shifted, in part, to ecological groups with low EEs (sea urchins, ascidians, sponges, etc.). This implied a shift to lower trophic levels.

The diet of large carnivorous fish groups was similarly modified, often from carnivorous to herbivorous fishes. The latter showed in general low EEs, especially the groups containing large species, which also had high biomasses. For example, large parrotfish (Scaridae) with the highest output biomass for a single fish family in the 50-box model (almost 19 gm^{-2}) have a very low EE (EE = 0.336). The original DC matrix of fishes did not identify large herbivorous reef fish as a preferred food item of carnivorous species. It might be an artefact from Randall's stomach analyses, but this is unlikely since it can be assumed that herbivorous fish should have been identified as reliably as carnivorous fish. This suggests that large predatory fish species tend to avoid herbivorous reef fish as prey. Parrotfish produce a skin mucus which is reported to protect them from predation while they sleep. If the low predation mortality of herbivorous reef fish is true, and not an artefact, this would mean that predator biomass would have to be lowered further to lower the EE of prey groups below 1. This would also mean that large herbivorous reef fish serve mainly as energy supply for the detrital pool. This matter will be discussed further below.

The initial P/B values, especially of fish groups, were considered to be more reliable than the initial biomass estimates; thus, the overwhelming majority of P/B outputs were kept within the initial range of input P/B estimated for the respective groups.

The consumption estimates for nonfish groups were slightly modified in a few groups only. For sea urchins and sponges, Q/B was raised in order to lower their gross efficiency below 0.4 and to lower their P/R ratio to 0.6 $year^{-1}$.

Output gross efficiencies (GE = production/consumption) for all boxes were generally between 0.1 and 0.5. High GEs are characteristic of small-sized and/or young animals. Low GEs are characteristic of large-sized and/or old animals. The GE of apex predators should be close to zero when they are not exploited by fisheries. GE output values from the 50-box model for fish groups were somewhat low, never exceeding 0.3. To raise these estimates, the P/B ratios could be increased and/or the Q/B reduced, thus decreasing the EEs of prey groups. These modifications would result in an increase of the biomass of a number of prey groups.

Graphical Representation of the 50-Box Model

Fig. 3.2 shows the mass-balanced 50-box model of an unexploited segment of coral reef in the PRVI area. This graph demonstrates that it is possible to balance a quantitative steady-state model of the energy flow within a coral reef system based on literature data and parameter estimations derived from multivariate statistics.

3.3.1.6. SUMMARY STATISTICS

Summary statistics computed by ECOPATH II for the 50-box model are presented in Table 3.25.

3.3.1.7. NETWORK FLOW INDICES

Network flow indices computed by ECOPATH II for the 50-box model are listed in Table 3.26.

3.3.1.8. FLOWS AND TRANSFER EFFICIENCIES

Table 3.27 presents flows and transfer efficiencies for discrete trophic levels computed by ECOPATH II for the 50-box model.

3.3.1.9. MIXED TROPHIC IMPACTS

Fig. 3.3 shows the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms would have on the groups positioned above them. The bars pointing upwards show positive impacts while those pointing downwards, negative impacts. The impacts are relative, not absolute ones but are comparable between histograms. Note that the routine assumes the food matrix to remain stable, which would not happen in the long term (but may be reasonable for the short term). The mixed trophic impacts can also be viewed as a simple sensitivity analysis *sensu* Majkowski (1982).

A biomass increase of benthic autotrophs (group 49) has a direct positive effect on all groups feeding on benthic producers. The impact is greatest for groups which feed almost exclusively on benthic autotrophs, such as Kyphosidae (group 10), intermediate herbivorous reef fish (11), parrotfish (family Scaridae, groups 23, 24, 25), herbivorous blennies (26), echinoids (37) and corals (45). The impact on detritus is also positive since a larger amount of biomass would be directed towards this box.

An increase in phytoplankton biomass would have a strong direct positive impact on engraulids (16) since they feed largely on phytoplankton. It has a moderate direct positive

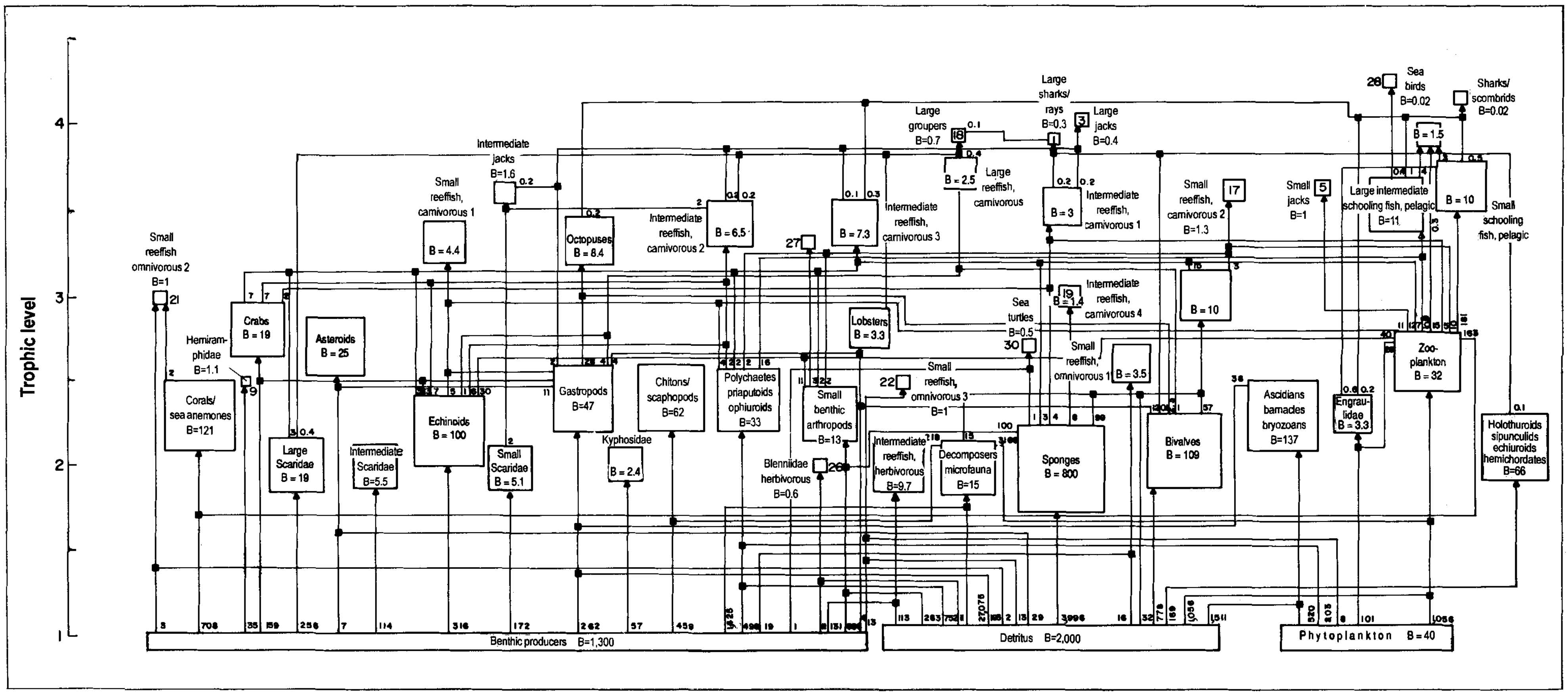


Fig. 3.2. Graphical representation of the 50-box model of a Caribbean coral reef. The area of each box is proportional to the logarithm of the biomass (B, in gm^{-2}WW) of each group. Values represent the average for all subsystems in Fig. 2.1. Flows are in gm^{-2}year^{-1} WW. Incoming flows (bottom half of a box) represent at least 80% of the diet of a group.

Table 3.25. Summary statistics computed by ECOPATH II for a 50-box model of a Caribbean coral reef. PP = primary production.

Sum of all production	=	51,282	$gm^{-2}year^{-1}$
Sum of all imports[a]	=	475	$gm^{-2}year^{-1}$
Sum of all respiratory flows	=	32,523	$gm^{-2}year^{-1}$
Sum of all flows into detritus	=	23,193	$gm^{-2}year^{-1}$
Total system throughput	=	107,473	$gm^{-2}year^{-1}$
Throughput cycled	=	19,686	$gm^{-2}year^{-1}$
Finn's cycling index	=	18.3%	of throughput
Input total net PP	=	20,500	$gm^{-2}year^{-1}$
Calculated total net PP	=	20,025	$gm^{-2}year^{-1}$

[a]Difference between input total net PP and calculated total net PP.

Table 3.26. Network flow indices computed by ECOPATH II for a 50-box model of a Caribbean coral reef.

Source	Ascendency (flowbits)	%	Overhead (flowbits)	%	Capacity (flowbits)	%
Inputs	952	0.2	2,678	0.6	3,630	0.8
Internal	94,210	21.5	226,071	51.6	320,281	73.1
Dissipations	52,362	12.0	61,940	14.1	114,302	26.1
Totals	147,524	33.7	290,689	66.3	438,213	100.0

Table 3.27. Flows and transfer efficiencies for discrete trophic levels computed by ECOPATH II for a 50-box model of a Caribbean coral reef.

Trophic level	Import	Export	Respiration	Throughput	Flow to detritus
	Flows originating from the primary producers				
I	0.000	480.000	0.000	0.000	11,750.450
II	0.000	0.000	5,252.860	7,794.549	1,665.249
III	0.000	0.000	578.620	876.441	188.912
IV	0.000	0.000	74.367	108.909	23.422
V	0.000	0.000	7.595	11.120	2.393
VI	0.000	0.000	0.763	1.133	0.246
VII	0.000	0.000	0.083	0.124	0.027
VIII	0.000	0.000	0.009	0.013	0.003
IX	0.000	0.000	0.001	0.001	0.000
	Flows originating from the detritus				
I	475.000	0.000	0.000	23,668.000	0.000
II	0.000	0.000	22,975.980	36,171.262	8,299.198
III	0.000	0.000	2,985.809	4,896.084	1,060.269
IV	0.000	0.000	582.137	850.005	183.624
V	0.000	0.000	58.936	84.245	17.906
VI	0.000	0.000	4.997	7.404	1.599
VII	0.000	0.000	0.543	0.808	0.176
VIII	0.000	0.000	0.060	0.089	0.020
IX	0.000	0.000	0.007	0.010	0.002

Transfer efficiencies (%) by trophic level

Source	I	II	III	IV	V	VI	VII	VIII
Producers	-	11.2	12.4	10.2	10.2	10.9	10.8	-
Detritus	-	13.5	17.4	9.9	8.8	10.9	11.1	-
All flows	-	13.1	16.6	9.9	9.0	10.9	11.0	-

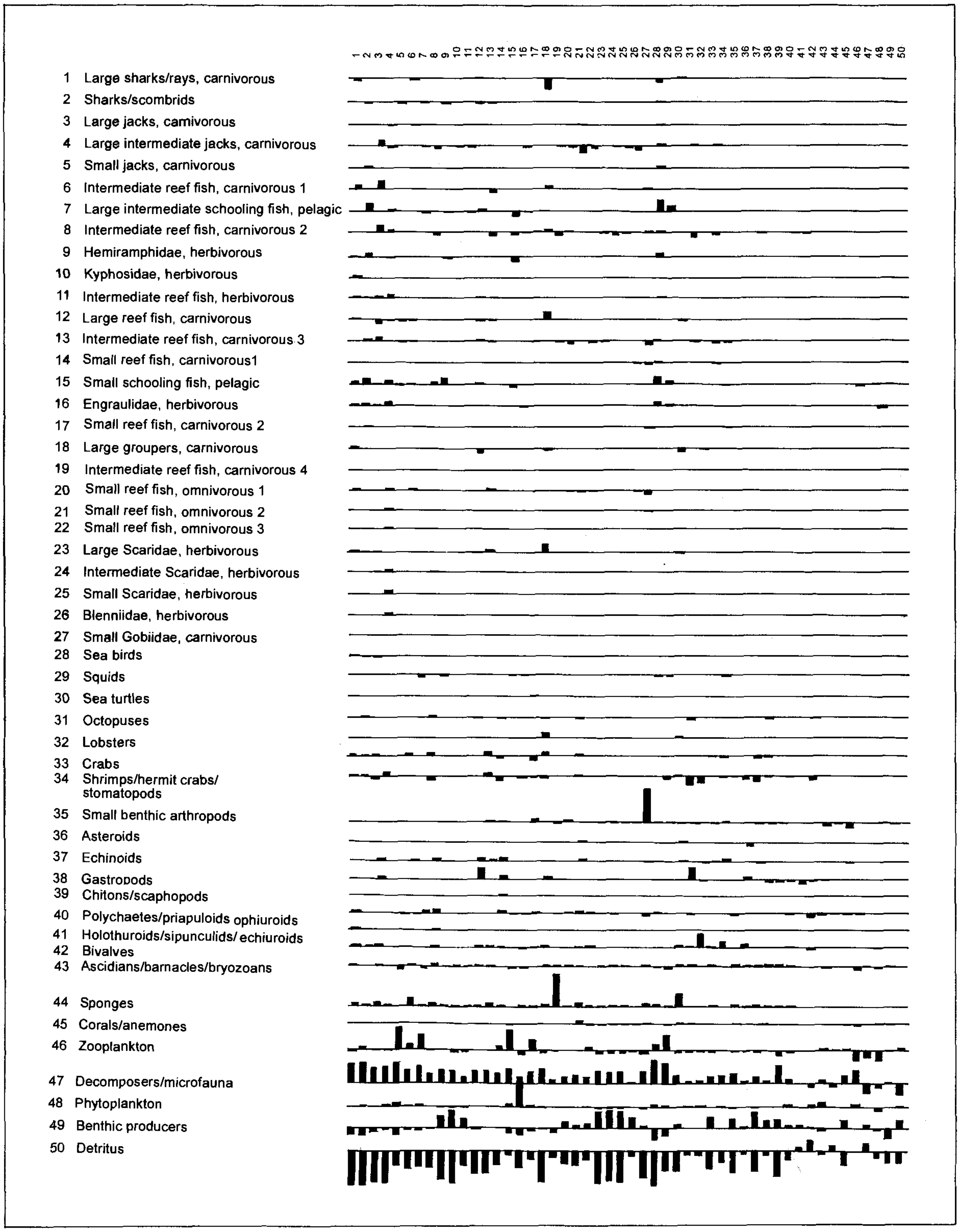


Fig. 3.3. Mixed trophic impacts of a 50-box model of a Caribbean coral reef showing the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms will have on the groups positioned above the histograms.

impact on bivalves (42), ascidians, barnacles and bryozoans (43) and zooplankton (46) since these groups feed to some extent on phytoplankton. A slight indirect positive impact is observed for groups feeding on groups which feed on phytoplankton, such as sharks and scombrids, which feed on phytoplanktivorous engraulids.

An increase in biomass of decomposers/microfauna (group 47) has a large indirect positive impact on almost all other groups (recall the analogy with the system's motor), except for a small indirect negative impact on groups, which feed to a large extent on detritus. These groups may be regarded as competitors for the same food source since group 47 feeds almost exclusively on detritus. Therefore an increase of decomposers/microfauna biomass would have a direct negative impact on the detritus box.

Increasing the biomass of the apex predators (birds, sharks, scombrids, large jacks and groupers) would have a relatively small negative impact on their prey groups. This is due to the small biomass of these groups combined with moderate relative food requirements. An increase in the biomass of apex predators would have a slight direct positive effect on groups which themselves feed, albeit, to a small extent on these predators, such as the seabirds.

Overall, an increase in biomass of a given group has a direct negative impact on its prey groups and an indirect negative impact on groups competing for the same food source. Further, such increase has a direct positive impact on the predators of that group and an indirect positive impact on groups feeding, in turn, on those predators.

3.3.2. Comparison of Models Based on Two Methods of Aggregation

3.3.2.1. FURTHER AGGREGATION OF FISH GROUPS BY CLUSTER ANALYSIS

The results of the cluster analysis used to pass from 29 to 1 fish species group are depicted in Fig. 3.1.

The strong separation of herbivores and carnivores is maintained up to a cutoff level of 80% (QED 1.2). The strongest separation between large and fast-swimming apex predators and the vast majority of reef fish is maintained up to a cutoff level of 99.9% (QED 1.49). The reef fish fauna is thus characterized by three principal energetic groups: (1) the large and fast-swimming apex predators with a predominantly pelagic habitat and wide-ranging migrations (exceptions are not well identified due to set values used here for the aspect ratios of sharks and rays; some of them, especially rays and the nurse shark, probably belong to the large reef fishes); (2) the predominantly carnivorous; and (3) the predominantly herbivorous reef fishes. (The omnivores were pooled with either group depending on the percentage of plant or animal food in their diet).

3.3.2.2. AGGREGATION BY THE ECOPATH II AGGREGATION ROUTINE

Fig. 3.4 shows the results of the ECOPATH II aggregation routine which allowed a stepwise reduction of the number of boxes from 50 to 1. Species groups with a similar trophic level were aggregated first as in the case of the strictly herbivorous fish groups and the strictly carnivorous groups which belong largely to the apex predators; within each trophic set, groups with a low biomass were aggregated first in order to reduce ascendency as little as possible. It may also be observed from Fig. 3.4 that the aggregation routine tends to form two main trophic groups by combining groups with a similar trophic level: one carnivorous and one herbivorous. This tendency becomes more obvious when the number of boxes is further reduced. Due to their

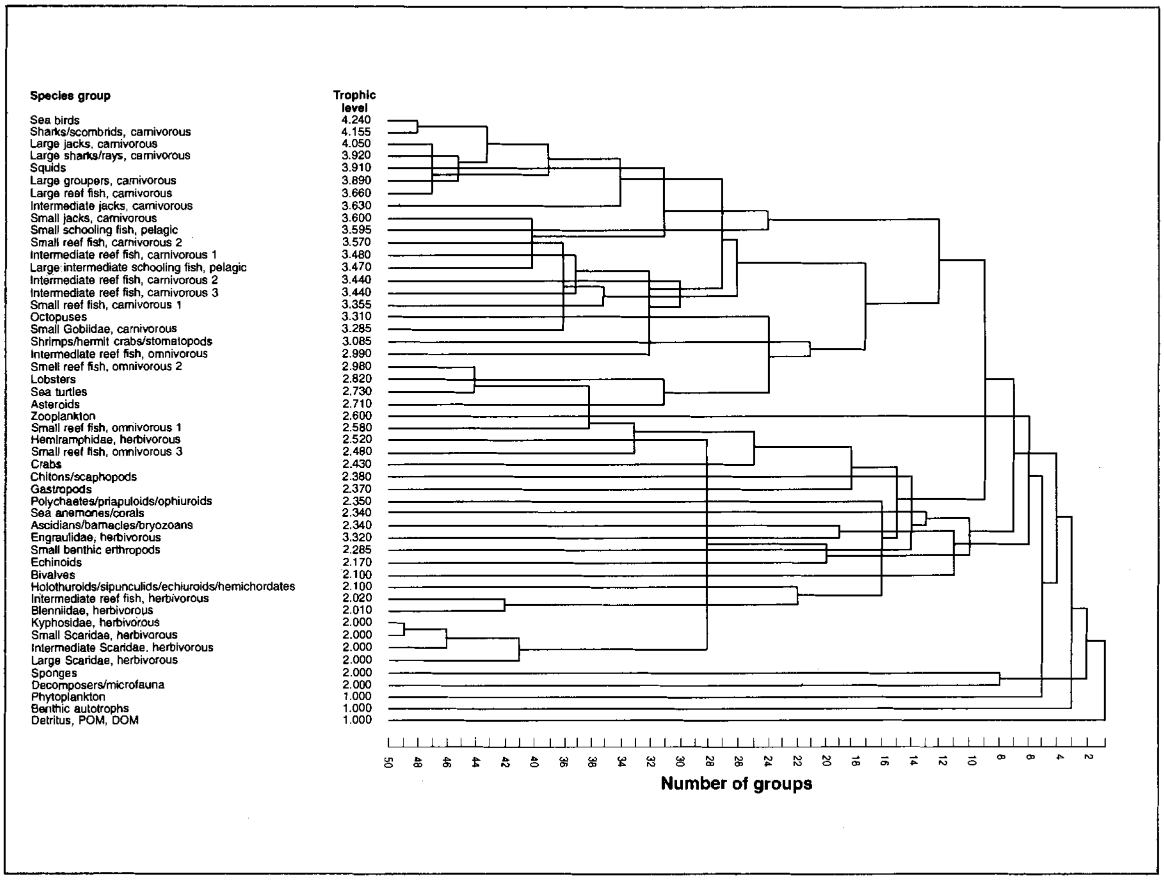


Fig. 3.4. Graphical representation of the results of the ECOPATH II aggregation routine showing the stepwise reduction of the number of boxes from 50 to 1 for models of a Caribbean coral reef.

high biomass and/or degree of detritivory, sponges and microfauna are kept as single groups until the system is reduced to 8 boxes.

Benthic producers and detritus are also kept separate until the system is reduced to a minimum number of boxes (5, 3 and 1). This dendrogram cannot be compared directly with the results of the cluster analysis, since the latter was applied exclusively to fish species. Nevertheless, it should be noticed that both figures show a separation into main trophic groups (recall the separation into herbivorous and carnivorous reef fish groups which was maintained up to a cutoff level of 80% in Fig. 3.1). The separation into large apex predators with a mainly pelagic habitat and reef fish with a demersal habitat was not repeated by the ECOPATH II aggregation routine.

3.3.2.3. THE 20-BOX MODELS

Method 1: Cluster Analysis + Intuition

Composition of Groups. Table 3.28 shows the composition of groups for the first of the two 20-box models. As pointed out in "Materials and methods", the group composition resulted from an aggregation of fish species by cluster analysis and "intuitive guesswork" for the nonfish groups based on the criteria relative to DC, body size and lifestyle.

In contrast to the 50-box model, some of the boxes of the 20-box model include both fish and nonfish groups: groups are now classified by a combination of diet, size and lifestyle, leaving apart the separation into fish and nonfish. This is a first step away from taxonomics, toward a purely energetic approach (within the fish community, steps in this direction were taken by combining species and groups with similar energy requirements, also irrespective of taxonomics).

Parameter Estimation. The condensed input values for the key parameters and the inputs for the DC matrix may be found in Tables 3.29 and 3.30, respectively. Output values are the same as input values with one exception referring to box 8, small benthic carnivores. In the 50-box model, due to their low biomass (1.3 gm^{-2}), the sea anemones were merged with the corals, even though they are fully heterotrophic (feeding mainly on zooplankton). Within the 20-box model, they were merged with small benthic carnivores. Their excessive predation mortality was shifted to benthic autotrophs; this was unproblematic since the predators of sea anemones include omnivorous and herbivorous groups. Therefore, the EE of benthic autotrophs (box 19) increased from 0.360 to 0.362, while the EE of "corals" decreased from 0.977 in the 50-box model to 0.713 in the 20-box model.

Table 3.31 presents additional parameters and ratios computed by ECOPATH II. These parameter estimates allow, as already mentioned for the 50-box model, computation of the energy balance, following the "master equation", of each box of the system.

Fig. 3.5 presents the 20-box model of an unexploited segment of the PRVI coral reefs system, aggregated following method 1 (see above).

System Properties. System properties, such as summary statistics, network flow indices, flows and transfer efficiencies and mixed trophic impacts, were estimated by ECOPATH II for the 20-box model as obtained by method 1. The results showed only negligible differences in relation to the 50-box model. Summary statistics, network flow indices and flows for the 20-box model, obtained by method 1, are listed in Appendix Tables 8.9.1 to 8.9.3. Table 3.32 presents the transfer efficiencies between discrete trophic levels.

Table 3.28. Composition of groups of a 20-box model of a Caribbean coral reef obtained by method 1 (cluster analysis + intuition); names of subgroups refer to original groups in the 50-box model.

Group no.		Predator/prey group	Group no.		Predator/prey group
1	B	Sea birds	9		Benthic invertebrates, omnivorous
2		Sharks/rays/scombrids		I	Gastropods +
				I	Polychaetes/priapuloids/ ophiuroids
	F	Large sharks/rays, carnivorous +	10		Large to intermediate reef fish, herbivorous
	F	Sharks/scombrids, carnivorous			(>50% plant food)
3		Large to intermediate jacks, carnivorous			F Kyphosidae, herbivorous +
				F	Intermediate reef fish, herbivorous +
	F	Large jacks, carnivorous +		F	Large Scaridae, herbivorous +
	F	Intermediate jacks, carnivorous		F	Intermediate Scaridae, herbivorous
4		Large to intermediate schooling pelagics	11		Small reef fish, herbivorous
					(>50% plant food)
	F	Small jacks, carnivorous +			
	F*	Large to intermediate schooling fish, pelagic +		F	Small reef fish, omnivorous 3 +
	F	Hemiramphidae, herbivorous +		F	Small Scaridae, herbivorous +
	I	Squids		F	Blenniidae, herbivorous
			12		Benthic invertebrates, herbivorous
5		Small schooling fish, pelagic			(>50% plant food)
				I	Crabs
	F	Small schooling fish, pelagic +		I	Amphipods/isopods/ tanaids/pycnogonids +
	F	Engraulidae, herbivorous		I	Echinoids +
				I	Chitons/scaphopods
6		Large groupers, carnivorous			
			13		Semisessile detritivores
7		Large to intermediate benthic carnivores			(>50% detrital food)
		(>50% live animal food)			
				I	Holothuroids/sipunculids/ echiuroids/
	F	Intermediate reef fish, carnivorous 1 +			hemichordates +
	F	Large reef fish, carnivorous +		I	Bivalves
	F	Intermediate reef fish, carnivorous 2 +			
	F	Intermediate reef fish, carnivorous 3 +	14		Sessile detritivores
	F	Intermediate reef fish, carnivorous 4 +			(>50% detrital food)
	R	Sea turtles +			
	F	Octopuses +		I	Ascidians/barnacles/bryozoans +
	F	Lobsters		I	Sponges
8		Small benthic carnivores	15		Corals
		(> 50 % live animal food)			
			16		Zooplankton
	F	Small reef fish, carnivorous 1 +			
	F	Small reef fish, carnivorous 2 +	17		Decomposers/microfauna
	F	Small reef fish, omnivorous 1 +			
	F	Small reef fish, omnivorous 2 +	18		Phytoplankton
	F	Small Gobiidae, carnivorous +			
	I	Shrimps/hermit crabs/stomatopods +	19		Benthic autotrophs
	I	Asteroids +			
	I	Sea anemones	20		Detritus

B = bird, F = fish, I = invertebrate, R = reptile.

Table 3.29. Results of the ECOPATH II parameter estimation for a 20-box model of a Caribbean coral reef (method 1: cluster analysis + intuition; average values are weighted by biomass); P/B = production/biomass ratio, Q/B = consumption/unit biomass, EE = ecotrophic efficiency (part of production consumed by predators).

Group no.	Predator group	No.of groups[a]	Biomass ($g \cdot m^{-2}$)	Average P/B ($year^{-1}$)	Average Q/B ($year^{-1}$)	End EE
1	Sea birds	1	0.017	5.400	80.000	0.344
2	Sharks/rays/scombrids, carnivorous	2	0.714	0.298	7.364	0.527
3	Large to intermediate jacks, carnivorous	2	1.811	1.106	8.805	0.355
4	Large to intermediate schooling pelagics	4	14.797	0.795	14.954	0.923
5	Small schooling pelagic fish	2	13.471	3.366	24.910	0.789
6	Large groupers, carnivorous	1	0.725	0.370	2.300	0.51
7	Large to intermediate benthic carnivores (>50% live animal food)	8	32.893	1.084	7.149	0.831
8	Small benthic carnivores (>50% live animal food)	8	46.718	1.320	10.722	0.942 (1.423)
9	Benthic invertebrates, omnivorous	2	79.800	3.792	33.684	0.937
10	Large to intermediate reef fish, herbivorous (>50% plant food)	4	36.563	0.843	18.468	0.475
11	Small reef fish, herbivorous (>50%plant food)	3	6.635	1.342	34.938	0.788
12	Benthic invertebrates, herbivorous (>50% plant food)	4	194.250	1.179	15.569	0.798
13	Semisessile detritivores (>50% detrital food)	2	175.490	1.505	7.182	0.909
14	Sessile detritivores (>50% detrital food)	2	937.400	1.617	7.199	0.364
15	Corals	1	120.000	1.090	9.000	0.713
16	Zooplankton	1	32.000	40.000	165.000	0.928
17	Decomposers/microfauna	1	15.000	280.000	1,900.000	0.979
18	Phytoplankton	1	40.000	70.000	-	0.74
19	Benthic autotrophs	1	1,300.000	13.250	-	0.362 (0.360)
20	Detritus, POM, DOM	1	2,000.000	-	-	-

[a] Number of groups refers to original groups from the 50-box model.

Table 3.30. Diet composition matrix for a 20-box model of a Caribbean coral reef (method 1: cluster analysis + intuition). Values in parentheses refer to original values which had to be modified to balance the model.

Group no.	Predator group	No. of groups[a]	Prey group 1	2	3	4	5	6	7	8	9	10	11
1	Sea birds	1	-	0.02	0.07	0.41	0.3	-	0.09	0.041	-	0.017	0.002
2	Sharks/rays/scombrids, carnivorous	2	0.006	0.013	0.039	0.258	0.148	0.026	0.21	0.105	0.027	0.09	0.003
3	Large to intermediate jacks, carnivorous	2	-	-	0.01	0.056	0.203	-	0.14	0.13	0.014	0.2	0.212
4	Large to intermediate schooling pelagics	4	-	-	-	0.023	0.093	-	-	0.014	0.075	0.007	-
5	Small schooling pelagic fish	2	-	-	-	-	0.002	-	-	-	-	-	-
6	Large groupers, carnivorous	1	-	0.01	0.01	0.01	-	-	0.612	-	-	0.288	-
7	Large to intermediate benthic carnivores (>50% live animal food)	8	-	-	0.001	0.004	0.028	-	0.058	0.05 (0.055)	0.234	0.038	0.009
8	Small benthic carnivores (>50% live animal food)	8	-	-	-	0.004	0.007	-	0.023	0.04 (0.05)	0.135	-	0.003
9	Benthic invertebrates, omnivorous	2	-	-	-	-	-	-	-	0.004 (0.006)	0.047	-	-
10	Large to intermediate reef fish, herbivorous (>50% plant food)	4	-	-	-	-	-	-	-	0.001	0.001	-	-
11	Small reef fish, herbivorous (>50% plant food)	3	-	-	-	-	-	-	-	-	0.008	-	-
12	Benthic invertebrates, herbivorous (>50% plant food)	4	-	-	-	-	-	-	-	0.003 (0.009)	0.005	-	-
13	Semisessile detritivores (>50% detrital food)	2	-	-	-	-	-	-	-	-	-	-	-
14	Sessile detritivores (>50% detrital food)	2	-	-	-	-	-	-	-	-	-	-	-
15	Corals	1	-	-	-	-	-	-	-	-	-	-	-
16	Zooplankton	1	-	-	-	-	-	-	-	-	-	-	-
17	Microfauna	1	-	-	-	-	-	-	-	-	-	-	-
18	Phytoplankton	1	-	-	-	-	-	-	-	-	-	-	-
19	Benthic autotrophs	1	-	-	-	-	-	-	-	-	-	-	-
20	Detritus	1	-	-	-	-	-	-	-	-	-	-	-

[a]Number of groups refers to original groups from the 50-box model.

continued...

Table 3.30 continued

Group no.	Prey group 12	13	14	15	16	17	18	19	20	Sum
1	-	-	-	-	0.05	-	-	-	-	1
2	0.031	0.038	-	-	-	-	-	-	0.006	1
3	0.01	0.004	-	-	0.021	-	-	-	-	1
4	-	-	-	-	0.574	-	-	0.214	-	1
5	0.006		0.017	-	0.628	0.003	0.301	-	0.043	1
6	0.07	-	-	-	-	-	-	-	-	1
7	0.15	0.198	0.116	0.002	0.057	-	-	0.043	0.012	1
								(0.038)		
8	0.15	0.151	0.014	0.002	0.153	0.038	-	0.119	0.161	1
								(0.109)		
9	0.018	0.036	0.092	0.006	0.038	0.045	0.076	0.286	0.352	1
								(0.284)		
10	-	-	0.001	-	0.001	-	-	0.828	0.168	1
11	0.001	0.012	-	-	0.033	-	-	0.844	0.102	1
12	0.007	0.006	0.087	0.025	0.025	0.097	0.002	0.645	0.098	1
								(0.639)		
13	-	-	-	-	-	0.1	0.125	0.023	0.752	1
14	-	-	-	-	0.061	0.041	0.081	-	0.817	1
15	-	-	-	-	0.15	0.1	-	0.65	0.1	1
16	-	-	-	-	-	0.6	0.2	-	0.2	1
17	-	-	-	-	-	-	-	0.05	0.95	1
18	-	-	-	-	-	-	-	-	(1)	(1)
19	-	-	-	-	-	-	-	-	(1)	(1)
20	-	-	-	-	-	-	-	-	-	0

Table 3.31. Results of the ECOPATH II parameter estimation for a 20-box model of a Caribbean coral reef; method 1 (cluster analysis + intuition). Additional parameters. Import to detritus: 475 g·m^{-2}, other imports to boxes are 0: catches for all boxes are 0. Excretion = 5% and egestion = 15% (nonassimilated food, default values) of the food intake of each box.

Group no.	Predator group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Trophic level
1	Sea birds	1.36	0.996	0.032	0.332	1.088	4.189
2	Sharks/rays/scombrids, carnivorous	5.26	3.994	0.112	1.152	4.206	4.038
3	Large to intermediate jacks, carnivorous	15.95	10.754	0.712	4.481	12.757	3.652
4	Large to intermediate schooling pelagics	221.27	165.256	10.857	45.161	177.019	3.297
5	Small schooling pelagic fish	335.56	223.107	35.763	76.692	268.450	3.039
6	Large groupers, carnivorous	1.67	1.066	0.137	0.465	1.334	3.872
7	Large to intermediate benthic carnivores (>50% live animal food)	235.15	152.466	29.639	53.047	188.122	3.306
8	Small benthic carnivores (>50% live animal food)	500.91	339.061	58.073	103.777	400.728	3.005
9	Benthic invertebrates, omnivorous	2,687.98	1,847.785	283.596	556.603	2,150.386	2.353
10	Large to intermediate reef fish, herbivorous (>50% plant food)	675.25	509.374	14.650	151.221	540.196	2.006
11	Small reef fish, herbivorous (>50% plant food)	231.81	176.547	7.018	48.249	185.451	2.078
12	Benthic invertebrates, herbivorous (>50% plant food)	3,024.28	2,190.402	182.647	651.229	2,419.423	2.298
13	Semisessile detritivores (>50% detrital food)	1,260.37	744.183	240.156	276.030	1,008.295	2.100
14	Sessile detritivores (>50% detrital food)	6,748.34	3,882.898	551.077	2,314.367	5,398.674	2.139
15	Corals	1,080.00	733.200	93.207	253.593	864.000	2.340
16	Zooplankton	5,280.00	2,944.000	1,187.915	1,148.085	4,224.000	2.600
17	Microfauna	28,500.00	18,600.000	4,113.075	5,786.925	22,800.000	2.000
18	Phytoplankton	-	0.000	2,071.501	728.498	-	1.000
19	Benthic autotrophs	-	0.000	6,227.238	10,997.762	-	1.000
20	Detritus, POM, DOM	-	0.000	-	-	-	1.000

[a](g·m^{-2}·year^{-1} WW).

continued....

Table 3.31 continued

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
1	0.0872	0.068	0.085	0.915	0.091
2	0.2729	0.040	0.051	0.949	0.053
3	0.2968	0.126	0.157	0.843	0.186
4	0.4948	0.053	0.066	0.934	0.071
5	0.5716	0.135	0.169	0.831	0.203
6	0.3758	0.161	0.201	0.799	0.252
7	0.2180	0.152	0.190	0.810	0.234
8	0.4612	0.123	0.154	0.846	0.182
9	0.3236	0.113	0.141	0.859	0.164
10	0.0097	0.046	0.057	0.943	0.061
11	0.1092	0.038	0.048	0.952	0.050
12	0.2701	0.076	0.095	0.905	0.105
13	0.0900	0.210	0.262	0.738	0.355
14	0.1780	0.225	0.280	0.719	0.390
15	0.3684	0.121	0.151	0.849	0.178
16	0.2400	0.242	0.303	0.697	0.435
17	0.0000	0.147	0.184	0.816	0.226
18	0.0000	-	-	-	-
19	0.0000	-	-	-	-
20	0.3667	-	-	-	-

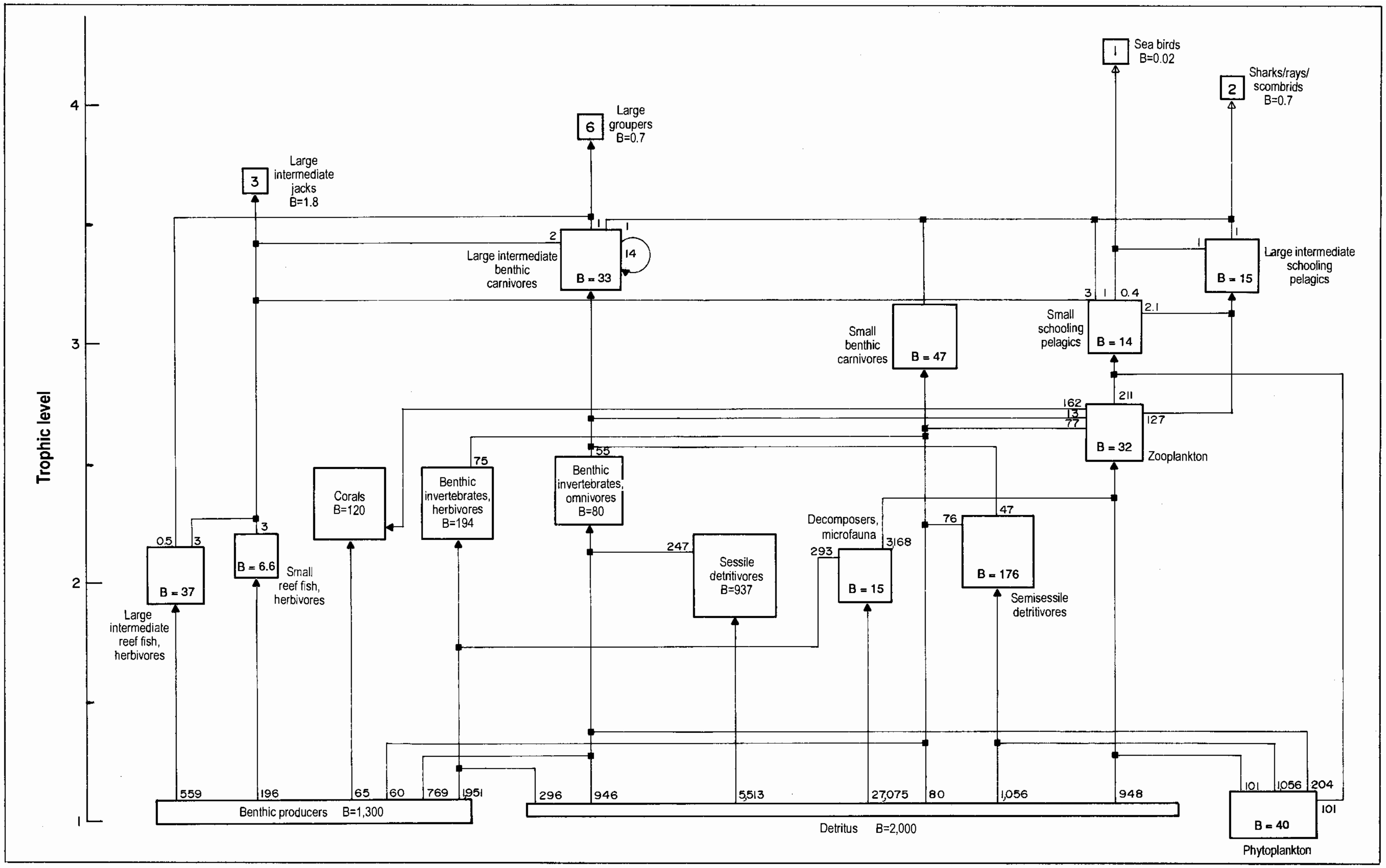


Fig. 3.5. Graphical representation of a 20-box model of a Caribbean coral reef as obtained by method 1 (cluster analysis + intuition). The area of each box is proportional to the logarithm of the biomass (B, in gm^{-2} WW) of each group. Values represent the average for all subsystems in Fig. 2.1. Flows are in $gm^{-2}year^{-1}$WW. Incoming flows (entering bottom half of a box) represent at least 90% of the diet of a group.

Table 3.32. Transfer efficiencies (%) by discrete trophic level for a 20-box model (method 1).

Source	I	II	III	IV	V	VI	VII	VIII
Producers	-	10.8	11.8	9.3	9.6	10.1	-	
Detritus	-	13.6	17.4	8.9	8.8	10.1	10.1	-
All flows	-	13.1	16.6	8.9	8.9	10.1	11.1	-

Transfer efficiencies by discrete trophic levels for primary producers were somewhat lower (4% to 9%) than in the 50-box model. For detritus, transfer efficiencies were lower for levels IV, VI and VII. Throughput per trophic level for detritus is around 7-10 times that for primary producers. Thus, resulting transfer efficiencies for combined flows were mainly affected by efficiencies computed for detritus. The differences in transfer efficiencies for models with a different number of boxes may be because the efficiencies are computed after the flows involved in cycles are removed, and there are more flows involved in cycles after aggregating formerly distinct boxes. Since detritus is involved in more cycles than any other food source, the differences in transfer efficiencies for detritus must also be more pronounced when comparing models with a different number of boxes.

Trophic level VII for primary producers had, in contrast to the 50-box model, no estimate of transfer efficiency. This may be explained by the effect of aggregating groups of differing food types, where the fraction of plant food in the resulting groups was reduced to nearly zero due to weighting of DC by the biomass and consumption requirements of the groups included.

Mixed Trophic Impacts. Fig. 3.6 shows the direct and indirect impacts on the biomass of prey groups by an increased biomass of the predator group for the 20-box model obtained by method 1. Relationships and impacts between groups correspond basically to those discussed for the 50-box model. The figure was included here for a better visualization of impacts, when the system is reduced to 20 boxes and for comparison with the 20-box model obtained by method 2 (see below).

Method 2: ECOPATH II - Aggregation Routine

Composition of Groups. Table 3.33 shows the group composition of the second of the two 20-box models. The group composition is the result of a combination of groups from the balanced 50-box model by the ECOPATH II aggregation routine. In contrast to method 1, the combination of groups is based on a single criterion, the least reduction (by pairing boxes) of average shared information (i.e., ascendency). Interestingly, this routine tends to group boxes of similar trophic levels, i.e., the aggregated boxes in the reduced models consist of carnivorous, omnivorous and herbivorous groups without reference criteria, such as size. Therefore, a large carnivorous fish group is produced which includes species ranging from tiger shark to gobies (Group 1, aggregation 26).

Also, because a trophic level of 1 is assigned to autotrophs as well as to detritus (see Introduction), nonfish taxa or groups feeding to some or large extent on detritus are combined with groups feeding on benthic autotrophs (group 4, aggregation 22).

The omnivorous group 6 (aggregation 25) includes fish and nonfish groups with a wide spectrum of omnivory. The groups with similar trophic levels are more likely to be aggregated when their biomass values are low because the associated flows are less, and hence have little impact on ascendency. This might also be the reason why so many nonfish groups from the 50-

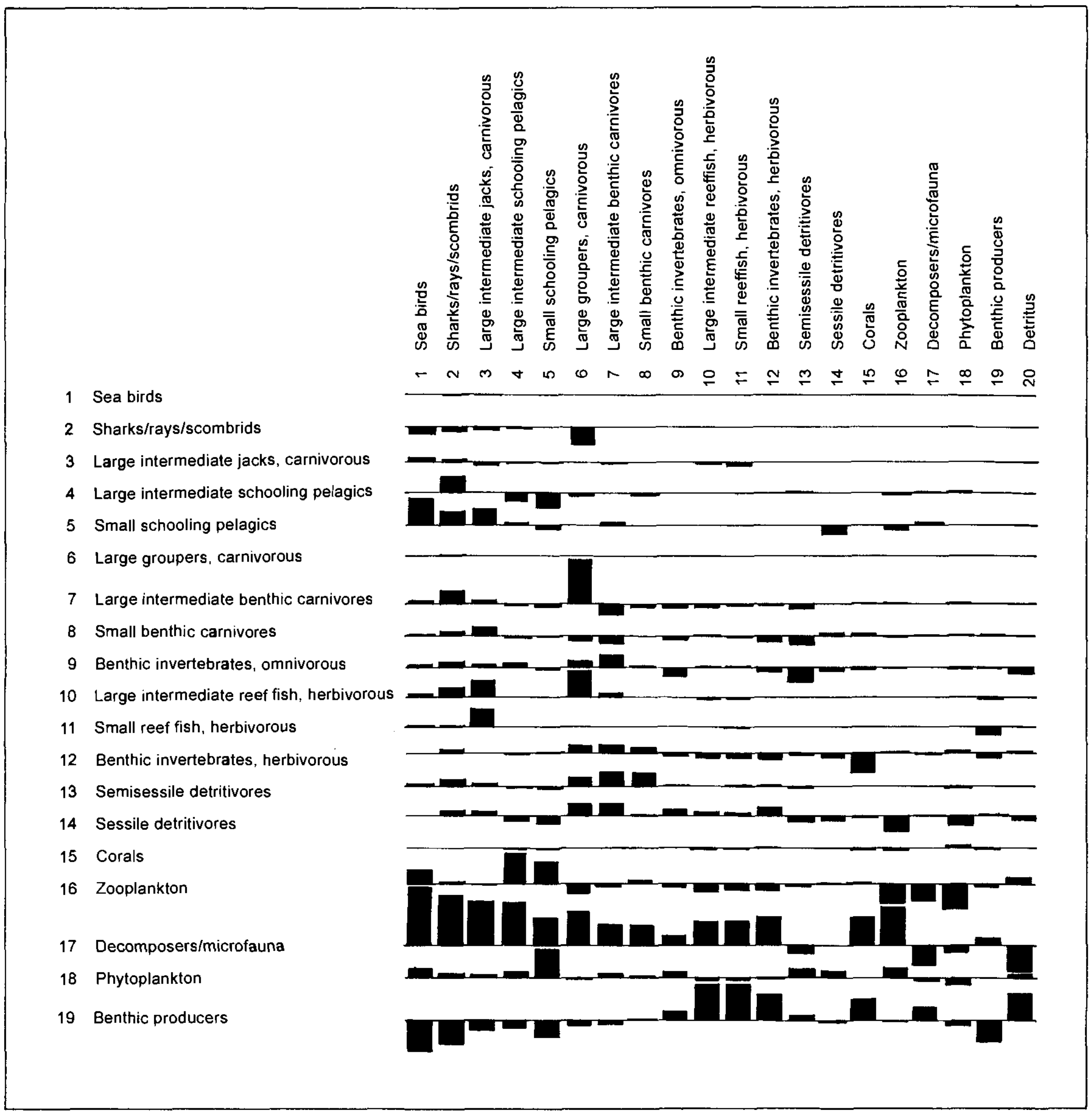


Fig. 3.6. Mixed trophic impacts of a 20-box model (method 1) of a Caribbean coral reef showing the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms will have on the groups above the histograms.

Table 3.33. Composition of groups of a 20-box model of a Caribbean coral reef as obtained by method 2 (ECOPATH II aggregation routine); names of subgroups refer to original groups in the 50-box model.

Group no.		Predator/prey group
1		Aggregation 26
	F	Large sharks/rays, carnivorous
	F	Sharks/scombrids, carnivorous
	F	Large jacks, carnivorous
	F	Intermediate jacks, carnivorous
	F	Intermediate reef fish, carnivorous 1
	F	Intermediate reef fish, carnivorous 2
	F	Large reef fish, carnivorous
	F	Intermediate reef fish, carnivorous 3
	F	Small reef fish, carnivorous 1
	F	Small reef fish, carnivorous 2
	F	Large groupers, carnivorous
	F	Intermediate reef fish, carnivorous 4
	F	Small Gobiidae, carnivorous
	B	Sea birds
2		Aggregation 24
	F	Small jacks, carnivorous
	F	Large to intermediate schooling fish, pelagic
	F	Small schooling fish, pelagic
	I	Squids
3		Aggregation 20
	F	Hemiramphidae, herbivorous
	F	Kyphosidae, herbivorous
	F	Large Scaridae, herbivorous
	F	Intermediate Scaridae, herbivorous
	F	Small Scaridae, herbivorous
	I	Echinoids
4		Aggregation 22
	F	Intermediate reef fish, herbivorous
	F	Blenniidae, herbivorous
	I	Holothuroids/sipunculids/ echiuroids/hemichordates
5		Engraulidae, herbivorous
6		Aggregation 25
	F	Small reef fish, omnivorous 1
	F	Small reef fish, omnivorous 2
	F	Small reef fish, omnivorous 3
	R	Sea turtles
	I	Crabs
7		Aggregation 21
	I	Octopuses
	I	Lobsters
	I	Shrimps/hermit crabs/stomatopods
	I	Asteroids
8		Amphipods/isopods/tanaids/pycnogonids
9		Gastropods
10		Chitons/scaphopods
11		Polychaetes/priapuloids/ophiuroids
12		Bivalves
13		Ascidians/barnacles/bryozoans
14		Sponges
15		Sea anemones/corals
16		Zooplankton
17		Microfauna
18		Phytoplankton
19		Benthic autotrophs
20		Detritus, POM, DOM

B = bird, F = fish, I = invertebrate, R = reptile.

box model continued to exist as separate entities within the 20-box model. This is certainly a positive feature, since differences in DC, consumption requirements and size are pronounced between nonfish groups.

When comparing the group composition produced by method 1 with that by method 2, the food type is apparently the principal aggregation criterion. The basic producer groups of the system are left unchanged in both 20-box models (groups 15-20, corals to detritus). The combination of fish with nonfish and the distinction of the food type in a group depend primarily on the contrast of (1) intuitive use of more than one aggregation criterion, and (2) objective combination of groups by a single aggregation criterion. The choice of method depends on the objective of the modelling effort. Method 1 produces a more detailed view of the system where ecological criteria, such as size, lifestyle and, to some extent, habitat (e.g., pelagic vs. demersal) are explicitly considered. If one aims, though, to produce an energy pyramid of the system considered, where energy transfer efficiencies and flow rates between distinct trophic levels are of interest, method 2 is certainly the better choice.

Parameter Estimation. Tables 3.34 and 3.35 list the outputs for the three key parameters, as well as EEs and additional parameters. The percent food intake of prey for 20 predator groups (database of a food matrix) may be found in Appendix Table 8.8.3. Fig. 3.7 shows the 20-box model of the PRVI coral reef as obtained by method 2.

Table 3.34. Results of the ECOPATH II parameter estimation for a 20-box model of a Caribbean coral reef (method 2: ECOPATH II aggregation routine); P/B = production/biomass ratio, Q/B = consumption/unit biomass, EE = ecotrophic efficiency (part of production consumed by predators).

Group no.	Predator group	No. of groups[a]	Biomass ($g \cdot m^{-2}$)	Average P/B ($year^{-1}$)	Average Q/B ($year^{-1}$)	End EE
1	Aggregation 26	14	29.884	1.064	8.100	0.854
2	Aggregation 24	4	23.818	1.944	15.473	0.822
3	Aggregation 20	6	133.112	1.053	7.616	0.615
4	Aggregation 22	3	76.491	0.380	6.429	0.855
5	Engraulidae, herbivorous	1	3.325	2.835	43.400	0.791
6	Aggregation 25	5	24.984	1.603	15.196	0.902
7	Aggregation 21	4	46.670	1.274	9.235	0.926
8	Amphipods/isopods/tanaids/pycnogonids	1	13.250	5.000	125.500	0.927
9	Gastropods	1	46.800	2.800	14.000	0.974
10	Chitons/scaphopods	1	62.000	0.360	11.700	0.911
11	Polychaetes/priapuloids/ophiuroids	1	33.000	5.200	61.600	0.919
12	Bivalves	1	109.500	2.230	9.500	0.913
13	Ascidians/barnacles/bryozoans	1	137.400	2.300	20.000	0.798
14	Sponges	1	800.000	1.500	5.000	0.249
15	Corals/sea anemones	1	121.000	1.090	9.000	0.977
16	Zooplankton	1	32.000	40.000	165.000	0.921
17	Decomposers/microfauna	1	15.000	280.000	1,900.000	0.979
18	Phytoplankton	1	40.000	70.000	-	0.74
19	Benthic autotrophs	1	1,300.000	13.250	-	0.36
20	Detritus, DOM, POM	1	2,000.000	-	-	-

[a] Number of groups refers to original groups from the 50-box model.

Table 3.35. Results of the ECOPATH II parameter estimation for a 20-box model of a Caribbean coral reef method 2 (ECOPATH II aggregation routine). Additional parameters.
Import to detritus: 475 $g \cdot m^{-2}$, other imports to boxes are 0: catches for all boxes are 0. Excretion = 5% and egestion = 15% (nonassimilated food, défault vaues) of the food intake of each box.

Group no.	Predator group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Trophic level
1	Aggregation 26	242.06	161.848	27.145	53.070	193.650	3.45
2	Aggregation 24	368.53	248.534	38.067	81.934	294.828	3.57
3	Aggregation 20	1,013.73	670.880	86.182	256.670	810.985	2.08
4	Aggregation 22	491.77	364.329	24.860	102.585	393.420	2.05
5	Engraulidae, herbivorous	144.31	106.018	7.456	30.832	115.444	2.32
6	Aggregation 25	379.66	263.680	36.105	79.875	303.728	2.48
7	Aggregation 21	430.98	285.306	55.052	90.624	344.786	3.02
8	Amphipods/isopods/tanaids/pycnogonids	1,662.88	1,264.050	61.417	337.408	1,330.300	2.28
9	Gastropods	655.20	393.120	127.695	134.385	524.160	2.37
10	Chitons/scaphopods	725.40	558.000	20.339	147.061	580.320	2.38
11	Polychaetes/priapuloids/ophiuroids	2,032.80	1,454.640	157.634	420.526	1,626.240	2.35
12	Bivalves	1,037.88	586.672	222.354	228.849	830.300	2.10
13	Ascidians/barnacles/bryozoans	2,748.00	1,882.380	252.302	613.318	2,198.400	2.34
14	Sponges	4,000.00	2,000.000	299.177	1,700.823	3,200.000	2.00
15	Corals/sea anemones	1,089.00	739.310	128.803	220.887	871.200	2.34
16	Zooplankton	5,280.00	2,944.000	1,179.004	1,156.996	4,224.000	2.60
17	Microfauna	28,500.00	18,600.000	4112.797	5,787.203	22,800.000	2.00
18	Phytoplankton	-	0.000	2,073.120	726.880	-	1.00
19	Benthic autotrophs	-	0.000	6,201.429	11,023.570	-	1.00
20	Detritus, POM, DOM	-	-	-	-	-	1.00

[a]($g \cdot m^{-2} \cdot year^{-1}$ WW).

continued...

Table 3.35 continued

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
1	0.2593	0.131	0.160	0.836	0.196
2	0.1323	0.126	0.160	0.843	0.186
3	0.1269	0.138	0.170	0.827	0.209
4	0.0559	0.059	0.070	0.926	0.080
5	0.4096	0.065	0.080	0.918	0.089
6	0.4553	0.105	0.130	0.868	0.152
7	0.3900	0.138	0.170	0.827	0.208
8	0.2831	0.040	0.050	0.950	0.052
9	0.3334	0.200	0.250	0.750	0.333
10	0.2585	0.031	0.040	0.962	0.040
11	0.3277	0.084	0.110	0.894	0.118
12	0.0900	0.235	0.290	0.707	0.415
13	0.3648	0.115	0.140	0.856	0.168
14	0.0010	0.300	0.380	0.625	0.600
15	0.3684	0.121	0.150	0.849	0.178
16	0.2400	0.242	0.300	0.697	0.435
17	0.0000	0.147	0.180	0.816	0.226
18	0.0000	-	-	-	-
19	0.0000	-	-	-	-
20	0.3660	-	-	-	-

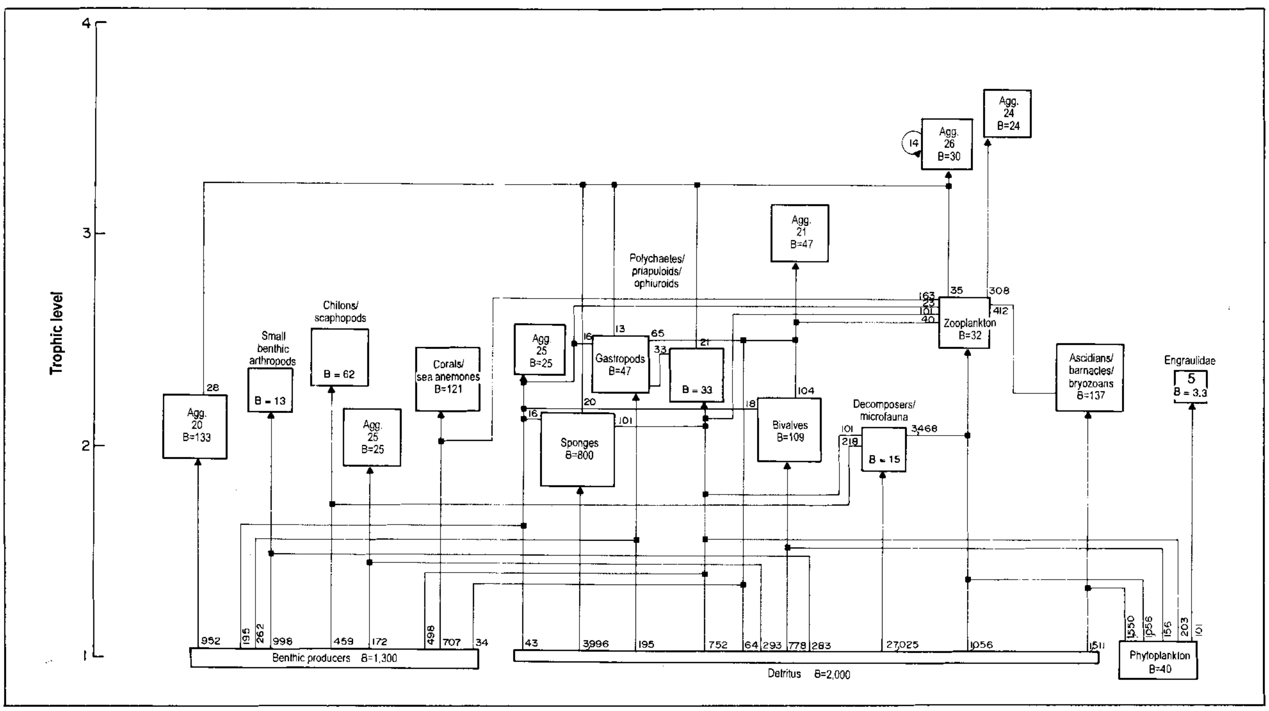


Fig. 3.7. Graphical representation of a 20-box model of a Caribbean coral reef as obtained by method 2 (ECOPATH II aggregation routine). The area of each box is proportional to the logarithm of the biomass (B, in $gm^{-2}WW$) of each group. Values represent the average for all subsystems in Fig. 2.1. Flows are in $gm^{-2}year^{-1}WW$. Incoming flows (entering bottom half of a box) represent at least 90% of the diet of a group.

System Properties. System properties, such as summary statistics, network flow indices and size of flows from primary producers, detritus and all flows combined for a 20-box model as obtained by method 2, are shown in Appendix Tables 8.9.4 to 8.9.6. These properties showed only small differences in relation to the 50-box model and to the 20-box model as obtained by method 1. This is mainly due to the fact that both methods of aggregation maintain a given throughput during the aggregation process. Table 3.36 presents the transfer efficiencies between discrete trophic levels.

Transfer efficiencies by discrete trophic levels for primary producers were somewhat higher (1% to 6.5%) than in the 50-box model. Compared to the 20-box model obtained by method 1, differences varied from 5% to 14%. For detritus, transfer efficiencies showed differences to the 50-box model of -1% to +4% and to the 20-box model, obtained by method 1, of -1% to +14%. For combined flows, differences of transfer efficiencies varied from -1% to +5% compared to the 50-box model, and from -1% to +14% for the 20-box model as obtained by method 1. Differences in transfer efficiencies were more pronounced for levels V, VI and VII when compared to the 50-box model (+5% to +9%), and for levels IV to VII when compared to the 20-box model as obtained by method 1 (+10% to +14%). These more pronounced differences between the 20-box models, obtained by two different aggregation methods, may as well be due to efficiencies computed after removing flows involved in cycles. Since the two methods produced somewhat differing groups, the efficiencies should also be different.

Mixed Trophic Impacts. Fig. 3.8 shows, as its predecessors of the 50-box model and the 20-box model obtained by method 1, the direct and indirect impacts on the biomass of prey groups by a raise of biomass of the predator group. As for the 20-box model obtained by method 1, the present figure was included for a better visualization of impacts, when the system is reduced to 20 boxes by the ECOPATH II aggregation routine and for comparison with the 20-box model as obtained by method 1.

3.3.2.2. THE 11-BOX MODELS

Method 1 : Cluster Analysis + Intuition

Composition of Groups. Table 3.37 shows the group composition for the 11-box model of a Caribbean coral reef as obtained by method 1. Main aggregation criterion was now the food type, and the aim was to reduce the system to a very low number of boxes. The division into two main habitats (pelagic-midwater, demersal-off bottom) is still visible, mainly because the group of apex predators was maintained by the cluster analysis. The zooplanktivorous schooling pelagics (group 2) correspond exactly to group 2 (aggregation 24) in the 20-box model obtained by method 2.

The omnivore group (4) is rather small, consisting of only two invertebrate taxa, because a group or taxon was identified as omnivorous only when none of the three main food sources (live animal, plant, detrital food) outweighted the others, i.e., when one element could not be classified by the criterion ">50% of a distinct food source".

For this method of aggregation and with increasing level of aggregation, the number of aggregation criteria is reduced. This means that distinctness of main features of a system is paid for in terms of loss in detail. Thus, it is up to the modeller or user of the model to decide which element is more appropriate for the respective objective and from this, to select an appropriate number of boxes for the final model.

Table 3.36. Transfer efficiencies (%) by discrete trophic level for a 20-box model (method 2).

Source	I	II	III	IV	V	VI	VII	VIII
Producers	-	11.3	12.2	10.3	10.8	11.5	11.5	-
Detritus	-	13.5	17.3	9.7	9.6	11.4	11.5	-
All flows	-	13.1	16.5	9.8	9.8	11.4	11.5	-

Table 3.37. Composition of groups of an 11-box model of a Caribbean coral reef obtained by method 1 (cluster analysis + intuition); names of subgroups refer to original groups in the 50-box model.

Group no.		Predator/prey group
1		Apex predators, mainly pelagic
	F	Large sharks/rays, carnivorous +
	F	Sharks/scombrids, carnivorous +
	F	Large jacks, carnivorous +
	F	Intermediate jacks, carnivorous +
	B	Sea birds
2		Schooling pelagics, zooplanktivorous
	F	Small jacks, carnivorous +
	F	Large to intermediate schooling fish, pelagic +
	F	Hemiramphidae, herbivorous +
	F	Small schooling fish, pelagic +
	F	Engraulidae, herbivorous +
	I	Squids
3		Benthic carnivores (>50% live animal food)
	F	Large groupers, carnivorous +
	F	Intermediate reef fish, carnivorous 1 +
	F	Large reef fish, carnivorous +
	F	Intermediate reef fish, carnivorous 2 +
	F	Intermediate reef fish, carnivorous 3 +
	F	Intermediate reef fish, carnivorous 4 +
	F	Small reef fish, carnivorous 1 +
	F	Small reef fish, carnivorous 2 +
	F	Small reef fish, omnivorous 1 +
	F	Small reef fish, omnivorous 2 +
	F	Small Gobiidae, carnivorous +
	R	Sea turtles +
	I	Octopuses +
	I	Lobsters +
	I	Asteroids +
	I	Sea anemones +
4		Benthic omnivores
	I	Gastropods +
	I	Polychaetes/priapuloids/ophiuroids
5		Benthic herbivores (>50% plant food)
	F	Kyphosidae, herbivorous +
	F	Intermediate reef fish, herbivorous +
	F	Large Scaridae, herbivorous +
	F	Intermediate Scaridae, herbivorous +
	F	Small reef fish, omnivorous 3 +
	F	Small Scaridae, herbivorous +
	F	Blenniidae, herbivorous +
	I	Crabs +
	I	Amphipods/isopods/tanaids/pycnogonids +
	I	Echinoids +
	I	Chitons/scaphopods +
	I	Corals
6		Benthic detritivores (>50% detrital food)
	I	Holothuroids/sipunculids echiuroids/hemichordates +
	I	Bivalves +
	I	Ascidians/barnacles/bryozoans +
	I	Sponges
7		Zooplankton
8		Decomposers/microfauna
9		Phytoplankton
10		Benthic autotrophs
11		Detritus

B = bird, F = fish, I = invertebrate, R = reptile.

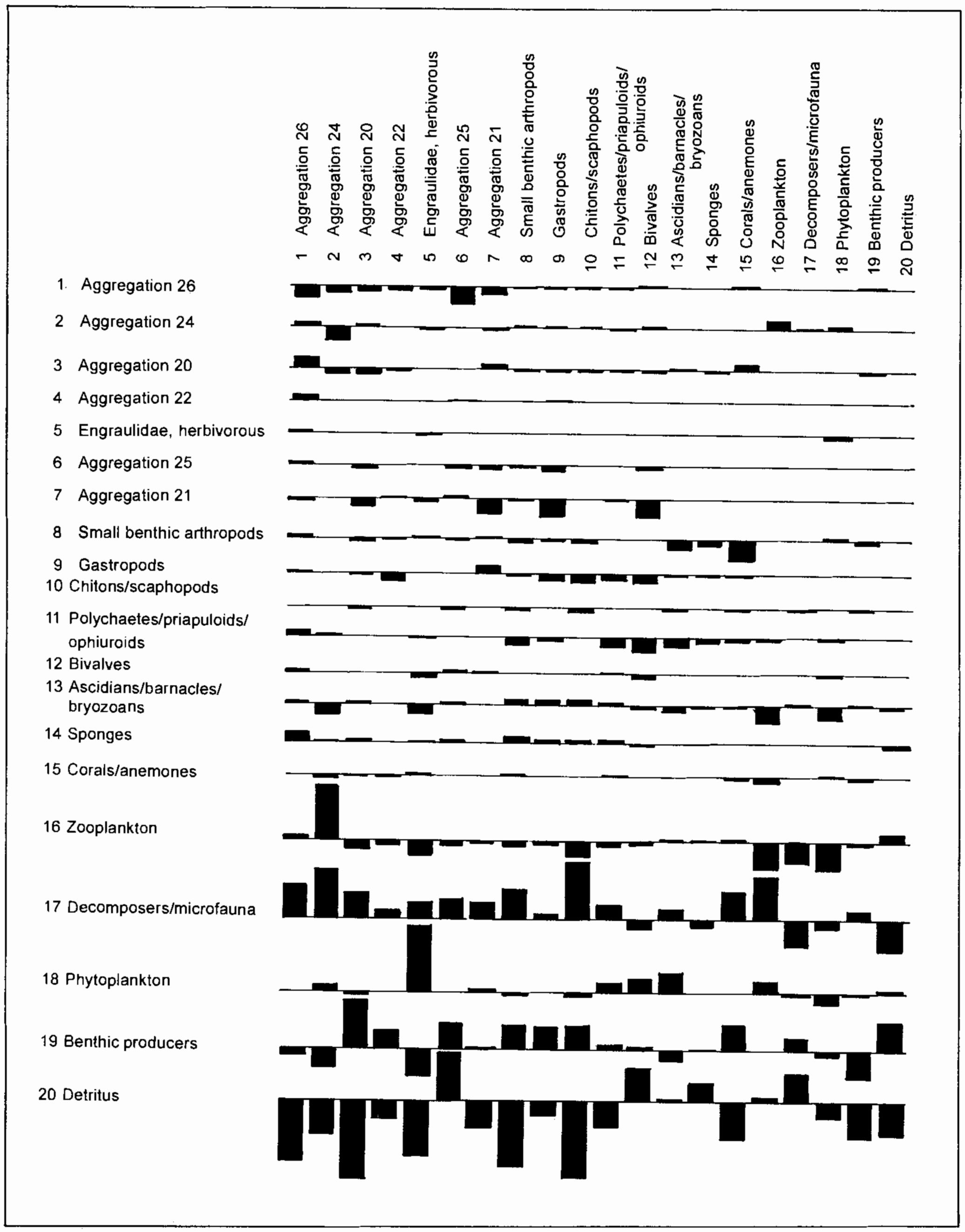


Fig. 3.8. Mixed trophic impacts of a 20-box model (method 2) of a Caribbean coral reef showing the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms will have on the groups above the histograms.

Parameter Estimation. Tables 3.38 and 3.40 present input/output estimates for the three key parameters as well as EEs and additional parameters and ratios. Input values did not have to be modified to equilibrate the system, therefore the same tables are valid for input as well as for output. The same is true for the diet matrix (Table 3.39).

Fig. 3.9 shows the 11-box model as produced by method 1.

System Properties. Summary statistics, network flow indices and size of flows for primary producers, detritus and all flows combined for an 11-box model, obtained by method 1, are presented in Appendix Tables 8.9.7 to 8.9.9. The results, again, showed only small differences when compared to the previous models. Table 3.41 presents the transfer efficiencies between discrete trophic levels.

Overall, transfer efficiencies for primary producers showed only negligible differences when compared to the 20-box model obtained by the same method. The only more pronounced differences could be observed in level V for detritus (+8%) and consequently for all flows combined (+7%) and in level VII for all flows combined (-10%). The differences may be because before computing the transfer efficiencies, ECOPATH II removes the flows involved in cycles. A difference in group composition between the two methods must therefore result in differing transfer efficiencies.

Mixed Trophic Impacts. Fig. 3.10 shows the direct and indirect impacts on the biomass of prey groups by a raise of biomass of the predator group for an 11-box model obtained by method 1. As for the 20-box models, the figure was included here for comparison with the previous models.

Method 2: ECOPATH II - Aggregation Routine

Composition of Groups. Table 3.42 shows the composition of groups for an 11-box model resulting from a further reduction of the number of boxes by the ECOPATH II aggregation routine. At this level of reduction, fish groups are strongly fused with nonfish ones. The tendency to produce groups of similar food type is maintained. Aggregation 12 (group 1) represents a very large group (large in the sense of containing the highest number of groups from the 50-box model) of carnivores. Group 2 (aggregation 20) holds the herbivores consisting of few groups, then group 3 (aggregation 15), the omnivores. Group 4 (aggregation 11) is a mixture of phytoplankton-feeding engraulids with detritivorous and phytoplanktivorous bivalves, ascidians, barnacles and bryozoans. Group 5 (aggregation 13) consists of invertebrates feeding predominantly on autotrophs. Groups 6-11 were maintained as in the 50-box model. Except for the sponges (group 6), which were pooled with other detritivores in the 20- and 11-box models of method 1, these groups are represented as single boxes in the 11-box models from both methods. Both 11-box models contain similar qualitative groupings although, as stated above, the detritivores are not separated from the herbivores due to the assignment of the same trophic level to both food types in method 2.

Parameter Estimation. Tables 3.43, 3.44 and Appendix Table 8.8.5 show the ECOPATH II outputs for the 11-box model. Fig. 3.11 presents the second of the two 11-box models of a Caribbean coral reef.

Table 3.38. Results of the ECOPATH II parameter estimation for an 11-box model of a Caribbean coral reef (method 1: cluster analysis + intuition); average values are weighted by biomass; P/B = production/biomass ratio, Q/B = consumption/unit biomass, EE = ecotrophic efficiency (part of production consumed by predators).

Group no.	Predator group	No. of groups[a]	Biomass ($g \cdot m^{-2}$)	Average P/B ($year^{-1}$)	Average Q/B ($year^{-1}$)	End EE
1	Apex predators, mainly pelagic	5	2.542	0.908	8.876	0.254
2	Schooling pelagics, zooplanktivorous	6	28.268	2.02	19.689	0.817
3	Benthic carnivores (>50% live animal food)	17	80.336	1.215	9.183	0.894
4	Benthic invertebrates, omnivorous	2	79.8	3.792	33.684	0.947
5	Benthic herbivores (>50% plant food)	11	357.448	1.118	14.02	0.739
6	Benthic detritivores (>50% detrital food)	4	1,112.89	1.599	7.196	0.445
7	Zooplankton	1	32	40	165	0.925
8	Decomposers/microfauna	1	15	280	1,900	0.979
9	Phytoplankton	1	40	70	-	0.74
10	Benthic autotrophs	1	1,300	13.25	-	0.362
11	Detritus, POM, DOM	1	2,000	-	-	-

[a] Number of groups refers to original groups from the 50-box model.

Table 3.39. Diet composition matrix for an 11-box model of a Caribbean coral reef, method 1 (cluster analysis + intuition).

Group no.	Predator group	No. of groups[a]	Prey group 1	2	3	4	5	6	7	8	9	10	11	Sum
1	Apex predators, mainly pelagic	5	0.026	0.32	0.279	0.016	0.328	0.012	0.018	-	-	-	0.001	1
2	Schooling pelagics, zooplanktivorous	6	-	0.047	0.006	0.03	0.006	0.01	0.607	0.002	0.181	0.085	0.026	1
3	Benthic carnivores (>50% live animal food)	17	-	0.018	0.077	0.167	0.169	0.213	0.122	0.026	-	0.095	0.113	1
4	Benthic invertebrates, omnivorous	2	-	-	0.004	0.047	0.024	0.128	0.038	0.045	0.076	0.286	0.352	1
5	Benthic herbivores (>50% plant food)	12	-	-	0.002	0.004	0.019	0.057	0.049	0.08	0.001	0.68	0.108	1
6	Benthic detritivores (>50% detrital food)	4	-	-	-	-	-	-	0.051	0.05	0.088	0.004	0.807	1
7	Zooplankton	1	-	-	-	-	-	-	-	0.6	0.2	-	0.2	1
8	Microfauna	1	-	-	-	-	-	-	-	-	-	0.05	0.95	1
9	Phytoplankton	1	-	-	-	-	-	-	-	-	-	-	(1)	(1)
10	Benthic autotrophs	1	-	-	-	-	-	-	-	-	-	-	(1)	(1)
11	Detritus, POM, DOM	1	-	-	-	-	-	-	-	-	-	-	-	0

[a] Number of groups refers to original groups from the 50-box model.

Table 3.40. Results of the ECOPATH II parameter estimation for an 11-box model of a Caribbean coral reef, method 1 (cluster analysis + intuition). Additional parameters. Import to detritus: 475 $g \cdot m^{-2}$, other imports to boxes are 0: catches for all boxes are 0.
Excretion = 5% and egestion = 15% (nonassimilated food, default values) of the food intake of each box.

Group no.	Predator group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Trophic level
1	Apex predators, mainly pelagic	22.56	15.742	0.587	6.234	18.050	4.320
2	Schooling pelagics, zooplanktivorous	556.57	388.154	46.658	121.757	445.255	3.574
3	Benthic carnivores (>50% live animal food)	737.73	492.572	87.214	157.939	590.180	3.469
4	Benthic invertebrates, omnivorous	2,687.98	1,847.785	286.639	553.559	2,150.386	2.774
5	Benthic herbivores (>50% plant food)	5,011.42	3,609.510	295.144	1,106.767	4,009.137	2.969
6	Benthic detritivores (>50% detrital food)	8,008.36	4,627.174	792.685	2,588.498	6,406.685	2.234
7	Zooplankton	5,280.00	2,944.000	1,184.375	1,151.625	4,224.000	2.800
8	Decomposers/microfauna	28,500.00	18,600.000	4,110.585	5,789.415	22,800.000	2.000
9	Phytoplankton	-	0.000	2,070.772	729.228	-	1.000
10	Benthic autotrophs	-	0.000	6,230.956	12,419.045	-	1.000
11	Detritus, POM, DOM	-	0.000	-	-	-	1.000

[a]($g \cdot m^{-2} \cdot year^{-1}$ WW).

continued....

Table 3.40 continued

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
1	0.1224	0.102	0.128	0.872	0.147
2	0.2388	0.103	0.128	0.872	0.147
3	0.4523	0.132	0.165	0.835	0.198
4	0.3915	0.113	0.141	0.859	0.164
5	0.1661	0.080	0.100	0.900	0.111
6	0.2526	0.222	0.278	0.722	0.385
7	0.1600	0.242	0.303	0.697	0.435
8	0.0000	0.147	0.184	0.816	0.226
9	0.0000	-	-	-	-
10	0.0000	-	-	-	-
11	0.3656	-	-	-	-

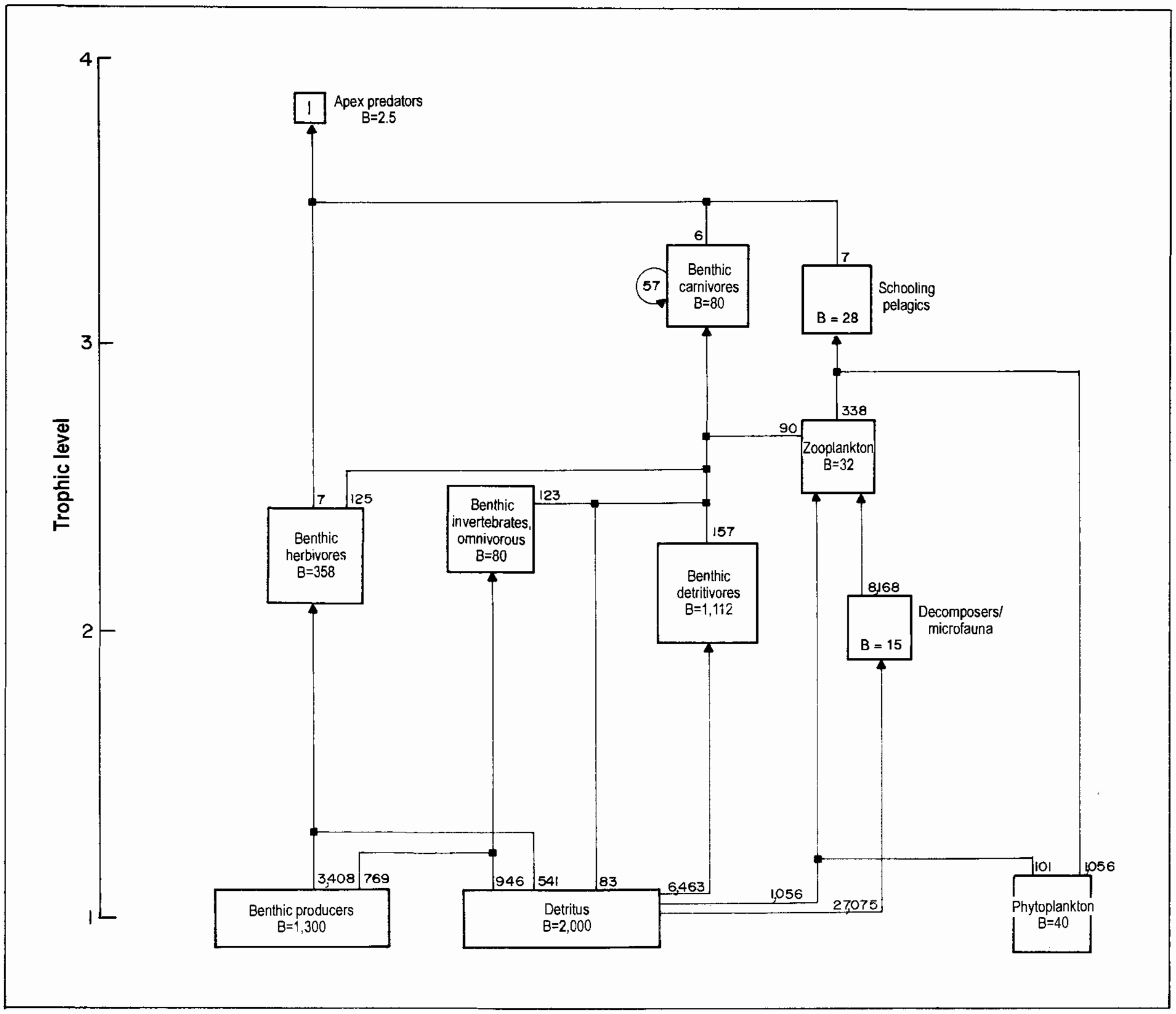


Fig. 3.9. Graphical representation of an 11-box model as obtained by method 1 (cluster analysis + intuition). The area of each box is proportional to the logarithm of the biomass (B, in $gm^{-2}WW$) of each group. Values represent the average for all subsystems in Fig. 2.1. Flows are in $gm^{-2}year^{-1}WW$. Incoming flows (entering bottom half of a box) represent at least 95% of the diet of a group.

Table 3.41. Transfer efficiencies (%) by discrete trophic level for an 11-box model (method 1).

Source	I	II	III	IV	V	VI	VII	VIII
Producers	-	10.7	11.8	9.5	9.8	10.0	-	-
Detritus	-	13.6	17.1	9.0	9.5	9.9	10.0	-
All flows	-	13.1	16.4	9.1	9.5	9.9	10.0	-

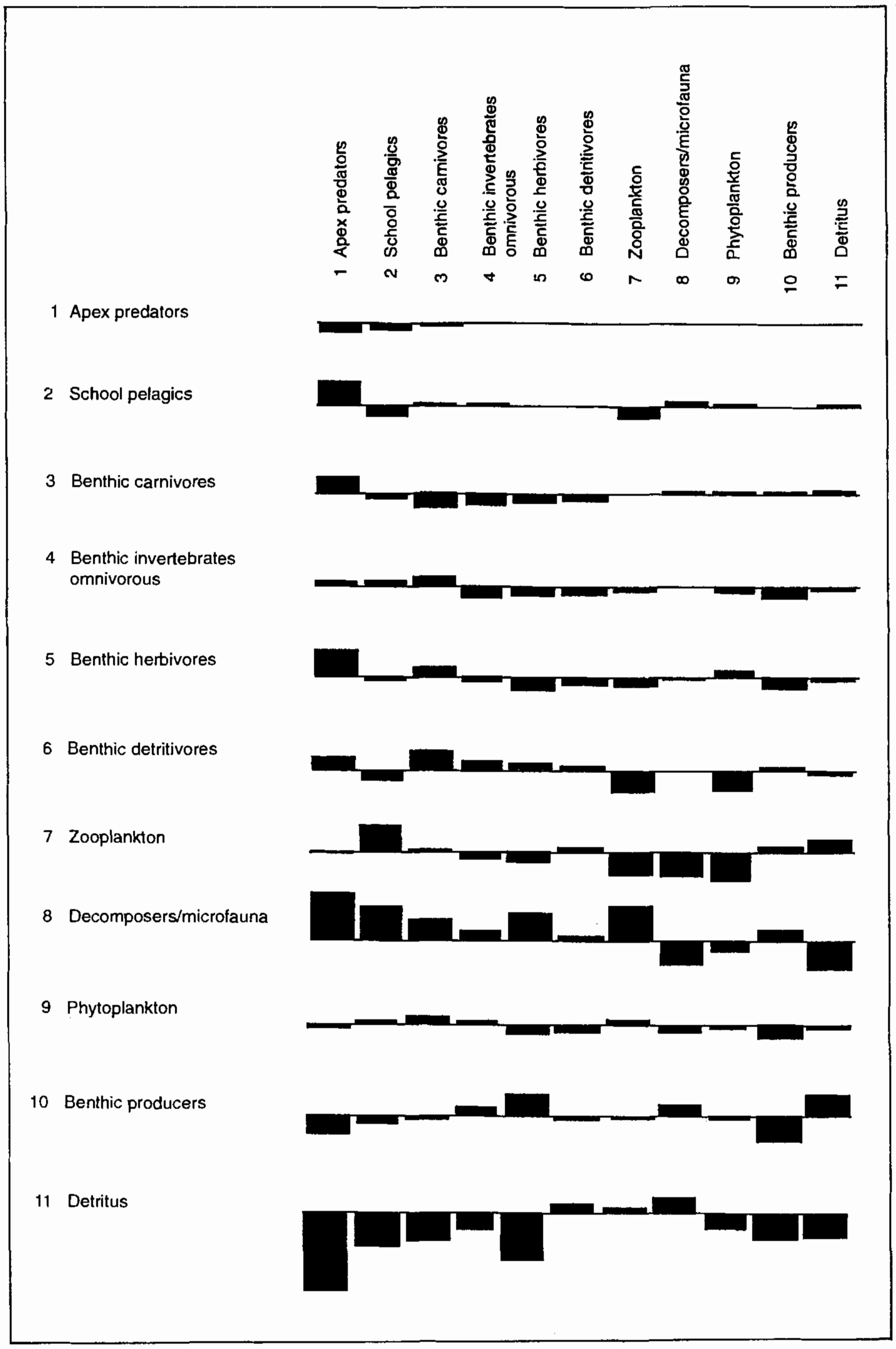


Fig. 3.10. Mixed trophic impacts of an 11-box model (method 1) of a Caribbean coral reef showing the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms will have on the groups positioned above the histograms.

Table 3.42. Composition of groups for an 11-box model of a Caribbean coral reef obtained by method 2 (ECOPATH II aggregation routine); names of subgroups refer to original groups in the 50-box model.

Group no.		Predator/prey group
1		Aggregation 12
	F	Large sharks/rays, carnivorous +
	F	Sharks/scombrids, carnivorous +
	F	Large jacks, carnivorous +
	F	Intermediate jacks, carnivorous +
	F	Small jacks, carnivorous +
	F	Intermediate reef fish, carnivorous 1 +
	F	Large to intermediate schooling fish, pelagic +
	F	Intermediate reef fish, carnivorous 2 +
	F	Large reef fish, carnivorous +
	F	Intermediate reef fish, carnivorous 3 +
	F	Small reef fish, carnivorous 1 +
	F	Small schooling fish, pelagic +
	F	Small reef fish, carnivorous 2 +
	F	Large groupers, carnivorous +
	F	Intermediate reef fish, carnivorous 4 +
	F	Small Gobiidae, carnivorous +
	B	Sea birds +
	I	Squids +
	I	Octopuses +
	I	Lobsters +
	I	Shrimps/hermit crabs/stomatopods +
	I	Asteroids +
2		Aggregation 20
	F	Hemiramphidae, herbivorous +
	F	Kyphosidae, herbivorous +
	F	Large Scaridae, herbivorous +
	F	Intermediate Scaridae, herbivorous +
	F	Small Scaridae, herbivorous +
	I	Echinoids +
3		Aggregation 15
	F	Intermediate reef fish, herbivorous +
	F	Small reef fish, omnivorous 1 +
	F	Small reef fish, omnivorous 2 +
	F	Small reef fish, omnivorous 3 +
	F	Blenniidae, herbivorous +
	R	Sea turtles +
	I	Crabs +
	I	Gastropods +
	I	Polychaetes/priapuloids/ophiuroids +
	I	Holothuroids/sipunculids/echiuroids/hemichordates
4		Aggregation 11
	F	Engraulidae, herbivorous +
	I	Bivalves +
	I	Ascidians/barnacles/bryozoans
5		Aggregation 13
	I	Amphipods/isopods/tanaids/pycnogonids +
	I	Chitons/scaphopods +
	I	Sea anemones/corals
6		Sponges
7		Zooplankton
8		Microfauna
9		Phytoplankton
10		Benthic autotrophs
11		Detritus, POM, DOM

B = bird, F = fish, I = invertebrate, R = reptile.

Table 3.43. Results of the ECOPATH II parameter estimation for an 11-box model of a Caribbean coral reef (method 2: ECOPATH II aggregation routine); P/B = production/biomass ratio, Q/B = consumption/unit biomass, EE = ecotrophic efficiency (part of production consumed by predators).

Group no.	Predator group	No. of groups[a]	Biomass ($g \cdot m^{-2}$)	Average P/B ($year^{-1}$)	Average Q/B ($year^{-1}$)	End EE
1	Aggregation 12	22	100.372	1.371	10.377	0.874
2	Aggregation 20	6	133.112	1.053	7.616	0.615
3	Aggregation 15	10	181.275	2.051	19.636	0.931
4	Aggregation 11	3	249.975	2.277	15.722	0.847
5	Aggregation 13	3	196.250	1.123	17.719	0.955
6	Sponges	1	800.000	1.500	5.000	0.249
7	Zooplankton	1	32.000	40.000	165.000	0.921
8	Decomposers/microfauna	1	15.000	280.000	1,900.000	0.979
9	Phytoplankton	1	40.000	70.000	-	0.740
10	Benthic autotrophs	1	1,300.000	13.250	-	0.360
11	Detritus, DOM, POM	1	2,000.000	-	-	-

[a] Number of groups refers to original groups from the 50-box model.

Table 3.44. Results of the ECOPATH II parameter estimation for an 11-box model of a Caribbean coral reef, method 2 (ECOPATH II aggregation routine). Additional parameters. Import to detritus: 475 g·m^{-2}, other imports to boxes are 0: catches for all boxes are 0.
Excretion = 5% and egestion = 15% (nonassimilated food, default values) of the food intake of each box.

Group no.	Predator group	Food intake[a]	Respiration[a]	Predation mortality (production *EE)[a]	Flow to detritus[a]	Assimilation[a]	Trophic level
1	Aggregation 12	1,041.58	695.688	120.265	225.627	833.263	3.33
2	Aggregation 20	1,013.73	670.880	86.182	256.670	810.985	2.08
3	Aggregation 15	3,559.43	2,475.769	346.294	737.371	2,847.547	2.33
4	Aggregation 11	3,930.18	2,575.070	482.112	872.998	3,144.143	2.28
5	Aggregation 13	3,477.28	2,561.360	210.559	705.356	2,781.820	2.32
6	Sponges	4,000.00	2,000.000	299.177	1,700.823	3,200.000	2.00
7	Zooplankton	5,280.00	2,944.000	1,179.004	1,156.996	4,224.000	2.60
8	Decomposers/microfauna	28,500.00	18,600.000	4,112.797	5,787.203	22,800.000	2.00
9	Phytoplankton	-	-	2,073.121	726.880	-	1.00
10	Benthic autotrophs	-	-	6,201.430	11,023.570	-	1.00
11	Detritus, POM, DOM	-	-	-	-	-	1.00

[a](g·m^{-2}·year^{-1} WW).

Group no.	Omnivory index	Gross efficiency	Net efficiency	Respiration/ assimilation	Production/ respiration
1	0.3260	0.132	0.170	0.835	0.198
2	0.1216	0.138	0.170	0.827	0.209
3	0.3234	0.104	0.130	0.869	0.150
4	0.3075	0.145	0.180	0.819	0.221
5	0.3014	0.063	0.080	0.921	0.086
6	0.0010	0.300	0.380	0.625	0.600
7	0.2400	0.242	0.300	0.697	0.435
8	0.0000	0.147	0.180	0.816	0.226
9	0.0000	-	-	-	-
10	0.0000	-	-	-	-
11	0.3648	-	-	-	-

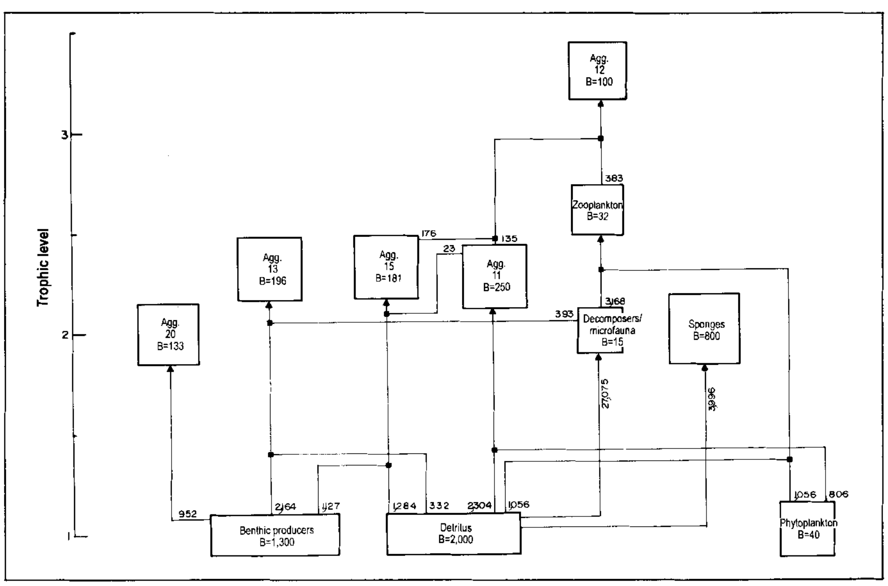


Fig. 3.11. Graphical representation of an 11-box model as obtained by method 2 (ECOPATH II aggregation routine). The area of each box is proportional to the logarithm of the biomass (B, gm^{-2}WW) of each group. Values represent the average for all subsystems in Fig. 2.1. Flows are in gm^{-2}year^{-1}WW. Incoming flows (entering bottom half of a box) represent at least 95% of the diet of a group.

System Properties. System properties such as summary statistics, network flow indices and size of flows for primary producers, detritus and all flows combined are listed in Appendix Tables 8.9.10 to 8.9.12. Table 3.45 presents the transfer efficiencies between discrete trophic levels.

Table 3.45. Transfer efficiencies (%) by discrete trophic level for an 11-box model (method 2).

Source	I	II	III	IV	V	VI	VII	VIII
Producers	-	11.4	12.2	10.4	10.5	10.9	-	-
Detritus	-	13.5	17.4	10.4	10.1	10.7	-	-
All flows	-	13.1	16.6	10.4	10.2	10.8	-	-

Transfer efficiencies of levels II to IV for primary producers showed only negligible differences when compared to those of the 20-box model obtained by the same method (2). Transfer efficiencies of levels V and VI showed differences of -3% and -5%, respectively. Level VII had no estimate. When compared to transfer efficiencies of the 11-box model obtained by method 1, differences were more pronounced, ranging from +3% to +9% for primary producers. For detritus, estimates for levels IV to VI differed from -6% to +7% when compared to those of the 20-box model obtained by method 2 and from +6% to +16% (level IV) when compared to the 11-box model obtained by method 1. No estimate of transfer efficiency of level VII was computed for detritus. Resulting transfer efficiencies for all flows of levels IV to VI showed differences from -5% to +6% when compared to the 20-box model obtained by the same method and from +7% to +14% (level IV) when compared to the 11-box model obtained by method 1. The 11-box model obtained by method 2 includes one discrete trophic level less than the previous models. This is due to the differing composition of carnivores which in the 20- and 11-box models obtained by method 1 discriminate between reef carnivores, schooling pelagics and large pelagic apex predators. In the 11-box model obtained by method 2, these groups are combined into a single group of carnivores.

Mixed Trophic Impacts. Fig. 3.12, showing the direct and indirect impacts on the biomass of prey groups by a raise of biomass of the predator group, was included for comparison of the 11-box model obtained by method 2 with the previous models.

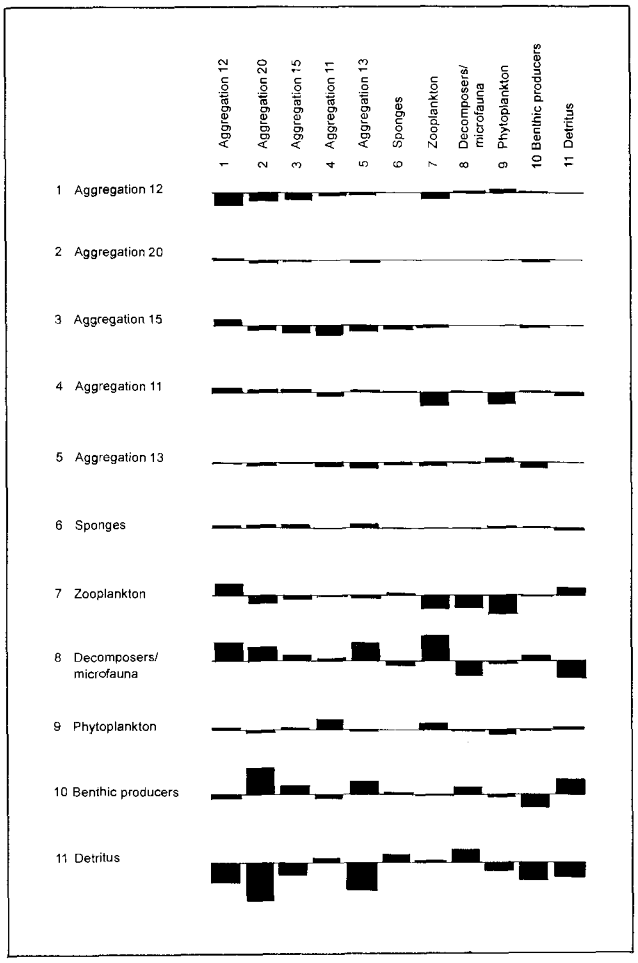


Fig. 3.12. Mixed trophic impacts of an 11-box model (method 2) of a Caribbean coral reef showing the direct and indirect impacts an increase in the biomass of the groups to the left of the histograms will have on the groups above the histograms.

4. DISCUSSION

The models presented in the "Results" section show that it is possible to construct a quantitative steady-state model of a coral reef system from published data and parameter estimates based largely on multivariate statistics.

4.1. Compatibility of the Models with the PRVI Coral Reef System

In the following, selected outputs will be compared to "external" estimates, i.e., values not used to produce the models, to assess the "match" between the models and real coral reef ecosystems (unexploited segments of the Puerto Rico-Virgin Islands [PRVI] reef area and coral reef ecosystems in general).

Benthic autotrophs showed a relatively high ecotrophic efficiency (EE) of 0.36 in the five models. According to Jacobsen and Browder (1987), only 5%-10% of net productivity of *Thalassia* is consumed directly. This corresponds to an EE of 0.05-0.1. Seagrasses formed a sizable fraction of benthic autotrophs but it is well possible that a considerably stronger grazing pressure was exerted on the algae, the other elements of this box. The reef contains a specialized fish fauna feeding directly on benthic plants: mixed aggregations of acanthurids, scarids, chaetodontids, for example, graze on coral-algal reef flats like sheep on a meadow (see e.g., Earle 1972).

Based on rotenone sampling, Randall (1963b) obtained a reef fish biomass of 160 gm^{-2} and 158 gm^{-2} for two fringing reef areas in the Virgin Islands. Small pelagics as well as large apex predators (sharks, rays, scombrids, jacks) were not included in this figure. These values were not used as biomass inputs for the models presented here because (1) the estimates referred only to a single subsystem and, more important, (2) an independent estimate of reef fish biomass was needed for validation of the models' outputs (subsequent comparison of results from the model with "external" estimates). Only by using independent estimates can the compatibility of both be checked and thus the results confirmed or rejected.

The models' output of total fish biomass amounted to 104 gm^{-2}, including small pelagics and apex predators for an average system composed of the five subsystems in Fig. 2.1. Demersal reef fish biomass was 75 gm^{-2}. This value was only 47% of Randall's (1963b) estimate. Although his figure was based on a rotenone sampling from the subsystem "coral reef" where biomasses for typical reef fishes usually are higher than for an average square meter from five subsystems, his figure was probably still an underestimate of the real values. Apparently, the two reefs were sampled by fish poison only once each. Even sampling by poison will underestimate fish biomass on a reef probably due to escape of larger individuals or, in case of small cryptic species, by flight into hiding places, where they subsequently die undetected (Pauly 1984).

Smith (1973) showed that not all individuals present in a specific reef area are killed by the first application of poison. For a more realistic estimate of population size, sampling has to be repeated. A "Leslie" plot of catch/effort (catch per application of poison) versus cumulative catch can be used to obtain an estimate of real population size from the intersection of the resulting regression line with the abscissa, as was shown by Pauly (1984) for two coral reef fish species (see Fig. 4.1).

From Fig. 4.1, a ratio between the first sample and the initial population size of 0.31 for reef eels and of 0.32 for bluehead wrasse can be estimated. Applying the mean ratio of 0.315 to Randall's fish biomass estimate of 160 gm^{-2} yielded an initial fish biomass of 533 gm^{-2}.

Another evaluation of reef fish standing stock, carried out by Dammann (1969, cited in Lewis 1981) yielded a fish biomass for a Virgin Islands fringing reef of 38 gm^{-2}. Since this paper was not available to me, I cannot discuss the methodology involved. Note, however, that the fish biomass estimated here is intermediate between Randall's and Dammann's estimates of fish biomass.

Fast and Pagan-Font (1973, cited in Jacobsen and Browder 1987) obtained a biomass estimate for a natural reef in Puerto Rico of 23.3 gm^{-2}. Fishing pressure on reef fish in Puerto Rico is more pronounced than in the Virgin Islands, and this is sufficient to explain the lower biomasses.

Jacobsen and Browder (1987, p. 34) stated that "herbivorous fishes dominate tropical reef faunas throughout the world". They do not specify in what sense, if in numbers or in biomass. I assume they are referring to biomass.

The strictly herbivorous reef fish of the families Scaridae and Acanthuridae in Randall's study made up between 20.7% (33.1:160.1 gm^{-2}) and 28.7% (45.4:157.8 gm^{-2}) of reported fish biomass. The biomass estimate of herbivores for the first reef area of 33.1 gm^{-2} compares very well with the models' estimate of 32.6 gm^{-2} (demersals only), although this figure contains additional species from other families. Herbivorous fish biomass of the model amounts to 43.4% (32.6:75.1 gm^{-2}) of total reef fish biomass (demersals only) whereas herbivorous fish contribute to total number of demersal reef species only with 12% (30 out of 243). The model's output for herbivorous reef fish biomass is thus compatible with "external" estimates.

4.2. Comparison of the Models with Other Coral Reef Areas

In the following, features of our PRVI coral reef model will be compared to those of other coral reefs. Table 4.1 presents a comparison of selected outputs of three coral reef models,

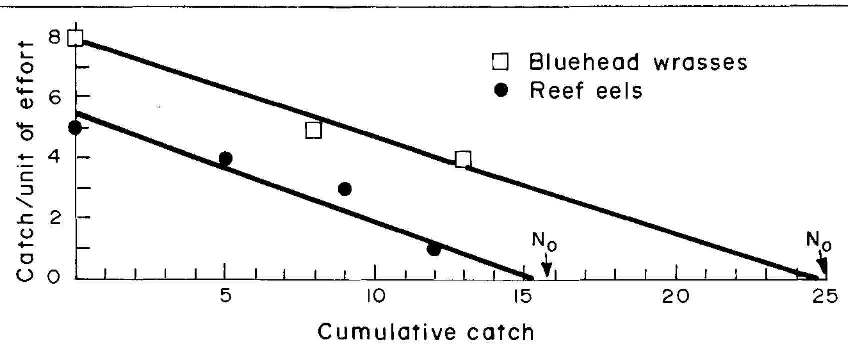


Fig. 4.1.Leslie plots for reef eels (*Kaupichthys hyoproroides*) and bluehead wrasses (*Thalassoma bifasciatum*) from an isolated Bahamian reef patch, with estimates of unexploited population size (reproduced from Fig. 6.1 in Pauly 1984).

Table 4.1. Comparison of properties of three coral reef models, analyzed by ECOPATH II.

Properties/models	PRVI	Bolinao	FFS
Number of boxes	50, 20, 11[a]	23	16
Total system throughput ($g \cdot m^{-2} \cdot year^{-1}$WW)	107,473	39,307	4,973
Cycling index (% of throughput)	18.3	-[b]	11.0
Capacity (flowbits)	438,213	86,774	8,893,465
Ascendency (% of capacity)	34	44	14.2
Overhead (% of capacity)	66	(56)[c]	74.8
Sum of all production ($g \cdot m^{-2} \cdot year^{-1}$)	51,282	1,938	-
Sum of all respiratory flows ($g \cdot m^{-2} \cdot year^{-1}$)	32,523	18,965	-
Sum of all flows into detritus ($g \cdot m^{-2} \cdot year^{-1}$)	23,193	18,405	-
Total biomass excluding detritus (D) (gm^{-2})	3,048	1,879	175
	(2,000)	(10)	-
Total fish biomass (gm^{-2})	104	6.8	17.5
Ratio fish/total biomass	0.03	0.004	0.1

[a]Estimates in this column refer to 50 boxes. Values for 20 and 11 boxes differ only slightly.
[b]No estimate available.
[c]Computed here as capacity (100%) - ascendency (44%).

analyzed by ECOPATH II, such as (1) our PRVI coral reef system; (2) the French Frigate Shoals (FFS) in Hawaii (Pauly et al. 1993a); and (3) segments of the Bolinao coral reef system (Aliño et al. 1993) in the Philippines.

Table 4.1 shows that the PRVI system is large in terms of throughput when compared to Bolinao and FFS. Total biomass and fish biomass are highest in the PRVI system, although the ratio of fish biomass to total biomass is highest for FFS. It is surprising that such a high fish biomass is maintained by such a small biomass of nonfish groups. Estimates of P/B and Q/B differ to some degree for those ecological groups from both models which can be compared directly (see tables in Pauly et al. 1993a). If P/B of prey groups is higher and Q/B is lower than in the PRVI model, the ecological efficiency (production/consumption) is increased and thus, the same biomass of predators can be maintained by a smaller biomass of prey groups. The inverse seems to be the case for the Bolinao model in which a very low fish biomass is maintained by a large nonfish biomass. This very low fish biomass is the result of the strong overfishing of the fish resources of the Bolinao reef system (McManus et al. 1992).

Ascendency is, as stated before, a measure of average mutual information in a system. Ulanowicz and Norden (1990) supposed systems, in the absence of major perturbations, to mature in the direction of increasing ascendency. This would imply that the Bolinao system is the most mature, the PRVI area intermediate and the FFS system the most immature. On the other hand, FFS is situated close to the northern limit for coral reefs and hence, production, respiration, etc. and, in consequence, ascendency are low compared to PRVI and Bolinao. This indicates that caution must be taken when using ascendency as an index of maturity (Christensen 1995).

Parrish et al. (1986), in their study on "piscivory in a Hawaiian coral reef fish community", found that 12%-31% of the biomass of the reef fish community of the four stations sampled consisted of piscivores. Piscivory is not considered as a separate feeding type in the model of a Caribbean coral reef presented here; rather as part of carnivory. Our findings can thus not be directly compared. However, one can estimate from the output diet composition (DC) matrix of the 50-box model (Table 3.23) that about one-third of the diet of the carnivorous-omnivorous fish (referring only to demersal groups) consists of fish. Piscivory amounts thus to 18.7% of demersal reef fish biomass. This figure is well within the range reported by Parrish et al. (1986).

As stated, (large) herbivorous reef fish are not a preferred food item of piscivorous reef fish, as demonstrated by the respective input and output percentages of this prey item in the DC matrix of the 50-box model (see "Results" section). This is further reflected by the "standardized forage ratios" (S_i) computed by ECOPATH II for each predator in relation to its prey groups. This ratio indicates a preference or avoidance of a potential prey group. In contrast to Ivlev's electivity index, this ratio is independent of prey density. Table 4.2 shows the ratios for all groups of herbivorous fish in the 50-box model in relation to their predator groups.

The majority of values in Table 4.2 are negative, and several values are positive but close to zero. Many of these were increased (as shown by the "+" sign in Table 4.2) due to a raise of the respective diet fraction performed to reduce predation pressure on carnivorous fish groups (see "Results"). Since a value of -1 for S_i corresponds to total avoidance of a prey group and S_i = 0 to nonselective feeding, this confirms that herbivorous fishes are indeed not a preferred food item for the majority of carnivorous predators.

Interestingly, Parrish et al. (1986) stated, with reference to Hawaiian reefs, that a number of herbivorous and omnivorous species from the families Scaridae, Acanthuridae, Chaetodontidae, etc. "are not eaten in significant quantity by abundant predators"! They stated further that "these non-piscivorous fishes consume considerable food resources; the route by which these resources pass on through the trophic system remains in doubt". Parrish et al.'s findings confirmed the model's results on low EEs for larger herbivorous fish groups.

If not esteemed as food source by higher trophic levels, herbivorous reef fish seem to be more strongly involved in other processes on the reef. Gygi (1975) estimated the erosion of coral reefs (i.e., sediment production), generated by the stoplight parrotfish *Sparisoma viride* on two reef types in Bermuda, as a side-effect of its feeding habits: "The fish scrape away algae and some of the rock below with strong, beak-like jaws, and crush the mouthful in the pharyngeal mill. Swallowed rock bits are used as a milling agent to rip up algal cells". The excreted sediment is then deposited as sand. For an algal-vermetid rock flat with coral-algal patch reefs, Gygi determined a parrotfish standing stock of 20 gm^{-2}WW. The resulting erosion from this fish biomass was computed to be 5,814 $gha^{-1}day^{-1}$. This corresponded to an erosion of 0.58 $gm^{-2}day^{-1}$ and to 212 $gm^{-2}year^{-1}$. The model's output biomass for scarids was ca. 30 gm^{-2}.

Table 4.2. Standardized forage ratios for herbivorous reef fish groups as computed by ECOPATH II for a 50-box model of a Caribbean coral reef.

	Herbivorous prey groups[a]					
Predator	KY	IH	LS	IS	SS	BH
Large sharks/rays	-0.121+	-0.712+	-0.921+	-0.978-	-0.988-	-
Sharks/scombrids	0.115+	-0.527+	-0.618+	-0.947	-0.889	-0.602
Intermediate jacks	-0.053	0.240	-0.785	0.325	0.573	0.889
Intermediate reef fish carnivorous 1	0.051+	-0.465+	0.174+	0.456+	0.490	-
Intermediate reef fish carnivorous 2	0.085+	-0.439+	0.002+	0.700+	0.313+	-
Large reef fish carnivorous	-0.359	-0.044+	-0.667+	-0.181+	-0.249+	-0.222
Intermediate reef fish carnivorous 3	-0.310+	-0.434+	0.110+	-0.229+	-0.332+	0.181
Small reef fish carnivorous 1	-	-	-	-	-0.545	0.795
Large groupers	0.112+	-0.529+	0.335+	-	-	-
Small reef fish omnivorous 1	-	-	-	-	-0.173	0.739
Sea birds	-	-0.760	-0.973	-0.787	-0.902	-

[a]BH = herbivorous Blenniidae KY = Kyphosidae
H = intermediate reef fish herbivorous LS = large Scaridae
IS = intermediate Scaridae SS = small Scaridae

Thus, sediment production or reef erosion due to scarid feeding activities would amount to 318 $gm^{-2}year^{-1}$. Parrotfish in the model do not feed exclusively on encrusting algae or corals. From the algal composition in stomachs of West Indian parrotfish, given by Randall (1967, see also Appendix Table 8.5.1), it was estimated, that at least 50% of the diet consisted of encrusting algae and corals. The sediment production by parrotfish would thus amount to at least 160 gm^{-2} $year^{-1}$. Parrotfish can therefore be considered important sediment producers in coral reefs of the PRVI area.

4.3. New Insights into Structure and Functioning of a Coral Reef as an Ecosystem Unit

The overwhelming part of production of large- to intermediate-sized herbivorous reef fish, which provide the bulk of herbivorous fish biomass, is not transferred to higher trophic levels. The models' outputs indicate that much of their production is recycled directly into the detrital pool. However, the fish must die before they can be decomposed by bacteria and other microfauna. The large- and intermediate-sized parrotfish (groups 23 and 24 in the 50-box model) showed, indeed, higher natural mortalities (= P/B values) than similar-sized carnivorous reef fish groups (Table 4.3).

The nutrients from the decomposed fish are available to reef autotrophs. These autotrophs (mainly reef algae), once more, are consumed by the herbivorous reef fish population. This represents, thus, a very short loop for effective recycling of matter. This shortcut is also reflected in the difference in transfer efficiencies between discrete trophic levels. In the case of the 50-box model, highest efficiencies of 13% to 16% were computed by the corresponding ECOPATH II routine for the transfer of matter between levels I to II and II to III for all flows and of 11.2% to 12.4%, respectively, for primary producers (see Table 3.27). Following is a sharp decline in transfer efficiencies between levels III to IV to 9.9% for all flows and to 10.2% for primary producers.

In the "Introduction", I pointed out three features of general agreement characterizing coral reefs: high species diversity, pronounced complexity of trophic relationships and high rates of production in spite of being surrounded by nutrient-poor oceanic waters.

A fourth feature should be added to these three: the existence of shortcuts for the effective recycling of matter. Throughputs of 59% for all flows and of 89% for primary producers of the respective total throughputs occur on trophic level II, the highest observed. Second highest throughputs occur on trophic level III with 7.7% for all flows and 10% for primary producers of the respective total throughputs. An 86% of total flow from primary producers to detritus is

Table 4.3. Comparison of natural mortalities M (= P/B values) of selected groups of herbivorous and carnivorous reef fish from the outputs of the balanced 50-box model (Tables 3.18 and 3.22).

Group no.	Group name	Size range (g)	M ($year^{-1}$)
6	Intermediate reef fish, carnivorous 1	2,586 - 12,407	0.580
12	Large reef fish, carnivorous	7,728 - 70,000	0.380
13	Intermediate reef fish, carnivorous 3	290 - 5,010	0.640
11	Intermediate reef fish, herbivorous	288 - 1,200	0.710
23	Large Scaridae, herbivorous	5,558 - 23,000	0.850
24	Intermediate Scaridae, herbivorous	1,102 - 3,720	1.155

recycled directly without entering the higher levels of the system. Thus, for primary producers, the corresponding backflows to detritus are second highest for trophic level II with 12.2% and third for III with 1.4% of total backflow. For combined flows, as well, they are second highest for trophic level II with 43% and third for III with 5.4%.

Coral reef ecosystems are often viewed as "mature" systems, in which structures and processes are maintained at some optimum level, i.e., with minimum leaks (see Odum and Odum 1955). Thus, the reef, as a thermodynamical unit, may not benefit from sharks or tunas which are not an integral part of the actual reef community. "Feeding" these occasional visitors might mean a net loss of energy, since sharks and tunas and other large apex predators, feeding in part on the reef community, tend to migrate away from these systems and take the energy ingested with them.

The reef, as a thermodynamical unit, may also not benefit from passing matter up through many trophic levels. With every additional trophic level through which matter is passed, about 80%-90% of its energy is lost. Thus, direct recycling of matter may be the best way for the reef to conserve energy and to build up biomass. Other reef components with a high biomass for a single taxon, such as the strongly herbivorous echinoids (80% plant food) or the detritivorous sponges, are additional examples for this aspect of reef metabolism. They show rather low exploitation rates as food source for other elements of the system, as expressed by relatively low EEs compared to the majority of nonfish taxa. This feature is furthermore supported by the fact that transfer efficiencies between discrete trophic levels stay on the same rather low level of 9%-11% up to the highest discrete trophic levels in all models. Pauly and Christensen (1995) found, when comparing trophic efficiencies in 48 different ecosystems, all analyzed using ECOPATH II, an average trophic efficiency of 10%, with a range of 2%-34%.

Summarizing, it can be hypothesized that the reef's "strategy" is not to achieve high transfer efficiencies between trophic levels but to build up biomass through maintenance of short cycles for an effective recycling of matter back to its base, the detrital pool. Or else: only ecosystems where those features had developed during evolution could survive in nutrient-poor waters.

During a long-term study on community structure of an artificial reef in the Virgin Islands, Ogden and Ebersole (1981) found an astonishing stability in species composition. They discussed critically results from the Pacific (Great Barrier Reef, Australia) where this stability was never reported. Sale (1975,1977) and Talbot et al. (1978) suggested that high diversity in coral reef fish communities is maintained by the chance arrival—"lottery"—of larval colonists to unpredictably available habitat space. They cited as evidence the stochastic composition of coral reef fish communities on small natural and artificial structures. Ogden and Ebersole (1981) attributed this stochastic community structure found by some workers in the Pacific to the small structures—natural and artificial—that these workers have studied. Small coral heads are, according to Ogden and Ebersole (1981), too small for detection of "real" differences in community structure. They argued that, when the appropriate scale is selected, coral reef systems become stable (i.e., display flow-through equilibrium) and show an orderly functioning. Moreover, the predictability of the community seems to increase with the size of the reef. From the results of the models presented here, it can be concluded that a coral reef system can straightforwardly be made to reflect a steady-state or flow-through equilibrium, when a whole system approach, such as in our models, is applied.

This does not prevent stochastic events such as predation, disturbance, incidental recruitment of species, etc., from taking place on a smaller scale within that system. As pointed out earlier, for the present models, fish groups were aggregated, based on similarity of energetic requirements and not on taxonomical closeness. Thus, individuals of a certain fish species within a "box" may easily be replaced by those of another species with similar energetic features. When considering the flow of energy through the reef, the only important feature of a species group or "box" is its capacity to maintain its biomass and production rate, so that the same amount of energy remains available to other boxes of the system. The species composition within that box may be viewed as a stochastic feature, depending on the above-described "lottery". The results of investigations of community structures, which emphasize their stochastic feature, cannot express anything about overall performance of reef metabolism, such as stability or instability of structures and processes at higher scales (e.g., relationships between boxes, trophic levels, etc.). Thus, from these experiments, it cannot be concluded if the reef as an entity is in a steady state or not.

Hall et al. (1990), in their study on the usefulness of power analysis for the experimental design of energy flow studies, discussed the compatibility of results from energy flow models with those from field experiments. They concluded that field experiments could not be substituted by modelling. They did not specify to what scale of model or experiment they referred. From their examples, it must be assumed that the scale is relatively small, e.g., one predator and a few prey items. I do not doubt the necessity of field experiments on energy flow, on the contrary, they provide urgently needed estimates for modelling energy flows on a larger scale.

Jones (1986, 1987) discussed the hypothesis of recruitment limitation to coral reefs. In general, space and food are assumed to be major limiting factors. Opinions on this subject are divided. Jones (1987) found indications from his experiments with a zooplankton-feeding pomacentrid species at One Tree Island (Great Barrier Reef, Australia) that recruitment of larvae or postlarval 0+ cohorts of this species was not limited by the reef community, it was accidental. Mortality did not seem to be density-dependent, but time of maturation of juveniles was influenced by population structure. When individuals from older cohorts were present, maturation time of young fish was longer, suggesting a possible food limitation for recruitment. If this kind of "stock-recruitment interaction" is valid for the majority of species within a box, it would substantiate the hypothesis that a "box" tends to maintain its average standing stock biomass and food requirements.

Most fisheries can be viewed as an apex predator within a system. First, they remove the predators, then take the production these took. When the apex predators of our PRVI reef models, such as sharks, rays, large scombrids, jacks and groupers, are removed, the production of the reef fish community consumed by these groups becomes available to the fisheries. Excluding the schooling pelagic fish (the production of this group consumed by apex predators is 1.9 $gm^{-2} \cdot year^{-1}$), the reef fish production then available to the fisheries amounts to about 4 $gm^{-2} \cdot year^{-1}$ (excluding small blennies and gobies). The fish production available to the fisheries may be increased by extending these to lower trophic levels, such as the large carnivorous reef fish (group 12 in the 50-box model). Recalling the "norm" of 5 t km^{-2} fisheries yield for Caribbean coral reefs (Munro 1984), it seems possible to attain this yield as well for the unfished parts of the PRVI reef area, without destructive effects for the reef fish community as a whole. Overall, it is advisable to fish large individuals from higher trophic levels. This has a positive effect on prey density and should lead, at least when overall fishing pressure remains low, to increase of recruits to the adult guilds. This, again, may lead to sustainable fisheries yields.

The overfishing of invertebrates, presently occurring in PRVI, can also be explained, if to a small extent, by the results of the model. A strong predation pressure is already exerted in the unexploited system on, e.g., crustaceans and gastropods (see high EEs for these groups). There is not much surplus production for the fisheries.

The deductions on fisheries potential for the area are very preliminary. The shortcomings of input data for nonfish groups were already pointed out. Actual standing stocks might be higher than outputs from models imply, but the "true" relations among biomass, production and consumption for nonfish groups are to date not known with sufficient accuracy.

4.4. Identification and Solution of Methodological Problems During the Modelling Process

4.4.1. Aggregation of Fish Groups

The high fish species diversity within the PRVI coral reef system was successfully reduced into fewer groups with similar energetic requirements. It is difficult to parametrize and combine ecological information of various dimensions, e.g., spatial, temporal, energetic in a given model. Emphasis should focus on one aspect, depending on the objectives of the model. In the present case, the emphasis was on energy flow and trophic relations. The model reflects to some extent the spatial aspect by the separation of pelagics and demersals and by the explicit consideration of subsystems. The division in two distinct horizontal levels is also reflected by consumption requirements and prey items.

The aggregation of nonfish taxa was achieved by considering as well as possible the energetic aspect, leading to more or less distinct trophic groups. Taxa were aggregated intuitively based on criteria known to be related to energetic requirements. This was only achieved for higher taxonomic categories, since estimates at the species level were generally unavailable. A first attempt to leave the taxonomic level and proceed to an ataxonomic approach for combining elements, including fish and nonfish, was realized in the 20- and 10-box models of methods 1 and 2.

4.4.2. Weighting Factors

Parrish et al. (1986) emphasized the impact of predator abundance on predation pressure for a Hawaiian coral reef system. I agree with these authors. Indeed, it is not only abundance (in weight) of a predator which is of importance, but also its food requirements (Q/B). Within species groups, a weighting factor could be calculated for every species of the model from average biomasses and Q/B estimates to determine the "throughput" of every species in a group. The percentages of respective prey items (DC matrix) were then weighted by these factors (see "Materials and methods"). Between species groups, this relationship is produced by the key input parameters for each group (biomass, mortality = P/B ratio, and Q/B).

Thus, ECOPATH II and some of the methods developed in the course of the work leading to this report provide possible solutions for a variety of problems related to ecosystem analysis.

4.4.3. Input Estimates for Nonfish Taxa

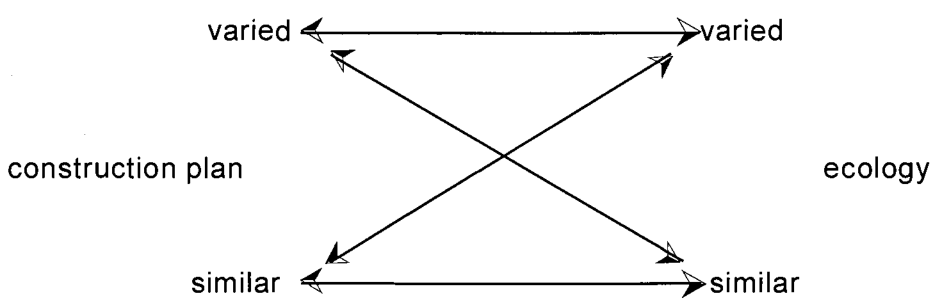
Input values for nonfish taxa had to be assembled from a wide geographical range for a wide variety of taxa. Preparation of input values was based on various qualitative and quantitative assumptions. The match between these data and the actual rates and states on the ground is not necessarily close. However, balancing of the model forced the various rates for these groups to become mutually compatible. It is assumed that this process also rendered them more similar to the values on the ground.

4.5. Gaps of Knowledge and Suggestions for Future Research

4.5.1. Theoretical Research

From the above considerations, the following theoretical research topics may be deducted:

1. Determination of appropriate scales: How can a suitable ecological system unit be determined for modelling, and how does one deal with migrations? The system unit should not be too small because of stochastic effects, and not too large because of possible loss of genuine system identity. Is it possible to identify objective criteria?
2. Construction of groups: Objective methods for assembling of nonfish groups should be developed. Ataxonomical aggregation of reef nonfish taxa should be initiated at the specific level, as was done for the fishes. Nonfish taxa tend to strongly differ in their anatomy (they represent a much larger systematical range than fishes). If one aims to assemble ecologically similar groups, one must base the aggregation process on ecological features, not on morphological ones. The figure below shows possible combinations between construction plan and ecology by connecting all features.



An objective procedure for the construction of groups would be as follows: (1) determination of relevant ecological variables (depending on one's objective); (2) application of a factor analysis to identify independent variables; (3) cluster analysis to aggregate species, and eventually; (4) discriminant analysis to determine if clusters differ significantly.

4.5.2. Field Research

Several times in the foregoing, it was pointed out that the input data for nonfish groups were too scattered, often based on risky assumptions and therefore quite unreliable. To improve this situation, the database for inputs must be improved. This opens a wide area for future practical research. In the first place, the existing literature could be searched more thoroughly for estimates and data sets on the species level.

Needed are, furthermore, analyses of diet, food consumption requirements, abundances and biomass, growth performance, etc., of reef invertebrates and other nonfish taxa, preferably at the species level.

Other areas requiring work are length-weight data and growth parameters for reef fish species which may not be of interest for fisheries, and rigorous studies of the DC of apex predators.

The initial biomasses of fish groups had to be changed considerably to balance the 50-box model. Biomasses of groups, including small pelagic or cryptic fish species, were strongly increased whereas biomasses of groups, including large- to intermediate-sized fish species (both carnivores and herbivores), were decreased, more or less proportional to the size of the fishes. The input biomasses of the large, highly motile predators had to be decreased the most.

Densities, used to compute biomasses of small pelagic fish species, were assumed to correspond to the highest abundance level encountered for reef fish species. More realistic estimates of abundance of small pelagic stocks in a given area should be obtained by the application of, e.g., hydroacoustic techniques (Thorne 1979).

The need to increase input biomasses of groups, including cryptic species, is not surprising: very small, cryptic species tend to be overlooked during visual censuses, and other methods should be used for biomass estimation (e.g., successive rotenone sampling and a Leslie plot, see above).

The case of large, highly motile predators is as straightforward. It could be that the SCUBA divers performing the censuses actually attract faraway apex predators (whose sense of smell and hearing is geared, indeed, to detect faraway, potential preys).

It could also be that census surveys in general, or at least those whose results were used in the present study, do not account appropriately for potential effect on estimated biomass of a brief sighting of a large or very large fish, compared with much longer sightings of smaller fish.

If so, one could imagine a correction factor, proportional to the inverse of the sighting time of any recorded fish, which would lead to estimates of "effective" biomass, i.e., to estimates of the biomass relying on a given reef for its food.

Last but not least, catch data must be considered, since there is fishing activity in the area. If it is not possible to obtain such data at the species level, attempts should be made to report catch data for ecological guilds, i.e., at the generic or family level. The fish species are divided into three main groups: (1) apex predators, loosely related to the reef; (2) a mainly carnivorous group comprising around 70%-80% of reef fish species; and (3) a mainly herbivorous group comprising a little more than 10% of species but around 40% of total fish biomass. This division could be utilized for other purposes. The species-rich cluster of (predominately) carnivores could be grouped by species of the same family or genus and thus better be matched with species clusters used in fisheries statistics. Appeldoorn and Lindeman (1985) referred to species clusters known from fisheries statistics "in many respects to behave similar to a unispecies stock with size selective mortality". They identified species clusters to "approximating an ecological guild". Many of the model's fish groups contain several species of a family or genus. Examples are members of the families Haemulidae, Muraenidae, Blenniidae, Scaridae, Serranidae, etc. Note that, for fisheries management purposes, it is generally advisable to separate fish groups from nonfish groups.

What are the mechanisms by which stock size of, e.g., herbivorous reef fish is controlled, since predation pressure on these groups is rather low? Are they food- or recruitment-limited?

In future models, the ecological position of the different developmental stages of a fish species could be modelled by treating each stage as a different species with different inputs. These inputs could be prepared and stages clustered according to, e.g., energetic requirements.

Seasonal differences (e.g., rainy and dry seasons) could be modelled by producing one model for each season or month (as done by Jarre-Teichmann and Pauly 1993 for the Peru system).

New insights into structure and functioning of a coral reef as an ecosystem unit were achieved by the modelling process. By modifying inputs deducted from published information on the system (these changes are fully documented in the input-output tables in the "Results" section), a hypothetical reef could be constructed. Overall, the model presented here can be assumed to represent the specific coral reef system from which the majority of information was gathered. This hypothetical reef can now be tested and improved.

5. CONCLUSIONS

1. Quantitative steady-state models of a Caribbean coral reef system could be constructed from published data and estimates, based largely on multivariate statistics.

2. Calculated net primary production necessary to support the system modelled therein, of 20,025 $gm^{-2}year^{-1}$WW, was well within the range of a rough estimate of 15,000-25,000 $gm^{-2}year^{-1}$WW previously available for the Puerto Rico-Virgin Islands (PRVI) coral reef area.

3. Total fish biomass of 104 gm^{-2}WW rendered an intermediate value when compared to model-independent estimates of coral reef fish biomass (23-160 gm^{-2}WW) for several segments in the PRVI coral reef area.

4. The estimated total biomass, total fish biomass and total system throughput of the models indicate a large system compared to two other coral reef models analyzed by ECOPATH II (French Frigate Shoals [FFS], Hawaii, and Bolinao reef area, Philippines). The ratio of fish biomass/total biomass was intermediate for PRVI with a higher ratio for FFS and a very low ratio for Bolinao due to high exploitation by fisheries.

5. The degree of piscivory for the Caribbean reef models presented here of 19% of reef fish biomass is well within the range reported for a Hawaiian coral reef fish community.

6. Large- to intermediate-sized herbivorous reef fish are not a preferred food item of larger piscivorous reef fish. This finding is also in agreement with observations from a Hawaiian coral reef fish community.

7. It was estimated that, based on their output biomass, parrotfish produce at least 160 g sand $m^{-2}year^{-1}$ and may thus be considered as important sediment producers of the PRVI reef area.

8. The models' outputs indicate the existence of short cycles for an effective recycling of organic matter within the reef system. Most of the net primary production is recycled directly to the detrital pool. Transfer efficiencies between trophic levels are low.

9. The fact that the model could be balanced straightforwardly can be interpreted as showing that coral reef systems are in a "steady-state" or "flow-through equilibrium", when the appropriate spatial and temporal scale is selected. Investigations on small scales of reef community structure, which emphasize the stochastic variability of coral reefs, do not necessarily yield information on stability or instability of structures and processes at higher scales.

10. A very preliminary potential fisheries yield of 4 $gm^{-2}year^{-1}$WW for unfished segments of the PRVI reef area was estimated from one of the models' outputs, i.e., the amount consumed by the models' apex predators. When these predators are removed first, their consumption becomes available to the fisheries.

11. A strong predation pressure is exerted on lobsters and conchs in unexploited parts of the PRVI coral reef system as indicated by the high ecotrophic efficiencies for crustaceans and gastropods. This shows how vulnerable these resources may be to an additional exploitation by fisheries.

12. The large number of fish species occurring in the PRVI reefs can effectively be reduced to a smaller number of groups by cluster analysis. Appropriate aggregation parameters are those referring to energetic requirements of a species, such as size, activity level and type of food.

13. For assembling nonfish groups, one should start from the species level and define appropriate energetic aggregation criteria by objective selection of ecological variables.

14. The contribution of predator abundance to predation pressure can be accounted for by weighting the fractions of prey of the diet composition by applying a weighting factor. This should be the product of density, mean weight and relative food consumption (Q/B) of a predator.

15. A theoretical task for future models will be to identify objective criteria for the determination of spatial and temporal scales of the system which is to be modelled and define appropriate system boundaries.

16. Information on diet, food consumption requirements, abundances and growth performance should be obtained for nonfish taxa in the PRVI reef area. This would strongly improve the reliability of the models' outputs.

17. Information on length-weight data and growth parameters for fish species without interest for fisheries (e.g., very small ones) are needed.

18. Density estimates from visual censuses, especially for highly motile species, such as apex predators, should account for factors which may lead to overestimation of biomass. Density estimates for small and/or cryptic reef species should be obtained from repeated rotenone or similar sampling.

Density estimates for small schooling pelagics are urgently needed; appropriate estimates could be obtained by hydroacoustic techniques.

19. Catch data, preferably at the species level, should be obtained and included into the models. If it is impossible to obtain such data, attempts should be made to report catch data for ecological guilds, i.e., at the generic or family level.

20. The models, as they are now, represent a more constraining hypothesis than in the beginning. This new hypothesis can again be tested and improved.

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7. REFERENCES

Abolmasova, G.I. 1985. Energy metabolism and food requirements in captive squid *Sthenoteuthis oualaniensis* (Lesson) from the Indian Ocean. Ehkol. Morya 19:104-110.

Acevedo, M., O. Gomez and V. Berovides. 1984. Alimentación de tres especies de quelonios marinos en la plataforma suroccidental de Cuba. Rev. Invest. Mar. 3:29-35.

Akhmeteva, E.A., B.A. Smirnov and O.K. Bordovskij. 1982. On some peculiarities of organic matter composition in the intestine contents of the bottom detritus-feeding holothurians. Okeanologiya 22(6):1021-1024.

Alcolado, P.M. 1990. Breve comentario acerca de las comunidades de gorgonáceos de la macrolaguna del Golfo de Batabanó, p. 33-36. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba. 161 p.

Aliño, P.M., L.T. McManus, J.W. McManus, C.L. Nañola, Jr., M.D. Fortes, G.C. Trono, Jr. and G.S. Jacinto. 1993. Initial parameter estimations of a coral reef flat ecosystem in Bolinao, Pangasinan, northwestern Philippines, p. 252-258. *In* V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, 390 p.

Allen, K.R. 1971. Relation between production and biomass. J. Fish. Res. Board Can. 28:1573-1581.

Alvarez-Lajonchere, L. 1981. Determinacion de la edad y el crecimiento de *Mugil liza*, *M. curema*, *M. hospes* y *M. trichodon* (pisces, Mugilidae) en aguas cubanas. Rev. Invest. Mar. 2(1):142-162.

Amaratunga, T. 1983. The role of cephalopods in the marine ecosystem, p. 416-452. *In* J.F. Caddy (ed.) Advances in assessment of world cephalopod resources. FAO Fish. Tech. Pap. 231. FAO, Rome.

Ambrose, R.F. 1984. Food preferences, prey availability, and the diet of *Octopus bimaculatus* Verrill. J. Exp. Mar. Biol. Ecol. 77:29-44.

Ambrose, R.F. and B.V. Nelson. 1983. Predation by *Octopus vulgaris* in the Mediterranean. P.S.Z.N.I:Mar. Ecol. 4(3):251-261.

Andersen, K.P. 1982. An interpretation of the stomach contents of fish in relation to prey abundance. Dana 2:1-50.

Andersen, K.P. and E.A. Ursin. 1977. A multispecies extension to the Beverton and Holt theory of fishing with accounts of phosphorus circulation and primary production. Medd. Dan. Fisk. Havunders NS 7:319-435.

Andrew, N.L. and L.J. Stocker. 1986. Dispersion and phagokinesis in the echinoid *Evechinus chloroticus* (Val.). J. Exp. Mar. Biol. Ecol. 100(1-3):11-23.

Anon. 1983. A study of the ecology of *Turritella gonostoma* living in the Gulf of California, Mexico. Abstract presented to the Fifteenth Annual Meeting: Titles and Abstracts. Annu. Rep. West. Soc. Malacol.

Appeldoorn, R.S. and K.C. Lindeman. 1985. Multispecies assessment in coral reef fisheries using higher taxonomic categories as unit stocks, with an analysis of an artisanal haemulid fishery, p. 507-514. *In* M. Harmelin Vivien and B. Salvat (eds.) Proceedings of the Fifth International Coral Reef Congress, 27 May-1 June 1985, Tahiti. Vol. 5. Antenne Museum - EPHE, Moorea, French Polynesia.

Armstrong, D.W., J.R.G. Hislop, A.P. Raobb and M.A. Brown. 1983. A preliminary report on the analysis of whiting stomachs collected during the 1981 North Sea Stomach Sampling Project. ICES, Doc. C.M. 1983/G:59.

Au, D. 1975. Considerations on squid (*Loligo* and *Ilex*) population dynamics and recommendations for rational exploitations. ICNAF Res. Doc. 75/61, Ser. No. 3543.

Augustinovics, M. 1970. Methods of international and intertemporal comparison of structure, p. 249-269. *In* A.P. Carter and A. Brody (eds.) Contributions to input-output analysis. Vol. I. North Holland, Amsterdam.

Backhaus, K., B. Erichson, W. Plinke, C. Schuchard-Fischer and R. Weiber. 1987. Multivariate analysemethoden. Springer Verlag, Berlin, Germany. 404 p.

Baerlocher, F., J. Gordon and R.J. Ireland. 1988. Organic composition of seafoam and its digestion by *Corophium volutator* (Pallas).J. Exp. Mar. Biol. Ecol. 115(2):179-186.

Baez, M., L.L. Alvarez and B. Pedroso. 1980. Edad y crecimiento del caballerote *Lutjanus griseus* (Linné), en Tunas de Zaza, Cuba. Rev. Invest. Mar. I(2-3):135-159.

Bajkov, A.D. 1935. How to estimate the daily food consumption of fish under natural conditions. Trans. Am. Fish. Soc. 65:288-289.

Bak, R.P.M., M.J.E. Carpay and E.D. de Ruyter van Steveninck. 1984. Densities of the sea urchin *Diadema antillarum* before and after mass mortalities on the coral reefs of Curaçao. Mar. Ecol. (Prog. Ser.) 17:105-108.

Balasubramanian,T., C.B. Lalithambika Devi and M. Krishnankutty. 1979. Feeding behaviour and preying efficiency of *Metapenaeus dobsoni.* Indian J. Mar. Sci. 8(3):197-199.

Bamber, R.N. and M.H. Davis. 1982. Feeding of *Achelia echinata* Hodge (Pycnogonida) on marine algae. J. Exp. Mar. Biol. Ecol. 60(2-3):181-187.

Bannerot, S.P., W.W. Fox, Jr. and J.E. Powers. 1987. Reproductive strategies and the management of snappers and groupers in the Gulf of Mexico and Caribbean, p. 561-604. *In* J.J. Polovina and S. Ralston (eds.) Tropical snappers and groupers: biology and fisheries management. Westview Press, Boulder, Colorado.

Barnes, R.D. 1963. Invertebrate zoology. W.B. Saunders Co., Philadelphia and London. 632 p.

Beal, B.F. 1983. Predation of juveniles of the hard clam *Mercenaria mercenaria* (Linné) by the snapping shrimp *Alpheus heterochaelis* Say and *Alpheus normanni* Kingsley. J. Shellfish Res. 3(1): 1-9.

Beebe, W. and J. Tee-Van. 1928. The fishes of Port-au-Prince Bay, Haiti, with a summary of the known species of marine fish of the island of Haiti and Santo Domingo. Zoologica 10(1):279 p., 268 text-figures.

Beets, J. and L. Lewand. 1986. Collection of common organisms within the Virgin Islands National Park/ Biosphere Reserve. Biosphere Reserve Res. Rep. 3, 45 p. Virgin Islands Resource Management Cooperative, Virgin Islands National Park.

Behrens-Yamada, S. 1982. Growth and longevity of the mud snail *Batillaria attramentaria.* Mar. Biol. 67(2):187-192.

Berg, C.J., Jr. and D.A. Olsen. 1989. Conservation and management of queen conch (*Strombus gigas*) fisheries in the Caribbean, p. 421-442. *In* J.F. Caddy (ed.) Marine invertebrate fisheries: their assessment and management. J. Wiley and Sons, New York.

Berg, C.J., Jr. and P. Alatalo. 1981. Laboratory culture of Bahamian bivalve molluscs: reproduction and general biology. Biol. Bull. Mar. Biol. Lab. Woods Hole 161:337-338. (Summary only.)

Berkeley, S.A. and E.D. Houde. 1978. Biology of two exploited species of halfbeaks, *Hemiramphus brasiliensis* and *H. balao* from southeast Florida. Bull. Mar. Sci. 28(4):624-644.

Berry, A.J. 1984. *Umbonium vestiarium* (L.) (Gastropoda, Trochacea) as the food source for naticid gastropods and a starfish on a Malaysian sandy shore. J. Molluscan Stud. 50(1):1-7.

Berry, A.J. 1988. Annual cycle in *Retusa obtusa* (Montagu) (Gastropoda, Opisthobranchia) of reproduction, growth and predation upon *Hydrobia ulvae* (Pennant). J. Exp. Mar. Biol. Ecol. 117(3):197-209.

Berry, P.F. 1982. Biomass and density of detritivores on a littoral rocky reef on the Natal Coast, with an estimate of population production for the ascidian *Pyura stolonifera.* Oceanogr. Res. Inst. Invest. Rep. 53:12 p.

Bertalanffy, L. von. 1934. Untersuchungen über die Gesetzlichkeiten des Wachstums I. Roux'. Arch. Entwicklungsmech. 131:613-652.

Bertalanffy, L. von. 1938. A quantative theory of organic growth (inquiries on growth laws II) Hum. Biol. 10(2): 181-213.

Bertalanffy, L. von. 1951. Theoretische Biologie. Vol.2.A. Francke, A.G. Verlag., Bern.

Beverton, R.J.H. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fish. Invest. Min. Agric. Fish Food, London, Ser. II, Vol. 19:533 p.

Bitter, R. and P.E. Penchaszadeh. 1983. Ecologia trofica de dos estrellas de mar del genero *Astropecten* coexistentes en Golfo Triste, Venezuela. Stud. Neotrop. Fauna Environ. 18(3):163-180.

Bitter, R.A., R. Molinet and P.E. Penchaszadeh. 1980. Interaccion trofica entre dos estrellas de mar (*Astropecten riensis* y *Tethyaster vestitus*) en Golfo Triste, Venezuela. Bol. Inst. Oceanogr. S. Paulo 29(2):61-63.

Bitter Soto, R. 1984. Composicion de la dieta de *Astropecten marginatus* (Echinodermata: Asteroidea). Bol. Inst. Oceanogr. Univ. Oriente Cumana 23(1/2):169-176.

Boggs, C.H., J.A. Rice, J.A. Kitchell and J.F. Kitchell. 1984. Predation at a snail's pace: what's time to a gastropod? Oecologia 62(1):13-17.

Bohlke, J.E. and C.C.G. Chaplin. 1968. Fishes of the Bahamas and adjacent tropical waters. Livingstone Publishing Co., Wynnewood, Pennsylvania. 771 p.

Borja, A. 1986. La alimentacion y distribucion del espacio en tres molluscos gastropodos:*Rissoa parva* (da Costa), *Barleeia unifasciata* (Montagu) y *Bittium reticulatum* (da Costa). Cah. Biol. Mar. 27(1):69-75.

Bouain, A. 1983. Croissance linéaire des serrans des côtes sud-est de la Tunisie. Rapp. Comm. Int. Mer Medit. 28(5):87-91.

Boulon, R.H., Jr. 1986a. Map of fishery habitats within the Virgin Islands Biosphere Reserve. Biosphere Reserve Res. Rep. 8, 52 p. + appendix. Virgin Islands Resource Management Cooperative, Virgin Islands National Park.

Boulon, R.H., Jr. 1986b. Fisheries habitat of the Virgin Islands region of ecological importance to the fishery resources of the Virgin Islands Biosphere Reserve. Biosphere Reserve Res. Rep. 9, 22 p. Virgin Islands Resource Management Cooperative, Virgin Islands National Park.

Boulon, R.H., Jr. and I.E. Clavijo. 1986. Utilization of the Virgin Islands Biosphere Reserve by artisanal fishermen. Biosphere Reserve Res. Rep. 11, 36 p. Virgin Islands Resource Management Cooperative, Virgin Islands National Park.

Brawley, S.H. and W.H. Adey. 1981. The effect of micrograzers on algal community structure in a coral reef microcosm. Mar. Biol. 61(2-3):167-177.

Brawley, S.H. and W.H. Adey. 1982. *Coralliophila abbreviata*: a significant corallivore. Bull. Mar. Sci. 32(2):595-599.

Brawley, S.H. and X.G. Fei. 1987. Studies of mesoherbivory in aquaria and in an unbarricaded mariculture farm on the Chinese coast. J. Phycol. 23(4):614-623.

Briscoe, C.S. and K.P. Sebens. 1988. Omnivory in *Strongylocentrotus droebachiensis* (Mueller) (Echinodermata: Echinoidea): predation on subtidal mussels. J. Exp. Mar. Biol. Ecol. 115(1):1-24.

Brito-Perez, R. and E. Diaz-Iglesia. 1983. Observaciones sobre el consumo de alimento y su efecto sobre el crecimiento en juveniles de langosta (*Panulirus argus*) en el laboratorio. Rev. Invest. Mar. 1983:75-90.

Broom, M.J. 1981. Size-selection, consumption rates and growth of the Gastropoda *Natica maculosa* (Lamarck) and *Thais carinifera* (Lamarck) preying on the bivalve *Anadara granosa* (L.). J. Exp. Mar. Biol. Ecol. 56(2-3):213-233.

Broom, M.J. 1983. A preliminary investigation into prey species preference by the tropical gastropods *Natica maculosa* Lamarck and *Thais carinifera* (Lamarck). J. Molluscan Stud. 49(1):43-52.

Buchan, P.R. and M.J. Smale. 1981. Estimates of biomass, consumption and production of *Octopus vulgaris* Cuvier off the east coast of South Africa. Invest. Rep. Oceanogr. Res. Inst. 50:9 p.

Buesa, R.J. 1969. Biology and fishing of spiny lobsters, *Panulirus argus* (Latreille), p. 62-78. *In* A. Bogdanov (ed.) Soviet-Cuban fishery research. United States Department of Interior and Israel Program on Science Translation, Jerusalem.

Buesa, R.J. 1974. Population and biological data on turtle grass *Thalassia testudinum* König, 1805, on the northwestern Cuban shelf. Aquaculture 4:207-226.

Burkholder P.R., L.M. Burkholder and J.A. Rivero. 1959. Some chemical constituents of turtle grass *Thalassia testudinum*. Bull. Torrey Bot. Club 86:88-93.

Buschmann, A. and B. Santelices. 1987. Micrograzers and spore release in *Iridaea laminarioides* Bory (Rhodophyta: Gigartinales). J. Exp. Mar. Biol. Ecol. 108(2):171-179.

Caddy, J.F. 1983. The cephalopods: factors relevant to their population dynamics and to the assessment and management of stocks, p. 416-452. *In* J.F. Caddy (ed.) Advances in the assessment of world cephalopod resources. FAO Fish. Tech. Pap. 231. FAO, Rome.

Cammen, L.M. 1980. Ingestion rate: an empirical model for aquatic deposit feeders and detritivores. Oecologia 44:303-310.

Carefoot, T.H. 1970. A comparison of absorption and utilization of food energy in two species of tropical *Aplysia*. J. Exp. Mar. Biol. Ecol. 5:47-62.

Carpenter, R.C. 1981. Grazing by *Diadema antillarum* (Phillippi) and its effects on the benthic algal community. J. Mar. Res. 39(4):749-765.

Carpenter, R.C. 1985. Relationships between primary production and irradiance in coral reef algal communities. Limnol. Oceanogr. 30(4):784-793.

CFMC (Caribbean Fishery Management Council). 1984. Draft fishery management plan, regulatory impact review, and environmental impact statement for the shallow-water reef fish fishery of Puerto Rico and the U.S. Virgin Islands. Caribbean Fishery Management Council. 67 p. + appendix.

CFMC (Caribbean Fishery Management Council). 1985. Fishery management plan, final environmental impact statement, and draft regulatory impact review for the shallow-water reef fish fishery of Puerto Rico and the U.S. Virgin Islands. Caribbean Fishery Management Council. 45 p. + appendix.

CFMC (Caribbean Fishery Management Council). 1990. Amendment number 1 to the fishery management plan for the shallow-water reef fish fishery, preliminary environmental assessment and regulatory impact review. Caribbean Fishery Management Council. 30 p. + appendix.

Chang, M., J.S. Hong and H.T. Huh. 1988. Environmental conditions in the pearl oyster culture grounds and food organisms of *Pinctada fucata martensii* (Dunker) (Bivalvia, Pteroidea). Ocean Res. 10(1):67-77.

Chartock, M.A. 1983. Habitat and feeding observations on species of *Ophiocoma* (Ophiocomidae) at Enewetak. Micronesia 19(1/2):131-149.

Chesalin, M.V. 1987. On the feeding of *Stenoteuthis pteropus* (Steenstrup, 1985) on lanternfishes (Myctophidae, Pisces). Ehkol. Morya 25:75-80.

Chesson, J. 1983. The estimation and analysis of preference and its relationship to foraging models. Ecology 64(5):1297-1304.

Child, C.A. and G.R. Harbison. 1986. A parasitic association between a pycnogonid and a scyphomedusa in midwater. J. Mar. Biol. Assoc. U.K. 66(1):113-117.

Chilton, N.B. and C.M. Bull. 1986. Size-related selection of two intertidal gastropods by the reef crab *Ozius truncatus*. Mar. Biol. 93(3):475-480.

Chiu, S.T., V.W.W. Lam and P.K.S. Shin. 1985. Mollusc predation by *Luidia* spp. (Echinodermata: Asteroidea) in Tolo Harbour and Channel, Hong Kong, p. 365-379. The Malacofauna of Hong Kong and Southern China: Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China, Hong Kong, 6-24 April 1983. Vol. 2.

Chong, V.C. and A. Sasekumar. 1981. Food and feeding habits of the white prawn *Penaeus merguiensis*. Mar. Ecol. (Prog. Ser.) 5:185-191.

Choy, S.C. 1986. Natural diet and feeding habits of the crabs *Liocarcinus puber* and *L. holsatus* (Decapoda, Brachyura, Portunidae). Mar. Ecol. (Prog. Ser.) 31(1):87-99.

Christensen, V. 1995. Ecosystem maturity - toward quantification. Ecol. Modelling 77:3-32.

Christensen, V. and D. Pauly. 1990. The ECOPATH II model. Poster No. C.M. 1990/L:68 (Sess.Q) presented at the Annual Meeting of the International Council for the Exploration of the Sea, 2-8 October 1990, Copenhagen.

Christensen, V. and D. Pauly. 1991. A guide to the ECOPATH II program (version 2.0). ICLARM Software 6, 71 p.

Christensen, V. and D. Pauly. 1992a. ECOPATH II: a software for balancing steady-state ecosystem models and calculating network characteristics. Ecol. Modelling 61:169-185.

Christensen, V. and D. Pauly. 1992b. A guide to the ECOPATH II program (version 2.1). ICLARM Software 6, 72 p.

Christensen, V. and D. Pauly. 1995. Fish production, catches and the carrying capacity of the world oceans. Naga, ICLARM Q. 18(3):34-40.

Christensen, V. and D. Pauly. 1996. Ecological modelling for all. Naga, ICLARM Q. 19(2):25-26.

Clark, E. and K. von Schmidt. 1965. Sharks of the Central Gulf Coast of Florida. Bull. Mar. Sci. 15(1):13-83.

Claro, R., Editor. 1990. Asociaciones de peces en el Golfo de Batabanó. Editorial Academia, La Habana, Cuba. 128 p.

Clavijo, I.E., J.A. Yntema and J.C. Ogden. 1980. An annotated list of the fishes of St. Croix, U.S.V.I. Second edition. West Indies Laboratory, Christiansted, St. Croix.

Clements, L.A.J. and S.E. Stancyk. 1984. Particle selection by the burrowing brittlestar *Micropholis gracillima* (Stimpson) (Echinodermata: Ophiuroidea). J. Exp. Mar. Biol. Ecol. 84(1):1-13.

Cockcroft, A. and A. Mclachlan. 1986. Food and feeding habits of the surf zone penaeid prawn *Macropetasma africanus* (Balss). P.S.Z.N.I: Mar. Ecol. 7(4):345-357.

Coen, L.D. 1988. Herbivory by Caribbean majid crabs: feeding ecology and plant susceptibility. J. Exp. Mar. Biol. Ecol. 122(3):257-276.

Coffroth, M.A. 1990. Mucous sheet formation on poritid corals: an evaluation of coral mucus as a nutrient source on reefs. Mar. Biol. 105:30-49.

Colin, P.I. 1978. Caribbean reef invertebrates and plants. T.F.H. Publications, Inc., Neptune City, New Jersey. 512 p.

Collette, B.B. and C.E. Nauen. 1983. Scombrids of the world. FAO Fish. Synop. 125(2), 137 p. FAO, Rome.

Collette, B.B. and F.H. Talbot. 1972. Activity patterns of coral reef fishes with emphasis on nocturnal-diurnal changeover, p. 98-124. *In* B.B. Collette and S.A. Earle (eds.) Results of the Tektite Program. Ecology of Coral Reef Fishes. Nat. Hist. Mus. L.A. Co. Sci. Bull. 14:180 p.

Collette, B.B. and S.A. Earle. 1972. Results of the Tektite Program: ecology of coral reef fishes. Nat. Hist. Mus. L.A. Co. Sci. Bull. 14:180 p.

Connor, J.L. and W.H. Adey. 1977. The benthic algal composition, standing crop and productivity of a Caribbean algal ridge. Atoll Res. Bull. 211:1-40.

Corredor, L. and M.M. Criales. 1977. Ethological and ecological aspects of fish cleaning shrimp (Crustacea: Stenopodidae, Palaemonidae, Hippolytidae) in the Bay of Santa Marta, Columbia, and Young Island Channel; St. Vincent, West Indies. Proc. Assoc. Isl. Mar. Lab. Caribb. 12:32 p.

Corvea, A., M. Abreu and P.M. Alcolado. 1990. Características de las comunidades de equinodermos de la macrolaguna del Golfo de Batabanó, p. 90-112. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Coyer, J.A., J.M. Engle, R.F. Ambrose and B.V. Nelson. 1987. Utilization of purple and red sea urchins (*Stongylocentrotus purpuratus* Stimpson and *S. franciscanus* Agassiz) as food by the white sea urchin (*Lytechinus anamesus* Clark) in the field and laboratory. J. Exp. Mar. Biol. Ecol. 105(1):21-38.

Creese, R.G. and A.J. Underwood. 1982. Analysis of inter- and intra-specific competition amongst intertidal limpets with different methods of feeding. Oecologia 53(3):337-346.

Criales, M.M. 1984. Shrimps associated with coelenterates, echinoderms, and molluscs in the Santa Marta region, Columbia. J. Crust. Biol. 4(2):307-317.

Daan, N. 1973. A quantitative analysis of the food intake of North Sea cod (*Gadus morhua*). Neth. J. Sea Res. 6:279-517.

Daan, N. 1983. Analysis of the cod data collected during the 1981 stomach sampling project. ICES Doc. C.M. 1983/G:61.

Dahl, A.L. 1973. Benthic algal ecology in a deep reef and sand habitat off Puerto Rico. Bot. Mar. 16:171-175.

Dammann, A.E. 1969. Study of the fisheries potential of the Virgin Islands. V.I. Ecol. Res. Stn. Contrib. 1:1-197.

Darcy, G.H. 1983. Synopsis of biological data on the pigfish, *Orthopristis chrysoptera* (Pisces: Haemulidae). NOAA Tech. Rep. NMFS Circ. 449. FAO Fish. Synop. 134, 23 p.

Davenport, J. 1988. The feeding mechanism of Yoldia (=*Aequiyoldia*) *eightsi* (Courthouy). Proc. R. Soc. Lond. Ser. B 232(1269):431-442.

Dean, T.A., F.R. Jacobsen, K. Thies and S.L. Lagos. 1988. Differential effects of grazing by white sea urchins on recruitment of brown algae. Mar. Ecol. (Prog. Ser.) 48(1):99-102.

Dearborn, J.H. and K.C. Edwards. 1985. Analysis of data on the feeding biology of Antarctic sea stars and brittle stars. Antarct. J. U.S. 19(5):138-139.

Delille, D., L.D. Guidi and J. Soyer. 1985. Nutrition of *Allotanais hirsutus* (Crustacea: Tanaidacea) at Kerguelen Island. Antarct. Nutr. Cycles Food Webs: 378-380.

Deslous-Paoli, J.M., M. Heral and H. Masse. 1985. Bilan énergetique d'une population naturelle de *Crepidula fornicata* dans le bassin de Marennes-Oleron. Base Biologiques de l'Aquaculture, Montpellier, 12-16 December 1983. Actes Colloq. IFREMER: 109-124.

DHI (Deutsches Hydrographisches Institut). 1960. Monatskarten für den Indischen Ozean. No. 2422. Third edition. Deutsches Hydrographisches Institut, Hamburg.

DHI (Deutsches Hydrographisches Institut). 1967. Monatskarten für den Nordatlantischen Ozean. No. 2420. Fourth edition. Deutsches Hydrographisches Institut, Hamburg.

Dilly, P.N. 1985. The habitat and behaviour of *Cephalodiscus gracilis* (Pterobranchia, Hemichordata) from Bermuda. J. Zool. 207(2):223-239.

Dominguez, C.J. and P.M. Alcolado. 1990. Características del macrofitobentos de la macrolaguna del Golfo de Batabanó, p. 8-17. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Dominguez, J.H. and M.L. Reaka. 1988. Temporal activity patterns in reef-dwelling stomatopods: a test of alternative hypotheses. J. Exp. Mar. Biol. Ecol. 117:47-69.

Doornbos, G. and F. Twisk. 1987. Density, growth and annual food consumption of gobiid fish in the saline lake Grevelingen, the Netherlands. Neth. J. Sea Res. 21(1):45-74.

Downing, N. and C.R. El-Zahr. 1987. Gut evacuation and filling rates in the rock-boring sea urchin, *Echinometra mathaei*. Bull. Mar. Sci.: 579-584.

Drifmeyer, J.E. 1981. Urchin *Lytechinus variegatus* grazing on eelgrass, *Zostera marina*. Estuaries 4(4):374-375.

Drits, A.V., T.N. Semenova and B.V. Konovalov. 1987. Production of zooxanthellae in planktonic Foraminifera and colonial Radiolaria from the tropical Atlantic. Okeanologiya 27(1):125-131.

Drummond-Davis, N.C., K.H. Mann and R.A. Pottle. 1982. Some estimates of population density and feeding habits of the rock crab, *Cancer irroratus*, in a kelp bed in Nova Scotia. Can. J. Fish. Aquat. Sci. 39(4):636-639.

DSouza, M. 1986. The food of some neritid prosobranch mollusks found at Mkomani Mombasa, Kenya. Kenya Aquat. 3:46-49.

DuPreez, H.H. 1984. Molluscan predation by *Ovalipes punctatus* (De Haan) (Crustacea: Brachyura: Portunidae). J. Exp. Mar. Biol. Ecol. 84(1):55-71.

Durbin, E.G., A.G. Durbin, R.W. Langton and R.E. Bowma. 1983. Stomach contents of silver hake *Merluccius bilinearis*, and Atlantic cod, *Gadus morhua*, and estimation of their daily rations. Fish. Bull. 81(3):437-454.

Earle, S.A. 1972. The influence of herbivores on the marine plants of Great Lameshur Bay, with an annotated list of plants, p. 17-44. *In* B.B. Collette and S.A. Earle (eds.) Results of the Tektite Program: ecology of coral reef fishes. Nat. Hist. Mus. L.A. Co. Sci. Bull. 14,180 p.

Elliot, J.A. and L. Persson. 1978. The estimation of daily rates of food consumption for fish. J. Anim. Biol. Ecol. 47:977-991.

Engstrom, N.A. 1977. Behaviour of two snails: escape by *Turbo castanea* from predatory attacks of *Fasciolaria tulipa*. Proc. Assoc. Isl. Mar. Lab. Caribb. 12:35 p.

Erhardt, N.M. and V.R. Restrepo. 1989. The Florida stone crab fishery: a reusable resource?, p. 225-240. *In* J.F. Caddy (ed.) Marine invertebrate fisheries: their assessment and management. J. Wiley and Sons, New York.

Eyberg, I. 1984. The biology of *Parablennius cornutus* (L.) and *Scartella emarginata* (Günther) (Teleostei: Blenniidae) on a Natal Reef. Invest. Rep. Oceanogr. Res. Inst. 54:16 p.

Fauchald, K. and P.A. Jumars. 1979. The diet of worms: a study of polychaete feeding guilds. Oceanogr. Mar. Biol. Annu. Rev. 17:193-284.

Fehlbeck, H. 1983. Sulfide oxidation and carbon fixation by the gutless clam *Solemya reidi*: an animal-bacteria symbiosis. J. Comp. Physiol. B 152(1):3-11.

Ferreira de Menezes, M. and M. Pinto Paiva. 1966. Notes on the biology of tarpon, *Tarpon atlanticus* (Cuvier & Valenciennes), from coastal waters of Ceará state, Brazil. Arq. Est. Biol. Mar. Univ. Fed. Ceara 6(1):83-98.

Figueras, A. 1986. Alimentacion de *Palaemon adspersus* (Rathke, 1837) y *Palaemon serratus* (Pennant, 1777) (Decapoda: Natantia) en la ria de Vigo (N.O. España). Cah. Biol. Mar. 27(1):77-90.

Figuereido, J.L. and N.A. Menezes. 1977. Manual de peixes marinhos do sudeste do Brasil. Vol. I-IV. Museu de Zoologia, Universidade de São Paulo.

Finn, J.T. 1976. Measure of ecosystem structure and function derived from the analysis of flows. J. Theor. Biol. 56:363-380.

Fischer, W., Editor. 1978. FAO species identification sheets for fishery purposes. Western Central Atlantic (Fishing Area 31). Vol. I-VII. Food and Agriculture Organization of the United Nations, Rome.

Foster, S.A. 1987. The relative impacts of grazing by Caribbean coral reef fishes and *Diadema*: effects of habitat and surge. J. Exp. Mar. Biol. Ecol. 105(1):1-20.

Freitas, J.C. de. 1982. Predaçao de *Stenorhynchus seticornis* (Crustacea, Majidae) por *Diplasterias brandtii* (Asteroidea) e *Epinephelus morio* (Teleostei). Cienc. Cult. 34(8):1056-1058.

Fujioka, Y. and K. Yamazato. 1983. Host selection of some Okinawan coral associated gastropods belonging to the genera *Drupella*, *Coralliophila* and *Quoyula*. Galaxea 2(1):59-73.

Garcia, S. 1985. Reproduction, stock assessment models and population parameters in exploited penaeid shrimp populations, p. 139-158. *In* P.C. Rothlisberg, B.J. Hill and D.J. Staples (eds.) Second Australian National Prawn Seminar, 22 October 1984, Kooralbyn, Australia.

Garrity, S.D. and S.C. Levings. 1981. A predator-prey interaction between two physically and biologically constrained tropical rocky shore gastropods: direct, indirect and community effects. Ecol. Monogr. 51(3):267-286.

Gerking, S.D. 1962. Production and food utilization in a population of bluegill sunfish. Ecol. Monogr. 32:31-78.

Gibbons, M.C. 1984a. Comparison of energetics of hard clam predation by *Neopanope sayi*, *Ovalipes ocellatus*, and *Pagurus longicarpus*. J. Shellfish Res. 4(1):90. (Summary only.)

Gibbons, M.C. 1984b. Predation of juveniles of the hard clam *Mercenaria mercenaria* (Linné) by fifteen invertebrate species with special reference to crabs. J. Shellfish Res. 4(1):90. (Summary only.)

Giovanardi, O. and G. Piccinetti Manfrin. 1984. Report of the Third Technical Consultation on Stock Assessment in the Adriatic, Fano, Italy, 6-10 June 1983. FAO Fish. Rep. 290:131-134.

Gladfelter, W.B. 1980. Fish community structure and dynamics in five reef environments. *In* E.H. Gladfelter and W.B. Gladfelter (eds.) Environmental studies of Buck Island Reef National Monument III, St. Croix, U.S.V.I. West Indies Laboratory, St. Croix.

Gladfelter, W.B., E.H. Gladfelter, R.K. Monahan, J.C. Ogden and R.F. Dill. 1977. Environmental studies of Buck Island Reef National Monument. U.S. National Park Service Report. 144 p.

Glynn, P.W. 1973. Aspects of the ecology of coral reefs in the Western Atlantic region, p. 271-324. *In* O.A. Jones and R. Endean (eds.) Biology and geology of coral reefs. Vol. II. Biology 1. Academic Press, New York.

Glynn, P.W. 1983. Increased survivorship in corals harboring crustacean symbionts. Mar. Biol. Lett. 4(2):105-111.

Gomez, E.D., R.A. Guieb and E. Aro. 1983. Studies on the predators of commercially important seaweeds. Fish. Res. J. Philipp. 8(1):1-17.

Gomez, O., D. Ibarzabal and A. Silva. 1980. Evaluacion cuantitativa de bentos en la region suroccidental de Cuba. Inf. Cient.-Tec. 149:1-25. Academia de Ciencias de Cuba, Havana, Cuba.

Gonzalez-Liboy, J.A. 1979. An examination of the present condition of seagrasses in La Parguera, Puerto Rico. Final Report. Department of Natural Resources and United States F.W.S., Atlanta, Georgia. 87 p.

Gottfried, M. and M.R. Roman. 1983. Ingestion and incorporation of coral-mucus detritus by reef zooplankton. Mar. Biol. 72:211-218.

Graham, R. 1984. Bay scallop mariculture. Underwat. Nat. 14(4):14-17.

Greenway, M. 1974. The effects of cropping on the growth of *Thalassia testudinum* (König) in Jamaica. Aquaculture 4:199-206.

Griffiths, R.J. 1981. Predation on the bivalve *Choromytilus meridionalis* (Kr.) by the gastropod *Natica* (*Tectonatica*) *tecta* Anton. J. Mollusc. Stud. 47(1):112-120.

Guerra, A. 1979. Fitting a von Bertalanffy expression to *Octopus vulgaris* growth. Invest. Pesq. 43(1):319-326.

Guitart, B. and A. Hondares. 1980. Crustáceos. Rev. Cub. Invest. Pesq. 5(3):1-21.

Gulland, J.A. 1983. Fish stock assessment: a manual of basic methods. John Wiley and Sons, New York. 223 p.

Gunnill, F.C. 1983. Differing distributions of potentially competing amphipods, copepods and gastropods among specimens of the intertidal alga *Pelvetia fastigiata*. Mar. Biol. 82(3):277-291.

Guo-Xin, Fan-Guangzuan, Jia-Guosheng. 1986. A preliminary study of the feeding habit of *Sepiella maindroni* de Rochebrune. J. Zhejiang Coll. Fish. 5(2):171-176.

Gygi, R.A. 1975. *Sparisoma viride* (Bonnaterre), the stoplight parrotfish, a major sediment producer on coral reefs of Bermuda? Eclogae Geol. Helv. 68(2):327-359.

Hall, S.J., D. Raffaelli and W.R. Turrell. 1990. Predator-caging experiments in marine systems: a reexamination of their value. Am. Nat. 136(5):657-672.

Hallock, P. 1981. Production of carbonate sediments by selected large benthic Foraminifera on two Pacific coral reefs. J. Sediment. Petrol. 51(2):467-474.

Hammond, L.S. 1983. Nutrition of deposit-feeding holothuroids and echinoids (Echinodermata) from a shallow reef lagoon, Discovery Bay, Jamaica. Mar. Ecol. (Prog. Ser.) 10(3):297-305.

Hammond, L.S. and C.R. Wilkinson. 1985. Exploitation of sponge exudates by coral reef holothuroids. J. Exp. Mar. Biol. Ecol. 94:1-9.

Hannon, B. 1973. The structure of ecosystems. J. Theor. Biol. 41:535-546.

Hannon, B. and C. Joiris. 1989. A seasonal analysis of the southern North Sea ecosystem. Ecology 70(6):1916-1934.

Hardison, L.K. and C.L. Kitting. 1985. Epiphytic algal browsing by *Bittium varium* (Gastropoda) among *Thalassia testudinum* turtlegrass. Papers presented at the Annual Meeting of the Phycological Society of America at the University of Florida, 13-15 August 1985, Gainesville. J. Phycol. 21(Suppl.):13. (Summary only.)

Hargrave, B.T. 1985. Feeding rates of abyssal scavenging amphipods (*Eurythenes gryllus*) determined in situ by time-lapse photography. Deep-Sea Res. 32(41):443-450.

Harrold, C. 1982. Escape responses and prey availability in a kelp forest predator-prey system. Am. Nat. 119(1):132-135.

Hatcher, B.G. 1990. Coral reef primary productivity: a hierarchy of pattern and process. Trends Ecol. Evol. 5:149-155.

Hawkins, C.M. 1979. Ecological energetics of the tropical sea urchin *Diadema antillarum* Philippi in Barbados, West Indies. McGill University. Ph.D. thesis.

Hawkins, C.M. 1985. Population carbon budget and the importance of the amphipod *Corophium volutator* in the carbon transfer on a Cumberland Basin mudflat, Upper Bay of Fundy, Canada. Neth. J. Sea Res. 19(2):165-176.

Hendler, G. and J.E. Miller. 1984. Feeding behavior of *Asteroporpa annulata*, a gorgonocephalid brittlestar with unbranched arms. Bull. Mar. Sci. 34(3):449-460.

Hensen, R. 1984. Food availability and feeding preferences of the queen conch *Strombus gigas* (Linne) collected from natural habitats. J. Shellfish Res. 4(1):91. (Summary only.)

Heukelem, W.F., van. 1984. A comparison of food intake, food conversion efficiency, and growth rate of *Octopus cyanea* Gray and *Octopus mya* Voss and Solis. J. Shellfish Res. 4(1):102. (Summary only.)

Hillis-Colinvaux, L. 1974. Productivity of the coral reef alga *Halimeda* (Order Siphonales), p. 35-42. *In* Proceedings of the Second International Symposium on Coral Reefs 1, 22 June-2 July 1973, Australia.

Hoffman, D.L., W.C. Homan, J. Swanson and P.J. Weldon. 1978. Flight responses of three congeneric species of intertidal gastropods (Prosobranchia: Neritidae) to sympatric predatory gastropods from Barbados. Veliger 21(2):293-296.

Horn, P.L. 1986. Energetics of *Chiton pelliserpentis* (Quoy and Gaimard, 1835) (Mollusca: Polyplacophora) and the importance of mucus in its energy budget. J. Exp. Mar. Biol. Ecol. 101:119-141.

Hourigan, T.F., F.G. Stanton, P.J. Motta, C.D. Kelley and B. Carlson. 1989. The feeding ecology of three species of Caribbean angelfishes (family Pomacanthidae). Environ. Biol. Fish. 24(2):105-116.

Howard, R.K. 1982. Impact of feeding activities of epibenthic amphipods on surface-fouling of eelgrass leaves. Aquat. Bot. 14(1):91-97.

Howard, R.K. 1984. The trophic ecology of caridean shrimps in an eelgrass community. Aquat. Bot. 18(1/2):155-174.

Hubold, G. and M.V. Mazzetti. 1982. Growth, morphometry, and aspects of life history of the scaled sardine *Harengula jaguana* Poey, 1865 in the Guanabara Bay (Brazil). Meeresforschung 29:80-88.

Huebner, J.D. and D.C. Edwards. 1981. Energy budget of the predatory marine gastropod *Polinices duplicatus*. Mar. Biol. 61:221-226.

Hughes, R.N. 1985a. Notes on the feeding behaviour of *Tonna zonatum* (Tonnidae) and *Phalium bisulcatum* (Cassidae) (Tonnacea). The malacofauna of Hong Kong and Southern China, p. 623-626. *In* Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China, 6-24 April 1983, Hong Kong. Vol. II.

Hughes, R.N. 1985b. Predatory behaviour of *Natica unifasciata* feeding intertidally on gastropods. J. Molluscan Stud. 51(3):331-335.

Hughes, T.P., B.D. Keller, J.B.C. Jackson and M.J. Boyle. 1985. Mass mortality of the echinoid *Diadema antillarum* Philippi in Jamaica. Bull. Mar. Sci. 36(2):377-384.

Ibarzábal, D.R. 1990. Características de las comunidades de poliquetos de la macrolaguna del Golfo de Batabanó, p. 37-52. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Ivlev, V.S. 1939. Balance of energy in carps. Zool. Zh. 18:303-318.

Ivlev, V.S. 1961. Experimental ecology of the feeding of fishes. (Translated from Russian by Douglas Scott). Yale University, New Haven. 302 p.

Ivlev, V.S. 1966. The biological productivity of the sea. (Translated from Russian by W.E. Ricker). J. Fish. Res. Board Can. 23(11):1727-1759.

Jacobsen, T. and J. Browder. 1987. The ecological basis of fishery yield of the Puerto Rico-Virgin Islands insular shelf. 1. Literature review. (Unpubl.)

Jafari, R.D. and D.M. Mahasneh. 1987. The effect of seagrass grazing on the sexual maturity of the sea urchin *Tripneustes gratilla* in the Gulf of Aquaba. Dirasat. 14(1):127-136.

Jarre-Teichmann, A. and D. Pauly. 1993. Seasonal changes in the Peruvian upwelling ecosystem, p. 307-316. *In* V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, 390 p.

Jarre-Teichmann, A., P. Muck and D. Pauly. 1991. Two approaches for modelling fish stock interactions in the Peruvian upwelling ecosystem. ICES Mar. Symp. 193:171-184.

Jarre-Teichmann, A., M.L. Palomares, M. Soriano, V. Sambilay, Jr. and D. Pauly. 1990. MAXIMS computer program for estimating food consumption of fishes. ICLARM Software 4. 19 p.

Jimenez, C. and D. Ibarzabal. 1982. Evaluacion cuantitativa del mesobentos en la plataforma nororiental de Cuba. Cienc. Biol. 7:54-69.

Jobling, M. 1981. Mathematical models for gastric emptying and the estimation of daily rates of food consumption for fish. J. Fish Biol. 19:245-257.

Johnson, A.G. and C.H. Salomon. 1984. Age, growth, and mortality of gray triggerfish, *Balistes capriscus*, from the northeastern Gulf of Mexico. Fish. Bull. 82(3):485-492.

Johnson, S.B. and Y.G. Attramadal. 1983. A functional-morphological model of *Tanais cavolinii* Milne-Edwards (Crustacea, Tanaidacea) adapted to a tubiculous life strategy. Sarsia 67(1):29-42.

Joll, L.M. and B.F. Phillips. 1984. Natural diet and growth of juvenile western rock lobster *Panulirus cygnus* George. J. Exp. Mar. Biol. Ecol. 75(2):145-169.

Jones, G.P. 1986. Food availability affects growth in a coral reef fish. Oecologia 70(1):136-139.

Jones, G.P. 1987. Competitive interactions among adults and juveniles in a coral reef fish. Ecology 68(5):1534-1547.

Jones, J.A. 1963. Ecological studies of southeastern Florida patch reefs. Part I. Diurnal and seasonal changes in the environment. Bull. Mar. Sci. 13:282-307.

Jones, R. 1976. Growth of fishes, p. 251-279. *In* D.H. Cushing and J.J. Walsh (eds.) The ecology of the seas. Blackwell Scientific Publications, Oxford.

Kaminski, M. 1984. Food composition of three bryozoan species (Bryozoa, Phylactolaemata) in a mesotrophic lake. Pol. Arch. Hydrobiol. 31(1):45-53.

Kanwisher, J.W. and S.A. Wainwright. 1967. Oxygen balance in some reef corals. Biol. Bull. 33:378-390.

Kasinathan, R., K. Govindan and B.N. Desai. 1975. On the Opisthobranch *Haminoea vitrea* (A. Adams, 1850) from Madh Island (Bombay). J. Mar. Biol. Assoc. India 17(3):696-701.

Kilar, J.A. and R.M. Lou. 1986. The subtleties of camouflage and dietary preference of the decorator crab, *Microphrys bicornutus* Latreille (Decapoda: Brachyura). J. Exp. Mar. Biol. Ecol. 101(1-2):143-160.

Kim, Y.H., S.D. Lee and B.G. Kim. 1983. Ecological studies on the shrimp, *Trachypenaeus curvirostris* (Stimpson). Bull. Fish. Res. Dev. Agency, Pusan 32:25-30.

Kimmel, J.J. 1985. A characterization of Puerto Rican fish assemblages. Ph. D. dissertation. Univ. Puerto Rico, Mayagüez.

Kitting, C.L. 1985. Adaptive significance of short-range diel migration differences in a seagrass meadow snail population. Migration: mechanisms and adaptive significance. Contrib. Mar. Sci.:227-243.

Klumpp, D.W. and A.D. McKinnon. 1989. Temporal and spatial patterns in primary production of a coral-reef epilithic algal community. J. Exp. Mar. Biol. Ecol. 131:1-22.

Klumpp, D.W. and N.V.C. Polunin. 1989. Partitioning among grazers of food resources within damselfish territories on a coral reef. J. Exp. Mar. Biol. Ecol. 125:145-169.

Klumpp, D.W. and P.D. Nichols. 1983. Utilisation of the seagrass *Posidonia australis* as food by the rock crab *Nectocarcinus integrifons* (Latreille) (Crustacea: Decapoda: Portunidae). Mar. Biol. Lett. 4(6):331-339.

KNMI (Koninklijk Nederlands Meteorologisch Instituut). 1957. Middellandse Zee. Oceanografische en meteorologische gegevens. Koninklijk Nederlands Meteorologisch Instituut Publ. No. 138, 91 p.

Knoppers, B.A. and S. Opitz. 1984. An annual cycle of particulate organic matter in mangrove waters, Laranjeiras Bay, southern Brazil. Arq. Biol. Tecnol. 27(1):79-93.

Kobayashi, D.R. 1986. *Octopus* predation on hermit crabs: A test of selectivity. Mar. Behav. Physiol. 12(2):125-131.

Kohlmeyer, J. and B. Bebout. 1986. On the occurrence of marine fungi in the diet of *Littorina angulifera* and observations on the behavior of the periwinkle. P.S.Z.N.I: Mar. Ecol. 7(4):333-343.

Kohn, A.J. 1980. Abundance, diversity, and resource use in an assemblage of *Conus* species in Enewetak Lagoon. Pac. Sci. 34(4):359-369.

Kohn, A.J. and M.C. Lloyd. 1973. Polychaetes of truncated reef limestone substrates on Eastern Indian Ocean coral reefs: diversity, abundance and taxonomy. Int. Rev. Gesamt. Hydrobiol. 58:369-399.

Kotaki, Y, Y. Oshima and T. Yasumoto. 1985. Bacterial transformation of paralytic shellfish toxins in coral reef crabs and a marine snail. Bull. Japan Soc. Sci. Fish./Nissuishi 51(6):1009-1013.

Kropp, R.K. 1981. Additional porcelain crab feeding methods. (Decapoda, Porcellanidae). Crustaceana 40(3):307-310.

Kurihara, Y. and K. Okamoto. 1987. Cannibalism in a grapsid crab, *Hemigrapsus penicillatus*. Mar. Ecol. (Prog. Ser.) 41(2):123-127.

Laevastu, T. and H.A. Larkins. 1981. Marine fisheries ecosystem, its quantitative evaluation and management. Fishing News Books, Farnham, United Kingdom.

Lafontaine, Y. de and R.H. Peters. 1986. Empirical relationships for marine primary production: the effect of environmental variables. Oceanol. Acta 9(1):65-72.

Lam, V.W.W. and S.T. Chiu. 1985. Prey selection and feeding behaviour of *Octopus membranaceus* (Quoy and Gaimard 1822). The malacofauna of Hong Kong and Southern China, p. 661-681. *In* Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China, 6-24 April 1983, Hong Kong. Vol. 2.

Lau, C.J. 1987. Feeding behavior of the Hawaiian slipper lobster *Scyllarides squammosus*, with a review of decapod crustacean feeding tactics on molluscan prey. Second International Symposium on Indo-Pacific Marine Biology, Western Society of Naturalists, 23-28 June 1986, University of Guam. Bull. Mar. Sci.:378-391.

Laughlin, R.A. 1982. Feeding habits of the blue crab, *Callinectes sapidus* Rathbun, in the Apalachicola Estuary, Florida. Bull. Mar. Sci. 32(4):807-822.

Lawton, P. and R.N. Hughes. 1985. Foraging behaviour of the crab *Cancer pagurus* feeding on the gastropods *Nucella lapillus* and *Littorina littorea*: Comparisons with optimal foraging theory. Mar. Ecol. (Prog. Ser.) 27(1-2):143-154.

Lee, J.H., J.S. Hong and S.K. Yi. 1983. Studies on the benthic fauna in Garolim Bay, Korea. Subtidal soft-bottom community. J. Oceanol. Soc. Korea 18(2):111-116.

Leontief, W. 1951. The structure of the American economy, 1919-1939. Second edition. Oxford University Press, New York. 264 p.

Lester, S.M. 1985. *Cephalodiscus* sp. (Hemichordata: Pterobranchia): observations of functional morphology, behavior and occurrence in shallow water around Bermuda. Mar. Biol. 85(3):263-268.

Lewis, C.A. 1981. Juvenile to adult shift in feeding strategies in the pedunculate barnacle *Pollicipes polymerus* (Sowerby) (Cirripedia, Lepadomorpha). Crustaceana 41(1):14-20.

Lewis, J.B. 1981. Coral reef ecosystems, p. 127-158. *In* A. Longhurst (ed.) Analysis of marine ecosystems. Academic Press Ltd., San Diego.

Lewis, J.B. 1982. Feeding behaviour and feeding ecology of the Octocorallia (Coelenterata: Anthozoa). J. Zool. 196(3):371-384.

Lindeman, R.L. 1942. The trophic-dynamic aspect of ecology. Ecology 23:399-418.

Lindsey, C.C. 1978. Form, function and locomotory habits in fish, p. 1-100. *In* W.S. Hoar and D.J. Randall (eds.) Fish physiology. Vol. 8: Locomotion. Academic Press, New York. 576 p.

Lipinski, M.R. and T.B. Linkowski. 1988. Food of the squid *Ommastrephes bartramii* (LeSueur, 1981) from the Southwest Atlantic Ocean. S. Afr. J. Mar. Sci. 6:43-46.

Longhurst, A.R. and D. Pauly. 1987. Ecology of tropical oceans. Academic Press, New York. 407 p.

Macdonald, J.S. and R.H. Green. 1983. Redundancy of variables used to describe importance of prey species in fish diets. Can. J. Fish. Aquat. Sci. 40:635-637.

Mackay, A. 1981. The generalized inverse. Practical Comput. (September):108-110.

Maes, V.O. 1982. Observations on the systematics and biology of a turrid gastropod assemblage in the British Virgin Islands. Bull. Mar. Sci. 33(2):305-335.

Mahon, R., Editor. 1987. Report and Proceedings of the Expert Consultation on Shared Fishery Resources of the Lesser Antilles Region, Mayagüez, 8-12 September 1986, Puerto Rico. FAO Fish. Rep. 383, 106 p. FAO, Rome.

Majkowski, J. 1982. Usefulness and applicability of sensitivity analysis in a multispecies approach to fisheries management, p. 149-166. *In* D. Pauly and G.I. Murphy (eds.) Theory and management of tropical fisheries. ICLARM Conf. Proc. 9, 360 p.

Majkowski, J. and W.S. Hearns. 1984. Comparison of three methods for estimating the food intake of a fish. Can. J. Fish. Aquat. Sci.41(1):212-215.

Malkov, A.S. 1978. Abundancia del stock comercial de langosta *Panulirus argus*, Latreille 1804, en la region suroccidental de la plataforma cubana. Rev. Cub. Invest. Pesq. 3(4):1-11.

Mann, K.H. 1978. Estimating the food consumption of fish in nature, p. 250-273. *In* S.D. Gerking (ed.) Ecology of freshwater fish production. Blackwell Scientific Publications, Oxford. 520 p.

Mann, K.H. 1982. Ecology of coastal waters: a systems approach. Blackwell Scientific Publications, Oxford. 322 p.

Margalef, R. 1971. The pelagic ecosystem of the Caribbean Sea, p. 477-482. *In* Symposium on Investigations on and Resources of Caribbean Sea and Adjacent Regions, 1968, Willemstad, Curaçao.

Marten, G.G. and J.J. Polovina. 1982. A comparative study of fish yields from various tropical ecosystems, p. 255-289. *In* D. Pauly and G.I. Murphy (eds.) Theory and management of tropical fisheries. ICLARM Conf. Proc. 9, 360 p.

Martínez-Estalella, N. and P.M. Alcolado. 1990a. Características de las comunidades de corales pétreos de la macrolaguna del Golfo de Batabanó, p. 25-32. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Martínez-Estalella, N. and P. M. Alcolado. 1990b. Características generales de las comunidades de moluscos de la macrolaguna del Golfo de Batabanó, p. 53-74. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Martínez-Iglesias, J.C. and P.M. Alcolado. 1990. Características de la fauna de crustáceos decápodos de la macrolaguna del Golfo de Batabanó, p. 75-89. *In* P.M. Alcolado (ed.) El bentos de la macrolaguna del Golfo de Batabanó. Editorial Academia, La Habana, Cuba.

Massin, C. and C. Doumen. 1986. Distribution and feeding of epibenthic holothuroids on the reef flat of Laing Island (Papua New Guinea). Mar. Ecol. (Prog. Ser.) 31(2):185-195.

Matsui, S., Y. Hagiwara, H. Tou and H. Tsukahara. 1986. Study on the feeding habit of the Japanese blue crab, *Portunus trituberculatus* (Miers). Sci. Bull. Fac. Agric. Kyushu Univ. 40(2/3):175-182.

Maurer, R.O. and R.E. Bowman. 1985. Food consumption of squids (*Illex illecebrosus* and *Loligo pealei*) off the northeastern United States. Biology and ecology of squids *Illex illecebrosus* and *Loligo pealei* in the Northwest Atlantic. NAFO Sci. Counc. Stud.:117-124.

McClanahan, T.R. 1988. Coexistence in a sea urchin guild and its implications to coral reef diversity and degradation. Oecologia 77:210-218.

McClintock, J.B. and J.M. Lawrence. 1985. Characteristics of foraging in the soft-bottom benthic starfish *Luidia clathrata* (Echinodermata: Asteroidea): prey selectivity, switching behavior, functional responses and movement patterns. Oecologia 66(2):291-298.

McClintock, J.B., T.S. Klinger and J.M. Lawrence. 1982. Feeding preferences of echinoids for plant and animal food models. Bull. Mar. Sci. 32(1):365-369.

McDonald, J. 1982. Divergent life history patterns in the co-occurring intertidal crabs *Panopeus herbstii* and *Eurypanopeus depressus* (Crustacea: Brachyura: Xanthidae). Mar. Ecol. (Prog. Ser.) 8(2):173-180.

McKillup, S.C. and A.J. Butler. 1983. The measurement of hunger as a relative estimate of food available to populations of *Nassarius pauperatus*. Oecologia 56(1):16-22.

McLean, R. 1983. Gastropod shells: a dynamic resource that helps shape benthic community structure. J. Exp. Mar. Biol. Ecol. 69(2):151-174.

McManus, J.W., C.L. Nañola, Jr., R.B. Reyes, Jr. and K.N. Kesner. 1992. Resource ecology of the Bolinao coral reef system. ICLARM Stud. Rev. 22, 117 p.

Meekan, M.G. 1988. Settlement and mortality patterns of juvenile reef fishes at Lizard Island, northern Great Barrier Reef, p. 779-784. *In* Proceedings of the Sixth International Coral Reef Symposium, 8-12 August 1988, Townsville, Australia. Vol. 2.

Meinkoth, N.A. 1981. The Audubon Society field guide to North American seashore creatures. Alfred A. Knopf, Inc., New York. 799 p.

Menzel, D.W. 1958. Utilization of algae for growth by the angelfish *Holacanthus bermudensis*. J. Cons. CIEM 24:308-313.

Menzel, D.W. 1960. Utilization of food by a Bermuda reef fish, *Epinephelus guttatus*. J. Cons. CIEM 25:216-222.

Meylan, A. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239(4838):393-395.

Milera, J. F. and I. Cortes. 1979. Habitos alimentarios de *Murex* (*Phyllonotus*) *pomum* Gmelin 1791 (Mollusca: Neogastropoda: Muricidae), p. 18. *In* Proceedings of the Fifth Scientific Event of the Oceanological Institute. (Summary only.)

Miller, D.C. 1984. Mechanical post-capture particle selection by suspension- and deposit-feeding *Corophium*. J. Exp. Mar. Biol. Ecol. 82(1):59-76.

Minchin, D. 1983. Predation on young *Pecten maximus* (L.) (Bivalvia), by the anemone *Anthopleura ballii*. J. Molluscan Stud. 49(3):228-231.

Moehlenberg, F. and H.U. Riisgard. 1979. Filtration rate, using a new indirect technique, in thirteen species of suspension-feeding bivalves. Mar. Biol. 54:143-147.

Mook, D. 1986. Absorption efficiencies of the intertidal mangrove dwelling mollusk *Melampus coffeus* Linné, and the rocky intertidal mollusk *Acanthopleura granulata* Gmelin. P.S.Z.N. I: Mar. Ecol. 7(2):105-113.

Morales, C. and T. Antezana. 1983. Diet selection of the Chilean stone crab *Homalaspis plana*. Mar. Biol. 77(1):79-83.

Morgan, M.D. and C.L. Kitting. 1984. Productivity and utilization of the seagrass *Halodule wrightii* and its attached epiphytes. Limnol. Oceanogr. 29(5):1066-1076.

Moriarty, D.J.W. 1982. Feeding of *Holothuria atra* and *Stichopus chloronotus* on bacteria, organic carbon and organic nitrogen in sediments of the Great Barrier Reef. Aust. J. Mar. Freshwat. Res. 33(2):255-263.

Moriarty, D.J.W. and M.C. Barcley. 1981. Carbon and nitrogen content of food and the assimilation efficiencies of penaeid prawns in the Gulf of Carpenteria. Aust. J. Mar. Freshwat. Res. 32(2):245-251.

Morrisey, D.J. 1988. Differences in effects of grazing by deposit-feeders *Hydrobia ulvae* (Gastropoda: Prosobranchia) and *Corophium arenarium* Crawford (Amphipoda) on sediment microalgal populations. 1. Qualitative differences. J. Exp. Mar. Biol. Ecol. 118(1):33-42.

Motoh, H. 1985. Biology and ecology of *Penaeus monodon*, p. 27-36. *In* Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps, 4-7 December 1984, Iloilo City, Philippines.

Mullin, M.M. 1983. In situ measurement of filtering rates of the salp, *Thalia democratica*, on phytoplankton and bacteria. J. Plankton Res. 5(2):279-288.

Munro, J.L., Editor. 1983. Caribbean coral reef fishery resources. ICLARM Stud. Rev. 7, 276 p.

Munro, J.L. 1984. Report to the Caribbean Fishery Management Council on an assessment of the fisheries of Puerto Rico and the US Virgin Islands. (Unpubl.)

Muskatine, L. and J.W. Porter. 1977. Reef corals: mutualistic symbioses adapted to nutrient-poor environments. Bioscience 27:454-460.

Naim, O. and L. Amoureux. 1982. Le peuplement d'annelides polychaetes motiles associé aux algues d'un récif corallien de Polynésie Francaise (île de Moorea, Archipel de la Societé). Bull. Ecol. 13(1):25-33.

Nelson, W.G. 1981. The role of predation by decapod crustaceans in seagrass ecosystems. *In* Lower organisms and their role in the food web. Kiel. Meeresforsch. Sonderh. 5:529-536.

Nemoto, T., M. Okiyama and M. Takahashi. 1984. Aspects of the roles of squid in food chains of the Antarctic marine ecosystems, p. 89-92. *In* Proceedings of the Sixth Symposium on Polar Biology. Mem. Natl. Inst. Polar Res. (Japan) (Spec. Issue).

Nicholson, W. and L. Hartsuijker. 1982. The state of the fisheries resources of the Pedro Bank and South Jamaica shelf, p. 215-254. *In* FAO Fish. Rep. 278-Suppl. FAO, Rome.

Nicol, S. and R.K. ODor. 1985. Predatory behaviour of squid (*Illex illecebrosus*) feeding on surface swarms of euphausiids. Can. J. Zool. 63(1):15-17.

Nielsen, M.V. and L.H. Kofoed. 1982. Selective feeding and epipsammic browsing by the deposit-feeding amphipod *Corophium volutator*. Mar. Ecol. (Prog. Ser.) 10(1):81-88.

Nigmatullin, Ch.M. and N.M. Toporova. 1982. Food spectrum of the short-finned squid *Sthenoteuthis pteropus* (Steenstrup 1855) in the tropical Atlantic epipelagial, p. 3-8. *In* Feeding and food relationships of the Atlantic fishes and invertebrates. Atlanticheskij Nauchno Issledovaticheskij Institut, Rybnovo Khozjajstva; Okeanografii, Kaliningrad. (In Russian with English abstract.)

Nishihama, S., S. Nojima and T. Kikuchi. 1986. Distribution, diet and activity of a chiton *Liolophura japonica* (Lischkel), in Amakusa, West Kyushu. Publ. Amakusa Mar. Biol. Lab. 8(2):113-123.

Nixon, M. and B.U. Budelmann. 1984. Scale worms - occasional food of *Octopus*. J. Molluscan Stud. 50(1):39-42.

Nuitja, I.N.S. and I. Uchida. 1982. Preliminary studies on the growth and food consumption of the juvenile loggerhead turtle (*Caretta caretta* L.) in captivity. Aquaculture 27:157-160.

Odum, H.T. 1957. Primary production measurements in 11 Florida springs and a marine turtle grass community. Limnol. Oceanogr. 3:85-97.

Odum, H.T. and C.M. Hoskin. 1958. Comparative studies on the metabolism of marine waters. Publ. Inst. Mar. Sci. Univ. Texas 5:16-46.

Odum, H.T. and E.P. Odum. 1955. Trophic structure and productivity of a windward coral reef community on Eniwetok Atoll. Ecol. Monogr. 25:291-320.

Odum, H.T., P.R. Burkholder and J. Rivero. 1959. Measurements of productivity of turtle grass flats, reefs and the Bahia Fosforescente of Southern Puerto Rico. Publ. Inst. Mar. Sci. Univ. Texas 6:159-170.

Odum, W.E. and E.J. Heald. 1975. The detritus-based food web of an estuarine mangrove community, p. 265-286. *In* L.E. Cronin (ed.) Estuarine research. Vol. 1. Academic Press, New York.

Ogden, J.C. and E.H. Gladfelter. 1983. Coral reefs, seagrass beds and mangroves: their interaction in the coastal zones of the Caribbean. UNESCO Rep. Mar. Sci. 23, 133 p.

Ogden, J.C. and J.C. Zieman. 1977. Ecological aspects of coral reef - seagrass bed contacts in the Caribbean. Proc. Int. Coral Reef Symp. 3:377-382.

Ogden, J.C. and J.P. Ebersole. 1981. Scale and community structure of coral reef fishes: a long-term study of a large artificial reef. Mar. Ecol. (Prog. Ser.) 4:97-103.

Ohta, S. 1984. Star shaped feeding traces produced by echiuran worms on the deep-sea floor of the Bay of Bengal. Deep-Sea Res. 31(12a):1415-1432.

OSullivan, D. and J.M. Cullen. 1983. Food of the squid *Nototodarus gouldi* in Bass Strait. Aust. J. Mar. Freshwat. Res. 324(2):261-285.

Owen, G.P. and L.J. Tilly. 1985. A preliminary examination of outwelling from a tropical lagoon. Caribb. J. Sci. 21(1/2):13-18.

Oya, F. 1987. Growth, stomach contents and parasites in a tidepool population of the hippolytid shrimp *Heptacarpus futilirostris*, with reference to reproduction. Mar. Biol. 96(2):225-234.

Paloheimo, J.E. and L.M. Dickie. 1966. Food and growth of fishes III. Relation among food, body size and growth efficiency. J. Fish. Res. Board Can. 23:1209-1248.

Palomares, M.L. 1987. Comparative studies on the food consumption of marine fishes with emphasis on species occurring in the Philippines. University of the Philippines, Diliman, Philippines. 107 p. M.S.thesis.

Palomares, M.L. and D. Pauly. 1989. A multiple regression model for predicting the food consumption of marine fish populations. Aust. J. Mar. Freshwat. Res. 40:259-273.

Pamatmat, M.M. and S. Findlay. 1983. Metabolism of microbes, nematodes, polychaetes, and their interactions in sediment, as detected by heat flow measurements. Mar. Ecol. (Prog. Ser.) 11:31-38.

Parrish, J.D. 1982. Fishes at a Puerto Rican coral reef: distribution, behavior, and response to passive fishing gear. Caribb. J. Sci. 18(1-4):9-20.

Parrish, J.D., J.E. Norris, M.W. Callahan, J.K. Callahan, E.J. Magarifuji and R.E. Schroeder. 1986. Piscivory in a coral reef fish community, p. 285-297. *In* C.A. Simenstad and G.M. Cailliet (eds.) Contemporary studies on fish feeding. Dr. W. Junk Publishers, The Netherlands.

Parsons, T.R. and R.J. LeBrasseur. 1970. The availability of food to different trophic levels in the marine food chain, p. 325-343. *In* J.H. Steele (ed.) Marine food chains. Oliver and Boyd, Edinburgh.

Patel, N.M., N.D. Chhaya and M. Bhaskaran. 1979. Stomach contents of *Portunus pelagicus* (Linn.) from AD net catches. Indian J. Mar. Sci. 8(1):48-49.

Patriquin, D.G. 1973. Estimation of growth rate, production and age of the marine angiosperm *Thalassia testudinum* König. Caribb. J. Sci. 13:111-123.

Paul, R.K.G. 1981. Natural diet, feeding and predatory activity of the crabs *Callinectes arcuatus* and *C. toxotes* (Decapoda, Brachyura, Portunidae). Mar. Ecol. (Prog. Ser.) 6(1):91-99.

Pauly, D. 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel 55, 200 p.

Pauly, D. 1979a. Theory and management of tropical multispecies stocks: a review with emphasis on the Southeast demersal fisheries. ICLARM Stud. Rev. 1, 35 p.

Pauly, D. 1979b. Gill size and temperature as governing factors in fish growth: a generalization of von Bertalanffy's growth formula. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel 63, 156 p.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Cons. CIEM 39(3):175-192.

Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev. 8, 325 p.

Pauly, D. 1985. Zur Fischereibiologie Tropischer Nutztiere. Eine Bestandsaufnahme von Konzepten und Methoden. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel 147, 155 p.

Pauly, D. 1986. A simple method for estimating the food consumption of fish populations from growth data and food conversion experiments. Fish. Bull. 84(4):827-840.

Pauly, D. and G.I. Murphy, Editors. 1982. Theory and management of tropical fisheries. ICLARM Conf. Proc. 9, 360 p.

Pauly, D. and H. Calumpong. 1984. Growth, reproduction and mortality of the sea hare *Dolabella auricularia* (Gastropoda: Aplysiidae) in the Central Visayas, Philippines. Mar. Biol. 79:289-293.

Pauly, D. and J. Ingles. 1981. Aspects of the growth and natural mortality of exploited coral reef fishes. Proc. Fourth Int. Coral Reef Symp. 1:89-98.

Pauly, D. and M.L. Palomares. 1986. Shrimp consumption by fish in Kuwait waters: a methodology, preliminary results and their implications for management and research. Kuwait Bull. Mar. Sci. 9:101-125.

Pauly, D. and V. Christensen. 1993. Graphical representation of steady-state trophic ecosystem models, p. 20-28. *In* V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, 390 p.

Pauly, D. and V. Christensen. 1995. Primary production required to sustain global fisheries. Nature 374:255-257.

Pauly, D., M.L. Soriano-Bartz and M.L.D. Palomares. 1993a. Improved construction, parametrization and interpretation of steady-state ecosystem models, p. 1-13. *In* V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, 390 p.

Pauly, D., V. Sambilay, Jr. and S. Opitz. 1993b. Estimates of relative food consumption by fish and invertebrate populations, required for modelling the Bolinao reef ecosystem, Philippines, p. 236-251. *In* V. Christensen and D. Pauly (eds.) Trophic models of aquatic ecosystems. ICLARM Conf. Proc. 26, 390 p.

PDT (Plan Development Team). 1990. The potential of marine fishery reserves for reef fish management in the U.S. Southern Atlantic. NOAA Tech. Memo. NMFS-SEFC-261, 40 p.

Pearson, M. and J.D. Gage. 1984. Diets of some deep-sea brittle stars in the Rockall Trough. Mar. Biol. 82(3):247-258.

Penchaszadeh, P.E. and R. Molinet. 1983. Diet of the sea-star *Tethyaster vestitus* Say (Astropectinidae) in the Golfo Triste (Venezuela). Bull. Mar. Sci. 33(1):187-191.

Penney, A.J. and C.L. Griffiths. 1983. Prey selection and the impact of a suite of predators on populations of the mussel *Choromytilus meridionalis*, p. G20. Abstracts of the Fifth National Oceanographic Symposium, 24-28 January 1983, Rhodes University, Grahamstown.

Pennington, M. 1984. Estimating the average food consumption by fish in the field from stomach contents data. ICES Doc. C.M. 1984/H:28.

Perez, O.S. and D.R. Bellwood. 1988. Ontogenetic changes in the natural diet of the sandy shore crab, *Matuta lunaris* (Forsskål) (Brachyura: Calappidae). Aust. J. Mar. Freshwat. Res. 39(2):193-199.

Perron, F.E., G.A. Heslinga and J.O. Fagolimul. 1985. The gastropod *Cymatium muricinum*, a predator on juvenile tridacnid clams. Aquaculture 48(3/4):211-221.

Pielou, E.C. 1984. The interpretation of ecological data. John Wiley and Sons, Inc., New York. 263 p.

Platt, T., K.H. Mann and R.E. Ulanowicz. 1981. Mathematical models in biological oceanography. UNESCO Press, Paris. 156 p.

Pohlo, R. 1982. Evolution of the Tellinacea (Bivalvia). J. Molluscan Stud. 48(3):245-256.

Polovina, J.J. 1984a. An overview of the ECOPATH model. Fishbyte 2(2):5-7.

Polovina, J.J. 1984b. Model of a coral reef ecosystem. Part I. The ECOPATH model and its application to French Frigate Shoals. Coral Reefs 3:1-11.

Polovina, J.J. 1984c. ECOPATH - an ecosystem model applied to French Frigate Shoals, p. 375-398. *In* R.W. Grigg and K.Y. Tanoue (eds.) Proceedings of the Second Symposium on Resource Investigations in the Northwestern Hawaiian Islands, 25-27 May 1983. Vol. 1. University of Hawaii, Honolulu, Hawaii.

Polovina, J.J. 1985. An approach to estimating an ecosystem box model. U.S. Fish. Bull. 83(3):457-460.
Polovina, J.J. 1986. Corrections for the listing of the ECOPATH model. Fishbyte 4(1):21.
Polovina, J.J. and M.D. Ow. 1983. ECOPATH: a user's manual and program listings. Southwest Fish. Cent. Adm. Rep. H82-23, 46 p. NMFS, Honolulu.
Polovina, J.J. and S. Ralston, Editors. 1987. Tropical snappers and groupers: biology and fisheries management. Westview Press, Boulder and London. 659 p.
Poon, P.A. 1987. The diet and feeding behavior of *Cadulus tolmiei* Dall 1897 (Scaphopoda: Siphonodentalioida). Nautilus 101(2):88-92.
Pozo, E. 1979. Edad y crecimiento del pargo criollo (*Lutjanus analis* (Cuvier 1828)) en la plataforma nororiental de Cuba. Rev. Cuba. Invest. Pesq. 4(2):1-24.
Prahl, H., F. Guhl and M. Groegl. 1978. Crustáceos decápodos commensales del coral *Pocillopora damicornis* L. en la Isla de Gorgona, Colombia. Ann. Inst. Invest. Mar. 10:81-93.
Primavera, J.H. and R.Q. Gacutan. 1985. *Ruppia maritima* and *Najas graminea* as natural foods for *Penaeus monodon* juveniles, p. 182-183. *In* Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps, 4-7 December 1984, Iloilo City, Philippines.
Ralston, S. 1976. Age determination of a tropical reef butterfly fish utilizing daily growth rings in otoliths. Fish Bull. 74(4):990-994.
Randall, J.E. 1962. Tagging reef fishes in the Virgin Islands. Proc. Gulf Caribb. Fish. Inst. 14:201-241.
Randall, J.E. 1963a. Additional recoveries of tagged reef fishes in the Virgin Islands. Proc. Gulf Caribb. Fish. Inst. 15:155-157.
Randall, J.E. 1963b. An analysis of the fish populations of artificial and natural reefs in the Virgin Islands. Caribb. J. Sci. 3:31-48.
Randall, J.E. 1967. Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. 5:665-847.
Randall, J.E. 1968. Caribbean reef fishes. T.F.H. Publications, Inc., Neptune City, New Jersey. 318 p.
Randall, J.E. 1983. Caribbean reef fishes. Second edition. T.F.H. Publications, Inc., Neptune City, New Jersey.
Reed, J.K., R.H. Gore, L.E. Scotto and K.A. Wilson. 1982. Community composition, structure, areal and trophic relationships of decapods associated with shallow- and deep-water *Oculina varicosa* coral reefs: studies on decapod crustacea from the Indian River region of Florida, XXIV. Bull. Mar. Sci. 32(3):761-786.
Regis, M.B. and B.A. Thomassin. 1982. Regular echinoids in coral reefs of the Tulear region (S-W Malagasy): morphological adaptations of spine's microstructure. Ann. Inst. Oceanogr. Paris (Nouv. Ser.) 58(2):117-158.
Reid, R.G.B. 1985. Isognomon: life in two dimensions. The malacofauna of Hong Kong and Southern China, p. 311-319. *In* Proceedings of the Second International Workshop on the Malacofauna of Hong Kong and Southern China, 6-24 April 1983, Hong Kong. Vol. 1.
Reiswig, H.M. 1971. Particle feeding in natural populations of three marine demosponges. Biol. Bull. 141:568-591.
Rice, J.A., J.E. Breck, S.M. Bartell and J.F. Kitchell. 1983. Evaluating the constraints of temperature, activity and consumption on growth of largemouth bass. Environ. Biol. Fish. 9:263-275.
Ricker, W.E. 1969. Food from the sea, p. 87-108. *In* Resources and man: the Report of the Committee on Resources and Man to the US National Academy of Science. W.H. Freeman and Co., San Francisco. 259 p.
Ricker, W.E. 1973. Linear regression in fishery research. J. Fish. Res. Board Can. 30:409-434.
Riddle, M.J., D.M. Alongi, P.K. Dayton, J.A. Hansen and D.W. Klumpp. 1990. Detrital pathways in a coral reef lagoon. Mar. Biol. 104:109-118.
Rietsma, C.S., I. Valiela and A. Sylvester-Serianni. 1982. Food preferences of dominant salt marsh herbivores and detritivores. P.S.Z.N. I: Mar. Ecol. 3(2):179-189.
Robertson, J.R. and W.J. Pfeiffer. 1981. Deposit-feeding by the ghost crab *Ocypode quadrata* (Fabricius). J. Exp. Mar. Biol. Ecol. 56(2/3):165-177.
Robertson, R. and P.L. Schutt. 1984. Golden wentletraps on golden corals. Hawaii. Shell News 32(11).
Rogers, C.S. and N. Salesky. 1981. Productivity of *Acropora palmata* (Lamarck), macroscopic algae, and algal turf from Tague Bay reef, St. Croix, U.S.V.I. J. Exp. Mar. Biol. Ecol. 49:179-187.
Roushdy, H.M. and V.K. Hansen. 1960. Ophiuroids feeding on phytoplankton. Nature 188:517-518.

Rudloe, A. 1983. Preliminary studies of the mariculture potential of the slipper-lobster, *Scyllarides nodifer*. Aquaculture 34(1/2):165-169.

Saccardo, S.A. 1983. Biologia y disponibilidad de sardina (*Sardinella brasiliensis*, Steindachner 1879) en la costa sudeste del Brasil. FAO Fish. Rep. 291(2):449-464.

Saisho, T., T. Noguchi, K. Koyama, A. Uzu, T. Kikuta and K. Hashimoto. 1983. Examination of stomach contents in xanthid crabs. Bull. Jap. Soc. Sci. Fish. 49(6):939-947.

Sale, P.F. 1975. Patterns of use of space in a guild of territorial reef fishes. Mar. Biol. 29:89-97.

Sale, P.F. 1977. Maintenance of high diversity in coral reef fish communities. Am. Nat. 111:337-359.

Salvat, B. and M. Denizot. 1982. La distribution des mollusques supralittoraux sur substrats carbonates tropicaux (Polynésie Française) et leur régime alimentaire, p. 541-544. *In* Proceedings of the Seventh International Malacological Congress, 31 August-7 September 1980. Malacologia.

Salzwedel, H. 1980. Energy budgets for two populations of the bivalve *Tellina fabula* in the German Bight. Veröff. Inst. Meeresforsch. Bremerh. 18(2):257-287.

Sandifer, P.A. and J.H. Kerby. 1983. Early life history and biology of the common fish parasite, *Lironeca ovalis* (Say) (Isopoda, Cymothoidae). Estuaries 6(4):420-425.

Scheibling, R.E. 1982. Feeding habits of *Oreaster reticulatus* (Echinodermata: Asteroidea). Bull. Mar. Sci. 32(2):504-510.

Schembri, P.J. 1981. Feeding in *Ebalia tuberosa* (Pennant) (Crustacea: Decapoda: Leucosiidae). J. Exp. Mar. Biol. Ecol. 55(1):1-10.

Schembri, P.J. and V. Jaccarini. 1978. Some aspects of the ecology of the echiuran worm *Bonellia viridis* and associated infauna. Mar. Biol. 47:55-61.

Schmid, P.H. and R. Schaerer. 1981. Predator-prey interaction between two competing sea star species of the genus *Astropecten*. P.S.Z.N.I: Mar. Ecol. 2(3):207-214.

Schwinghamer, P., B. Hargrave, D. Peer and C.M. Hawkins. 1986. Partitioning of production and respiration among size groups of organisms in an intertidal benthic community. Mar. Ecol. (Prog. Ser.) 31:131-142.

Scott, P.J.B. 1988. Distribution, habitat and morphology of the Caribbean coral- and rock-boring bivalve, *Lithophaga bisulcata* (d'Orbigny) (Mytilidae: Lithophaginae). J. Molluscan Stud. 54(1):83-95.

Scott, P.J.B., H.M. Reiswig and B.M. Marcotte. 1988. Ecology, functional morphology, behaviour, and feeding in coral- and sponge-boring species of *Upogebia* (Crustacea: Decapoda: Thalassinidea). Can. J. Zool. 66(2):483-495.

Sebens, K.P. and M.A.R. Koehl. 1984. Predation on zooplankton by the benthic anthozoans *Alcyonium siderium* (Alcyonacea) and *Metridium senile* (Actiniaria) in the New England subtidal. Mar. Biol. 81(3):255-271.

Segal, E. 1987. Behavior of juvenile *Nerocila acuminata* (Isopoda, Cymothoidae) during attack, attachment and feeding on fish prey. Bull. Mar. Sci. 41(2):351-360.

Seiple, W. and M. Salmon. 1982. Comparative social behavior of two grapsid crabs, *Sesarma reticulatum* (Say) and *S. cinereum* (Bosc). J. Exp. Mar. Biol. Ecol. 62(1):1-24.

Shafir, A. and Y. Loya. 1983. Consumption and assimilation of coral mucus by the burrowing mussel *Lithophaga lessepsiana*. Bull. Inst. Oceanogr. Fish. (Cairo):135-140.

Shivji, M., D. Parker, B. Hartwick, M.J. Smith and N.A. Sloan. 1983. Feeding and distribution study of the sunflower sea star *Pycnopodia helianthoides* (Brandt 1835). Pac. Sci. 37(2):133-140.

Sierra, L.M. and J. Diaz-Zaballa. 1984. Alimentacion de 2 especies de sardina *Harengula humeralis* (Cuvier, 1829) y *Harengula clupeola* (Cuvier, 1829), en la costa norte de la Ciudad de La Habana (rada del Instituto de Oceanologia). Rep. Invest. Inst. Oceanol. Acad. Cienc. Cuba 25, 18 p.

Signor, P.W. III. 1985. The role of shell geometry as a deterrent to predation in terebrid gastropods. Veliger 28(2):179-185.

Silvert, W.L. 1981. Principles of ecosystem modelling, p. 651-676. *In* A.R. Longhurst (ed.) Analysis of marine ecosystems. Academic Press, New York. 741 p.

Sisak, M.M. and F. Sander. 1987. On the general ecology of *Holothuria glaberrima* Selenka (Echinodermata). Proc. Assoc. Isl. Mar. Lab. Caribb. 17:14. (Summary only.)

Smale, M.J. 1978. Migration, growth and feeding in the Natal rock lobster *Panulirus homarus* (Linnaeus). Oceanogr. Res. Inst. Invest. Rep. 47, 56 p.

Smale, M.J. and P.R. Buchan. 1981. Biology of *Octopus vulgaris* off the East coast of South Africa. Mar. Biol. 65(1):1-12.

Smith, C.L. 1973. Small rotenone stations: a tool for studying coral reef fish communities. Am. Mus. Novit. 2512:1-21.

Smith, C.L. and J.C. Tyler. 1972. Space resource sharing in a coral reef fish community, p. 125-170. *In* B.B. Collette and S.A. Earle (eds.) Results of the Tektite program: ecology of coral reef fishes. Nat. Hist. Mus. L. A. Co. Sci. Bull. 14, 180 p.

Sorokin, Yu.I. 1987. Problems of productivity, trophology, and energy balance of coral reef ecosystems. Sov. J. Mar. Biol. (Transl. Biol. Morya) 12(6):325-335.

Stanhope, J.J. 1980. Marine benthic algae, with an indication of their distribution, relative abundance, and standing crop. *In* E.H. Gladfelter and W.B. Gladfelter (eds.) Environmental studies of Buck Island Reef National Monument III, St. Croix, U.S.V.I.: Chapter II. West Indies Laboratory, St. Croix.

Staples, D.A. and J.E. Watson. 1987. Associations between pycnogonids and hydroids, p. 215-226. *In* Modern trends in the systematics, ecology, and evolution of hydroids and hydromedusae. Oxford Sci. Publ.

Steele, H. 1974. The structure of marine ecosystems. Blackwell Scientific Publications, Oxford. 128 p.

Steinberg, P.D. 1985. Feeding preferences of *Tegula funebralis* and chemical defenses of marine brown algae. Ecol. Monogr. 55(3):333-349.

Steneck, R.S. 1982. A limpet-coralline algal association: adaptations and defenses between a selective herbivore and its prey. Ecology 63(2):507-522.

Steneck, R.S. and L. Watling. 1982. Feeding capabilities and limitation of herbivorous molluscs: a functional group approach. Mar. Biol. 68:299-319.

Stevenson, J.C. 1988. Comparative ecology of submersed grass beds in freshwater, estuarine, and marine environments. Limnol. Oceanogr. 33(4/2):867-893.

Stewart, D.J., D. Weininger, D.V. Rottiers and T.A. Edsall. 1983. An energetics model for lake trout *Salvelinus namaycush*: application to the Lake Michigan population. Can. J. Fish. Aquat. Sci. 40:681-698.

Stoner, A.W. and R.J. Zimmerman. 1988. Food pathways associated with penaeid shrimps in a mangrove-fringed estuary. Fish. Bull. 86(3):543-552.

Stuart, V and D.W. Klumpp. 1984. Evidence for food-resource partitioning by kelp-bed filter feeders. Mar. Ecol. (Prog. Ser.) 16(1/2):27-37.

Stuart, V., E.J.H. Head and K.H. Mann. 1985. Seasonal changes in the digestive enzyme levels of the amphipod *Corophium volutator* (Pallas) in relation to diet. J. Exp. Mar. Biol. Ecol. 88(3):243-256.

Sushchenya, L.M. 1970. Food rations, metabolism and growth of crustaceans, p. 127-141. *In* J. H. Steele (ed.) Marine food chains. Oliver and Boyd, Edinburgh.

Suthers, I.M. and D.T. Anderson. 1981. Functional morphology of mouthparts and gastric mill of *Ibacus peronii* (Leach) (Palinura: Scyllaridae). Aust. J. Mar. Freshwat. Res. 32(6):931-944.

Talbot, F.H., B.C. Russell and G.R.V. Anderson. 1978. Coral reef fish communities: unstable, high diversity system? Ecol. Monogr. 48:425-440.

Taylor, J.D. 1982. Diets of sublittoral predatory gastropods of Hong Kong, p. 907-920. *In* B. Morton and C.K. Tseng (eds.) The marine flora and fauna of Hong Kong and Southern China. Vol. 2: ecology, morphology, behaviour and physiology. Proceedings of the International Marine Biological Workshop, 18 April 1980, Hong Kong.

Taylor, J.D. 1987. Feeding ecology of some common intertidal neogastropods at Djerba, Tunisia. Vie Milieu 37(1):13-20.

Tertschnig, W.P. 1989. Diel activity patterns and foraging dynamics of the sea urchin *Tripneustes ventricosus* in a tropical seagrass community and a reef environment (Virgin Islands). P.S.Z.N. I. Mar. Ecol. 10(1):3-21.

Thangavelu, R. and P. Muthiah. 1983. Predation of oyster *Crassostrea madrasensis* by gastropod *Cymatium cingulatum* (Lamarck) in the oyster farm at Tuticorin, p. 488-494. *In* Proceedings of the Symposium on Coastal Aquaculture, 12-18 January 1980, Cochin, India. Part 2: Molluscan culture.

Thorne, R.E. 1979. The application of hydroacoustics to stock assessment for tropical small-scale fisheries, p. 110-118. *In* P.M. Roedel and S.B. Saila (eds.) Stock assessment for tropical small-scale fisheries. Proceedings of an International Workshop, 19-21 September 1979, University of Rhode Island, Kingston, Rhode Island.

Tomita, K. and T. Mizushima. 1984. Mollusks on leaves of *Zostera marina* in Notsuke Bay. 1. Fauna and growth of the major three species. Venus Jap. J. Malacol. 43(4):331-338.

Town, J.C. 1981. Prey characteristics and dietary composition in intertidal *Astrostole scabra (*Echinodermata: Asteroidea). N.Z. J. Mar. Freshwat. Res. 15(1):69-80.

Tsikhon-Lukanina, E.A., G.G. Nikolaeva and O.G. Reznichenko. 1986. Food spectra of oceanic fouling organisms. Okeanologiya 26(6):1006-1009.

Tsikhon-Lukanina, Y.A. 1982. Food spectra of bottom molluscs. Oceanology 22(6):751-754.

Ulanowicz, R.E. 1980. An hypothesis on the development of natural communities. J. Theor. Biol. 85:223-245.

Ulanowicz, R.E. 1986. Growth and development. Ecosystems phenomenology. Springer Verlag, New York. 203 p.

Ulanowicz, R.E. and J.S. Norden. 1990. Symmetrical overhead in flow networks. Int. J. Syst. Sci. 21(2):429-437.

Ulanowicz, R.E. and T. Platt, Editors. 1985. Ecosystem theory for biological oceanography. Can. Bull. Fish. Aquat. Sci. 213:260 p.

Underwood, A.J. 1984. Vertical and seasonal patterns in competition for microalgae between intertidal gastropods. Oecologia 64(2):211-222.

Ursin, E. 1967. A mathematical model of some aspects of fish growth, respiration and mortality. J. Fish. Res. Board Can. 24:2355-2435.

Vadas, R.L., T. Fenchel and J.C. Ogden. 1982. Ecological studies on the sea urchin, *Lytechinus variegatus*, and the algal-seagrass communities of the Miskito Cays, Nicaragua. Aquat. Bot. 14(2):139-150.

Vahl, O. 1980. Volume of water pumped and particulate matter deposited by the Iceland scallop (*Chlamys islandica*) in Balsfjord, Northern Norway. Fjord oceanography. NATO Conf. Ser. 4. Mar. Sci.:639-644.

Vakily, J.M. 1992. Determination and comparison of bivalve growth with emphasis on Thailand and other tropical areas. ICLARM Tech. Rep. 36, 125 p.

VanMontfrans, J., R.J. Orth and S.A. Vay. 1982. Preliminary studies of grazing by *Bittium varium* on eelgrass periphyton. Aquat. Bot. 14(1):75-89.

Vevers, H.G. 1956. Observations on feeding mechanisms in some echinoderms. Proc. Zool. Soc. London 126:484-485.

Vittor, B.A. and P.G. Johnson. 1977. Polychaete abundance, diversity and trophic role in coral reef communities at Grand Bahama Island and the Florida Middle Ground, p. 163-168. *In* D.L. Taylor (ed.) Proceedings of the Third Coral Reef Symposium 1. Rosenstiel School of Marine and Atmospheric Science, Miami.

Vovk, A.N. 1985. Feeding spectrum of longfin squid (*Loligo pealei*) in the Northwest Atlantic and its position in the ecosystem. NAFO Sci. Counc. Stud. 8:33-38.

Vreeland, H.V. and H.R. Lasker. 1989. Selective feeding of the polychaete *Hermodice carunculata* Pallas on Caribbean gorgonians. J. Exp. Mar. Biol. Ecol. 129:265-277.

Waegele, J.W. 1982. Redescription and comparison of the Mediterranean species of *Paranthura* (Crustacea, Isopoda, Anthuridea). P.S.Z.N. I: Mar. Ecol. 3(2):109-132.

Wanders, J.B.W. 1976a. The role of benthic algae in the shallow reef of Curaçao (Netherlands Antilles) I. Primary productivity in the coral reef. Aquat. Bot. 2:235-270.

Wanders, J.B.W. 1976b. The role of benthic algae in the shallow reef of Curaçao (Netherlands Antilles) II. Primary productivity of the Sargassum beds in the north-east coast submarine plateau. Aquat. Bot. 2:327-335.

Watanabe, J.M. 1984. Food preference, food quality and diets of three herbivorous gastropods (Trochidae: *Tegula*) in a temperate kelp forest habitat. Oecologia 62(1):47-52.

Wear, R.G. and M. Haddon. 1987. Natural diet of the crab *Ovalipes catharus* (Crustacea, Portunidae) around central and northern New Zealand. Mar. Ecol. (Prog. Ser.) 35(1/2):39-49.

Weil, E., F. Losada and D. Bone. 1984. Spatial variations in density and size of the echinoid *Diadema antillarum* Philippi on some Venezuelan coral reefs. Bijdr. Dierkd. 54(1):73-82.

Wicksten, M.K. 1988. Antennary cast net feeding in California hermit crabs (Decapoda, Paguridea). Crustaceana 54(3):321-324.

Wilber, D.H. and T. P. Wilber, Jr. 1989. The effects of holding space and diet on the growth of the West Indian spider crab *Mithrax spinosissimus* (Lamarck). J. Exp. Mar. Biol. Ecol. 131:215-222.

Wilkinson, C.R. 1987. Interocean differences in size and nutrition of coral reef sponge populations. Science 236:1654-1657.

Wilkinson, C.R. and A.C. Cheshire. 1988. Growth rate of Jamaican coral reef sponges after hurricane Allen. Biol. Bull. 175:175-179.

Williams, M.J. 1982. Natural food and feeding in the commercial sand crab *Portunus pelagicus* Linnaeus 1766 (Crustacea: Decapoda: Portunidae) in Moreton Bay, Queensland. J. Exp. Mar. Biol. Ecol. 59(2-3):165-176.

Winberg, G.G. 1956. Rate of metabolism and food requirements of fishes. Fish. Res. Board Can. Trans. Ser. 194, 202 p.

Windell, J.T. 1978. Estimating food consumption rates of fish populations, p. 227-254. *In* T. Bagenal (ed.) Methods for assessment of fish production in fresh waters. Blackwell Scientific, Oxford. 365 p.

Winfree, R.A. and S. Weinstein. 1989. Food habits of the Caribbean king crab *Mithrax spinosissimus* (Lamarck), p. 458-464. *In* G.T. Waugh and M.H. Goodwin (eds.) Proceedings of the 39th Annual Gulf and Caribbean Fisheries Institute, November 1986, Hamilton, Bermuda.

Winston, J.E. 1986. Victims of *Avicularia*. P.S.Z.N. I: Mar. Ecol. 7(3):193-199.

Winter, M.A. and P.V. Hamilton. 1985. Factors influencing swimming in bay scallops, *Argopecten irradians* (Lamarck, 1819). J. Exp. Mar. Biol. Ecol. 88(3):227-242.

Witzell, W.N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fish. Synop. 137, 78 p.

Wulff, F., J.G. Field and K.H. Mann, Editors. 1989. Network analysis in marine ecology: methods and applications. Coast. Estuar. Stud. 32, 284 p. Springer Verlag, New York.

Wurzian, R.S. 1984. The role of higher trophic levels in a sublittoral benthic community. 1. Estimates of ingestion in *Astropecten aranciacus* (Linné). P.S.Z.N. I.: Mar. Ecol. 5(1):1-8.

Yamashita, Y., D. Kitagawa and T. Aoyama. 1985. A field study of predation of the hyperiid amphipod *Parathemisto japonica* on larvae of the Japanese sand eel *Ammodytes personatus*. Bull. Jap. Soc. Sci. Fish./Nissuishi 51(10):1599-1607.

Yang, W.T., R.F. Hixon, P.E. Turk, M.E. Krejci, W.H. Hulet and R.T. Hanlon. 1986. Growth, behaviour, and sexual maturation of the market squid, *Loligo opalescens* cultured through the life cycle. Fish. Bull. 84(4):771-798.

Yoshioka, B.B. and P.M. Yoshioka. 1990. Size-specific patterns of colony survivorship in shallow-water gorgonians. Paper presented at the 2do Congreso de Ciencias del Mar, 18-22 June 1990, La Habana, Cuba. (Abstract only).

Zieman, J.C., G.W. Thayer, M.B. Robblee and R.T. Zieman. 1979. Production and export of seagrasses from a tropical bay, p. 21-33. *In* R.J. Livingston (ed.) Ecological processes in coastal and marine systems. Plenum Press, New York. 348 p.

Zimmerman, R.J. 1979. Seagrasses and the evolution of marine gammaridean amphipods. Proc. Assoc. Isl. Mar. Lab. Caribb. 1979, 17 p.

Zimmerman, R.J., R.A. Gibson and J.B. Harrington. 1977. Gammaridean amphipod feeding strategies in a Florida seagrass bed. Proc. Assoc. Isl. Mar. Lab. Caribb. 12:20 p.

8. APPENDICES

Appendix 8.1. Length-weight data of Caribbean reef fishes by author.

Table 8.1.1. Length-weight data of Caribbean reef fishes after Beebe and Tee-Van (1928).

		Observed		Estimated		
Family	Species	Length (cm)[a]	Weight (g)	L_∞ (cm)	W_∞ (g)[b]	a[b,c]
Acanthuridae	*Acanthurus bahianus*	12.5	67	32 /		
	Acanthurus coeruleus	9.5	40	32 /		
Albulidae	*Albula vulpes*	45.0	1,361	82	6,300	0.01494
Atherinidae	*Atherinomorus stipes*	4.5	2	8 -		0.022
Aulostomidae	*Aulostomus maculatus*	57.8	341			0.00177
Balistidae	*Balistes vetula*	16.6	171	40		
	Canthidermis sufflamen			64		
Belonidae	*Ablennes hians*	65.4	320	95		
Canthigasteridae	*Canthigaster rostrata*	5.0	7			
Carangidae	*Caranx bartholomaei*	6.5	5	40		
	Caranx crysos	9.5	17	32		
	Caranx latus	11.5	42	58		
		15.8	103			
		23.8	320			
	Decapterus punctatus	9.5	15	32		0.0175
	Oligoplites saurus	23.3	132	32		0.0104
	Selar crumenophthalmus	17.5	104	64		0.01935 ma
		17.8	109			
	Trachinotus falcatus	18.0	206	32	1,400	
Chaetodontidae	*Chaetodon striatus*	10.2	44	13		0.0415
Clupeidae	*Opisthonema oglinum*	8.5	10			0.0173 ma
		12.7	31			
		21.4	201			
Coryphaenidae	*Coryphaena hippurus*	32.5	1,474	191	15,000	
		64.5	2,268			
Dactylopteridae	*Dactylopterus volitans*	7.0	6	32 /		0.02
		18.2	136			
Diodontidae	*Chilomycterus antennatus*	12.7	160	21		0.0781
	Diodon hystrix	5.6	15			0.0854
Echeneidae	*Echeneis naucrates*	29.7	80	101		0.00305
Elopidae	*Elops saurus*	27.8	92			0.00428
Engraulidae	*Anchoa hepsetus*	3.9	1	16		0.0147
		5.4	2			
		7.0	5			
Ephippidae	*Chaetodipterus faber*			95	9,100	
Gerreidae	*Gerres cinereus*	30.0	1,247	40		0.04619
Ginglymostomatidae	*Ginglymostoma cirratum*	72.2	1,928	318		

continued...

Table 8.1.1 continued

		Observed		Estimated		
	Length	Weight	L_∞	W_∞		
Family	Species	(cm)[a]	(g)	(cm)	(g)[b]	a[b,c]
Gobiidae	*Bathygobius soporator*			16		
	Gobiosoma horsti			7		
Haemulidae	*Anisotremus virginicus*	20.5	330	32	900	
(Pomadasyidae)	*Haemulon bonariense*	18.5	147			
		26.4	401			
	Haemulon plumieri	23.5	316	48	1,800	0.0244
	Haemulon sciurus	21.1	270	48		
	Pomadasys corvinaeformis	12.2	45			0.0247 ma
		18.4	153			
Hemiramphidae	*Hemiramphus brasiliensis*			40		
	Hyporamphus unifasciatus	14.7	27	32		0.0085
Holocentridae	*Holocentrus ascensionis*	15.6	85	64		0.0224
	Holocentrus coruscus	8.5	16			0.0261
	Myripristis jacobus	13.2	75	32		0.0326
	Neoniphon marianus	13.0	52	17 +		0.0237
	Sargocentron vexillarium	10.0	31			0.031
Kyphosidae	*Kyphosus sectatrix*	7.8	13	48		0.0274
Labridae	*Bodianus rufus*	17.3	136	64		0.0263
	Clepticus parrae	16.3	124			0.0286
	Halichoeres garnoti	14.0	53	21		0.0193
	Halichoeres radiatus	6.8	4			0.02345 ma
		13.9	55			
		32.5	907			
	Lachnolaimus maximus	34.1	1,361	64	6,800	0.0301
	Thalassoma bifasciatum	11.5	30			0.0197
Lutjanidae	*Lutjanus analis*	54.2	4,536		11,000	
	Lutjanus apodus	11.5	42		3,600	
		22.5	308			
	Lutjanus campechanus	21.7	252	95	18,000	0.02466
	Lutjanus griseus	9.0	14	95	8,200	0.00956
	Lutjanus jocu	15.0	107			
	Lutjanus synagris	12.8	50	32	1,800	0.03932 ma
		28.5	907			
	Ocyurus chrysurus			64		
Malacanthidae	*Malacanthus plumieri*	29.7	190	40		0.00725
Megalopidae	*Tarpon atlanticus*	7.8	5	260	159,000	
		18.8	65			
		106.0	16,329			
Monacanthidae	*Aluterus schoepfii*	2.2	1			0.01426
		43.0	1,134			
	Aluterus scripta	8.3	7	95		
	Cantherines pullus	13.1	72		2,700	0.032
	Monacanthus ciliatus	5.0	7	21		0.056
Mugilidae	*Mugil curema*	41.8	1,021			0.01398
Mullidae	*Mulloidichthys martinicus*	16.5	98	28		0.02182
	Pseudupeneus maculatus	19.0	145	22		0.02114
Muraenidae	*Gymnothorax funebris*	108.6	1,588			0.00124
	Lycodontis moringa	63.6	227			0.00088
Myliobatidae	*Aetobatus narinari*			382 Length 239 Width	204,000	
Ogcocephalidae	*Ogcocephalus nasutus*	18.5	185			0.0292
Ostraciidae	*Lactophrys bicaudalis*	10.1	63	42		0.06115
	Lactophrys trigonus	21.6	316	24		0.03136
	Lactophrys triqueter	13.5	127	27 +		0.05162

continued...

Table 8.1.1 continued

Family	Species	Observed Length (cm)[a]	Observed Weight (g)	Estimated L_∞ (cm)	Estimated W_∞ (g)[b]	a[b,c]
Pomacanthidae	*Holacanthus ciliaris*			64		
	Holacanthus tricolor	11.5	84	32		0.05523
	Pomacanthus arcuatus	24.0	794	64		0.05744
	Pomacanthus paru	23.5	680	32 +		0.0524
Pomacentridae	*Abudefduf saxatilis*	10.8	76	16		0.06033
	Chromis cyanea	8.5	26	13 /		0.04234
	Microspathodon chrysurus	10.0	53	16		0.05149
		11.5	76			
	Stegastes fuscus	7.5	21	16 /		0.04978
Priacanthidae	*Priacanthus arenatus*	24.0	357			0.02583
Scaridae	*Scarus coelestinus*	46.0	3,175	95		0.03262
	Scarus guacamaia	50.0	3,856	95		0.03085
	Scarus iserti			19		
	Scarus taeniopterus	18.0	150			0.02572
	Sparisoma aurofrenatum	12.8	54	23 /		0.02653 ma
		13.0	60			
	Sparisoma chrysopterum			32 /		
	Sparisoma viride	24.0	416			0.03009
Sciaenidae	*Equetus lanceolatus*	14.0	57			0.02077
	Equetus punctatus	18.7	137			0.02095
	Odontoscion dentex	9.5	18	32		0.02035
		12.6	41			
		13.1	44			
Scombridae	*Auxis thazard*	39.5	907			0.01472
	Euthynnus aletteratus	49.6	1,701			
	Scomberomorus maculatus	28.0	234	111	4,500	
		74.5	4,309			
	Scomberomorus regalis			191	9,100	
	Thunnus obesus	62.0	5,443	159		
Scorpaenidae	*Scorpaena brasiliensis*	8.7	24			0.03427 ma
		14.2	92			
	Scorpaena grandicornis	10.9	47			0.03629
	Scorpaena plumieri	11.6	85	32 /		0.05446
Serranidae	*Alphestes afer*	14.5	102	32 +		0.03346
	Cephalopholis cruentata	5.9	6	32		
		16.6	114			
	Cephalopholis fulva	17.7	143	32		0.02579
	Epinephelus guttatus	13.8	59	48		0.0229
		23.5	303			
	Epinephelus itajara	12.2	45	254	314,000	
	Epinephelus morio	26.5	460	95		0.02472
	Epinephelus striatus			95	23,000	
	Mycteroperca venenosa	40.6	1,814	95 -		0.02711
	Paranthias furcifer	16.4	96	27		0.02176
	Serranus tabacarius	10.5	26			0.02416 m
		10.8	29			
		10.8	34			
	Serranus tigrinus	7.3	8			0.02056
Sparidae	*Calamus bajonado*	14.3	94	64	4,500	
	Calamus calamus	21.9	295	40		0.02809
Sphyraenidae	*Sphyraena barracuda*	70.5	2,495	167	25,000	0.00712
Synodontidae	*Synodus intermedius*	22.5	129	40		0.01133
Tetraodontidae	*Sphoeroides spengleri*	8.0	14			0.02734

[a]Type of length not stated.
[b]'a' computed with equation (2.4); 'b' assumed equal to 3.0.
[c]Calculated only when an estimate of 'a' or W_∞ was needed for combined asymptotic sizes from various authors (Table 3.5).
Symbols:
ma = mean 'a' from several L/W pairs.
/ = approximate maximum size.
+ = rather more than the recorded maximum size.
- = rather less than the recorded maximum size.

Table 8.1.2 Length-weight data of Caribbean reef fishes after Randall (1962, 1967, 1968).

Family	Species	Length (cm)	Weight (g)	L_{max} (cm)	W_{max} (g)[a]	a[a]	b
Acanthuridae	*Acanthurus bahianus*			36 !		0.0541	2.665 FL
	Acanthurus chirurgus			34 !			
	Acanthurus coeruleus			37 !			
Albulidae	*Albula vulpes*	49.5	1,180	102 *	8,600 *	0.011	3 as
Antennariidae	*Antennarius multiocellatus*			15 (-)			
	Phrynelox scaber			15 /			
Apogonidae	*Apogon conklini*			5 /			
	Apogon maculatus			10 /			
Atherinidae	*Allanetta harringtonensis*			8 /			
	Atherinomorus stipes			9 +			
Aulostomidae	*Aulostomus maculatus*			76 /			
Balistidae	*Balistes capriscus*			30 (+)			
	Balistes vetula			57 !		0.0291	2.993 FL
	Canthidermis sufflamen			56 +	4,500 -		
	Melichthys niger			36			
	Xanthichthys ringens			25			
Belonidae	*Platybelone argalus argalus*			51 /			
	Strongylura timucu			46 /			
	Tylosurus crocodilus			152			
Blenniidae	*Entomacrodus nigricans*			8+			
	Ophioblennius atlanticus			12/			
	Parablennius marmoreus			8			
	Scartella cristata			11			
Bothidae	*Bothus lunatus*			46 /			
	Bothus ocellatus			18			
	Paralichthys tropicus			51 +			
Carangidae	*Alectis ciliaris*	40.6	950	91 /		0.0142	3 as
	Caranx bartholomaei			76 /			
	Caranx crysos			58 !			
	Caranx hippos	85.6	6,210		18,000 /	0.0099	3 as
	Caranx latus	71.9	3,860	76 !		0.0122	3 as
		33.8	540				
	Caranx lugubris	62.2	3,080	76 !		0.0128	3 as
	Caranx ruber			61 !			
	Decapterus macarellus			30 +			
	Decapterus punctatus			30 (-)			
	Elagatis bipinnulatus	41.9	450	119	13,600		
	Oligoplites saurus			30 +			
	Selar crumenophthalmus			41 /			
	Seriola dumerili	111.8	14,060		80,000	0.0108 ma	3 as
		180.3	67,585				
	Seriola rivoliana	66.0	2,860		23,000 (+)		
	Trachinotus falcatus	31.2	450	107	23,000		
	SL	50.0	3,620				
	SL	81.0	14,950				
		104.1	15,195				
	Trachinotus goodei			37			
				51 ( )			
Carcharhinidae	*Carcharhinus perezi*			274 +			
	Galeocerdo cuvier	279.4	117,930	549		0.00804 ma	3 as
		422.9	807,390	914 ( )			
	Negaprion brevirostris	63.5	1,220	335		0.0048	3 as
	Rhizoprionodon porosus	88.9	2,860	107		0.0041	3 as
Chaetodontidae	*Chaetodon aculeatus*			9 !			
	Chaetodon capistratus			10			
				15 ( )			
	Chaetodon sedentarius			14 !			
	Chaetodon striatus			15			

continued...

Table 8.1.2 continued

Family	Species	Length (cm)	Weight (g)	L_{max} (cm)	W_{max} (g)[a]	a[a]	b
Cirrhitidae	*Amblycirrhitus pinos*			8			
Clinidae	*Labrisomus nuchipinnis*			20 /			
Clupeidae	*Harengula clupeola*			14			
	Harengula humeralis			22			
	Jenkinsia lamprotaenia			6			
	Opisthonema oglinum			30			
Congridae	*Heteroconger halis*			48			
Dactylopteridae	*Dactylopterus volitans*			33 !			
Dasyatidae	*Dasyatis americana*			152 Width			
	Urolophus jamaicensis			76			
Diodontidae	*Chilomycterus antennatus*			25 !			
	Chilomycterus antillarum			25 !			
	Diodon holocanthus			51			
	Diodon hystrix			57 !			
				91			
Echeneidae	*Echeneis naucrates*			81 !	1,800 !		
	Remora remora			79			
Emmelichthyidae	*Inermia vittata*			23 /			
Engraulidae	*Anchoa lyolepis*			8			
Ephippidae	*Chaetodipterus faber*	35.1	1,360·	90	9,000		
Fistulariidae	*Fistularia tabacaria*			183			
Gerreidae	*Eucinostomus argenteus*			19 !			
	Gerres cinereus	36.8	540	39 !		0.0108	3 as
Ginglymostomatidae	*Ginglymostoma cirratum*	160.0	23,590	427 ( )			
Gobiidae	*Bathygobius soporator*			15			
	Coryphopterus glaucofraenum			8			
	Gobiosoma sp.*(evelynae)*			4 /			
	Gnatholepis thompsoni			6 /			
Grammidae	*Gramma loreto*			8 +			
(Serranidae)	*Gramma melacara*			10 -			
Grammistidae (Serranidae)	*Rypticus saponaceus*			28 !			
Haemulidae	*Anisotremus surinamensis*			60 !	4,100 !		
(Pomadasyidae)	*Anisotremus virginicus*			30 /			
	Haemulon album	46.7	1,540	65 !		0.0151	3 as
	Haemulon aurolineatum			25 -			
	Haemulon bonariense			28 /			
	Haemulon boschmae			19 /			
	Haemulon carbonarium			36 !			
	Haemulon chrysargyreum			23 !			
	Haemulon flavolineatum			27 /		0.0197	3 as
	Haemulon macrostomum	38.6	1,130	43 !			
	Haemulon melanurum			33			
	Haemulon parrai			41			
	Haemulon plumieri	26.4	450	41		0.0245	3 as
	Haemulon sciurus	29.7	450	39 !		0.0172	3 as
				46			
	Haemulon steindachneri			27			
	Haemulon striatum			28			
	Orthopristis ruber			33			
Hemiramphidae	*Hemiramphus balao*			38 /			
	Hemiramphus brasiliensis			38 /			

continued...

Table 8.1.2 continued

Family	Species	Length (cm)	Weight (g)	L_{max} (cm)	W_{max} (g)[a]	a[a]	b
Holocentridae	*Holocentrus ascensionis*			35 !			
	Holocentrus coruscus			13			
	Holocentrus rufus			32 +			
	Myripristis jacobus			22 !			
	Neoniphon marianus			18 !			
	Plectrypops retrospinis			13			
	Sargocentron vexillarium			18 -			
Kyphosidae	*Kyphosus incisor*	67.3	5,440	76 ( )		0.01785	3 as
	Kyphosus sectatrix			76 !			
Labridae	*Bodianus rufus*			39			
				61 ( )			
	Clepticus parrae			25			
				30 ( )			
	Halichoeres bivittatus			22 !			
	Halichoeres garnoti			19			
	Halichoeres maculipinna			11			
	Halichoeres poeyi			20			
	Halichoeres radiatus			46			
	Lachnolaimus maximus	81.3	6,530		11,000 ( )	0.0121	3 as
	Thalassoma bifasciatum			15 ( )			
	Xyrichtys novacula			22 !			
	Xyrichtys splendens			14			
Lutjanidae	*Lutjanus analis*	38.1	770		11,000 ( )	0.0136 m	3 as
		69.9	4,540				
	Lutjanus apodus	53.3	2,495	56 !	3,600 ( )	0.0218	2.939 FL
	Lutjanus cyanopterus	90.2	12,380		45,000 +	0.0168	3 as
	Lutjanus griseus	39.6	1,040		3,600	0.0167	3 as
	Lutjanus jocu	39.4	950	79 !	9,000 (+)	0.0234	3 as
	SL	63.0	7,825				
	Lutjanus mahagoni			38 !			
	Lutjanus synagris			36			
	Ocyurus chrysurus	71.1	2,270	76 /		0.0063	3 as
Malacanthidae	*Malacanthus plumieri*	52.8	730	61 /		0.0049	3 as
Megalopidae	*Tarpon atlanticus*	36.6	1,590	244 +	160,000		
Monacanthidae	*Aluterus monoceros*			61 +			
	Aluterus schoepfii			51			
	Aluterus scripta			72 !	2,500 !	0.0067	3 as
				91			
	Cantherines macrocerus			42 !			
	Cantherines pullus			18 ♀			
				20 ♂			
	Monacanthus ciliatus			13 !			
	Monacanthus tuckeri			9 !			
	Stephanolepis setifer			18 !			
Mugilidae	*Mugil curema*			38			
Mullidae	*Mulloidichthys martinicus*	32.8	500	39		0.0141	3 as
	Pseudupeneus maculatus			28 /			
Muraenidae	*Enchelycore nigricans*			76 +			
	Echidna catenata			71			
	Gymnothorax funebris	83.8	1,500	189	12,000	0.0025	3 as
	Gymnothorax miliaris			51 /			
	Gymnothorax vicinus			122 /			
	Lycodontis moringa			122 /			
Myliobatidae	*Aetobatus narinari*	91.4	34,470	230 Width		0.0451	3 as
Ogcocephalidae	*Ogcocephalus nasutus*			28 /			
Ophichthidae	*Myrichthys breviceps*			91 +			
	Myrichthys ocellatus			91 /			
	Ophichtus ophis	122.0	1,400	135		0.0008 ma	3 as
		116.3	1,470				

continued...

Table 8.1.2 continued

Family	Species	Length (cm)	Weight (g)	L_{max} (cm)	W_{max} (g)[a]	a[a]	b
Opisthognathidae	*Opisthognathus aurifrons*			10 -			
	Opistognathus macrognathus			20 -			
	Opistognathus maxillosus			13 /			
	Opisthognathus whitehurstii			8 !			
Ostraciidae	*Acanthostracion polygonius*	770		39 !			
	Acanthostracion quadricomis	4,540		46 /			
	Lactophrys bicaudalis	12,380		41 +			
	Lactophrys trigonus	2,495		46 +			
	Lactophrys triqueter			30 /			
Pempheridae	*Pempheris poeyi*			10 /			
	Pempheris schomburgki			15			
Pomacanthidae	*Centropyge argi*			7			
	Holacanthus ciliaris	42.7	1,590	46		0.0204	3 as
	Holacanthus tricolor			25			
				30			
	Pomacanthus arcuatus			43			
				61			
	Pomacanthus paru			41			
Pomacentridae	*Abudefduf saxatilis*			18 +			
	Abudefduf taurus			20 /			
	Chromis cyanea			13 /			
	Chromis multilineata			16 !			
	Microspathodon chrysurus			19 /			
	Stegastes fuscus			13 !			
				15 /			
	Stegastes leucostictus			10			
	Stegastes planifrons			13 /			
	Stegastes variabilis			10 +			
Priacanthidae	*Heteropriacanthus cruentatus*			30 /			
	Priacanthus arenatus			41 /			
Rachycentridae	*Rachycentron canadum*	56.6	1,720	178	46,000	0.0088 ma	3 as
Scaridae	*Cryptotomus roseus*			13 ( )			
	Nicholsina usta			29 !			
	Scarus coelestinus	51.6	2,400	76 !	7,000 !	0.0167 ma	3 as
	Scarus coeruleus	62.5	3,360	58 !♂	3,400 !♂	0.0156 ma	3 as
				91			
	Scarus guacamaia	57.2	3,220	94 !	20,000 !		
	Scarus iserti			25			
	Scarus taeniopterus			30 /			
	Scarus vetula			51 !			
	Sparisoma aurofrenatum			25 +			
	Sparisoma chrysopterum			41 ! ♀			
				51 / ♂			
	Sparisoma radians			19 !			
	Sparisoma rubripinne			34 ! ♀		0.0031	3.562 FL
				44 ! ♂			
	Sparisoma viride			51 +	1,600 +		
Sciaenidae	*Equetus lanceolatus*			23 /			
	Equetus punctatus			27 !			
	Odontoscion dentex			18 +			
	Pareques acuminatus			23 ( )			
Scombridae	*Euthynnus aletteratus*	32.5	450	91 /	9,100 +		
	Scomberomorus cavalla	110.7	10,660	165 +	36,000 /		
	Scomberomorus maculatus	53.3	860	122 ( )	9,100 ( )		
	Scomberomorus regalis	41.4	450	81 !	12,000 ( )		
				122 ( )			
Scorpaenidae	*Scorpaena brasiliensis*			36 /			
	Scorpaena grandicornis			18 /			
	Scorpaena plumieri			43 /			
	Scorpaenodes caribbaeus			13 /			

continued...

Table 8.1.2 continued

Family	Species	Length (cm)	Weight (g)	L_{max} (cm)	W_{max} (g)[a]	a[a]	b
Serranidae	*Alphestes afer*			30 /			
	Cephalopholis cruentata			30 /			
	Cephalopholis fulva			41 -			
	Dermatolepis inermis			81 !	9,100 !	0.0171	3 as
	Diplectrum formosum			30 ( )			
	Epinephelus adscensionis	33.8	590	61 /		0.0158 m	3 as
	Epinephelus guttatus			55			
	Epinephelus itajara	165.1	154,220	217 !	308,000 !	0.0322 m	3 as
	Epinephelus morio	42.7	1,090		23,000 (+)	0.0140	3 as
	Epinephelus striatus	40.4	950		25,000 ( )	0.0033	3.425 FL
	Hypoplectrus aberrans			12			
	Hypoplectrus chlorurus			13			
	Hypoplectrus nigricans			15			
	Hypoplectrus puella			13-VI			
				15-Florida			
	Mycteroperca bonaci	39.6	910		82,000		
	Mycteroperca cidi			114			
	Mycteroperca interstitialis			69			
	Mycteroperca phenax			61 (-)			
	Mycteroperca rubra			70			
	Mycteroperca tigris	35.6	635	102		0.0160 m	3 as
		71.1	5,900				
	Mycteroperca venenosa			91 +		0.0045	3.325 FL
	Paranthias furcifer			27 +			
	Serranus dewegeri			32			
	Serranus tabacarius			18			
	Serranus tigrinus			10			
	Serranus tortugarum			8			
Sparidae	*Archosargus rhomboidalis*			33			
	Calamus bajonado			56			
	Calamus calamus			37			
	Calamus penna			41 +			
	Calamus pennatula			37			
	Diplodus caudimacula			30 /			
Sphyraenidae	*Sphyraena barracuda*	167.6	46,720	183 (-)		0.0099	3 as
	Sphyraena picudilla			46 (+)			
Sphyrnidae	*Sphyrna lewini*	276.9	108,860	305		0.0051	3 as
	Sphyrna mokarran	80.0	1,950	549 +		0.0038	3 as
Synodontidae	*Synodus foetens* .			46			
	Synodus intermedius			46			
	Synodus synodus			33			
Tetraodontidae	*Canthigaster rostrata*			11			
	Sphoeroides spengleri			30 (+)			
	Sphoeroides testudineus						

[a]Calculated only when an estimate of 'a' or W_∞ was needed for combined asymptotic sizes from various authors (Table 3.5).

Symbols:

! =	specimen measured by Randall.	SL =	standard length.
* =	world record (hook and line).	ma =	mean 'a' from several L/W pairs.
/ =	approximate maximum size.	as =	'b' from equation (2.3), assumed equal to 3.0.
+ =	rather more than the recorded size.	VI =	Virgin Islands.
- =	rather less than the recorded size.	♀ =	female.
( ) =	'said to reach' the recorded size.	♂ =	male.
FL =	fork length.		

Table 8.1.3. Length-weight data of Caribbean reef fishes after Smith and Tyler (1972).

Fish	Species	Length (cm)[a]	Weight (g)	a[b]
Acanthuridae	*Acanthurus bahianus*	2.3 juvenile	0.50	0.0411
	Acanthurus coeruleus	2.6	0.90	0.0512
Apogonidae	*Apogon binotatus*	3.6 ♂	1.50	0.0322
		3.8 ♀	1.80	0.0328
		4.0 ♀	1.90	0.0297
		4.0 ♀	2.00	0.0313
	Apogon conklini	2.5 ♂	0.40	0.0256
		3.2 ♀	0.90	0.0275
	Apogon maculatus	4.6 ♂	3.70	0.0380
		5.0 ♀	4.40	0.0352
		5.1 ♀	5.00	0.0377
	Apogon pigmentaria	1.8 ♂	0.20	0.0343
		2.6 ♀	0.50	0.0284
		3.0 ♂	0.70	0.0259
	Apogon quadrisquamatus	1.7 ♂	0.30	0.0611
		3.1 ♀	1.10	0.0369
	Apogon townsendi	3.6 ♂	1.30	0.0279
		4.0 ♀	1.70	0.0266
	Apogon xenus	2.4 ♂	0.40	0.0289
		3.5	1.20	0.0280
		3.6	1.20	0.0257
		4.4 ♀	2.40	0.0282
Blenniidae	*Hypleurocheilus* sp.	4.0 ?	1.00	0.0156
Canthigasteridae	*Canthigaster rostrata*	1.3 ♂	0.10	0.0455
		2.6	1.50	0.0853
		5.8 ♂	10.50	0.0538
Cirrhitidae	*Amblycirrhitus pinos*	2.3	0.40	0.0329
		3.4 ♀	1.00	0.0254
Clinidae	*Acanthemblemaria spinosa*	2.0	0.10	0.0125
	Emblemariopsis leptocirris	2.0	0.10	0.0125
	Enneanectes altivelis	2.0 ♂	0.40	0.0500
		2.3 ♀	0.50	0.0411
	Labrisomus haitiensis	3.6	0.80	0.0171
	Pseudemblemaria signifera	1.4 ♀	0.10	0.0364
		1.5 ♂	0.10	0.0296
		1.6 ♀	0.10	0.0244
		1.7 ♂	0.10	0.0204
	Starksia hassi	2.0	0.20	0.0250
	Starksia lepicoelia	2.1	0.20	0.0216
		2.2	0.20	0.0188
Emmelichthyidae	*Inermia vittata*	4.1	1.60	0.0232
Gobiidae	*Coryphopterus dicrus*	1.7 ♀	0.10	0.0204
		2.4 ♀	0.30	0.0217
		2.5 ♂	0.30	0.0192
	Coryphopterus eidolon	1.8	0.10	0.0171
		3.2 ♂	0.60	0.0183
		3.9 ♀	1.10	0.0185
		4.4	1.40	0.0164
	Coryphopterus glaucofraenum	3.4 ♂	0.80	0.0204
		3.4 ♀	0.90	0.0229
		3.8 ♀	1.00	0.0182
	Coryphopterus personatus	1.7 ♀	0.10	0.0204
		2.3 ♀	0.30	0.0247
		2.4 ♀	0.30	0.0217
		2.6 ♂	0.30	0.0171
		2.8 ♀	0.30	0.0137
		2.9 ♂	0.50	0.0205
	Coryphopterus thrix	2.7 ♀	0.30	0.0152
		2.8 ♀	0.40	0.0182
	Gnatholepis thompsoni	4.0 ♂	1.00	0.0156
		5.2 ♀	3.20	0.0228

continued...

Table 8.1.3 continued

Fish	Species	Length (cm)[a]	Weight (g)	a[b]
	Gobiosoma evelynae	1.8 ?	0.10	0.0171
		2.2 ?♂	0.20	0.0188
		2.6 ? ♀	0.30	0.0171
	Gobiosoma horsti	2.3 ?	0.30	0.0247
	Gobiosoma saucrum	1.4 ♀	0.10	0.0364
		1.6 ♀	0.10	0.0244
		1.7 ♂	0.10	0.0204
		2.0 ♂	0.10	0.0125
	Lythrypnus elasson	0.8	0.02	0.0391
		L_{max} 1.3	0.02	0.0091
	Lythrypnus nesiotes	0.7	0.02	0.0583
		1.2	0.02	0.0116
		L_{max} 1.4		
	Lythrypnus sp.	0.9	0.10	0.1372
	Quisquilius hipoliti	2.0	0.20	0.0250
		2.2 ♂	0.30	0.0282
	Risor ruber	1.0 ♂	0.10	0.1000
		1.1 ♀	0.10	0.0751
		1.2 ♂	0.10	0.0579
Grammistidae (Serranidae)	*Rypticus subbifrenatus*	6.4	7.00	0.0267
Haemulidae (Pomadasyidae)	*Haemulon aurolineatum*	3.0	0.50	0.0185
		4.9	2.50	0.0212
	Haemulon flavolineatum	3.0	0.90	0.0333
Holocentridae	*Holocentrus coruscus*	4.9	3.40	0.0289
	Holocentrus rufus	6.1	4.80	0.0211
	Myripristis jacobus	3.7	2.00	0.0395
		3.9	2.50	0.0421
	Neoniphon marianus	4.5	2.60	0.0285
		6.4	7.40	0.0282
Labridae	*Halichoeres garnoti*	4.2 ♀	1.50	0.0202
		6.0 ♂	4.10	0.0190
		7.3 ♀	6.70	0.0172
	Thalassoma bifasciatum	1.7	0.10	0.0204
		2.1	0.20	0.0216
		2.8 ♂	0.40	0.0182
		2.8 ♀	0.50	0.0228
		3.0 ♂	0.80	0.0296
		4.5 ♀	1.80	0.0198
		5.0 ♂	2.40	0.0192
		7.5 ♂	7.50	0.0178
Monacanthidae	*Monacanthus tuckeri*	1.6 ?juvenile	0.10	0.0244
Muraenidae	*Gymnothorax miliaris*	32.5 TL♀	55.40	0.0016
	Lycodontis moringa	25.9 TL	17.90	0.0010
Ostraciidae	*Lactophrys triqueter*	10.0	65.00	0.0650
Pomacanthidae	*Holacanthus ciliaris*	2.3	0.50	0.0411
	Pomacanthus arcuatus	1.8	0.30	0.0514
Pomacentridae	*Chromis cyanea*	3.7 ♂	2.40	0.0474
		8.1 ♀	22.20	0.0418
	Chromis multilineata	5.0	5.30	0.0424
	Pomacentrus partitus	3.0	1.20	0.0444
		4.1	2.20	0.0319
		4.4	3.80	0.0446
	Stegastes planifrons	5.7 ♀	9.50	0.0513
	Stegastes variabilis	2.4	0.80	0.0579
		3.5	2.10	0.0490
		3.8 ♀	3.30	0.0601
		5.1 ♂	6.30	0.0475
Scaridae	*Scarus vetula*	23.0 ♂	430.00	0.0353

continued...

Table 8.1.3 continued

Fish	Species	Length (cm)[a]	Weight (g)	a[b]
Serranidae	*Cephalopholis cruentata*	25.0	425.00	0.0272
		30.0	600.00	0.0222
	Epinephelus striatus	30.0	400.00	0.0148
	Hypoplectrus puella	2.2	0.30	0.0282
		3.5	1.30	0.0303
Syngnathidae	*Syngnathus* sp.	3.6 TL	0.10	0.0021
Synodontidae	*Synodus intermedius*	17.0	82.00	0.0167

[a]'Length' refers to standard length unless stated otherwise.
[b]'a' computed with equation (2.4); 'b' assumed equal to 3.0.
Symbols:
M = mean length from female and male. ♀ = female.
TL = total length. ♂ = male.
? = type of length not recorded.

Table 8.1.4. Length-weight data of fishes from the southeastern Atlantic coast of Brazil after Figuereido and Menezes (1977).

Family	Species	Length (cm)	Weight (g)	L_∞ (cm)	W_∞ (g)[a]	a[a,b]
Albulidae	*Albula vulpes*	35 !		100		
Antennariidae	*Antennarius striatus*			15		
Carangidae	*Alectis ciliaris*			100 +		
	Caranx bartholomaei			90 +	7,500	
	Caranx crysos			70 -		
	Caranx hippos			100 +	25,000	
	Caranx latus			80 /		
	Caranx lugubris			100 -	7,000 +	
	Caranx ruber			60 +		
	Decapterus macarellus			40 /		
	Decapterus punctatus			30 /		
	Oligoplites saurus			30 /		
	Selar crumenophthalmus			40 /		
	Selene vomer			50 /		
	Seriola dumerili			170	80,000	
	Seriola rivoliana			100	20,000	
	Trachinotus falcatus			120	40,000	
	Trachinotus goodei			50		
Carcharhinidae	*Galeocerdo cuvieri*	400	525,000	550 /		0.0082
	Negaprion brevirostris	250	80,000	300 /		
	Prionace glauca	270	70,000	400 /		0.0036
	Rhizoprionodon porosus			100 +	4,500	
Clupeidae	*Harengula clupeola*	17 !				
	Opisthonema oglinum			30 /		
Coryphaenidae	*Coryphaena hippurus*	118 !		200		
Dactylopteridae	*Dactylopterus volitans*	36 !		45 /		
Dasyatidae	*Dasyatis americana*			150 Width		
Echeneidae	*Echeneis naucrates*	65 !		100 /		
	Remora remora			60 +		
Elopidae	*Elops saurus*			90 /		
Engraulidae	*Anchoa lyolepis*	8.3 !				
Fistulariidae	*Fistularia tabacaria*			180		
Gerreidae	*Eucinostomus argenteus*	28 !		30 /		
Ginglymostomatidae	*Ginglymostoma cirratum*	250	250,000	450		0.0160
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*	35		50 +		
	Anisotremus virginicus	31.5 !		35 /		
	Haemulon aurolineatum	23.5 !		25 /		
	Haemulon plumieri	28.5 !		40		
	Haemulon steindachneri	28.3 !		30 /		
	Orthopristis ruber	28.8 !		40 /		
	Pomadasys corvinaeformis	24.8 !		25 /		
	Pomadasys crocro	21.5 !		30 /		
Holocentridae	*Holocentrus ascensionis*			34 +		
	Myripristis jacobus	22.5 !				
Lutjanidae	*Lutjanus analis*	35 !		80 /		
	Lutjanus cyanopterus	120 !				
	Lutjanus griseus	143 !				
	Lutjanus jocu	49 !		70 /		
	Lutjanus synagris	40.5 !		40 /		
	Lutjanus vivanus	34.3 !		50 +		
	Ocyurus chrysurus	42.5 !		70 /		
	Rhomboplites aurorubens	44.5 !		50 +		
Malacanthidae	*Malacanthus plumieri*	46.5 !		60		

continued...

Table 8.1.4 continued

Family	Species	Length (cm)	Weight (g)	L_∞ (cm)	W_∞ (g)[a]	a[a,b]
Megalopidae	*Tarpon atlanticus*			250	150,000	
Muraenidae	*Echidna catenata*			100 -		
	Gymnothorax funebris			200 /		
	Gymnothorax miliaris	50 !				
	Gymnothorax vicinus			100		
	Lycodontis moringa			100		
Myliobatidae	*Aetobatus narinari*			200 Width	200,000	
Ophichthidae	*Ophichtus ophis*			150 ?		
Pomatomidae	*Pomatomus saltator*			100 +		
Priacanthidae	*Heteropriacanthus cruentatus*			30		
	Priacanthus arenatus			40		
Rachycentridae	*Rachycentron canadum*			200 /		
Sciaenidae	*Equetus lanceolatus*			25 /		
	Odontoscion dentex	22 !		25 /		
	Pareques acuminatus	17 !		25 /		
Scorpaenidae	*Scorpaena brasiliensis*	21.5 !				
	Scorpaena plumieri			35 /		
Serranidae	*Alphestes afer*			33		
	Diplectrum formosum			30 /		
	Epinephelus adscensionis			60 /		
	Epinephelus itajara	270	375,000		400,000	
	Epinephelus morio			70 +	12,000+	
	Mycteroperca bonaci			100 +	90,000	
	Mycteroperca interstitialis			70 +	4,000	
	Mycteroperca microlepis			70 /		
	Mycteroperca rubra			80 /		
	Mycteroperca tigris	75	6,000	100 /		0.0142
	Mycteroperca venenosa			100 -	12,000	
	Paranthias furcifer			20 /		
Sparidae	*Archosargus rhomboidalis*	35.5 !		35		
	Calamus penna	50 !				
	Calamus pennatula	35 !				
Sphyrnidae	*Sphyrna lewini*	280	125,000	300 +		0.0057
	Sphyrna mokarran	370 ♀	240,000	550		0.0047
Synodontidae	*Synodus foetens*	36.5 !				
	Synodus intermedius			50		

[a]Calculated only when an estimate of 'a' or W_∞ was needed for combined asymptotic sizes from various authors (Table 3.5).
[b]'a' computed with equation (2.4); 'b' assumed equal to 3.0.
Symbols:
! = specimen measured by the authors.
/ = approximate maximum size.
\+ = rather more than the recorded size.
\- = rather less than the recorded size.

Table 8.1.5. Length-weight data of Caribbean reef fishes after FAO species identification sheets (Fischer 1978).

Family	Species	Common length (cm)	Common weight (g)	Maximum length (cm)	Maximum weight (g)
Acanthuridae	*Acanthurus bahianus*	25.0		36.0	
	Acanthurus chirurgus	25.0		35.0	
	Acanthurus coeruleus	25.0		36.0	
Albulidae	*Albula vulpes*	35.0		77.0	
Balistidae	*Balistes capriscus*	20.0		30.0	
	Balistes vetula	30.0		50.0	
	Melichthys niger	30.0		50.0	
Belonidae	*Ablennes hians*	70.0 SL		82.5 SL+	
	Platybelone argalus argalus	30.0 SL		38.2 SL+	
	Strongylura marina	50.0 SL		64.0 SL	
	Strongylura timucu	30.0 SL		42.0 SL	
	Tylosurus acus	90.0 SL		128.5 SL	
	Tylosurus crocodilus	90.0 SL		101.3 SL+.	
Bothidae	*Bothus lunatus*	35.0		45.0	
	Paralichthys tropicus	30.0		50.0 +	
Carangidae	*Alectis ciliaris*	90.0 FL		150.0	
		84.5 FL	7,900		
		109.0 FL	16,500		
	Caranx bartholomaei	45.0 FL		100.0	
		89.5	7,600		
	Caranx crysos	35.0 FL		68.0	
	Caranx hippos	60.0 FL		101.0	25,000
	Caranx latus	50.0 FL		80.0 +	16,000
	Caranx lugubris	70.0 FL		99.0	7,000
	Caranx ruber	40.0 FL		50.0 +	8,200 ( )
	Decapterus macarellus	20.0 SL		35.0 SL	
	Decapterus punctatus	15.0 FL		30.0 SL	
	Elagatis bipinnulatus	80.0 FL		107.0 FL	10,500
	Oligoplites saurus	27.0 FL		29.7 FL	287
	Selar crumenophthalmus	24.0 FL		27.0 SL	
	Seriola dumerili	70.0 FL	2,000		80,300
		110.0 FL	8,000		
		150.0 FL	67,600		
	Seriola rivoliana	55.0 FL	2,500	97.0	24,000
		80.0 FL	3,400		
		83.0 FL	9,800		
	Trachinotus falcatus	94.0	17,000	105.5 FL	36,000
		114.0	22,900		
	Trachinotus goodei	31.0 FL		49.3	
Carcharhinidae	*Carcharhinus acronotus*	100.0		200.0	
	Carcharhinus falciformis	250.0		350.0	
	Carcharhinus leucas	260.0		350.0	
	Carcharhinus limbatus	150.0		247.0	
	Carcharhinus longimanus	270.0		350.0	
	Carcharhinus perezi	150.0		230.0	
	Galeocerdo cuvier	400.0		650.0 +	
	Negaprion brevirostris	240.0		320.0	
Clupeidae	*Harengula clupeola*	9.0		10.0	
	Jenkinsia lamprotaenia	5.0		6.5	
	Opisthonema oglinum	20.0		25.0	
Coryphaenidae	*Coryphaena hippurus*	100.0		200.0	
Dactylopteridae	*Dactylopterus volitans*	20.0		45.0 +	
Dasyatidae	*Dasyatis americana*	90.0 Width		300.0 Length 200.0 Width	
Diodontidae	*Diodon hystrix*	25.0		65.0	
Elopidae	*Elops saurus*	60.0		100.0	

continued...

Table 8.1.5 continued

Family	Species	Common length (cm)	Common weight (g)	Maximum length (cm)	Maximum weight (g)
Engraulidae	*Anchoa hepsetus*	10.0		15.0	
	Anchoa lyolepis	6.0		7.5	
Ephippidae	*Chaetodipterus faber*	50.0		90.0	
Gerreidae	*Eucinostomus argenteus*	15.0		20.0	
	Gerres cinereus	28.0		39.0	
Tnglymostomatidae	*Ginglymostoma cirratum*	340.0		430.0	
Grammistidae (Serranidae)	*Rypticus saponaceus*	25.0		32.0	
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*	45.0		60.0	
	Anisotremus virginicus	25.0		35.0	
	Haemulon album	35.0		42.0	
	Haemulon aurolineatum	17.0		25.0	
	Haemulon bonariense	30.0		40.0	
	Haemulon boschmae	15.0		19.0	
	Haemulon carbonarium	20.0		35.0	
	Haemulon chrysargyreum	17.0		23.0	
	Haemulon flavolineatum	17.0		22.0	
	Haemulon macrostomum	24.0		28.0	
	Haemulon melanurum	25.0		33.0	
	Haemulon parrai	30.0		41.0	
	Haemulon plumieri	30.0		40.0	
	Haemulon sciurus	25.0		37.0	
	Haemulon steindachneri	20.0		27.0	
	Haemulon striatum	17.0		22.0	
	Orthopristis chrysoptera	30.0		46.0	
	Orthopristis poeyi	20.0		24.0	
	Orthopristis ruber	30.0		40.0	
	Pomadasys corvinaeformis	18.0		25.0	
	Pomadasys crocro	25.0		33.0	
Hemiramphidae	*Hemiramphus balao*	35.0		40.0	
	Hemiramphus brasiliensis	35.0		40.5	
	Hyporamphus unifasciatus	20.0		27.0	
Kyphosidae	*Kyphosus incisor*	45.0		67.0	
	Kyphosus sectatrix	50.0		76.0	
Labridae	*Bodianus rufus*	28.0		40.0	
	Lachnolaimus maximus	35.0		70.0	
Lutjanidae	*Lutjanus analis*	50.0		76.0	
	Lutjanus apodus	35.0		62.0	
	Lutjanus campechanus	60.0		80.0	
	Lutjanus cyanopterus	90.0		160.0	
	Lutjanus griseus	35.0		65.0	
	Lutjanus jocu	60.0		74.0	
	Lutjanus mahagoni	38.0		48.0	
	Lutjanus synagris	25.0		35.0	
	Ocyurus chrysurus	40.0		61.0	
Malacanthidae	*Malacanthus plumieri*	50.0		60.0	
Megalopidae	*Tarpon atlanticus*	130.0		250.0	
Monacanthidae	*Aluterus schoepfii*	40.0		60.0	
	Cantherines pullus	12.0		20.0	
	Monacanthus ciliatus	10.0		20.0	
	Stephanolepis setifer	10.0		20.0	
Mugilidae	*Mugil curema*	30.0		45.0	
Mullidae	*Mulloidichthys martinicus*	28.0		40.0	
	Pseudupeneus maculatus	22.0		30.0	

continued...

Table 8.1.5 continued

Family	Species	Common length (cm)	Common weight (g)	Maximum length (cm)	Maximum weight (g)
Muraenidae	*Enchelycore nigricans*			100.0	
	Gymnothorax funebris			190.0	
	Gymnothorax miliaris			50.0	
	Gymnothorax vicinus			122.0	
	Lycodontis moringa			100.0	
Myliobatidae	*Aetobatus narinari*	140.0 Width		370.0 Length 280.0 Width	
Ophichthidae	*Ophichtus ophis*			140.0	
Ostraciidae	*Acanthostracion quadricornis*	20.0		35.0	
	Lactophrys bicaudalis	20.0		45.0	
	Lactophrys trigonus	20.0		45.0	
	Lactophrys triqueter	15.0		30.0	
Pomacanthidae	*Holacanthus ciliaris*	30.0		45.0	
	Holacanthus tricolor	30.0		35.0	
	Pomacanthus arcuatus	45.0		60.0	
	Pomacanthus paru	28.0		37.0	
Pomacentridae	*Abudefduf saxatilis*	15.0		20.0	
	Abudefduf taurus	20.0		25.0	
	Chromis multilineata	12.0		20.0	
	Microspathodon chrysurus	15.0		20.0	
Pomatomidae	*Pomatomus saltator*	60.0		110.0	
Priacanthidae	*Heteropriacanthus cruentatus*	20.0		30.0	
	Priacanthus arenatus	35.0		40.0	
Rachycentridae	*Rachycentron canadum*	100.0		200.0	
Scaridae	*Nicholsina usta*	18.0		29.0	
	Scarus coelestinus	50.0		76.0	
	Scarus coeruleus	35.0		59.0 +	
	Scarus guacamaia	70.0		94.0	
	Scarus iserti	18.0		27.0	
	Scarus taeniopterus	22.0		33.0	
	Scarus vetula	32.0		51.0	
	Sparisoma aurofrenatum	20.0		28.0	
	Sparisoma chrysopterum	25.0		45.0	
	Sparisoma rubripinne	30.0		45.0	
	Sparisoma viride	38.0		64.0	
Scombridae	*Auxis rochei*	18.0		25.0	
	Auxis thazard	40.0		50.0	
	Euthynnus aletteratus	35.0	6,000	40.0 FL	
	Scomberomorus cavalla	70.0		150.0 FL	45,000
	Scomberomorus maculatus	50.0		70.0 FL+	
	Scomberomorus regalis	45.0		80.0 FL+	
	Thunnus obesus	180.0		236.0	
Scorpaenidae	*Scorpaena plumieri*	30.0		43.0	
Serranidae	*Alphestes afer*	25.0		33.0	
	Cephalopholis cruentata	20.0		32.0	
	Cephalopholis fulva	25.0		30.0	
	Dermatolepis inermis			90.0	
	Diplectrum formosum			30.0	
	Epinephelus adscensionis			40.0	
	Epinephelus guttatus	40.0		60.0	
	Epinephelus itajara		40,000	240.0	260,000
	Epinephelus morio	70.0 -		70.0 ♀ 72.0 ♂	
	Epinephelus striatus		10,000 -	100.0	20,000
	Mycteroperca bonaci	70.0	26,000	100.0 +	65,000
	Mycteroperca cidi	50.0		100.0	
	Mycteroperca interstitialis	40.0		50.0	

continued...

Table 8.1.5 continued

Family	Species	Common length (cm)	Common weight (g)	Maximum length (cm)	Maximum weight (g)
	Mycteroperca microlepis	50.0		70.0	
	Mycteroperca phenax	30.0		40.0 +	7,500
	Mycteroperca rubra	35.0	1,340	49.0 +	
	Mycteroperca tigris	40.0		50.0	
	Mycteroperca venenosa	50.0 -		70.0	
	Paranthias furcifer	20.0		35.0	
	Serranus dewegeri			30.0 +	
Sparidae	*Archosargus rhomboidalis*	20.0		32.0	
	Calamus bajonado	54.0		68.0	
	Calamus calamus	30.0		36.0	
	Calamus penna	28.0		36.0	
	Calamus pennatula	30.0		36.0	
	Diplodus caudimacula	22.0		28.0	
Sphyraenidae	*Sphyraena barracuda*	130.0		200.0	
	Sphyraena picudilla	36.0		50.0	
Sphyrnidae	*Sphyrna lewini*	360.0		420.0	
Tetraodontidae	*Sphoeroides spengleri*	12.0		15.0	
	Sphoeroides testudineus	20.0		30.0	

Symbols:
+ = rather more than the recorded size.
- = rather less than the recorded size.
( ) = 'reported' to reach the recorded size.
SL = standard length.
FL = fork length.
♀ = female.
♂ = male.

Table 8.1.6. Length-weight data of Caribbean reef fishes after Munro (1983).

Family	Species	L_∞ (cm) *	W_∞ (g)	M a	F b	Z K	M	F
Acanthuridae	*Acanthurus bahianus*	28 30 TL	547	0.0191	3.080	4.4 M/K		
	Acanthurus chirurgus	35	980	0.0221	3.009	4.9 M/K		
	Acanthurus coeruleus	30 33 TL	809	0.0278	3.022	4.7 M/K		
Balistidae	*Balistes capriscus*	31						
	Balistes vetula	45	2,920	0.0516	2.875	0.57	2.6	
	Canthidermis sufflamen	55	4,783	0.0599	2.817			
	Melichthys niger	32 *						
	Xanthichthys ringens	25						
Carangidae	*Alectis ciliaris*	76 *						
	Caranx bartholomaei	69 81 TL	9,862	0.0063	3.368			
	Caranx crysos	48 58 TL	2,314	0.0065	3.302			
	Caranx hippos	79 *						
	Caranx latus	73 85 TL				(2.46)		
	Caranx lugubris	69 *						
	Caranx ruber	52 60 TL	2,494	0.0083	3.191	0.24	1.3-1.5	
	Elagatis bipinnulatus	65 *						
	Selar crumenophthalmus	22 *						
	Selene vomer	21 *						
	Seriola dumerili	124 *						
	Seriola rivoliana	53 *						
Chaetodontidae	*Chaetodon aculeatus*	8.8 ?*	15.2 *	0.0223	3.000			
	Chaetodon capistratus	13 ?♀* 14 ?♂ *						
	Chaetodon ocellatus	16 ?*						
	Chaetodon sedentarius	13 ?*						
	Chaetodon striatus	15 ?*						
Haemulidae	*Anisotremus surinamensis*			0.0233	3.010			
(Pomadasyidae)	*Anisotremus virginicus*	30	846	0.0102	3.330			
	Haemulon album	65	5,297	0.0144	3.070	0.2		
	Haemulon aurolineatum	23	188	0.0298	2.790			
	Haemulon bonariense	30	385	0.0485	2.640			
	Haemulon carbonarium			0.0404	2.740			
	Haemulon chrysargyreum			0.0141	3.080			
	Haemulon flavolineatum	25	374	0.0107	3.250	4.88 M/K		
	Haemulon macrostomum			0.0176	3.060			
	Haemulon melanurum	30	427	0.0557	2.630			
	Haemulon plumieri	42	1,357	0.0238	2.930	0.345	1.77	5.13
	Haemulon sciurus	40	1,114	0.0314	2.840	0.26		1.6
Holocentridae	*Holocentrus ascensionis*	26.5	345	0.0565	2.660	3.66 M/K		
	Holocentrus rufus	23.5	231	0.0178	3.000	4.85 M/K		
Lutjanidae	*Apsilis dentatus*	56 ♀ 58 ♂			0.3 0.65	0.8 1.9		
	Lutjanus analis	60 ♂ * 64 TL♂ *						
	Lutjanus apodus	57 ♀* 60 TL♀*	3,800	0.0089	3.204	(0.18)		
	Lutjanus buccanella	46 ♀ 49.9 TL♀			0.35	1.8		
		54 ♂ 58.6 TL♂			0.7	2.2		
	Lutjanus griseus	45 ♂ *						
	Lutjanus jocu	72 ♂ *						
	Lutjanus mahagoni	26 ♂ *						
	Lutjanus synagris	41 ♂ * 44.6 TL♂ *	1,050 g	0.0189	2.943 g			
	Lutjanus vivanus	70 ( ) 76.5 (TL)						

continued...

Table 8.1.6 continued

Family	Species	L_∞ (cm)[a]	W_∞ (g)	M a	F b	Z K	M	F
	Ocyurus chrysurus	60	3,600	0.0145	3.032	0.25	0.6	
		75 TL						
	Pristipomoides macrophthalmus	35 ♂ *						
	Rhomboplites aurorubens	39 ♀*						
Mullidae	*Mulloidichthys martinicus*	30 ♀	513	0.0089	3.223			
		29 ♂	363	0.0820	2.493			
	Pseudupeneus maculatus	25 ♀	259	0.0552	2.626			
		26.5 ♂	367	0.0099	3.210			
Pomacanthidae	*Holacanthus ciliaris*	33.3 ?*		0.0280	3.000			
	Holacanthus tricolor	34.4 ?*	1,140 *					
	Pomacanthus arcuatus	60 (?)						
	Pomacanthus paru	36 ?*	1,625 *	0.0348	3.000			
		37.5 ?*						
Scaridae	*Scarus coelestinus*	32.1 ♀*						
		29.5 ♂ *						
	Scarus coeruleus	44.5 *						
	Scarus guacamaia	45.7 ♀*						
	Scarus iserti	19.7 ♀*		0.0166	3.020			
		20.8 ♂ *						
	Scarus taeniopterus	35				6.5 M/K		
	Scarus vetula	24.8 ♀*						
		28.6 ♂ *						
	Sparisoma aurofrenatum	26	324	0.0129	3.110	5.9 Z/K		
	Sparisoma chrysopterum	40	1,290	0.0093	3.210	11.7 Z/K		
	Sparisoma rubripinne	22.7 ♀*		0.0031	3.562			
		34.5 ♂ *						
	Sparisoma viride	50	2,430	0.0537	2.740	10.5 Z/K·		
Serranidae	*Cephalopholis cruentata*	34 ?	691	0.0076	3.237	0.34		
	Cephalopholis fulva	34 ?	638	0.0729	2.574	0.63	1.95	
	Epinephelus guttatus	52 ?	2,113	0.0176	2.960	0.48	0.68	
	Epinephelus striatus	90 ?	12,900	0.0107	3.112	0.09	0.235	
	Mycteroperca venenosa	86 ?				0.17	0.41	

[a]'Length' refers to fork length unless stated otherwise.

Symbols:

* = L_{max}, W_{max}

( ) = 'reported' to reach the recorded size.

g = gutted weight.

TL = total length.

? = type of length not stated.

♀ = female.

♂ = male.

Appendix 8.2

Table 8.2.1. Density (ind.m^{-3}) and crop (gm^{-3}) of fishes of a coral reef in the US Virgin Islands after Smith and Tyler (1972).

Family	Species	ind.m^{-3}	gm^{-3}
Acanthuridae	*Acanthurus bahianus*	0.01	0.005
	Acanthurus coeruleus	0.03	0.01
Apogonidae	*Apogon binotatus*	0.70	1.02
	Apogon conklini	0.11	0.05
	Apogon maculatus	0.09	0.37
	Apogon pigmentaria	0.03	0.014
	Apogon quadrisquamatus	0.12	0.03
	Apogon townsendi	1.18	1.55
	Apogon xenus	0.03	0.28
Blenniidae	*Hypleurochilus* sp.	0.02	0.002
Canthigasteridae	*Canthigaster rostrata*	0.07	0.280
Cirrhitidae	*Amblycirrhitus pinos*	0.02	0.010
Clinidae	*Acanthemblemaria spinosa*	0.01	0.001
	Emblemariopsis leptocirris	0.01	0.001
	Enneanectes altivelis	0.02	0.001
	Labrisomus haitiensis	0.10	0.08
	Pseudemblemaria signifera	0.05	0.005
	Starksia hassi	0.02	0.004
	Starksia lepicoelia	0.04	0.008
Emmelichthyidae	*Emmelichthyops atlanticus*	0.1	0.16
Gobiidae	*Coryphopterus dicrus*	0.06	0.01
	Coryphopterus eidolon	0.25	0.14
	Coryphopterus glaucofraenum	0.27	0.22
	Coryphopterus personatus	0.23	0.07
	Coryphopterus thrix	0.04	0.02
	Gnatholepis thompsoni	0.06	0.06
	Gobiosoma evelynae	0.10	0.02
	Gobiosoma horsti	0.01	0.003
	Gobiosoma saucrum	0.06	0.005
	Lythrypnus elasson	0.03	0.002
	Lythrypnus nesiotes	0.23	0.004
	Lythrypnus sp.	0.02	0.001
	Quisquilius hipoliti	0.04	0.009
	Risor ruber	0.03	0.003
Grammistidae (Serranidae)	*Rypticus subbifrenatus*	0.01	0.70
Haemulidae (Pomadasyidae)	*Haemulon aurolineatum*	0.55	0.62
	Haemulon flavolineatum	0.40	0.35
Holocentridae	*Holocentrus coruscus*	0.08	0.27
	Holocentrus rufus	0.01	0.05
	Myripristis jacobus	0.10	0.20
	Neoniphon marianus	0.30	1.63
Labridae	*Halichoeres bivittatus*	0.01	0.12
	Halichoeres garnoti	0.05	0.13
	Thalassoma bifasciatum	0.16	0.26
Lutjanidae	*Ocyurus chrysurus*	0.10	0.70
Monacanthidae	*Monacanthus tuckeri*	0.01	0.001
Mullidae	*Pseudupeneus maculatus*	0.01	1.10
Muraenidae	*Lycodontis moringa*	0.01	0.18
	Gymnothorax miliaris	0.02	0.03

continued...

Table 8.2.1 continued

Family	Species	ind.m^{-3}	gm^{-3}
Ostraciidae	*Lactophrys triqueter*	0.01	0.65
Pomacanthidae	*Holacanthus ciliaris*	0.03	0.012
	Chromis cyanea	0.35	1.23
	Chromis multilineata	0.18	0.96
	Pomacentrus partitus	0.06	0.15
	Stegastes planifrons	0.10	0.60
	Stegastes variabilis	0.09	0.26
Scaridae	*Scarus iserti*	0.02	0.30
	Scarus vetula	0.01	2.00
	Sparisoma viride	0.01	0.001
Serranidae	*Cephalopholis cruentata*	0.02	4.00
	Epinephelus striatus	0.01	4.00
	Hypoplectrus puella	0.04	0.032
Syngnathidae	*Syngnathus* sp.	0.01	0.001
Synodontidae	*Synodus intermedius*	0.01	0.82
Sum (64 species)			25.17

Appendix 8.3

Table 8.3.1. Aspect ratio (A) of Caribbean reef fishes based on drawings in Fischer (1978) and photographs in Randall (1968); length and sex of specimen from photographs in Randall (1968).

Family	Species	A (Fischer)	Length (cm)	Sex	A (Randall)
Acanthuridae	*Acanthurus bahianus*	2.22	20	-	2.18
	Acanthurus chirurgus	1.87	22	-	1.78
	Acanthurus coeruleus	1.98	17	-	1.86
Antennariidae	*Antennarius multiocellatus*		12		1.14
			19	-	1.22
	Antennarius striatus		7	-	1.11
			15		0.80
Apogonidae	*Apogon conklini*		6	-	1.72
	Apogon maculatus		6	-	1.53
Atherinidae	*Allanetta harringtonensis*		5	-	1.71
	Atherinomorus stipes		7	-	1.88
Aulostomidae	*Aulostomus maculatus*	1.19	59	-	1.70
Balistidae	*Balistes capriscus*	2.47	13	-	2.44
	Balistes vetula	1.99	33	-	1.98
	Canthidermis sufflamen		41	-	1.71
	Melichthys niger	2.05	33	-	2.30
	Xanthichthys ringens		12		1.92
Belonidae	*Ablennes hians*	3.27		-	
	Platybelone argalus argalus	2.44	34	-	2.65
	Strongylura marina	1.52		-	
	Strongylura notata		25	-	1.64
	Strongylura timucu	1.50	32	-	1.69
	Tylosurus acus	1.83		-	
	Tylosurus crocodilus	2.16	58	-	3.11
Blenniidae	*Entomacrodus nigricans*		6	-	1.02
	Ophioblennius atlanticus		11	-	0.92
	Parablennius marmoreus		5	-	1.26
	Scartella cristata		8	-	1.18
Bothidae	*Bothus lunatus*	1.40	28	-	1.11
	Bothus ocellatus		7	♀	1.18
			10	♂	1.51
	Paralichthys tropicus	1.71	24	-	1.38
Carangidae	*Alectis ciliaris*		41	-	4.82
	Caranx bartholomaei	4.14	37	-	4.06
	Caranx crysos (fusus)	3.52	29	-	4.19
	Caranx hippos	3.40	33	-	3.76
	Caranx latus	4.32	34	-	4.48
	Caranx lugubris	3.96	62	-	5.48
	Caranx ruber	2.40	27	-	4.52
	Decapterus macarellus	2.98	18	-	3.80
	Decapterus punctatus	2.80	16	-	3.66
	Oligoplites saurus	3.43	25	-	3.12
	Selar crumenophthalmus	3.15	17	-	3.54
	Seriola dumerili	3.30	112	-	4.49
	Trachinotus falcatus	3.97	31	-	5.79
			104	-	3.88
	Trachinotus goodei	2.69	21	-	5.01
Chaetodontidae	*Chaetodon aculeatus*		8	-	1.85
	Chaetodon capistratus		10	-	2.53
	Chaetodon sedentarius		11	-	2.29
	Chaetodon striatus		14	-	2.37
Cirrhitidae	*Amblycirrhitus pinos*		7	-	1.52
Clinidae	*Labrisomus nuchipinnis*		11	-	1.29

continued...

Table 8.3.1 continued

Family	Species	A (Fischer)	Length (cm)	Sex	A (Randall)
Clupeidae	*Harengula clupeola*	1.72	11	-	2.65
	Harengula humeralis		11	-	2.90
	Jenkinsia lamprotaenia	1.82	5	-	2.19
	Opisthonema oglinum	2.53	13	-	3.13
Dactylopteridae	*Dactylopterus volitans*	1.63	33	-	1.60
Diodontidae	*Chilomycterus antennatus*		14	-	1.40
	Diodon holocanthus		14	-	1.37
	Diodon hystrix	0.92	38	-	1.09
Echeneidae	*Echeneis naucrates*		32	-	1.10
	Remora remora		20	-	1.60
Elopidae	*Elops saurus*	4.53	33	-	3.41
Emmelichthyidae	*Emmelichthyops atlanticus*		10	-	2.67
	Inermia vittata		15	-	2.92
Engraulidae	*Anchoa hepsetus*	2.50		-	
	Anchoa lyolepis	1.96	6	-	1.77
	Anchoa mitchilli	2.95		-	
	Anchoa parva	2.24		-	
Ephippidae	*Chaetodipterus faber*	3.04	35	-	3.11
Exocoetidae	*Exocoetus volitans*	1.76		-	
Fistulariidae	*Fistularia tabacaria*		39	-	1.70
Gerreidae	*Eucinostomus argenteus*	2.98	12	-	1.94
	Eucinostomus lefroyi		12	-	2.64
	Gerres cinereus	3.68	37	-	3.91
Gobiidae	*Bathygobius soporator*		16	-	0.92
	Coryphopterus glaucofraenum		6	-	1.11
	Coryphopterus personatus		3	-	1.06
	Gnatholepis thompsoni		5	-	0.96
	Gobiosoma evelynae		4	-	0.79
	Ioglossus helenae		11	-	0.84
	Quisquilius hipoliti		3	-	1.09
Grammidae (Serranidae)	*Gramma loreto*		6	-	1.13
	Gramma melacara		6	-	1.36
Grammistidae (Serranidae)	*Rypticus saponaceus*	1.21	17	-	1.37
Haemulidae (Pomadasyidae)	*Anisotremus surinamensis*		26	-	2.66
	Anisotremus virginicus		6	juvenile	1.87
			32	adult	2.84
	Haemulon album		47	-	2.77
	Haemulon aurolineatum		18	-	2.44
	Haemulon bonariense		19	-	2.45
	Haemulon boschmae		11	-	1.96
	Haemulon carbonarium		33	-	2.84
	Haemulon chrysargyreum		19	-	2.59
	Haemulon flavolineatum		19	-	2.46
	Haemulon macrostomum		39	-	2.69
	Haemulon melanurum		18	-	1.79
	Haemulon parrai		33	-	2.53
	Haemulon plumieri		26	-	2.86
	Haemulon sciurus		30	-	2.45
	Haemulon steindachneri		14	-	2.02
	Haemulon striatum		18	-	1.83
	Orthopristis ruber		25	-	2.46
Hemiramphidae	*Hemiramphus balao*	2.87	25	-	2.73
	Hemiramphus bermudensis	3.15		-	

continued...

Table 8.3.1 continued

Family	Species	A (Fischer)	Length (cm)	Sex	A (Randall)
	Hemiramphus brasiliensis	3.04	28	-	3.23
	Hyporamphus unifasciatus	2.45		-	
Holocentridae	*Holocentrus ascensionis*	2.56	27	-	2.64
	Holocentrus coruscus		11	-	3.03
	Holocentrus rufus	2.24	25	-	2.23
	Myripristis jacobus	2.61	13	-	2.46
	Neoniphon marianus		12	-	3.02
	Plectrypops retrospinis		10	-	1.73
	Sargocentron vexillarium		9	-	2.65
Kyphosidae	*Kyphosus incisor*	2.97	25	-	2.83
	Kyphosus sectatrix	2.83	32	-	2.90
Labridae	*Bodianus pulchellus*	1.12	13	-	1.79
	Bodianus rufus	1.37	26	-	1.20
	Clepticus parrae		24	-	1.84
	Halichoeres bivittatus		14	-	1.27
	Halichoeres garnoti		6	juvenile	1.48
			9	♀	1.09
			12	♂	1.44
	Halichoeres maculipinna		6	juvenile	1.44
			13	♂	1.25
	Halichoeres pictus		9	♀	1.39
			11	♂	1.50
	Halichoeres poeyi		10	-	1.17
			16	♂	1.19
	Halichoeres radiatus	1.63	12	juvenile	0.87
			24	♀	1.58
	Xyrichtys novacula	1.40	18	-	1.48
	Xyrichtys splendens		5	-	1.54
			12	-	1.48
	Hemipteronotus martinicensis		8	♀	1.09
			13	♂	1.18
	Lachnolaimus maximus	1.66	22	-	1.51
	Thalassoma bifasciatum		9	♀	1.32
			12	♂	1.07
Lutjanidae	*Lutjanus analis*	2.66	38	-	2.06
	Lutjanus apodus	1.83	25	-	2.00
	Lutjanus campechanus	1.23		-	1.41
	Lutjanus cyanopterus	2.08	90	-	2.18
	Lutjanus griseus	1.90	40	-	2.06
	Lutjanus jocu	2.38	39	-	2.08
	Lutjanus mahagoni	2.01	24	-	2.05
	Lutjanus synagris	1.80	18	-	1.97
	Ocyurus chrysurus	3.56	16	-	2.96
Malacanthidae	*Malacanthus plumieri*	1.80	53	-	1.42
Megalopidae	*Tarpon atlanticus*		37	-	2.96
Monacanthidae	*Aluterus monoceros*		47		1.70
	Aluterus schoepfii	0.87	43	-	0.72
	Aluterus scripta		50	-	0.72
	Cantherines macrocerus		37	♀	1.46
	Cantherines pullus	1.68	17	-	1.47
	Monacanthus ciliatus	1.36	10	-	1.24
	Monacanthus tuckeri		9	-	1.37
	Stephanolepis setifer	1.13	18	-	1.25
Mugilidae	*Mugil curema*	1.92	26	-	2.72
Mullidae	*Mulloidichthys martinicus*	4.85	33	-	2.26
	Pseudupeneus maculatus	2.85	24	-	2.30
Opisthognathidae	*Opisthognathus aurifrons*		6	-	0.84
	Opistognathus macrognathus		12	-	1.14

continued...

Table 8.3.1 continued

Family	Species	A (Fischer)	Length (cm)	Sex	A (Randall)
	Opistognathus maxillosus		8	-	0.76
	Opisthognathus whitehurstii		5	-	0.82
Ostraciidae	*Acanthostracion polygonius*		25	-	1.17
	Acanthostracion quadricornis	1.82	24	-	1.14
	Lactophrys bicaudalis	1.89	37	-	1.23
	Lactophrys trigonus	1.77	29	-	1.89
			33		1.87
	Lactophrys triqueter	2.18	14	-	1.98
Pempheridae	*Pempheris schomburgki*		11	-	2.28
Pomacanthidae	*Centropyge argi*		5	-	1.44
	Holacanthus ciliaris		6	juvenile	1.44
			21	adult	1.29
	Holacanthus tricolor		17	-	1.65
	Pomacanthus arcuatus		30	-	2.89
	Pomacanthus paru		4	juvenile	1.39
			24	adult	1.81
Pomacentridae	*Abudefduf saxatilis*		13	-	2.98
	Abudefduf taurus		17	-	2.01
	Chromis cyanea		12	-	1.79
	Chromis multilineata		13	-	1.79
	Microspathodon chrysurus		18	-	1.88
	Pomacentrus partitus		6	-	1.38
	Stegastes fuscus		9	-	1.83
	Stegastes leucostictus		5	-	1.31
	Stegastes planifrons		6	-	1.37
	Stegastes variabilis		7	-	1.54
Pomatomidae	*Pomatomus saltator*	2.16		-	
Priacanthidae	*Heteropriacanthus cruentatus*		25	-	1.79
	Priacanthus arenatus		27	-	1.83
Rachycentridae	*Rachycentron canadus*		57	-	1.56
Scaridae	*Cryptotomus roseus*		10	-	1.21
	Nicholsina usta		15	-	1.12
	Scarus coelestinus		52	-	1.06
	Scarus coeruleus		33	-	0.95
			62	♂	1.48
	Scarus guacamaia		57	-	1.19
	Scarus iserti		21	♀	1.24
			22	♂	1.44
	Scarus taeniopterus		19	♀	1.23
			24	♂	1.09
	Scarus vetula		26	♀	1.49
			34	♂	1.05
	Sparisoma aurofrenatum		16	♀	1.17
			19	♂	1.33
	Sparisoma chrysopterum		26	♀	1.39
			27	♂	1.44
	Sparisoma radians		9	♀	1.26
			8	♂	1.18
	Sparisoma rubripinne		18	-	1.12
			41	♂	1.51
	Sparisoma viride		26	♀	1.66
			31	♂	1.43
Sciaenidae	*Equetus lanceolatus*		18	-	0.97
	Equetus punctatus		18	-	1.25
	Odontoscion dentex		14	-	1.68
	Pareques acuminatus		12	-	1.34
Scombridae	*Euthynnus aletteratus*		33	-	6.29
	Scomberomorus cavalla		111	-	6.31
	Scomberomorus maculatus		53	-	4.87
	Scomberomorus regalis		41	-	6.16

continued...

Table 8.3.1 continued

Family	Species	A (Fischer)	Length (cm)	Sex	A (Randall)
Scorpaenidae	*Scorpaena brasiliensis*		20	-	1.03
	Scorpaena grandicornis		12	-	1.03
	Scorpaena plumieri		16	-	1.00
	Scorpaenodes caribbaeus		7	-	1.01
Serranidae	*Alphestes afer*		23	-	1.20
	Cephalopholis cruentata		19	-	1.23
	Cephalopholis fulva		23	-	1.47
	Dermatolepis inermis		15	-	1.51
	Diplectrum formosum	1.63	18	-	1.49
	Epinephelus adscensionis		34	-	1.53
	Epinephelus guttatus		25	-	1.03
	*Epinephelus itajara**		165	-	1.28
	Epinephelus morio		43	-	1.46
	Epinephelus striatus		40	-	1.57
	Hypoplectrus aberrans		12	-	1.84
	Hypoplectrus chlorurus		9	-	1.53
	Hypoplectrus nigricans		11	-	1.77
	Hypoplectrus puella		12	-	1.58
	Mycteroperca bonaci		40	-	1.22
	Mycteroperca cidi		24	-	1.13
	Mycteroperca interstitialis		32	-	1.29
	Mycteroperca phenax		27	-	1.36
	Mycteroperca rubra		18	-	1.20
	Mycteroperca tigris		36	-	1.81
	Mycteroperca venenosa		22	-	1.08
	Paranthias furcifer		24	-	2.27
	Serranus dewegeri		22	-	1.40
	Serranus tabacarius		11	-	1.24
	Serranus tigrinus		9	-	1.45
	Serranus tortugarum		5	-	1.58
Sparidae	*Archosargus rhomboidalis*		17	-	2.47
	Calamus bajonado		34	-	3.04
	Calamus calamus		26	-	3.18
	Calamus penna		24	-	3.11
	Calamus pennatula		31	-	3.04
	Diplodus caudimacula		27	-	2.92
Sphyraenidae	*Sphyraena barracuda*		49	-	1.61
	Sphyraena picudilla		36	-	2.62
Synodontidae	*Synodus foetens*		31	-	2.65
	Synodus intermedius		38	-	2.38
	Synodus synodus		12	-	2.38
Tetraodontidae	*Canthigaster rostrata*		7	-	1.52
	Sphoeroides spengleri		12	-	1.57

Symbols:
♀ = female.
♂ = male.

Appendix 8.4

Table 8.4.1. Food consumption of Caribbean reef fishes (without accounting for omnivory); Q/B values represent mean population consumption of the corresponding species; mean environmental temperature = 28°C.

Family	Species		Food type	Aspect ratio	W_∞ (g)	Q/B (%BWD)	Q/B (year^{-1})
Acanthuridae	*Acanthurus bahianus*		1	2.18	288	10.82	39.49
	Acanthurus chirurgus		1	1.78	820	7.89	28.79
	Acanthurus coeruleus		1	1.86	983	7.77	28.36
Balistidae	*Balistes capriscus*		0 *	2.44	611	2.80	10.20
	Balistes vetula		0	1.98	2,586	1.87	6.84
	Canthidermis sufflamen		0	1.71	4,783	1.53	5.60
	Melichthys niger		1	2.30	960	8.71	31.79
Blenniidae	*Entomacrodus nigricans*		1	1.02	13	13.65	49.81
	Ophioblennius atlanticus		1	0.92	35	10.61	38.73
	Parablennius marmoreus		1	1.26	10	16.06	58.62
	Scartella cristata		1	1.18	27	12.68	46.28
Bothidae	*Bothus lunatus*		0	1.11	3,000	1.35	4.94
	Bothus ocellatus		0	1.51	180	2.79	10.19
Clupeidae	*Harengula humeralis*		0	2.90	440	3.27	11.92
Ephippidae	*Chaetodipterus faber*		0	3.11	9,000	1.84	6.72
Gobiidae	*Coryphopterus glaucofraenum*		0	1.11	10.5	4.22	15.41
	Gnatholepis thompsoni		1	0.96	4.1	16.67	60.83
Hemiramphidae	*Hemiramphus brasiliensis*		1	3.23	298	13.16	48.02
Monacanthidae	*Aluterus monoceros*		0 *	1.70	2,500	1.75	6.37
	Aluterus schoepfii		1	0.72	1,892	4.19	15.28
	Aluterus scripta		0	0.72	2,941	1.08	3.95
	Cantherines macrocerus		0	1.46	2,700	1.59	5.79
	Cantherines pullus		0	1.47	220	2.64	9.64
	Monacanthus ciliatus		0	1.24	448	2.09	7.65
	Monacanthus tuckeri		0	1.37	24	3.99	14.57
Ostraciidae	*Acanthostracion quadricornis*		0	1.14	3,050	1.37	4.98
	Lactophrys trigonus		0	1.87	3,052	1.76	6.43
	Lactophrys bicaudalis		0	1.23	5,572	1.26	4.59
	Lactophrys triqueter		0	1.98	1,394	2.13	7.76
Pomacanthidae	*Centropyge argi*		1	1.44	10	17.23	62.89
	Holacanthus ciliaris		0	1.29	1,988	1.59	5.80
	Holacanthus tricolor		0	1.65	1,306	1.96	7.15
	Pomacanthus arcuatus		0	2.89	12,407	1.66	6.06
	Pomacanthus paru	Virgin Islands	0	1.81	2,769	1.77	6.45
		Jamaica	0	1.81	2,229	1.84	6.73
Pomacentridae	*Abudefduf saxatilis*		0	2.98	483	3.25	11.86
	Abudefduf taurus		1	2.01	900	8.24	30.07
	Microspathodon chrysurus		1	1.88	412	9.31	33.99
	Stegastes fuscus		1	1.83	168	11.00	40.17
	Stegastes leucostictus		0	1.31	50	3.36	12.26
	Stegastes planifrons		0	1.37	68	3.23	11.79
	Stegastes variabilis		0	1.54	54	3.59	13.12
Scaridae	*Scarus coelestinus*		1	1.06	8,556	3.75	13.70
	Scarus taeniopterus		1	1.09	1,102	5.78	21.08
	Scarus vetula		1	1.05	5,558	4.09	14.93
	Sparisoma aurofrenatum		1	1.33	324	8.18	29.84
Sparidae	*Archosargus rhomboidalis*		1	2.47	1,200	8.64	31.54
	Diplodus caudimacula		1	2.92	600	10.84	39.57
Tetraodontidae	*Canthigaster rostrata*		0	1.52	82	3.28	11.98
	Sphoeroides spengleri		0	1.57	92	3.26	11.90

Symbol:
* = Assumed (derived from other members of genus or family).

Appendix 8.5. List of species of nonfish taxa.

Table 8.5.1. Benthic primary producers in fish stomachs of West Indian reef fishes (based on Randall 1967); occurrence refers to number of fish species with respective item in stomach.

Taxon and class	Species	Occurrence	Sum Genus	Sum Higher taxon
Spermatophytes	*Cymodocea manatorum*	16		
(including seagrasses)	*Cymodocea* sp.	1	17	
	Halophila baillonis	7	7	
	Ruppia maritima	1	1	
	Thalassia sp.	1		
	Thalassia testudineum	23	24	
	Vaucheria sp.	1	1	50
Algae	Algae *	3		3
Rhodophyta[a]	*Acanthophora spicifera*	8	8	
	Acrochaetium sp.	2	2	
	Amphiroa fragilissima	14	14	
	Anacystis marina	3		
	Anacystis sp.	2	5	
	Asterocystis ramosa	2	2	
Chlorophyta[b]	*Avrainvillea nigricans*	1		
	Avrainvillea rawsonii	1		
	Avrainvillea sp.	1	3	
Cyanophyta[c]	Bluegreens	1	1	
	Botryocladia occidentalis	1	1	
Chlorophyta	*Bryopsis pennata*	4		
	Bryopsis sp.	2	6	
	Bryothamnion triquetrum	2	2	
Rhodophyta	*Callithamnion* sp.	1	1	
	Calothrix crustacea	2		
	Calothrix sp.	2	4	
Chlorophyta	*Caulerpa cupressoides*	2		
	Caulerpa mexicana	1		
	Caulerpa prolifera	1		
	Caulerpa racemosa	5		
	Caulerpa sertularioides	5		
	Caulerpa sp.	1		
	Caulerpa taxifolia	2		
	Caulerpa vickersiae	1	18	
Rhodophyta	*Centroceras clavulatum*	14		
	Centroceras sp.	7	21	
	Ceramium byssoideum	12		
	Ceramium fastigiatum	1		
	Ceramium nitens	6		
	Ceramium sp.	18	37	
Chlorophyta	*Chaetomorpha* sp.	1	1	
Rhodophyta	*Champia parvula*	2	2	
	Chondria littoralis	1		
	Chondria sp.	1	2	
Chlorophyta	*Cladophora delicatula*	3		
	Cladophora sp.	8	11	
	Codium intertextum	1		
	Codium isthmocladum	1	2	
	Coelothrix irregularis	12	12	
	Colpomenia sinuosa	1	1	
Rhodophyta	*Corallina cubensis*	3		
	Corallina subulata	1	4	
	Cryptonemia crenulata	1	1	
	Diatoms	17	17	
	Dichothrix penicillata	1		
	Dichothrix sp.	1	2	
Phaeophyta[d]	*Dictyopteris delicatula*	10		
	Dictyopteris justii	1		
	Dictyopteris plagiogramma	2		
	Dictyopteris sp.	1	14	
Chlorophyta	*Dictyosphaeria favulosa*	2	2	
Phaeophyta	*Dictyota bartayresii*	4		
	Dictyota ciliata	1		
	Dictyota dentata	3		
	Dictyota divaricata	13		
	Dictyota linearis	1		
	Dictyota sp.	10	32	

continued...

Table 8.5.1 continued

Taxon and class	Species	Occurrence	Sum Genus	Sum Higher taxon
Rhodophyta	*Digenia simplex*	1	1	
	Dilophus guineensis	1	1	
Phaeophyta	*Ectocarpus breviarticulatus*	1		
	Ectocarpus sp.	2	3	
	Endesme zosterae	1	1	
	Enteromorpha flexuosa	6		
	Enteromorpha sp.	18	24	
	Eucheuma acanthocladum	1		
	Eucheuma echinocarpium	2	3	
Rhodophyta	*Galaxura lapidescens*	2		
	Galaxura sp.	1		
	Galaxura squalida	1	4	
	Gelidiella acerosa	1	1	
	Gelidium corneum	6		
	Gelidium pusillum	5		
	Gelidium rigidulum	3		
	Gelidium sp.	8	22	
Phaeophyta	*Giffordia mitchellae*	1	1	
Rhodophyta	*Gracilaria debilis*	1		
	Gracilaria mammillaris	1		
	Gracilaria sp.	2		
	Gracilaria verrucosa	1	5	
	Grateloupia cuneifolia	1	1	
Chlorophyta	*Halimeda incrassata*	2		
	Halimeda monile	2		
	Halimeda opuntia	8		
	Halimeda sp.	5	17	
Rhodophyta	*Halymenia floresia*	1	1	
	Herposiphonia secunda	4		
	Herposiphonia sp.	13		
	Herposiphonia tenella	1	18	
	Heterosiphonia wurdemanni	2	2	
	Hypnea musciformis	7		
	Hypnea spinella	5	12	
	Jania capillacea	5		
	Jania rubens	7		
	Jania sp.	1	13	
	Laurencia corallopsis	1		
	Laurencia gemnifera	1		
	Laurencia obtusa	11		
	Laurencia papillosa	6		
	Laurencia sp.	3	22	
	Liagora ceranoides	3	3	
	Lithothamnion sp.	1	1	
	Lomentaria uncinata	1	1	
	Lyngbya majuscula	14		
	Lyngbya sp.	18	32	
	Microcoleus chthonoplastes	3		
	Microcoleus sp.	6	9	
	Nitophyllum sp.	1	1	
Cyanophyta	*Oscillatoria* sp.	4	4	
Phaeophyta	*Padina gymnospora*	2		
	Padina sanctae-crucis	2		
	Padina sp.	1	5	
Chlorophyta	*Penicillus pyriformis*	1	1	
Rhodophyta	*Peyssonnelia* sp.	1	1	
	Phormidium penicellatum	1		
	Phormidium sp.	2	3	
	Plectonema nostocorum	2	2	
	Pocockiella variegata	5		
	Pocockiella sp.	1	6	
	Polysiphonia binneyi	1		
	Polysiphonia ferrulacea	13		
	Polysiphonia sp.	21	35	
	Rhizoclonium riparium	6		
	Rhizoclonium sp.	4	10	
Phaeophyta	*Sargassum fluitans*	3		
	Sargassum hystrix	2		
	Sargassum natans	3		
	Sargassum platycarpum	3		

continued...

Table 8.5.1 continued

Taxon and class	Species	Occurrence	Sum Genus	Sum Higher taxon
	Sargassum polyceratium	1		
	Sargassum pteropleuron	1		
	Sargassum rigidulum	1		
	Sargassum sp.	4	18	
	Spatoglossum schroderi	1	1	
Rhodophyta	*Spermothamnion investiens*	2	2	
Phaeophyta	*Sphacelaria tribuloides*	2		
	Sphacelaria sp.	1	3	
	Spirulina sp.	2	2	
Rhodophyta	*Spyridia filamentosa*	7	7	
Phaeophyta	*Turbinaria turbinata*	2	2	
Chlorophyta	*Udotea flabellum*	2	2	
	Ulva lactuca	4		
	Ulva sp.	3	7	
	Valonia utricularis	1	2	
	Valonia ventricosa	1		
	Vidalia obtusiloba	1	1	
Rhodophyta	*Wrangelia argus*	2	2	543

[a] Rhodophyta (red algae).
[b] Chlorophyta (green algae).
[c] Cyanophyta (blue-green algae).
[d] Phaeophyta (brown algae).

Table 8.5.2. Invertebrates in stomachs of West Indian reef fishes (based on Randall 1967); items are listed in systematical order; "occurrence" refers to number of fish species with respective item in stomach.

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
Foraminifera	-	6	-	6
Sponges	-	20	-	21
	Mycale sp.	1	1	
Hydrozoans	*Hydroids*	12	-	16
	Millepora alcicornis	2	2	
	Pennaria sp.	1	1	
	Sertularia sp.	1	1	
Gorgonians	-	6	-	14
(Sea fans)	*Eunicea calyculata*	1	1	
	Gorgonia flabellum	2	2	
	Muricea atlantica	1		
	Muricea laxa	1		
	Muricea sp.	1	3	
	Plexaura flexuosa	1	1	
	Pterogorgia sp.	1	1	
Alcyonarians (Leather corals)	-	1	-	1
Zoanthids	-	1	-	22
(Sea anemones)	*Bunodactis stelloides*	1	1	
	Bunodosoma granulifera	1	1	
	Palythoa sp.	1	1	
	Phyllactis flosculifera	2	2	
	Rhodactis sanctithomae	1	1	
	Zoanthus pulchellus	2		
	Zoanthus sociatus	5		
	Zoanthus sp.	8	15	
Scleractinia	-	7	-	10
(Stony corals)	*Cladocora arbuscula*	1	1	
	Colpophyllia sp.	1	1	
	Oculina diffusa	1	1	
Bryozoans	-	6	-	6
Sipunculids	-	8	-	22
	Aspidosiphon cumingi	1		
	Aspidosiphon sp.	9		
	Aspidosiphon speciosus	1		
	Aspidosiphon spinososcutatus	1	12	
	Siphonosoma cumanensis	2	2	
Priapuloids	-	1	-	1
Chitons	-	7	-	20
	Acanthochiton hemphilli	1	1	
	Acanthochitona pygmaea	3		
	Acanthochitona sp.	1	4	
	Calloplax janeirensis	1	1	
	Choneplax lata	2	2	
	Ischnochiton papillosus	4		
	Ischnochiton sp.	1	5	
Gastropods	-	15	-	328
	acmaeids (limpets)	8	-	
	acteonids	1	-	
	alcidids	1	-	
	buccinids	1	-	
	columbellids	1	-	
	muricids	1	-	
	turbinids	2	-	
	turrids	4	-	
	vermetids	3	-	
	Acmaea antillarum (limpets)	4		
	Acmaea leucopleura (limpets)	3		

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Acmaea pustulata (limpets)	10		
	Acmaea sp.	6	23	
	Alvania auberiana	2	2	
	Anachis sparsa	1		
	Anachis sp.	5	6	
	Arene tricarinata	2		
	Arene sp.	5	7	
	Astraea caelata	1		
	Astraea longispina	2		
	Astraea ruber	2		
	Astraea sp.	4	9	
	Atys riiseana	1		
	Atys sp.	1	2	
	Bailya sp.	1	1	
	Balcis intermedia (in Holoth.?)	1	1	
	Batillaria sp.	1	1	
	Bittium varium	4	1	
	Bulla sp.	1		
	Bulla striata	1	2	
	Bullata ovuliformis	2	2	
	Caecum nitidum	1		
	Caecum pulchellum	3		
	Caecum sp.	1	5	
	Calliostoma javanicum	1		
	Calliostoma sp.	3	4	
	Cerithiopsis emersoni	1	1	
	Cerithium algicola	3		
	Cerithium eburneum	1		
	Cerithium litteratum	3		
	Cerithium sp.	5	12	
	Cittarium pica	2	2	
	Columbella mercatoria	9	9	
	Conus juliae	1	1	
	Coralliophila caribea	1	1	
	Crassispira fuscescens	1		
	Crassispira nigrescens	1	2	
	Crassostrea rhizophorae	2	2	
	Crucibulum auricula	1	1	
	Cyclostremiscus ornatus	1	1	
	Cymatium labiosum	1	1	
	Daphnella lymneiformis	1	1	
	Diodora cayensis	1		
	Diodora listeri	3		
	Diodora sp.	3		
	Diodora variegata	1		
	Diodora viridula	1	9	
	Drillia sp.	1	1	
	Emarginula pumila	2	2	
	Epitonium sp.	2		
	Epitonium turritellulum	1	3	
	Fasciolaria tulipa	2	2	
	Fissurella angusta (limpets)	1		
	Fissurella barbadensis (limpets)	6		
	Fissurella nodosa (limpets)	1		
	Fissurella sp. (limpets)	6	14	
	Haminoea elegans	3	3	
	Hemitoma octoradiata	5	5	
	Hipponix subrufus	1	1	
	Hyalina albolineata	3		
	Hyalina avena	1		
	Hyalina sp.	6	10	
	Litiopa melanostoma	1	1	
	Littorina angulifera	1		
	Littorina meleagris	1		
	Littorina ziczac	1	3	
	Mangelia sp.	2	2	
	Marginella sp.	1	1	
	Melampus coffeus	2	2	
	Mitra barbadensis	1		
	Mitra sp.	1		

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Mitrella lunata	3		
	Mitrella nitens	1	6	
	Modulus modulus	9	9	
	Murex pomum	2		
	Murex sp.	1	3	
	Muricopsis hexagonus	1	1	
	Nassarius albus	2		
	Nassarius sp.	5	7	
	Natica canrena	1		
	Natica sp. (juvenile)	1	2	
	Nerita peloronta	1	1	
	Nitidella laevigata	1		
	Nitidella nitida	2		
	Nitidella ocellata	3		
	Nitidella sp.	3	9	
	Oliva caribaeensis	1		
	Oliva reticularis	1		
	Oliva sp.	2	4	
	Olivella nivea	1		
	Olivella petiolita	1		
	Olivella sp.	8	10	
	Persicula lavalleeana	4	4	
	Petaloconchus sp. (vermetid)	1	1	
	Planaxis lineatus	2	2	
	Polinices lacteus	1	1	
	Pseudostomatella coccinea	3		
	Pseudostomatella erythrocoma	1	4	
	Purpura patula (thaid)	1	1	
	Pusia sp.	1	1	
	Pyramidella candida	1	1	
	Pyrgocythara sp.	1	1	
	Retusa sp.	1	1	
	Risomurex roseus	1	1	
	Rissoina cancellata	1		
	Rissoina fischeri	1		
	Rissoina sp.	1	3	
	Schismope sp.	1	1	
	Seila adamsi	1	1	
	Sinum perspectivum	1	1	
	Siphonaria sp. (limpets)	2	2	
	Smaragdia viridis	3	3	
	Strombus gallus	1		
	Strombus gigas	12		
	Strombus sp.	2	15	
	Synaptocochlea picta	2	2	
	Tegula excavata	1		
	Tegula fasciata	6		
	Tegula lividomaculata	2		
	Tegula sp.	2	11	
	Tricolia adamsi	3		
	Tricolia bella	1		
	Tricolia tessellata	3	7	
	Tridachia crispata	1	1	
	Trivia sp.	1	1	
	Turbo castanea	7		
	Turbo sp.	1	8	
	Turbonilla sp.	1	1	
	Turritella sp.	1	1	
	Vasum muricatum	1	1	
	Zebina browniana	3	3	
Bivalves	-	13	-	143
	arcids	1	-	
	ostreids	1	-	
	pinnids	1	-	
	Aequipecten gibbus	2		
	Aequipecten lineolaris	1	3	
	Americardia guppyi	2		
	Americardia media	1	3	
	Antigona listeri	1	1	

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Arca imbricata	1		
	Arca sp.	1		
	Arca umbonata	1		
	Arca zebra	3	6	
	Arcopsis adamsi	2	2	
	Asaphis deflorata	1	1	
	Atrina rigida	1		
	Atrina seminuda	1	2	
	Barbatia cancellaria	3		
	Babartia domingensis	2	5	
	Brachidontes citrinus	1		
	Brachidontes exustus	3		
	Brachidontes sp.	1	5	
	Chama sarda	1		
	Chama sp.	1	2	
	Chione cancellata	1		
	Chione paphia	1		
	Chione sp.	1	3	
	Chlamys sp.	1	1	
	Codakia costata	1		
	Codakia orbicularis	1		
	Codakia pectinella	1	3	
	Corbula contracta	1	1	
	Crassinella sp.	1	1	
	Crassostrea rhizophorae	2	2	
	Crenella divaricata	1	1	
	Cumingia antillarum	4	4	
	Divaricella quadrisulcata	1	1	
	Ervilia nitens	2	2	
	Glycymeris decussata	1		
	Glycymeris pectinata	1		
	Glycymeris sp.	1	3	
	Gouldia cerina	2	2	
	Isognomon alatus	1		
	Isognomon radiatus	3		
	Isognomon sp.	2	6	
	Laevicardium sp.	7	7	
	Lima pellucida	1	1	
	Lithophaga bisulcata	1	1	
	Lyropecten antillarum	1	1	
	Macoma cerina	2	2	
	Microcardium sp.	1	1	
	Musculus lateralis	5	5	
	Nuculana sp.	1	1	
	Ostrea sp.	3	3	
	Papyridea semisulcata	2		
	Papyridea soleniformis	1		
	Papyridea sp.	1	4	
	Pecten ziczac	1		
	Pecten sp.	4	5	
	Pinctada radiata	2		
	Pinctada sp.	2	4	
	Pinna carnea	1	1	
	Pitar fulminata	1		
	Pitar sp.	3	4	
	Pseudochama sp.	1	1	
	Pteria colymbus	1	1	
	Solemya occidentalis	3	3	
	Spondylus sp.	1	1	
	Tellina caribaea	2		
	Tellina listeri	1		
	Tellina sp.	11	14	
	Trachycardium magnum	2		
	Trachycardium muricatum	1		
	Trachycardium sp.	2	5	
	Volsella sp.	1	1	
	Yoldia perprotracta	1	1	
Scaphopods	-	3	-	13
	Cadulus acus	1		

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Cadulus sp.	3	4	
	Dentalium semistriolatum	1		
	Dentalium sp.	5	6	
Squids	-	11	-	14
	Dorytheutis plei	1		
	Dorytheutis sp.	1	2	
	Sepiateuthis sepioidea	1	1	
Octopuses	-	18	-	20
	Octopus briareus	1		
	Octopus vulgaris	1	2	
Polychaetes	-	51	-	86
	ampharetids	1	-	
	arabellids	1	-	
	capitellids	1	-	
	chaetopterids	1	-	
	eunicids	2	-	
	flabelligerids	1	-	
	glycerids	1	-	
	lumbrinerids	1	-	
	maldanids	1	-	
	nereids	1	-	
	onuphids	2	-	
	opheliids	1	-	
	pectinariids	1	-	
	polynoids	1	-	
	sabellids	3	-	
	serpulids	4	-	
	syllids	1	-	
	terebellids	3	-	
	Cariboa sp.	1	1	
	Chloeia sp.	2	2	
	Eunice sp. (fire worm)	3	3	
	Sabellastarte magnifica (palolo worm)	1	1	
	Semiodera sp.	1	1	
Echiuroids	-	2	-	2
Pycnogonids	-	2	-	2
Barnacles	appendages	5	-	5
Stomatopods	-	26	-	53
	Gonodactylus curacaoensis	2		
	Gonodactylus oerstedii	6		
	Gonodactylus sp.	7	15	
	Lysiosquilla glabriuscula	2	2	
	Nannosqilla	1	1	
	Pseudosquilla ciliata	6	6	
	Squilla	1		
	Squilla tricarinata	1	2	
	Squillus sp.	1	1	
Amphipods	-	29	-	64
	caprellids	5	-	
	gammarids	3	-	
	hyperiids	8	-	
	isaeids	1	-	
	lysianassids (gammarid)	1	-	
	metopids	1	-	
	photids	1	-	
	Ampelisca sp. (gammarid)	1	1	
	Colomastix sp.	1	1	
	Corophium sp.	1	1	
	Cymadusa filosa	1		
	Cymadusa sp.	1	2	
	Elasmopus sp.	2	2	

continued.

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Eurystheus sp.	1	1	
	Hyale sp.	1	1	
	Leucothoe sp.	1	1	
	Magamphopus sp.	1	1	
	Neomicrodentopus sp.	1	1	
	Paraphoxus sp.	1	1	
	Photis sp.	2	2	
Tanaids	-	14	-	15
	apseudids	1	-	
Isopods	-	34	-	51
	anthurids	1	-	
	cymothoids	1	-	
	excorallanids	2	-	
	flabelliferans	1	-	
	gnathiids (larvae)	2	-	
	sphaeromids	2	-	
	Asellote sp.	1	1	
	Cymodoce sp.	1	1	
	Excorallana antillensis	1		
	Excorallana sp.	1	2	
	Paracerceis caudata	3	3	
	Stenetrium sp.	1	1	
Shrimps	-	32	-	166
	alpheids	40	-	
	axiids	2	-	
	carideans	24	-	
	gnathophyllids	6	-	
	hippolytids	1	-	
	palaemonids	7	-	
	penaeids	23	-	
	stenopids	1	-	
	stenopodids	1	-	
	Alpheus sp.	1	1	
	Brachycarpus biunguiculatus	1	1	
	Calianassa sp.	2	2	
	Gnathophylloides mineri	1	1	
	Lucifer faxani	1		
	Lucifer sp.	2	3	
	Lysmata moorei (cleaner shrimp)	1	1	
	Penaeopsis goodei	1		
	Penaeopsis sp.	1	2	
	Periclimenes sp. (cleaner shrimp)	3	3	
	Processa sp.	1	1	
	Sicyonia laevigata	1	1	
	Sicyona sp.	1	1	
	Solenocera sp.	1	1	
	Stenopus hispidus (cleaner shrimp)	2	2	
	Synalpheus sp.	2	2	
	Tozeuma sp.	3	3	
	Trachycaris restrictus	1	1	
	Trachypenaeus sp.	2	2	
	Upogebia sp. (Thalassinids)	1	1	
Spiny lobsters	-	1	-	7
	Panulirus argus	4		
	Panulirus guttatus	2	6	
Scyllarid lobsters	-	3	-	5
	Scyllarides aequinoctialis (slipper lobster)	2	2	
Hermit crabs	-	21	-	49
	diogenids	3	-	
	pagurids	3	-	
	Calcinus fibiceus	1		
	Calcinus sulcatus	1	2	
	Clibanarius sp.	1		

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Clibanarius tricolor	2	3	
	Dardanus venosus	2	2	
	Paguristes anomalus	2		
	Paguristes depressus	3		
	Paguristes grayi	2		
	Paguristes sp.	2		
	Paguristes wassi	1	10	
	Pagurus bonairensis	1		
	Pagurus miamensis	1	2	
	Petrochirus diogenes	2	2	
	Spiropagurus sp.	1	1	
Crabs	-	33	-	258
	calappids	9	-	
	gonoplacid (Speocarcinus)	3	-	
	grapsids	3	-	
	hippids	4	-	
	leucosids	1	-	
	majids	29	-	
	oxystomes	1	-	
	parthenopids	2	-	
	pinotherids	1	-	
	porcellanids	6	-	
	portunids	24	-	
	raninids	2	-	
	xanthids	17	-	
Majidae	*Acanthonyx petiverii*	1	1	
	Actaea acantha	1	1	
Albuneidae	*Albunea gibbesii*	2	2	
	Arenaeus cribarius	1	1	
Calappidae	*Calappa flammea*	1		
	Calappa gallus	2		
	Calappa ocellata	2		
	Calappa sp.	2	7	
	Callinectes sp.	1	1	
Xanthidae	*Carpilius corallinus*	2	2	
	Chorinus heros	1	1	
	Cronius ruber	5		
	Cronius tumidulus	2	7	
	Domecia hispida	4	4	
Leucosidae	*Ebalia stimpsonii*	1	1	
Hippidae	*Emerita portoricensis*	1		
	Emerita sp.	1	2	
	Euryplax nitida	1	1	
Majidae	*Herbstia* sp.			
	Leiolambrus nitidus	1	1	
	Leptodius floridanus	1	1	
	Macrocoelema sp.	1	1	
	Microphrys bicornutus	2	2	
	Mithrax cinctimanus	1		
	Mithrax coryphe	3		
	Mithrax forceps	1		
	Mithrax sculptus	7		
	Mithrax sp.	16		
	Mithrax verrucosus	1	29	
	Ocypode albicans	1	1	
	Panopeus sp.	2	2	
Parthenopidae	*Parthenope serrata*	1	1	
	Percnon gibbesi	7		
	Percnon sp.	1	8	
	Persephona punctata	1	1	
Porcellanidae	*Petrolisthes galathinus*	7		
	Petrolisthes ponta	1		

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Petrolisthes sp.	4	12	
	Pilumnus sp.	1	1	
	Pisosoma sp.	1	1	
Majidae	*Pitho aculeata*	1		
	Pitho lherminieri	2		
	Pitho sp.	3	6	
Xanthidae	*Platypodia spectabilis*	1	1	
Porcellanidae	*Porcellana sayana*	1	1	
Portunidae	*Portunus anaps*	1		
	Portunus bahamensis	1		
	Portunus ordwayi	2		
	Portunus sebae	5		
	Portunus sp.	6	15	
Raninidae	*Ranilia muricata*	1	1	
Grapsidae	*Sesarma* sp.	1	1	
Majidae	*Stenorynchus seticornis*	4	4	
	Xanthodius denticulatus	1	1	
Hemichordates	-	6	-	6
Asteroids	*Astropecten* sp.	1	1	6
	Linckia guildingii	1	1	
	Ophidiaster sp.	1	1	
	Oreaster reticulatus	3	3	
Ophiuroids	-	6	-	55
	amphiurid	1	-	
	Amphipholis gracillima	1	1	
	Amphiura fibulata	1	1	
	Ophiactis sp.	1	1	
	Ophiocoma echinata	7		
	Ophiocoma riisei	3		
	Ophiocoma sp.	3	13	
	Ophioderma brevispinum	1		
	Ophioderma rubicundum	3		
	Ophioderma sp.	2		
	Ophioderma squamosissima	1	7	
	Ophionereis sp.	3	3	
	Ophiothrix lineata	1		
	Ophiothrix sp.	21	22	
Echinoids	-	5	-	68
	spatangoids	8	-	
	Brissus brissus (heart urchin)	1	1	
	Clypeaster sp.	1	1	
	Diadema antillarum	22	22	
	Echinometra lacunter	3		
	Echinometra sp.	7		
	Echinometra viridis	6	16	
	Eucidaris tribuloides	6	6	
	Lytechinus variegatus	7	7	
	Moira atropus	1	1	
	Tripneustes esculentus	1	1	
Holothurians	-	8	-	10
	Holothuria arenicola	1	1	
	Thyone pseudofusus	1	1	
Tunicates	-	9	-	36
	appendicularians	8	-	
	didemnids	4	-	
	salps	4	-	
	Ascidia nigra	2	2	

continued...

Table 8.5.2 continued

Taxon	Species	Occurrence	Sum Genus	Sum Higher taxon
	Boltenia sp.	1	1	
	Ecteinascidia turbinata	1	1	
	Polycarpa insulsa	1	1	
	Microcosmos exasperatus	1	1	
	Trididemnum savignii	4		
	Trididemnum sp.	1	5	
Sea turtles	*Caretta caretta*	1	1	2
	Eretmochelys imbricata	1	1	

Table 8.5.3. Composition of "zooplankton" in the diet composition matrix of a Caribbean coral reef (US Virgin Islands, based on Randall 1967); "occurrence" refers to the number of fish species with respective item in stomach.

Taxon	Item	Occurrence
Arthropoda	Insects	3
Annelida	Polychaete larvae	1
Cnidaria	Scyphozoans (medusae)	2
	Siphonophores (medusae)	11
Crustacea	Barnacle larvae	5
	Copepods	47
	Crab larvae	26
	Euphausids	1
	Hermit crab larvae	4
	Isopod larvae	1
	Mysids	12
	Ostracods	19
	Scyllarid larvae	5
	Shrimp larvae	37
	Stomatopod larvae	11
Ctenophora	Ctenophores (medusae)	1
Mollusca	Bivalve larvae	2
	Cephalopod larvae	4
	Gastropod larvae	11
	Heteropods	2
	Mollusc eggs	6
	Pteropods	13
Tunicata	Appendicularians	11
	Salps	5
Unidentified	Fish eggs	14
	Fish larvae	11

Appendix 8.6. Diet composition matrix.

Table 8.6.1. Taxa and species included in the diet composition matrix of the ECOPATH II models of a Caribbean coral reef. Species are listed in alphabetical order of families.

Family or higher taxon	Code		Species
Organic detritus	D	1	
Benthic algae	A	1	
Spermatophytes	A	1	
Symbiotic algae	A	2	
Phytoplankton	A	3	
Decomposers/microfauna	I	1	
Zooplankton	I	2	
Sponges	I	3	
Hydrozoans	I	4	
Sea fans	I	5	
Sea anemones	I	6	
Stony corals	I	7	
Bryozoans	I	8	
Sipunculid worms	I	9	
Priapuloids	I	10	
Chitons	I	11	
Gastropods	I	12	
Bivalves	I	13	
Scaphopods	I	14	
Squids	I	15	
Octopuses	I	16	
Polychaetes	I	17	
Echiuroids	I	18	
Pycnogonids	I	19	
Barnacles	I	20	
Stomatopods	I	21	
Amphipods	I	22	
Tanaids	I	23	
Isopods	I	24	
Shrimps	I	25	
Spiny lobsters	I	26	
Scyllarid lobsters	I	27	
Hermit crabs	I	28	
Crabs	I	29	
Hemichordates	I	30	
Asteroids	I	31	
Ophiuroids	I	32	
Echinoids	I	33	
Holothurians	I	34	
Tunicates	I	35	
Sea turtles	R	1	
Sea birds	B	1	
	F	0	Unidentified fish
Acanthuridae	F	1	*Acanthurus bahianus*
	F	2	*Acanthurus chirurgus*
	F	3	*Acanthurus coeruleus*
Antennariidae	F	4	*Antennarius multiocellatus*
	F	5	*Antennarius striatus*
Apogonidae	F	6	*Apogon conklini*
	F	7	*Apogon maculatus*
Atherinidae	F	8	*Allanetta harringtonensis*
	F	9	*Atherinomorus stipes*
Aulostomidae	F	10	*Aulostomus maculatus*
Balistidae	F	11	*Balistes vetula*
	F	12	*Canthidermis sufflamen*
	F	13	*Melichthys niger*
Belonidae	F	14	*Platybelone argalus argalus*
	F	15	*Strongylura timucu*
	F	16	*Tylosurus acus acus*
	F	17	*Tylosurus crocodilus crocod.*
Blenniidae	F	18	*Entomacrodus nigricans*
	F	19	*Ophioblennius atlanticus*
	F	20	*Parablennius marmoreus*
	F	21	*Scartella cristata*
Bothidae	F	22	*Bothus lunatus*
	F	23	*Bothus ocellatus*

continued...

Table 8.6.1 continued

Family or higher taxon	Code		Species
Carangidae	F	24	*Caranx bartholomaei*
	F	25	*Caranx latus*
	F	26	*Caranx ruber*
	F	27	*Decapterus punctatus*
	F	28	*Oligoplites saurus*
	F	29	*Selar crumenophthalmus*
	F	30	*Seriola dumerili*
	F	31	*Trachinotus falcatus*
	F	32	*Trachinotus goodei*
Carcharhinidae	F	33	*Carcharhinus acronotus*
	F	34	*Carcharhinus falciformis*
	F	35	*Carcharhinus leucas*
	F	36	*Carcharhinus limbatus*
	F	37	*Carcharhinus longimanus*
	F	38	*Carcharhinus perezi*
	F	39	*Galeocerdo cuvier*
	F	40	*Negaprion brevirostris*
	F	41	*Rhizoprionodon porosus*
Chaetodontidae	F	42	*Chaetodon aculeatus*
	F	43	*Chaetodon capistratus*
	F	44	*Chaetodon sedentarius*
	F	45	*Chaetodon striatus*
Cirrithidae	F	46	*Amblycirrhitus pinos*
Clinidae	F	47	*Labrisomus guppyi*
	F	48	*Labrisomus nuchipinnis*
Clupeidae	F	49	*Harengula clupeola*
	F	50	*Harengula humeralis*
	F	51	*Jenkinsia lamprotaenia*
	F	52	*Opisthonema oglinum*
Congridae	F	53	*Heteroconger halis*
Dactylopteridae	F	54	*Dactylopterus volitans*
Dasyatidae	F	55	*Dasyatis americana*
Diodontidae	F	56	*Chilomycterus antennatus*
	F	57	*Diodon holocanthus*
	F	58	*Diodon hystrix*
Emmelichthyidae	F	59	*Inermia vittata*
Engraulidae	F	60	*Anchoa hepsetus*
	F	61	*Anchoa lyolepis*
Ephippidae	F	62	*Chaetodipterus faber*
Fistulariidae	F	63	*Fistularia tabacaria*
Gerreidae	F	64	*Eucinostomus argenteus*
	F	65	*Gerres cinereus*
Ginglymostomatidae	F	66	*Ginglymostoma cirratum*
Gobiidae	F	67	*Coryphopterus glaucofraenum*
	F	68	*Gnatholepis thompsoni*
	F	69	*Gobiosoma evelynae*
Grammidae	F	70	*Gramma loreto*
	F	71	*Gramma melacara*
Grammistidae	F	72	*Rypticus saponaceus*
Haemulidae	F	73	*Anisotremus surinamensis*
	F	74	*Anisotremus virginicus*
	F	75	*Haemulon album*
	F	76	*Haemulon aurolineatum*
	F	77	*Haemulon carbonarium*
	F	78	*Haemulon chrysargyreum*
	F	79	*Haemulon flavolineatum*
	F	80	*Haemulon macrostomum*
	F	81	*Haemulon parrai*
	F	82	*Haemulon plumieri*
	F	83	*Haemulon sciurus*
Hemiramphidae	F	84	*Hemiramphus balao*
	F	85	*Hemiramphus brasiliensis*
Holocentridae	F	86	*Holocentrus ascensionis*
	F	87	*Holocentrus coruscus*
	F	88	*Neoniphon marianus*
	F	89	*Holocentrus rufus*
	F	90	*Sargocentron vexillarium*
	F	91	*Myripristis jacobus*
Kyphosidae	F	92	*Kyphosus incisor*
	F	93	*Kyphosus sectatrix*
Labridae	F	94	*Bodianus rufus*
	F	95	*Clepticus parrae*

continued...

Table 8.6.1 continued

Family or higher taxon	Code		Species
	F	96	*Halichoeres bivittatus*
	F	97	*Halichoeres garnoti*
	F	98	*Halichoeres maculipinna*
	F	99	*Halichoeres poeyi*
	F	100	*Halichoeres radiatus*
	F	101	*Xyrichtys novacula*
	F	102	*Xyrichtys splendens*
	F	103	*Lachnolaimus maximus*
	F	104	*Thalassoma bifasciatum*
Lutjanidae	F	105	*Lutjanus analis*
	F	106	*Lutjanus apodus*
	F	107	*Lutjanus cyanopterus*
	F	108	*Lutjanus griseus*
	F	109	*Lutjanus jocu*
	F	110	*Lutjanus mahagoni*
	F	111	*Lutjanus synagris*
	F	112	*Ocyurus chrysurus*
Malacanthidae	F	113	*Malacanthus plumieri*
Megalopidae	F	114	*Tarpon atlanticus*
Monacanthidae	F	115	*Aluterus schoepfii*
	F	116	*Aluterus scripta*
	F	117	*Cantherines macroceros*
	F	118	*Cantherines pullus*
	F	119	*Monacanthus ciliatus*
Mugilidae	F	120	*Mugil curema*
Mullidae	F	121	*Mulloidichthys martinicus*
	F	122	*Pseudupeneus maculatus*
Muraenidae	F	123	*Echidna catenata*
	F	124	*Lycodontis moringa*
	F	125	*Gymnothorax vicinus*
Myliobatidae	F	126	*Aetobatus narinari*
Ogcocephalidae	F	127	*Ogcocephalus nasutus*
Ophichthidae	F	128	*Myrichthys breviceps*
	F	129	*Myrichthys ocellatus*
	F	130	*Ophichthus ophis*
Opisthognathidae	F	131	*Opisthognatus aurifrons*
	F	132	*Opisthognatus maxillosus*
	F	133	*Opisthognatus whitehurstii*
Ostraciidae	F	134	*Acanthostracion polygonius*
	F	135	*Acanthostracion quadricornis*
	F	136	*Lactophrys trigonus*
	F	137	*Lactophrys bicaudalis*
	F	138	*Lactophrys triqueter*
Pempheridae	F	139	*Pempheris schomburgki*
Pomacanthidae	F	140	*Centropyge argi*
	F	141	*Holacanthus ciliaris*
	F	142	*Holacanthus tricolor*
	F	143	*Pomacanthus arcuatus*
	F	144	*Pomacanthus paru*
Pomacentridae	F	145	*Abudefduf saxatilis*
	F	146	*Abudefduf taurus*
	F	147	*Chromis cyanea*
	F	148	*Chromis multilineata*
	F	149	*Microspathodon chrysurus*
	F	150	*Stegastes fuscus*
	F	151	*Stegastes leucostictus*
	F	152	*Stegastes planifrons*
	F	153	*Stegastes variabilis*
Priacanthidae	F	154	*Priacanthus arenatus*
	F	155	*Heteropriacanthus cruentatus*
Scaridae	F	156	*Scarus coelestinus*
	F	157	*Scarus iserti*
	F	158	*Scarus guacamaia*
	F	159	*Scarus taeniopterus*
	F	160	*Scarus vetula*
	F	161	*Sparisoma aurofrenatum*
	F	162	*Sparisoma chrysopterum*
	F	163	*Sparisoma radians*
	F	164	*Sparisoma rubripinne*
	F	165	*Sparisoma viride*
Sciaenidae	F	166	*Equetus lanceolatus*
	F	167	*Equetus punctatus*

continued...

Table 8.6.1 continued

Family or higher taxon	Code	Species
	F 168	*Odontoscion dentex*
	F 169	*Pareques acuminatus*
Scombridae	F 170	*Euthynnus alletteratus*
	F 171	*Scomberomorus cavalla*
	F 172	*Scomberomorus regalis*
Scorpaenidae	F 173	*Scorpaena brasiliensis*
	F 174	*Scorpaena grandicornis*
	F 175	*Scorpaena inermis*
	F 176	*Scorpaena plumieri*
	F 177	*Scorpaenodes caribbaeus*
Serranidae	F 178	*Alphestes afer*
	F 179	*Cephalopholis cruentata*
	F 180	*Cephalopholis fulva*
	F 181	*Epinephelus adscensionis*
	F 182	*Epinephelus guttatus*
	F 183	*Epinephelus itajara*
	F 184	*Epinephelus striatus*
	F 185	*Hypoplectrus aberrans*
	F 186	*Hypoplectrus chlorurus*
	F 187	*Hypoplectrus nigricans*
	F 188	*Hypoplectrus puella*
	F 189	*Mycteroperca bonaci*
	F 190	*Mycteroperca tigris*
	F 191	*Mycteroperca venenosa*
	F 192	*Paranthias furcifer*
	F 193	*Serranus tigrinus*
Sparidae	F 194	*Archosargus rhomboidalis*
	F 195	*Calamus bajonado*
	F 196	*Calamus calamus*
	F 197	*Calamus pennatula*
	F 198	*Diplodus argentus caudimacula*
Sphyraenidae	F 199	*Sphyraena barracuda*
	F 200	*Sphyraena picudilla*
Sphyrnidae	F 201	*Sphyrna lewini*
	F 202	*Sphyrna tiburo*
Synodontidae	F 203	*Synodus foetens*
	F 204	*Synodus intermedius*
	F 205	*Synodus synodus*
Tetraodontidae	F 206	*Canthigaster rostrata*
	F 207	*Sphoeroides spengleri*
Triakidae	F 208	*Mustelus canis*

Symbols:

A	=	autotroph	F	=	fish
B	=	bird	I	=	invertebrate
D	=	detritus	R	=	reptile

Table 8.6.2. The complete diet composition matrix for the construction of steady-state models of a Caribbean coral reef area, including 41 nonfish taxa and 208 fish species.

		Predator/prey	D1	A1	A2	A3	I1	I2	I3	I4	I5	I6	I7
D	1	Detritus, POM, DOM	-	-	-	-	-	-	-	-	-	-	-
A	1	Benthic autotrophs	-	-	-	-	-	-	-	-	-	-	-
A	2	Symbiotic algae	-	-	-	-	-	-	-	-	-	-	-
A	3	Phytoplankton	-	-	-	-	-	-	-	-	-	-	-
I	1	Zooplankton	-	-	-	0.2	-	0.8	-	-	-	-	-
I	2	Microfauna	1	-	-	-	-	-	-	-	-	-	-
I	3	Sponges	1	-	-	-	-	-	-	-	-	-	-
I	4	Fire corals	0.1	-	0.65	-	0.15	0.1	-	-	-	-	-
I	5	Sea fans	0.1	-	0.65	-	0.15	0.1	-	-	-	-	-
I	6	Sea anemones	0.2	-	-	-	0.7	0.1	-	-	-	-	-
I	7	Stony corals	0.1	-	0.65	-	0.15	0.1	-	-	-	-	-
I	8	Bryozoans	0.1	-	-	0.7	0.09	0.1	-	-	-	-	-
I	9	Sipunculid worms	0.5	0.25	-	-	-	0.25	-	-	-	-	-
I	10	Priapuloids	-	-	-	-	-	-	-	-	-	-	-
I	11	Chitons	-	0.8	-	-	-	0.04	0.04	0.04	-	-	-
I	12	Gastropods	0.2	0.35	-	-	-	0.064	0.04	0.006	0.012	0.006	0.008
I	13	Bivalves	0.72	-	-	0.16	-	0.12	-	-	-	-	-
I	14	Scaphopods	-	-	-	-	-	1	-	-	-	-	-
I	15	Squids	-	-	-	-	0.3	-	-	-	-	-	-
I	16	Octopuses	-	-	-	-	-	-	-	-	-	-	-
I	17	Polychaetes	0.3	0.15	-	0.14	0.1	0.1	0.03	0.009	0.018	0.009	0.009
I	18	Echiuroids	0.45	0.5	-	-	-	0.05	-	-	-	-	-
I	19	Pycnogonids	-	0.1	-	-	0.1	-	0.15	0.25	0.2	0.1	-
I	20	Barnacles	-	-	-	0.4	0.4	0.2	-	-	-	-	-
I	21	Stomatopods	-	-	-	-	0.05	-	-	-	-	-	-
I	22	Amphipods	0.2	0.5	-	-	0.2	0.1	-	-	-	-	-
I	23	Tanaids	-	0.8	-	-	-	0.2	-	-	-	-	-
I	24	Isopods	0.2	-	-	-	-	-	-	-	-	-	-
I	25	Shrimps	0.04	0.01	-	-	0.2	0.08	-	-	-	-	-
I	26	Spiny lobsters	-	0.3	-	-	-	-	-	-	-	-	-
I	27	Scyllarid lobsters	0.2	-	-	-	-	-	-	-	-	-	-
I	28	Hermit crabs	0.05	-	-	0.05	0.05	0.05	-	-	-	-	-
I	29	Crabs	0.03	0.55	-	0.03	0.04	0.03	0.02	-	-	-	0.04
I	30	Hemichordates	0.1	-	-	0.8	-	0.1	-	-	-	-	-
I	31	Asteroids	0.35	0.05	-	-	-	0.04	0.005	-	0.01	0.005	0.005
I	32	Ophiuroids	0.3	-	-	0.3	0.3	0.1	-	-	-	-	-
I	33	Echinoids	-	0.7	-	-	-	-	0.05	-	-	-	0.2
I	34	Holothurians	0.7	0.1	-	-	-	0.2	-	-	-	-	-
I	35	Tunicates	0.4	-	-	0.2	0.2	0.2	-	-	-	-	-
R	1	Sea turtles	-	0.39	-	-	-	-	0.34	-	-	-	0.04
B	1	Sea birds	-	-	-	-	0.05	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19	I20	I21
D	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	8	-	-	-	-	-	-	-	-	-	0.01	-	-	-	-
I	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	10	-	-	-	-	-	-	-	-	-	1	-	-	-	-
I	11	0.04	-	-	-	-	-	-	-	-	-	-	-	0.04	-
I	12	-	-	-	0.03	0.04	0.03	0.03	-	-	0.1	-	-	0.004	0.002
I	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	15	-	-	-	-	-	-	-	0.3	-	-	-	-	-	-
I	16	-	-	-	0.01	0.83	0.06	-	-	0.01	0.005	-	-	-	-
I	17	0.01	-	-	-	0.01	0.01	-	-	-	0.045	-	-	-	-
I	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	19	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
I	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	21	-	-	-	-	0.2	0.2	-	0.05	-	0.03	-	-	-	-
I	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	25	-	-	-	-	0.05	0.04	0.03	-	0.03	0.1	-	-	-	0.03
I	26	-	-	-	-	0.3	0.4	-	-	-	-	-	-	-	-
I	27	-	-	-	-	-	0.6	-	-	-	0.2	-	-	-	-
I	28	-	-	-	-	-	0.8	-	-	-	-	-	-	-	-
I	29	-	0.001	-	-	0.08	0.03	-	-	-	0.002	-	-	0.003	-
I	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	31	-	-	-	-	0.2	0.09	0.01	-	-	0.01	-	-	-	-
I	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	33	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
I	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R	1	-	-	-	-	0.025	0.02	-	-	-	-	-	-	0.02	0.02
B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I22	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33	I34	I35
D	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	12	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.018	-	-	-	-	0.004
I	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	15	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
I	16	-	-	-	0.01	-	-	0.02	0.035	-	-	-	-	-	-
I	17	0.045	-	-	-	-	-	-	-	-	-	0.01		-	0.005
I	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	21	0.12	0.05	0.05	0.09	-	-	-	-	-	0.02	0.02	0.02	0.02	-
I	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	25	0.11	0.09	0.05	0.02	0.01	0.01	0.01	0.01	-	-	0.06	-	-	-
I	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	29	0.01	-	-	-	-	-	0.07	0.04	-	-	0.002	0.002	-	-
I	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	31	-	-	-	-	-	-	-	0.02	-	0.12	0.05	0.02	0.01	0.005
I	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	33	-	-	-	-	-	-	-	-	-	0.01	0.01	0.01	0.01	-
I	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-
I	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R	1	-	-	-	-	0.06	-	0.02	0.025	-	0.02	-	0.02	-	-
B	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		R1	B1	FO	Sum	Qualitative indications on fish
D	1	-	-	-	0	
A	1	-	-	-	0	
A	2	-	-	-	0	
A	3	-	-	-	0	
I	1	-	-	-	1	
I	2	-	-	-	1	
I	3	-	-	-	1	
I	4	-	-	-	1	
I	5	-	-	-	1	
I	6	-	-	-	1	
I	7	-	-	-	1	
I	8	-	-	-	1	
I	9	-	-	-	1	
I	10	-	-	-	1	
I	11	-	-	-	1	
I	12	-	-	-	1	
I	13	-	-	-	1	
I	14	-	-	-	1	
I	15	-	-	0.3	1	small pelagics
I	16	-	-	0.02	1	Labridae, Pomacentridae, Myliobatidae
I	17	-	-	-	1	
I	18	-	-	-	1	
I	19	-	-	-	1	
I	20	-	-	-	1	
I	21	-	-	0.08	1	Engraulidae, Mullidae
I	22	-	-	-	1	
I	23	-	-	-	1	
I	24	-	-	0.8	1	Fish (parasite)
I	25	-	-	0.02	1	
I	26	-	-	-	1	
I	27	-	-	-	1	
I	28	-	-	-	1	
I	29	-	-	0.02	1	
I	30	-	-	-	1	
I	31	-	-	-	1	
I	32	-	-	-	1	
I	33	-	-	-	1	
I	34	-	-	-	1	
I	35	-	-	-	1	
R	1	-	-	-	1	
B	1	-	-	0.95	1	

continued...

Table 8.6.2 continued

		Predator/prey	D1	A1	A2	A3	I1	I2	I3	I4	I5
F	1	*Acanthurus bahianus*	0.459	0.541	-	-	-	-	-	-	-
F	2	*Acanthurus chirurgus*	0.469	0.527	-	-	-	-	-	-	-
F	3	*Acanthurus coeruleus*	0.464	0.532	0.001	-	-	0.003	-	-	-
F	4	*Antennarius multiocellatus*	-	-	-	-	-	-	-	-	-
F	5	*Antennarius striatus*	-	-	-	-	-	-	-	-	-
F	6	*Apogon conklini*	-	-	-	-	-	0.6	-	-	-
F	7	*Apogon maculatus*	-	-	-	-	-	0.387	-	-	-
F	8	*Allanetta harringtonensis*	-	-	-	-	-	1	-	-	-
F	9	*Atherinomorus stipes*	-	-	-	-	0.028	0.91	-	-	-
F	10	*Aulostomus maculatus*	-	-	-	-	-	-	-	-	-
F	11	*Balistes vetula*	-	0.012	0.001	-	-	-	-	-	-
F	12	*Canthidermis sufflamen*	-	0.025	-	-	-	0.609	-	-	-
F	13	*Melichthys niger*	-	0.752	0.004	-	0.001	0.153	-	-	-
F	14	*Platybelone argalus argalus*	-	-	-	-	-	0.03	-	-	-
F	15	*Strongylura timucu*	-	-	-	-	-	-	-	-	-
F	16	*Tylosurus acus*	-	-	-	-	-	0.037	-	-	-
F	17	*Tylosurus crocodilus*	-	-	-	-	-	-	-	-	-
F	18	*Entomacrodus nigricans*	0.482	0.482	-	-	-	-	-	-	-
F	19	*Ophioblennius atlanticus*	0.498	0.497	-	-	-	0.005	-	-	-
F	20	*Parablennius marmoreus*	0.396	0.396	0.014	-	-	-	-	0.01	-
F	21	*Scartella cristata*	0.496	0.496	-	-	-	-	-	-	-
F	22	*Bothus lunatus*	-	-	-	-	-	-	-	-	-
F	23	*Bothus ocellatus*	-	-	-	-	-	-	-	-	-
F	24	*Caranx bartholomaei*	-	-	-	-	-	-	-	-	-
F	25	*Caranx latus*	-	-	-	-	-	0.084	-	-	-
F	26	*Caranx ruber*	-	-	-	-	-	0.022	-	-	-
F	27	*Decapterus punctatus*	-	-	-	-	-	1	-	-	-
F	28	*Oligoplites saurus*	-	-	-	-	-	0.013	-	-	-
F	29	*Selar crumenophthalmus*	-	-	-	-	-	0.904	-	-	-
F	30	*Seriola dumerili*	-	-	-	-	-	-	-	-	-
F	31	*Trachinotus falcatus*	-	-	-	-	-	-	-	-	-
F	32	*Trachinotus goodei*	-	-	-	-	-	-	-	-	-
F	33	*Carcharhinus acronotus*	-	-	-	-	-	-	-	-	-
F	34	*Carcharhinus falciformis*	-	-	-	-	-	-	-	-	-
F	35	*Carcharhinus leucas*	0.1	-	-	-	-	-	-	-	-
F	36	*Carcharhinus limbatus*	-	-	-	-	-	-	-	-	-
F	37	*Carcharhinus longimanus*	0.1	-	-	-	-	-	-	-	-
F	38	*Carcharhinus perezi*	-	-	-	-	-	-	-	-	-
F	39	*Galeocerdo cuvier*	0.05	-	-	-	-	-	-	-	-
F	40	*Negaprion brevirostris*	0.1	-	-	-	-	-	-	-	-
F	41	*Rhizoprionodon porosus*	-	-	-	-	-	-	-	-	-
F	42	*Chaetodon aculeatus*	-	-	-	-	-	0.173	-	-	-
F	43	*Chaetodon capistratus*	-	-	0.039	-	-	0.064	-	-	0.026
F	44	*Chaetodon sedentarius*	-	-	0.124	-	-	-	-	0.082	-
F	45	*Chaetodon striatus*	-	-	-	-	-	0.025	-	-	-
F	46	*Amblycirrhitus pinos*	-	-	-	-	-	0.64	-	-	-
F	47	*Labrisomus guppyi*	-	-	-	-	-	-	-	-	-
F	48	*Labrisomus nuchipinnis*	-	-	-	-	-	-	-	-	-
F	49	*Harengula clupeola*	-	-	-	-	-	0.95	-	-	-
F	50	*Harengula humeralis*	-	0.025	-	-	-	0.679	-	-	-
F	51	*Jenkinsia lamprotaenia*	-	-	-	-	-	0.982	-	-	-
F	52	*Opisthonema oglinum*	-	-	-	-	-	0.592	-	-	-
F	53	*Heteroconger halis*	-	-	-	-	-	1	-	-	-
F	54	*Dactylopterus volitans*	-	-	-	-	-	-	-	-	-
F	55	*Dasyatis americana*	-	-	-	-	-	-	-	-	-
F	56	*Chilomycterus antennatus*	-	-	-	-	-	-	-	-	-
F	57	*Diodon holocanthus*	-	-	-	-	-	-	-	-	-
F	58	*Diodon hystrix*	-	-	-	-	-	-	-	-	-
F	59	*Inermia vittata*	-	-	-	-	-	0.987	-	-	-
F	60	*Anchoa hepsetus*	0.1	-	-	0.7	-	0.2	-	-	-

continued...

Table 8.6.2 continued

	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	0.002	-	-	-	-	0.002	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 6	-	-	-	-	-	-	-	-	-	-	-	0.059	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	0.037	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 11	-	0.001	-	0.009	-	0.001	0.017	0.047	-	-	-	0.022	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	0.002	-	-	-	-	-	-	-	-	-	-	-	-
F 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 18	-	-	-	-	-	-	-	-	-	-	-	0.036	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	0.092	-	-
F 21	-	-	-	-	-	-	0.008	-	-	-	-	-	-	-
F 22	-	-	-	-	-	-	-	-	-	-	0.029	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 26	-	-	-	-	-	-	0.004	-	-	0.014	-	-	-	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	0.478	0.172	-	-	-	-	-	-
F 32	-	-	-	-	-	-	0.083	0.039	-	-	-	-	-	-
F 33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 34	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F 35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 36	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F 37	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F 38	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 39	-	-	-	-	-	-	0.05	-	-	0.05	-	-	-	-
F 40	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 41	-	-	-	-	-	-	0.15	-	-	-	-	-	-	-
F 42	-	-	-	-	-	-	-	-	-	-	-	0.525	-	-
F 43	0.536	-	-	-	-	-	-	-	-	-	-	0.314	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	0.295	-	-
F 45	0.325	-	-	-	-	-	-	-	-	-	-	0.587	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	0.122	-	-
F 47	-	-	-	-	-	0.2	0.05	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	0.165	-	-	-	-	0.1	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	0.296	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	0.224	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	0.072	-	-	-	-	-	-
F 55	-	-	-	0.206	-	-	-	0.108	-	-	-	0.173	-	-
F 56	-	-	-	-	-	-	0.566	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	0.677	0.128	-	-	-	-	-	-
F 58	-	-	-	-	-	-	0.314	0.131	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	0.013	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I20	I21	I22	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	0.125	-	-	-	-	-	-	-	0.125	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	0.239	0.035	0.067	-	-	-	-	-	-	-	-	-
F	7	-	-	0.008	-	0.013	0.282	-	-	-	0.273	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	0.062	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	-	-	-	0.265	-	-	-	-	-	-	-	-
F	11	-	0.001	-	-	-	0.008	-	0.001	0.02	0.057	-	0.014	0.034	0.747
F	12	-	-	0.07	-	-	-	-	-	-	-	-	-	-	0.296
F	13	-	-	-	-	-	0.005	-	-	0.017	0.035	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	0.04	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	0.091	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	0.092	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	0.114	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	0.033	0.177	-	-	0.211	-	-	-	0.296	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	0.007	0.038	-	-	-	-	-	-	-	-
F	26	-	0.006	-	-	-	0.035	-	-	-	0.004	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	0.061	0.039	-	-	-	0.25
F	32	-	-	-	-	0.017	-	-	-	0.009	-	-	-	-	-
F	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	34	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F	35	-	-	-	-	-	0.1	-	-	-	0.1	-	-	-	0.1
F	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	37	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F	38	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	39	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-
F	40	-	-	-	-	-	0.1	-	-	-	0.1	-	-	-	-
F	41	-	-	-	-	-	0.15	-	-	-	-	-	-	-	-
F	42	-	-	-	0.019	-	0.129	-	-	-	-	-	-	-	0.154
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	0.234	-	-	0.265	-	-	-	-	-	-	-	-
F	45	-	-	0.021	0.021	-	0.021	-	-	-	-	-	-	-	-
F	46	-	-	0.021	0.014	0.025	0.106	-	-	-	0.072	-	-	-	-
F	47	-	-	-	-	0.025	-	-	-	-	0.725	-	-	-	-
F	48	-	-	0.053	-	-	0.077	-	-	-	0.272	-	-	0.123	0.105
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	0.018	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	0.086	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	0.193	0.014	-	-	0.054	-	-	-	0.617	-	-	-	-
F	55	-	0.02	-	-	-	0.076	-	-	-	0.176	0.023	-	-	-
F	56	-	-	-	-	0.206	0.004	-	-	0.214	0.01	-	-	-	-
F	57	-	-	-	-	-	-	-	-	0.042	0.037	-	-	-	0.116
F	58	-	-	-	-	-	-	-	-	0.059	0.149	-	-	-	0.347
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I34	I35	R1	B1
F	1	-	-	-	-
F	2	-	-	-	-
F	3	-	-	-	-
F	4	-	-	-	-
F	5	-	-	-	-
F	6	-	-	-	-
F	7	-	-	-	-
F	8	-	-	-	-
F	9	-	-	-	-
F	10	-	-	-	-
F	11	-	0.006	-	-
F	12	-	-	-	-
F	13	-	-	-	-
F	14	-	-	-	-
F	15	-	-	-	-
F	16	-	-	-	-
F	17	-	-	-	-
F	18	-	-	-	-
F	19	-	-	-	-
F	20	-	-	-	-
F	21	-	-	-	-
F	22	-	-	-	-
F	23	-	-	-	-
F	24	-	-	-	-
F	25	-	-	-	-
F	26	-	-	-	-
F	27	-	-	-	-
F	28	-	-	-	-
F	29	-	-	-	-
F	30	-	-	-	-
F	31	-	-	-	-
F	32	-	-	-	-
F	33	-	-	-	-
F	34	-	-	-	-
F	35	-	-	-	-
F	36	-	-	-	-
F	37	-	-	0.1	-
F	38	-	-	-	-
F	39	-	-	0.1	0.05
F	40	-	-	-	-
F	41	-	-	-	-
F	42	-	-	-	-
F	43	-	0.021	-	-
F	44	-	-	-	-
F	45	-	-	-	-
F	46	-	-	-	-
F	47	-	-	-	-
F	48	-	-	-	-
F	49	-	-	-	-
F	50	-	-	-	-
F	51	-	-	-	-
F	52	-	-	-	-
F	53	-	-	-	-
F	54	-	-	-	
F	55	-	-	-	-
F	56	-	-	-	-
F	57	-	-	-	-
F	58	-	-	-	-
F	59	-	-	-	-
F	60	-	-	-	-

Table 8.6.2 continued

		Predator/prey	F0	F1	F2	F3	F4	F5	F6	F7	F8
F	1	*Acanthurus bahianus*	-	-	-	-	-	-	-	-	-
F	2	*Acanthurus chirurgus*	-	-	-	-	-	-	-	-	-
F	3	*Acanthurus coeruleus*	-	-	-	-	-	-	-	-	-
F	4	*Antennarius multiocellatus*	-	-	-	-	-	-	-	-	-
F	5	*Antennarius striatus*	0.5	-	-	-	-	-	-	-	-
F	6	*Apogon conklini*	-	-	-	-	-	-	-	-	-
F	7	*Apogon maculatus*	-	-	-	-	-	-	-	-	-
F	8	*Allanetta harringtonensis*	-	-	-	-	-	-	-	-	-
F	9	*Atherinomorus stipes*	-	-	-	-	-	-	-	-	-
F	10	*Aulostomus maculatus*	-	0.049	0.012	0.012	-	-	0.019	0.019	-
F	11	*Balistes vetula*	0.002	-	-	-	-	-	-	-	-
F	12	*Canthidermis sufflamen*	-	-	-	-	-	-	-	-	-
F	13	*Melichthys niger*	0.031	-	-	-	-	-	-	-	-
F	14	*Platybelone argalus argalus*	-	-	-	-	-	-	-	-	-
F	15	*Strongylura timucu*	-	-	-	-	-	-	-	-	-
F	16	*Tylosurus acus*	-	-	-	-	-	-	-	-	-
F	17	*Tylosurus crocodilus*	-	0.182	-	-	-	-	-	-	-
F	18	*Entomacrodus nigricans*	-	-	-	-	-	-	-	-	-
F	19	*Ophioblennius atlanticus*	-	-	-	-	-	-	-	-	-
F	20	*Parablennius marmoreus*	-	-	-	-	-	-	-	-	-
F	21	*Scartella cristata*	-	-	-	-	-	-	-	-	-
F	22	*Bothus lunatus*	-	-	-	-	-	-	-	-	-
F	23	*Bothus ocellatus*	-	-	-	-	-	-	-	-	-
F	24	*Caranx bartholomaei*	0.4	-	-	-	-	-	-	-	-
F	25	*Caranx latus*	-	-	-	-	-	-	-	-	0.145
F	26	*Caranx ruber*	0.051	0.017	0.017	0.068	-	-	-	-	0.025
F	27	*Decapterus punctatus*	-	-	-	-	-	-	-	-	-
F	28	*Oligoplites saurus*	-	-	-	-	-	-	-	-	-
F	29	*Selar crumenophthalmus*	0.096	-	-	-	-	-	-	-	-
F	30	*Seriola dumerili*	-	-	-	-	-	-	-	-	-
F	31	*Trachinotus falcatus*	-	-	-	-	-	-	-	-	-
F	32	*Trachinotus goodei*	-	-	-	-	-	-	-	-	-
F	33	*Carcharhinus acronotus*	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
F	34	*Carcharhinus falciformis*	-	0.005	0.005	-	-	-	-	-	-
F	35	*Carcharhinus leucas*	-	-	-	-	-	-	-	-	-
F	36	*Carcharhinus limbatus*	-	-	-	-	-	-	-	-	0.05
F	37	*Carcharhinus longimanus*	-	-	-	-	-	-	-	-	-
F	38	*Carcharhinus perezi*	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	*Galeocerdo cuvier*	-	0.003	0.003	0.003	-	-	-	-	-
F	40	*Negaprion brevirostris*	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	41	*Rhizoprionodon porosus*	-	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
F	42	*Chaetodon aculeatus*	-	-	-	-	-	-	-	-	-
F	43	*Chaetodon capistratus*	-	-	-	-	-	-	-	-	-
F	44	*Chaetodon sedentarius*	-	-	-	-	-	-	-	-	-
F	45	*Chaetodon striatus*	-	-	-	-	-	-	-	-	-
F	46	*Amblycirrhitus pinos*	-	-	-	-	-	-	-	-	-
F	47	*Labrisomus guppyi*	-	-	-	-	-	-	-	-	-
F	48	*Labrisomus nuchipinnis*	0.105	-	-	-	-	-	-	-	-
F	49	*Harengula clupeola*	-	-	-	-	-	-	-	-	-
F	50	*Harengula humeralis*	-	-	-	-	-	-	-	-	-
F	51	*Jenkinsia lamprotaenia*	-	-	-	-	-	-	-	-	-
F	52	*Opisthonema oglinum*	0.098	-	-	-	-	-	-	-	-
F	53	*Heteroconger halis*	-	-	-	-	-	-	-	-	-
F	54	*Dactylopterus volitans*	0.05	-	-	-	-	-	-	-	-
F	55	*Dasyatis americana*	-	0.018	0.018	0.018	-	-	-	-	-
F	56	*Chilomycterus antennatus*	-	-	-	-	-	-	-	-	-
F	57	*Diodon holocanthus*	-	-	-	-	-	-	-	-	-
F	58	*Diodon hystrix*	-	-	-	-	-	-	-	-	-
F	59	*Inermia vittata*	-	-	-	-	-	-	-	-	-
F	60	*Anchoa hepsetus*	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	-	-	-	-	-	-	-	0.009	0.046	0.009	0.009	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	0.24	0.24	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	0.145	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	0.025	-	-	-	-	-	-	-	-	0.051	0.051	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	0.067	0.067	0.066	-	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	0.01	0.01	-	-	0.01	0.01	0.01	-	-	-	0.01	-	0.01	-
F	34	-	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	-	-	-	-	0.005
F	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	36	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	-	-	-	-	0.003
F	40	0.005	0.005	-	-	0.005	0.005	0.005	-	-	-	0.005	-	0.005	-
F	41	0.007	0.007	-	-	0.007	0.007	0.007	-	-	-	0.007	-	0.007	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	0.054	0.054	0.054	0.054	0.054	0.054	0.053	0.053	0.053	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	0.286	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
F	34	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	-	-	0.006
F	35	-	-	-	-	-	-	-	-	-	-	0.05	-	-	0.05
F	36	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-
F	37	-	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	-	-
F	39	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.01	0.01	0.01	0.01
F	40	-	-	-	-	-	0.005	-	-	-	-	-	-	-	-
F	41	-	-	-	-	-	0.007	-	-	-	-	-	-	-	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F37	F38	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	-	-	-	-	-	-	-	-	-	-	0.073	0.037	-	-
F 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	-	-	-	-	0.182
F 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-		-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	0.145	0.145
F 26	-	-	-	-	-	-	-	-	-	-	-	-	0.051	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 33	-	-	-	-	-	0.01	0.01	0.01	0.01	0.01	-	0.01	0.01	0.01
F 34	-	0.006	-	0.006	0.006	-	-	-	-	-	-	-	0.005	0.005
F 35	-	0.05	-	0.05	0.05	-	-	-	-	-	-	-	-	-
F 36	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.05
F 37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 38	-	-	-	0.005	0.01	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F 39	0.01	0.01	-	0.01	0.01	-	0.003	0.003	0.003	-	-	-	0.003	0.003
F 40	-	-	-	-	-	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005
F 41	-	-	-	-	-	0.007	0.007	0.007	0.007	0.007	-	-	0.007	0.007
F 42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.2.6 continued

	F51	F52	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	-	-	-	-	-	-	-	-	-	0.019	0.018	-	-	-
F 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 14	0.97	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	0.48	-	-	-	-	-	-	-	-	0.24	0.24	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	0.182	0.181	-	-	-
F 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-		-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 22	0.286	-	-	-	-	-	-	-	-	0.143	0.142	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 26	0.051	-	-	-	-	-	-	-	-	0.051	0.051	-	-	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	0.987	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 32	0.426	-	-	-	-	-	-	-	-	0.213	0.213	-	-	-
F 33	0.01	0.01	0.01	-	-	-	-	-	0.01	0.005	0.005	-	-	0.01
F 34	-	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	-	-	0.005	0.005	0.005
F 35	-	-	-	-	0.05	-	-	-	-	-	-	-	-	-
F 36	0.05	0.05	-	-	0.05	-	-	-	0.05	0.025	0.025	-	-	-
F 37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 38	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.003	0.002	0.005	0.005	0.005
F 39	-	0.003	0.003	0.003	0.04	0.003	0.003	0.003	0.003	-	-	0.003	0.003	0.003
F 40	0.005	0.005	0.005	-	0.1	-	-	-	0.005	0.003	0.002	-	-	0.005
F 41	0.007	0.014	0.007	-	-	-	-	-	0.007	0.004	0.003	-	-	0.007
F 42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 55	-	-	-	-	-	-	-	-	-	0.028	0.027	-	-	-
F 56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F65	F66	F67	F68	F69	F70	F71	F72	F73	F74	F75	F76	F77	F78
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	0.75	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	0.012	0.012	0.012	-	-	-	-	-	-	0.037	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	0.283	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	0.01	-	-	-	-	0.01	0.01	0.01	-	0.01	-	0.01	0.01	0.01
F	34	0.005	-	-	-	-	-	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	36	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.05
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	0.003	0.01	-	-	-	-	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003
F	40	0.005	-	-	-	-	0.005	0.005	0.005	-	0.005	-	0.005	0.005	0.005
F	41	0.007	-	-	-	-	0.007	0.007	0.007	-	0.007	-	0.007	0.007	0.007
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F79	F80	F81	F82	F83	F84	F85	F86	F87	F88	F89	F90	F91	F92
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	0.037	-	-	-	-	-	-	-	0.037	-	0.037	-	0.037	-
F 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	0.291	-
F 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 33	0.01	-	-	-	-	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-
F 34	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.005
F 35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 36	0.05	-	-	-	-	0.05	0.05	-	-	-	-	-	-	-
F 37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F 39	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	-	0.003	0.003	0.003	0.003	0.003
F 40	0.005	-	-	-	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-
F 41	0.007	-	-	-	-	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	-
F 42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F121	F122	F123	F124	F125	F126	F127	F128	F129	F130	F131	F132	F133	F134
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	0.037	-	-	-	-	-	-	-	-	-	-	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	0.051	0.051	-	-	-	-	-	-	-	-	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	0.01	0.01	0.01	0.01	-	-	-	0.01	0.01	-	0.01	0.01	-	-
F	34	0.005	0.005	0.005	0.005	0.005	0.006	0.005	0.005	0.005	0.005	-	-	-	0.005
F	35	-	-	-	-	-	-	0.05	-	-	-	-	-	-	-
F	36	-	-	-	-	-	-	0.05	-	-	-	-	-	-	-
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	0.003	0.003	0.003	0.003	0.003	0.04	0.003	0.003	0.003	0.003	-	-	-	0.003
F	40	0.005	0.005	0.005	0.005	-	0.1	-	0.005	0.005	-	0.005	0.005	-	-
F	41	0.007	0.007	0.007	0.007	-	-	-	0.007	0.007	-	0.007	0.007	-	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	0.018	0.018	0.018	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F135	F136	F137	F138	F139	F140	F141	F142	F143	F144	F145	F146	F147	F148
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	-	-	-	-	-	-	-	-	-	-	-	-	0.037	-
F 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-		-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 33	-	-	-	-	0.01	-	-	-	-	-	0.01	0.01	0.01	0.01
F 34	0.005	0.005	0.005	0.005	-	-	0.005	0.005	0.006	0.006	0.005	0.005	-	0.005
F 35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F 39	0.003	0.003	0.003	0.003	0.003	-	0.003	0.003	0.003	0.003	0.003	0.003	-	0.003
F 40	-	-	-	-	0.005	-	-	-	-	-	0.005	0.005	0.005	0.005
F 41	-	-	-	-	0.007	-	-	-	-	-	0.007	0.007	0.007	0.007
F 42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F149	F150	F151	F152	F153	F154	F155	F156	F157	F158	F159	F160	F161	F162
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	0.018	0.018	0.018	0.018	-	-	-	-	-	-	-	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	0.04	0.04
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	-	-	-	0.051	-	-	-	0.005	0.056	0.005	0.005	0.005	0.056	0.005
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	0.01	0.01	0.01	0.01	0.01	-	0.01	-	0.01	-	0.01	-	0.01	-
F	34	0.005	0.005	-	-	-	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.005	0.005
F	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	0.003	0.003	-	-	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
F	40	0.005	0.005	0.005	0.005	0.005	-	0.005	-	0.005	-	0.005	-	0.005	-
F	41	0.007	0.007	0.007	0.007	0.007	-	0.007	-	0.007	-	0.007	-	0.007	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F163	F164	F165	F166	F167	F168	F169	F170	F171	F172	F173	F174	F175	F176
F 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 5	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
F 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 24	0.04	0.04	0.04	-	-	-	-	-	-	-	-	-	-	-
F 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 26	0.005	0.005	0.005	-	-	-	-	-	-	-	-	-	-	-
F 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 33	0.01	-	-	0.01	0.01	0.01	0.01	-	-	-	-	0.01	-	-
F 34	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	0.005
F 35	-	-	-	-	-	-	-	0.05	0.05	0.05	-	-	-	-
F 36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 37	-	-	-	-	-	-	-	0.05	0.05	0.05	-	-	-	-
F 38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.005	0.01	0.005	0.005	0.005	0.005
F 39	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	-	0.003
F 40	0.005	-	-	0.005	0.005	0.005	0.005	-	-	-	-	0.005	-	-
F 41	0.007	-	-	0.007	0.007	0.007	0.007	-	-	-	-	0.007	-	-
F 42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 55	-	-	-	-	-	-	-	-	-	-	-	-	-	0.055
F 56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F177	F178	F179	F180	F181	F182	F183	F184	F185	F186	F187	F188	F189	F190
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-		-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	0.01	-	0.01	0.01	-	-	-	-	0.01	0.01	0.01	0.01	-	-
F	34	-	0.005	0.005	0.005	0.005	0.005	0.006	0.006	-	-	-	-	0.006	0.006
F	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	36	0.05	-	-	-	-	-	-	-	-	-	0.05	-	-	-
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F	39	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	-	-	-	-	0.003	0.003
F	40	0.005	-	0.005	0.005	-	-	-	-	0.005	0.005	0.005	0.005	-	-
F	41	0.007	-	0.007	0.007	-	-	-	-	0.007	0.007	0.007	0.007	-	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F191	F192	F193	F194	F195	F196	F197	F198	F199	F200	F201	F202	F203	F204
F	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	19	-	-	-	-	-	-	-	-	-	-	-		-	-
F	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	30	-	-	-	-	0.067	0.067	0.066	-	-	-	-	-	-	-
F	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	33	-	0.01	0.01	-	-	-	-	0.01	-	-	-	-	0.01	-
F	34	0.006	0.006	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	-	0.006	0.005	0.005
F	35	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-
F	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	38	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	0.01	0.005	0.005
F	39	0.003	0.003	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.01	0.01	0.003	0.003
F	40	-	0.005	0.005	-	-	-	-	0.005	-	-	-	-	0.005	-
F	41	-	0.007	0.007		-	-	-	0.007	-	-	-	-	0.007	-
F	42	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	46	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	49	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	51	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	52	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	55	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	56	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	57	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F205	F206	F207	F208	Sum
F 1	-	-	-	-	1
F 2	-	-	-	-	1
F 3	-	-	-	-	1
F 4	-	-	-	-	1
F 5	-	-	-	-	1
F 6	-	-	-	-	1
F 7	-	-	-	-	1
F 8	-	-	-	-	1
F 9	-	-	-	-	1
F 10	-	-	-	-	1
F 11	-	-	-	-	1
F 12	-	-	-	-	1
F 13	-	-	-	-	1
F 14	-	-	-	-	1
F 15	-	-	-	-	1
F 16	-	-	-	-	1
F 17	-	-	-	-	1
F 18	-	-	-	-	1
F 19	-	-	-	-	1
F 20	-	-	-	-	1
F 21	-	-	-	-	1
F 22	-	-	-	-	1
F 23	-	-	-	-	1
F 24	-	-	-	-	1
F 25	-	-	-	-	1
F 26	-	-	-	-	1
F 27	-	-	-	-	1
F 28	-	-	-	-	1
F 29	-	-	-	-	1
F 30	-	-	-	-	1
F 31	-	-	-	-	1
F 32	-	-	-	-	1
F 33	0.01	-	0.01	-	1
F 34	0.005	-	-	0.006	1
F 35	-	-	-	0.05	1
F 36	-	-	-	-	1
F 37	-	-	-	-	1
F 38	0.005	0.005	0.005	0.01	1
F 39	0.003	-	-	0.01	1
F 40	0.005	-	0.005	-	1
F 41	0.007	-	0.007	-	1
F 42	-	-	-	-	1
F 43	-	-	-	-	1
F 44	-	-	-	-	1
F 45	-	-	-	-	1
F 46	-	-	-	-	1
F 47	-	-	-	-	1
F 48	-	-	-	-	1
F 49	-	-	-	-	1
F 50	-	-	-	-	1
F 51	-	-	-	-	1
F 52	-	-	-	-	1
F 53	-	-	-	-	1
F 54	-	-	-	-	1
F 55	-	-	-	-	1
F 56	-	-	-	-	1
F 57	-	-	-	-	1
F 58	-	-	-	-	1
F 59	-	-	-	-	1
F 60	-	-	-	-	1

continued...

Table 8.6.2 continued

		Predator/prey	D1	A1	A2	A3	I1	I2	I3	I4	I5
F	61	*Anchoa lyolepis*	0.1	-	-	0.7	-	0.2	-	-	-
F	62	*Chaetodipterus faber*	-	0.073	0.052	-	-	0.168	0.327	-	0.025
F	63	*Fistularia tabacaria*	-	-	-	-	-	-	-	-	-
F	64	*Eucinostomus argenteus*	-	-	-	-	-	0.021	-	-	-
F	65	*Gerres cinereus*	-	-	-	-	-	-	-	-	-
F	66	*Ginglymostoma cirratum*	-	-	-	-	-	-	-	-	-
F	67	*Coryphopterus glaucofraenum*	0.25	0.25	-	-	-	0.3	-	-	-
F	68	*Gnatholepis thompsoni*	0.37	0.37	-	-	-	0.217	-	-	-
F	69	*Gobiosoma evelynae*	-	-	-	-	-	-	-	-	-
F	70	*Gramma loreto*	-	-	-	-	-	1	-	-	-
F	71	*Gramma melacara*	-	-	-	-	-	1	-	-	-
F	72	*Rypticus saponaceus*	-	-	-	-	-	-	-	-	-
F	73	*Anisotremus surinamensis*	-	-	-	-	-	-	-	-	-
F	74	*Anisotremus virginicus*	-	-	-	-	0.005	0.05	-	-	-
F	75	*Haemulon album*	-	-	-	-	-	-	0.001	-	-
F	76	*Haemulon aurolineatum*	-	-	-	-	-	0.35	-	-	-
F	77	*Haemulon carbonarium*	-	-	-	-	-	0.001	-	-	-
F	78	*Haemulon chrysargyreum*	-	-	-	-	-	0.23	-	-	-
F	79	*Haemulon flavolineatum*	-	-	-	-	-	-	-	-	-
F	80	*Haemulon macrostomum*	-	-	-	-	-	-	-	-	-
F	81	*Haemulon parrai*	-	-	-	-	-	-	-	-	-
F	82	*Haemulon plumieri*	-	-	-	-	-	-	-	-	-
F	83	*Haemulon sciurus*	-	-	-	-	-	0.016	-	-	-
F	84	*Hemiramphus balao*	-	-	-	-	-	0.678	-	-	-
F	85	*Hemiramphus brasiliensis*	-	0.81	-	-	-	-	-	-	-
F	86	*Holocentrus ascensionis*	-	-	-	-	-	-	-	-	-
F	87	*Holocentrus coruscus*	-	-	-	-	-	-	-	-	-
F	88	*Neoniphon marianus*	-	-	-	-	-	0.051	-	-	-
F	89	*Holocentrus rufus*	-	-	-	-	-	0.026	-	-	-
F	90	*Sargocentron vexillarium*	-	-	-	-	-	0.275	-	-	-
F	91	*Myripristis jacobus*	-	-	-	-	-	0.785	-	-	-
F	92	*Kyphosus incisor*	-	1	-	-	-	-	-	-	-
F	93	*Kyphosus sectatrix*	-	1	-	-	-	-	-	-	-
F	94	*Bodianus rufus*	-	-	-	-	-	-	-	-	-
F	95	*Clepticus parrae*	-	-	-	-	-	1	-	-	-
F	96	*Halichoeres bivittatus*	-	-	-	-	0.001	-	-	-	-
F	97	*Halichoeres garnoti*	-	-	-	-	-	-	-	-	-
F	98	*Halichoeres maculipinna*	-	-	-	-	-	0.188	-	-	-
F	99	*Halichoeres poeyi*	-	-	-	-	-	-	-	-	-
F	100	*Halichoeres radiatus*	-	-	-	-	-	-	-	-	-
F	101	*Xyrichtys novacula*	-	-	-	-	-	-	-	-	-
F	102	*Xyrichtys splendens*	-	-	-	-	-	0.775	-	-	-
F	103	*Lachnolaimus maximus*	-	-	-	-	-	-	-	-	-
F	104	*Thalassoma bifasciatum*	-	-	-	-	-	0.439	-	-	-
F	105	*Lutjanus analis*	-	-	-	-	-	-	-	-	-
F	106	*Lutjanus apodus*	-	-	-	-	-	-	-	-	-
F	107	*Lutjanus cyanopterus*	-	-	-	-	-	-	-	-	-
F	108	*Lutjanus griseus*	-	-	-	-	-	-	-	-	-
F	109	*Lutjanus jocu*	-	-	-	-	-	0.018	-	-	-
F	110	*Lutjanus mahagoni*	-	-	-	-	-	-	-	-	-
F	111	*Lutjanus synagris*	-	0.027	-	-	-	-	0.014	-	-
F	112	*Ocyurus chrysurus*	-	-	-	-	-	0.571	-	-	-
F	113	*Malacanthus plumieri*	-	-	-	-	-	-	-	-	-
F	114	*Tarpon atlanticus*	-	-	-	-	-	-	-	-	-
F	115	*Aluterus schoepfi*	-	0.988	-	-	-	-	-	-	-
F	116	*Aluterus scripta*	-	0.432	0.312	-	-	-	0.004	0.158	0.05
F	117	*Cantherines macroceros*	-	0.029	0.059	-	-	-	0.865	0.02	0.019
F	118	*Cantherines pullus*	0.214	0.26	0.035	-	-	0.001	0.327	0.013	0.007
F	119	*Monacanthus ciliatus*	0.107	0.26	0.002	-	-	0.306	-	0.001	-
F	120	*Mugil curema*	0.5	0.5	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	0.185	0.009	-	-	-	-	-	-	-	-	-	0.137	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	0.027	-	-	0.017	0.035	-	-	-	0.199	-	-
F	65	-	-	-	0.061	-	-	0.147	0.233	-	-	-	0.128	-	-
F	66	-	-	-	-	-	0.02	0.02	0.02	0.02	0.05	0.02	-	-	-
F	67	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	0.168	0.015	-	-	-	-	-	-
F	74	-	-	-	0.004	-	0.008	0.038	0.055	0.002	-	-	0.14	-	-
F	75	-	-	0.001	0.257	0.008	0.008	0.028	0.055	0.002	-	-	0.143	0.01	-
F	76	-	-	-	-	-	-	0.021	0.016	0.004	-	-	0.31	-	-
F	77	-	-	-	0.048	-	0.098	0.152	-	-	-	-	0.08	-	-
F	78	-	-	-	0.012	-	-	0.018	0.147	-	0.001	0.001	0.191	-	-
F	79	-	-	-	0.102	-	0.057	0.005	0.032	0.008	-	0.033	0.398	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	0.034	-	-	-	-	-	0.051	0.028	0.002	-	-	0.029	-	-
F	82	-	-	-	0.086	-	0.007	0.071	0.013	-	-	-	0.15	-	-
F	83	-	-	0.003	0.032	-	-	0.048	0.158	0.002	-	0.016	0.053	-	-
F	84	-	-	-	-	-	-	-	-	-	-	-	0.101	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	0.01	-	-	-	-	0.039	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	0.006	0.078	-	-	-	-	0.045	-	-
F	90	-	-	-	-	-	0.103	0.251	-	-	-	-	0.04	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	0.07	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	0.007	0.105	0.081	-	-	-	0.002	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	0.034	0.129	0.039	-	-	-	0.181	-	-
F	97	-	-	-	0.005	-	0.021	0.146	0.076	-	-	-	0.06	-	-
F	98	-	-	-	0.009	-	0.015	0.053	0.024	0.002	-	0.043	0.475	-	-
F	99	-	-	-	0.054	-	0.046	0.222	0.23	-	-	-	0.019	-	-
F	100	-	-	-	-	-	0.002	0.213	0.251	-	-	-	0.014	-	-
F	101	-	-	-	-	-	-	0.411	0.298	0.06	-	-	0.08	-	-
F	102	-	-	-	-	-	-	0.051	0.034	-	-	-	-	-	-
F	103	-	-	-	-	-	-	0.397	0.426	0.006	-	-	-	-	-
F	104	-	-	-	-	-	-	0.063	-	-	-	-	0.056	-	0.022
F	105	-	-	-	-	-	-	0.133	-	-	-	0.031	-	-	-
F	106	-	-	-	-	-	-	0.005	-	-	-	0.035	-	-	-
F	107	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	-	0.068	-	-	-	-	-	-	-
F	109	-	-	-	-	-	-	0.036	-	-	0.022	0.07	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	0.094	-	-	-
F	111	-	-	-	-	-	0.002	0.003	0.002	0.002	0.002	0.002	0.041	-	-
F	112	-	-	-	-	-	-	0.025	0.012	-	0.01	0.01	-	-	-
F	113	-	-	-	0.104	-	0.057	-	-	-	-	-	0.104	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	0.006	-	-	-	-	-	-	-
F	116	0.024	-	-	-	-	-	0.006	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	0.018	0.003	0.024	-	-	-	-	0.002	-	-	-	-	-	-
F	119	-	-	-	-	-	-	0.016	0.024	-	-	-	0.043	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I20	I21	I22	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	0.001	-	-	-	-	-	-	-	-	-	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	0.443	0.062	-	0.081	-	-	-	0.115	-	-	-	-
F	65	-	0.032	0.004	-	-	0.05	-	-	-	0.307	0.019	-	0.019	-
F	66	-	-	-	-	-	0.05	0.05	0.05	-	0.05	-	-	-	0.05
F	67	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-
F	68	-	-	0.043	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	1	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	0.083	-	-	-	0.342	-	-	-	0.096	-	-	-	-
F	73	-	0.025	-	-	-	0.025	-	-	0.033	0.105	-	0.018	0.055	0.541
F	74	-	0.052	0.033	0.012	0.09	0.162	-	-	0.006	0.178	-	-	0.165	-
F	75	-	0.017	0.006	-	-	0.049	-	-	0.006	0.097	0.036	-	0.053	0.203
F	76	-	-	0.04	0.011	0.003	0.197	-	-	0.026	0.022	-	-	-	-
F	77	0.019	-	0.002	-	-	0.041	-	-	-	0.383	-	-	0.06	0.109
F	78	-	0.065	0.063	-	0.052	0.088	-	-	0.02	0.108	-	-	-	-
F	79	-	0.008	0.006	-	0.041	0.036	-	-	0.009	0.169	-	-	0.031	0.015
F	80	-	-	-	-	-	-	-	-	-	0.132	-	-	-	0.868
F	81	-	0.005	0.072	-	0.005	0.38	-	-	-	0.337	-	-	0.024	-
F	82	-	-	0.006	0.004	-	0.069	-	-	-	0.311	0.034	-	0.059	0.128
F	83	-	0.048	0.021	0.001	0.015	0.11	-	-	-	0.295	-	-	0.059	0.092
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	0.007	0.119	-	-	-	0.825	-	-	-	-
F	87	-	-	-	-	-	0.719	-	-	-	0.281	-	-	-	-
F	88	-	-	-	-	-	0.596	-	-	-	0.353	-	-	-	-
F	89	-	0.004	-	-	0.016	0.155	-	-	-	0.587	-	-	0.071	-
F	90	-	-	-	-	0.059	0.107	-	-	-	0.139	-	-	-	-
F	91	-	-	0.033	-	0.018	0.063	-	-	-	0.031	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	0.013	-	-	0.007	0.063	-	-	0.039	0.342	-	-	0.196	0.145
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	0.032	-	-	-	0.038	-	-	0.009	0.241	-	-	0.076	0.187
F	97	-	-	-	-		0.081	-	-	0.048	0.331	-	-	0.168	0.032
F	98	-	-	0.055	0.015	0.018	0.07	-	-	-	0.033	-	-	-	-
F	99	-	0.002	-	-	0.004	-	-	-	0.053	0.331	-	-	0.106	0.071
F	100	-	0.009	-	-	-	-	-	-	0.047	0.197	-	-	0.068	0.199
F	101	-	-	0.008	-	0.047	0.096	-	-	-	-	-	-	-	-
F	102	-	-	0.132	-	0.008	-	-	-	-	-	-	-	-	-
F	103	0.005	-	0.01	-		-	-	-	0.049	0.061	-	-	-	0.046
F	104	-	-	-	0.025	0.077	0.042	-	-	-	0.083	-	-	0.082	0.016
F	105	-	0.008	-	-	-	0.023	0.019	-	0.029	0.453	-	-	-	-
F	106	-	0.045	-	-	-	0.041	-	-	-	0.267	-	-	-	-
F	107	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	0.132	-	0.009	-	0.4	-	-	-	-
F	109	-	-	-	-	-	-	0.069	0.018	-	0.16	-	-	-	-
F	110	-	-	-	-	-	0.125	-	-	-	0.031	-	-	-	-
F	111	-	0.027	0.007	0.007	0.007	0.206	0.007	0.007	0.007	0.206	-	-	-	-
F	112	-	0.025	-	-	-	0.066	-	-	-	0.203	-	-	-	-
F	113	-	0.15	0.016	-	-	0.014	-	-	-	0.185	-	-	0.219	0.027
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	0.006	-	-	-	-	-
F	116	-	-	-	-	-	0.003	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	0.006	-	-	0.005	-	-	-	-	-	-	0.02	0.001
F	119	-	-	0.067	0.056	0.038	0.08	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		I34	I35	R1	B1
F	61	-	-	-	-
F	62	0.023	-	-	-
F	63	-	-	-	-
F	64	-	-	-	-
F	65	-	-	-	-
F	66	-	-	-	-
F	67	-	-	-	-
F	68	-	-	-	-
F	69	-	-	-	-
F	70	-	-	-	-
F	71	-	-	-	-
F	72	-	-	-	-
F	73	-	-	-	-
F	74	-	-	-	-
F	75	-	-	-	-
F	76	-	-	-	-
F	77	-	-	-	-
F	78	-	-	-	-
F	79	0.05	-	-	-
F	80	-	-	-	-
F	81	0.033	-	-	-
F	82	0.028	-	-	-
F	83	-	-	-	-
F	84	-	-	-	-
F	85	-	-	-	-
F	86	-	-	-	-
F	87	-	-	-	-
F	88	-	-	-	-
F	89	-	-	-	-
F	90	-	-	-	-
F	91	-	-	-	-
F	92	-	-	-	-
F	93	-	-	-	-
F	94	-	-	-	-
F	95	-	-	-	-
F	96	-	-	-	-
F	97	-	-	-	-
F	98	-	-	-	-
F	99	0.017	-	-	-
F	100	-	-	-	-
F	101	-	-	-	-
F	102	-	-	-	-
F	103	-	-	-	-
F	104	-	-	-	-
F	105	-	-	-	-
F	106	-	-	-	-
F	107	-	-	-	-
F	108	-	-	-	-
F	109	-	-	-	-
F	110	-	-	-	-
F	111	0.014	-	-	-
F	112	-	-	-	-
F	113	-	-	-	-
F	114	-	-	-	-
F	115	-	-	-	-
F	116	-	0.011	-	-
F	117	0.008	-	-	-
F	118	-	0.064	-	-
F	119	-	-	-	-
F	120	-	-	-	-

continued...

Table 8.6.2 continued

		Predator/prey	F0	F1	F2	F3	F4	F5	F6	F7	F8
F	61	*Anchoa lyolepis*	-	-	-	-	-	-	-	-	-
F	62	*Chaetodipterus faber*	-	-	-	-	-	-	-	-	-
F	63	*Fistularia tabacaria*	-	-	-	-	-	-	-	-	-
F	64	*Eucinostomus argenteus*	-	-	-	-	-	-	-	-	-
F	65	*Gerres cinereus*	-	-	-	-	-	-	-	-	-
F	66	*Ginglymostoma cirratum*	-	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
F	67	*Coryphopterus glaucofraenum*	-	-	-	-	-	-	-	-	-
F	68	*Gnatholepis thompsoni*	-	-	-	-	-	-	-	-	-
F	69	*Gobiosoma evelynae*	-	-	-	-	-	-	-	-	-
F	70	*Gramma loreto*	-	-	-	-	-	-	-	-	-
F	71	*Gramma melacara*	-	-	-	-	-	-	-	-	-
F	72	*Rypticus saponaceus*	-	-	-	-	-	-	-	-	-
F	73	*Anisotremus surinamensis*	0.015	-	-	-	-	-	-	-	-
F	74	*Anisotremus virginicus*	-	-	-	-	-	-	-	-	-
F	75	*Haemulon album*	-	-	-	-	-	-	-	-	-
F	76	*Haemulon aurolineatum*	-	-	-	-	-	-	-	-	-
F	77	*Haemulon carbonarium*	-	-	-	-	-	-	-	-	-
F	78	*Haemulon chrysargyreum*	0.004	-	-	-	-	-	-	-	-
F	79	*Haemulon flavolineatum*	-	-	-	-	-	-	-	-	-
F	80	*Haemulon macrostomum*	-	-	-	-	-	-	-	-	-
F	81	*Haemulon parrai*	-	-	-	-	-	-	-	-	-
F	82	*Haemulon plumieri*	0.034	-	-	-	-	-	-	-	-
F	83	*Haemulon sciurus*	0.031	-	-	-	-	-	-	-	-
F	84	*Hemiramphus balao*	-	-	-	-	-	-	-	-	-
F	85	*Hemiramphus brasiliensis*	-	-	-	-	-	-	-	-	-
F	86	*Holocentrus ascensionis*	-	-	-	-	-	-	-	-	-
F	87	*Holocentrus coruscus*	-	-	-	-	-	-	-	-	-
F	88	*Neoniphon marianus*	-	-	-	-	-	-	-	-	-
F	89	*Holocentrus rufus*	0.012	-	-	-	-	-	-	-	-
F	90	*Sargocentron vexillarium*	-	0.009	0.009	0.008	-	-	-	-	-
F	91	*Myripristis jacobus*	-	-	-	-	-	-	-	-	-
F	92	*Kyphosus incisor*	-	-	-	-	-	-	-	-	-
F	93	*Kyphosus sectatrix*	-	-	-	-	-	-	-	-	-
F	94	*Bodianus rufus*	-	-	-	-	-	-	-	-	-
F	95	*Clepticus parrae*	-	-	-	-	-	-	-	-	-
F	96	*Halichoeres bivittatus*	0.033	-	-	-	-	-	-	-	-
F	97	*Halichoeres garnoti*	0.032	-	-	-	-	-	-	-	-
F	98	*Halichoeres maculipinna*	-	-	-	-	-	-	-	-	-
F	99	*Halichoeres poeyi*	0.052	-	-	-	-	-	-	-	-
F	100	*Halichoeres radiatus*	-	-	-	-	-	-	-	-	-
F	101	*Xyrichtys novacula*	-	-	-	-	-	-	-	-	-
F	102	*Xyrichtys splendens*	-	-	-	-	-	-	-	-	-
F	103	*Lachnolaimus maximus*	-	-	-	-	-	-	-	-	-
F	104	*Thalassoma bifasciatum*	0.095	-	-	-	-	-	-	-	-
F	105	*Lutjanus analis*	-	0.02	-	-	-	-	-	-	-
F	106	*Lutjanus apodus*	-	-	-	-	-	-	-	-	0.02
F	107	*Lutjanus cyanopterus*	-	-	-	-	-	-	-	-	-
F	108	*Lutjanus griseus*	-	-	-	-	-	-	-	-	-
F	109	*Lutjanus jocu*	-	-	-	-	-	-	-	-	0.014
F	110	*Lutjanus mahagoni*	-	-	-	-	-	-	-	-	0.125
F	111	*Lutjanus synagris*	0.109	-	-	-	-	-	0.014	-	0.035
F	112	*Ocyurus chrysurus*	-	-	-	-	-	-	-	-	-
F	113	*Malacanthus plumieri*	-	-	-	-	-	-	-	-	-
F	114	*Tarpon atlanticus*	-	-	-	-	-	-	-	-	0.5
F	115	*Aluterus schoepfi*	-	-	-	-	-	-	-	-	-
F	116	*Aluterus scripta*	-	-	-	-	-	-	-	-	-
F	117	*Cantherines macroceros*	-	-	-	-	-	-	-	-	-
F	118	*Cantherines pullus*	-	-	-	-	-	-	-	-	-
F	119	*Monacanthus ciliatus*	-	-	-	-	-	-	-	-	-
F	120	*Mugil curema*	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	0.006	-	-	0.006	0.006	0.006	-	-	-	0.006	-	0.006	-
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	0.002	0.002	0.002	0.001	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 106	0.02	0.041	-	-	-	-	-	-	-	-	-	-	-	-
F 107	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	0.014	0.03	-	-	0.029	-	-	-	-	-	-	-	-	-
F 110	0.125	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	0.035	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	-	-	-	0.006	-	0.006	-	-	-	-	-	-	-
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 106	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 107	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F37	F38	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	66	-	-	-	-	-	0.006	0.006	0.006	0.006	0.006	-	0.006	0.006	0.006
F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	97	-	-	-	-		-	-	-	-	-	-	-	-	-
F	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	103	-	-	-	-		-	-	-	-	-	-	-	-	-
F	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	106	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	107	-	-	-	-	-	-	-	-	-	-	-	-	0.042	0.042
F	108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	109	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F51	F52	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	0.006	0.006	-	-	-	-	-	0.006	0.003	0.003	-	-	0.006
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	0.221	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	0.01	0.01	-	-	-	-	0.021	-
F 106	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-
F 107	0.042	0.042	-	-	-	-	0.083	0.083	-	-	-	-	-	-
F 108	0.391	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	0.029	0.029	-	-	-	-	-	-	-	-	-	-	-	-
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	0.026	-	-	0.045	0.045	0.045	-	0.035	0.035	-	-	-
F 112	0.078	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	0.062	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F65	F66	F67	F68	F69	F70	F71	F72	F73	F74	F75	F76	F77	F78
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	-	-	-	-	0.006	0.006	0.006	-	0.006	-	0.006	0.006	0.006
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	0.053	0.053	0.053	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	0.007	0.007	0.007	-	-	-	-	-	-	0.02	-	-
F 106	-	-	-	-	-	-	-	-	-	-	0.005	0.004	0.004	0.005
F 107	-	-	-	-	-	-	-	-	-	-	-	0.163	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	-	-	-	-	-	-	-	-	0.003	0.032	0.003	0.003
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F79	F80	F81	F82	F83	F84	F85	F86	F87	F88	F89	F90	F91	F92
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	-	-	-	-	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	-
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	0.01	-	-	0.01	-	-	-	0.02	-	-	-	-	-	-
F 106	0.004	0.004	0.005	0.004	0.005	-	-	-	-	-	-	-	-	-
F 107	-	-	-	-	0.163		-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	0.003	0.003	0.003	0.032	0.003	-	-	0.005	0.005	0.005	0.034	0.005	0.005	-
F 110	-	-	-	-	-	-	-	0.042	0.042	0.041	0.042	0.042	0.041	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F93	F94	F95	F96	F97	F98	F99	F100	F101	F102	F103	F104	F105	F106
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	-	-	0.006	0.006	0.006	0.006	-	0.006	0.006	0.006	-	0.006	-	-
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	0.16	-	-	-	-	0.16	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	0.02	-	-	-	-	-	-	-	-	-
F 106	-	0.041	-	-	-	-	-	-	-	-	-	-	-	-
F 107	-	-	-	-	-		-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	0.029	-	-	-	-	-	-	-	-	-	-	-
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	0.013	0.012	0.012	0.012	0.013	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F107	F108	F109	F110	F111	F112	F113	F114	F115	F116	F117	F118	F119	F120
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	-	-	-	0.006	-	-	-	-	-	-	-	0.006	0.006	0.006
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	0.021	-	-	-	-	-	0.04	-
F 106	-	-	-	-	-	-	-	-	-	-	-	0.041	-	-
F 107	-	-	-	-	-		-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F121	F122	F123	F124	F125	F126	F127	F128	F129	F130	F131	F132	F133	F134
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	63	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	66	0.006	0.006	0.006	0.006	-	-	-	0.006	0.006	-	0.006	0.006	-	-
F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	97	-	-	-	-		-	-	-	-	-	-	-	-	-
F	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	103	-	-	-	-		-	-	-	-	-	-	-	-	-
F	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	105	-	0.021	-	-	-	-	-	-	-	-	-	-	-	-
F	106	-	-	-	0.04	-	-	-	-	-	-	-	-	-	-
F	107	-	-	-	-	-		-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	109	-	0.029	-	0.029	-	-	-	0.024	0.024	0.009	-	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F135	F136	F137	F138	F139	F140	F141	F142	F143	F144	F145	F146	F147	F148
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	-	-	-	-	0.006	-	-	-	-	-	0.006	0.006	0.006	0.006
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 106	-	-	-	-	-	-	-	-	-	-	-	-	-	0.04
F 107	-	-	-	-	-		-	-	-	-	-	-	-	-
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	-	-	-	-	-	0.029	-	-	-	-	-	-
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F149	F150	F151	F152	F153	F154	F155	F156	F157	F158	F159	F160	F161	F162
F 61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 66	0.006	0.006	0.006	0.006	0.006	-	0.006	-	0.006	-	-	-	0.006	-
F 67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 97	-	-	-	-		-	-	-	-	-	-	-	-	-
F 98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 103	-	-	-	-		-	-	-	-	-	-	-	-	-
F 104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 105	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-
F 106	-	0.041	-	-	-	-	-	0.008	0.008	0.008	0.008	0.008	0.049	0.008
F 107	-	-	-	-	-		-	0.051	0.051	0.051	0.051	0.051	0.017	0.017
F 108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 109	-	-	-	-	-	-	-	0.009	0.009	0.009	0.009	0.009	0.009	0.009
F 110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F163	F164	F165	F166	F167	F168	F169	F170	F171	F172	F173	F174	F175	F176
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	66	0.006	-	-	0.006	0.006	0.006	0.006	-	-	-	-	0.006	-	-
F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	97	-	-	-	-		-	-	-	-	-	-	-	-	-
F	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	103	-	-	-	-		-	-	-	-	-	-	-	-	-
F	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	105	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02
F	106	0.008	0.008	0.008	-	-	-	-	-	-	-	0.008	0.008	0.008	0.049
F	107	0.017	0.017	0.017	-	-		-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	109	0.009	0.009	0.036	-	-	-	-	-	-	-	-	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F177	F178	F179	F180	F181	F182	F183	F184	F185	F186	F187	F188	F189	F190
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	66	0.006	-	0.006	0.006	-	-	-	-	0.006	0.006	0.006	0.006	-	-
F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	83	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	97	-	-	-	-		-	-	-	-	-	-	-	-	-
F	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	103	-	-	-	-		-	-	-	-	-	-	-	-	-
F	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	106	0.008	0.005	0.005	0.005	-	-	-	-	0.005	0.005	0.005	0.005	-	-
F	107	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	109	-	-	0.014	0.014	-	-	-	-	-	-	-	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F191	F192	F193	F194	F195	F196	F197	F198	F199	F200	F201	F202	F203	F204
F	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	66	-	-	0.006	-	-	-	-	0.006	-	-	-	-	-	-
F	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	69	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	71	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	73	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	74	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	79	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	82	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	83	-	-	-	-	-	-	-	-	-	-	-	-	-	
F	84	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	86	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	91	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	93	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	95	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	97	-	-	-	-		-	-	-	-	-	-	-	-	-
F	98	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	99	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	101	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	102	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	103	-	-	-	-		-	-	-	-	-	-	-	-	-
F	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	105	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	106	-	-	0.005	-	-	-	-	-	-	-	-	-	-	-
F	107	-	-	-	-	-		-	-	-	-	-	-	-	-
F	108	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	109	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	110	-	-	-	-	-	-	-	-	-	-	-	-	0.083	0.083
F	111	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	113	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	114	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	116	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	117	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	118	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	119	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	120	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

		F205	F206	F207	F208	Sum
F	61	-	-	-	-	1
F	62	-	-	-	-	1
F	63	-	-	-	-	1
F	64	-	-	-	-	1
F	65	-	-	-	-	1
F	66	0.006	0.006	0.006	-	1
F	67	-	-	-	-	1
F	68	-	-	-	-	1
F	69	-	-	-	-	1
F	70	-	-	-	-	1
F	71	-	-	-	-	1
F	72	-	-	-	-	1
F	73	-	-	-	-	1
F	74	-	-	-	-	1
F	75	-	-	-	-	1
F	76	-	-	-	-	1
F	77	-	-	-	-	1
F	78	-	-	-	-	1
F	79	-	-	-	-	1
F	80	-	-	-	-	1
F	81	-	-	-	-	1
F	82	-	-	-	-	1
F	83	-	-	-	-	1
F	84	-	-	-	-	1
F	85	-	-	-	-	1
F	86	-	-	-	-	1
F	87	-	-	-	-	1
F	88	-	-	-	-	1
F	89	-	-	-	-	1
F	90	-	-	-	-	1
F	91	-	-	-	-	1
F	92	-	-	-	-	1
F	93	-	-	-	-	1
F	94	-	-	-	-	1
F	95	-	-	-	-	1
F	96	-	-	-	-	1
F	97	-	-	-	-	
F	98	-	-	-	-	1
F	99	-	-	-	-	1
F	100	-	-	-	-	1
F	101	-	-	-	-	1
F	102	-	-	-	-	1
F	103	-	-	-	-	1
F	104	-	-	-	-	1
F	105	-	-	0.02	-	1
F	106	-	-	-	-	1
F	107	-	-	-	-	1
F	108	-	-	-	-	1
F	109	-	-	-	-	1
F	110	0.084	-	-	-	1
F	111	-	-	-	-	1
F	112	-	-	-	-	1
F	113	-	-	-	-	1
F	114	-	-	-	-	1
F	115	-	-	-	-	1
F	116	-	-	-	-	1
F	117	-	-	-	-	1
F	118	-	-	-	-	1
F	119	-	-	-	-	1
F	120	-	-	-	-	1

continued...

Table 8.6.2 continued

	Predator/prey	D1	A1	A2	A3	I1	I2	I3	I4	I5
F 121	*Mulloidichthys martinicus*	-	-	-	-	-	0.161	-	-	-
F 122	*Pseudupeneus maculatus*	-	-	-	-	-	0.007	-	-	
F 123	*Echidna catenata*	-	-	-	-	-	-	-	-	-
F 124	*Lycodontis moringa*	-	-	-	-	-	-	-	-	-
F 125	*Lycodontis vicinus*	-	-	-	-	-	-	-	-	-
F 126	*Aetobatus narinari*	-	-	-	-	-	-	-	-	-
F 127	*Ogcocephalus nasutus*	-	0.111	-	-	-	-	-	-	-
F 128	*Myrichthys acuminatus*	-	-	-	-	-	-	-	-	-
F 129	*Myrichthys oculatus*	-	-	-	-	-	-	-	-	-
F 130	*Ophichthus ophis*	-	-	-	-	-	-	-	-	-
F 131	*Opisthognatus aurifrons*	-	-	-	-	-	1	-	-	-
F 132	*Opisthognatus maxillosus*	-	-	-	-	-	0.058	-	-	-
F 133	*Opisthognatus whitehurstii*	-	-	-	-	-	-	-	-	-
F 134	*Acanthostracion polygonius*	-	-	0.187	-	-	-	0.156	-	0.124
F 135	*Acanthostracion quadricornis*	-	0.102	0.029	-	-	0.038	0.352	-	0.019
F 136	*Lactophrys trigonus*	-	0.079	-	-	-	0.01	-	-	-
F 137	*Rhinesomus bicaudalis*	-	0.15	-	-	-	-	-	-	-
F 138	*Rhinesomus triqueter*	-	0.021	-	-	-	0.005	0.066	-	-
F 139	*Pempheris schomburgki*	-	-	-	-	-	0.715	-	-	-
F 140	*Centropyge argi*	0.5	0.5	-	-	-	-	-	-	-
F 141	*Holacanthus ciliaris*	-	0.014	0.003	-	-	-	0.968	0.002	-
F 142	*Holacanthus tricolor*	-	0.008	-	-	-	-	0.971	-	-
F 143	*Pomacanthus arcuatus*	-	0.084	0.012	-	-	0.016	0.728	0.002	0.006
F 144	*Pomacanthus paru*	-	0.135	0.01	-	-	0.001	0.748	0.001	0.006
F 145	*Abudefduf saxatilis*	-	0.088	-	-	-	0.319	-	-	-
F 146	*Abudefduf taurus*	-	0.94	0.001	-	-	-	-	-	-
F 147	*Chromis cyanea*	-	-	-	-	-	1	-	-	-
F 148	*Chromis multilineata*	-	-	-	-	-	1	-	-	-
F 149	*Microspathodon chrysurus*	0.446	0.447	0.021	-	-	0.008	0.003	-	-
F 150	*Stegastes fuscus*	0.281	0.3	0.001	-	-	0.114	-	0.001	-
F 151	*Stegastes leucostictus*	0.113	0.113	0.052	-	0.02	0.283	-	0.027	-
F 152	*Stegastes planifrons*	0.121	0.161	0.005	-	-	0.091	-	-	-
F 153	*Stegastes variabilis*	0.258	0.257	0.034	-	-	-	0.021	0.014	-
F 154	*Priacanthus arenatus*	-	-	-	-	-	0.267	-	-	-
F 155	*Priacanthus cruentatus*	-	-	-	-	-	0.52	-	-	-
F 156	*Scarus coelestinus*	-	0.986	0.001	-	0.002	-	0.001	-	-
F 157	*Scarus iserti*	-	1	-	-	-	-	-	-	-
F 158	*Scarus guacamaia*	-	1	-	-	-	-	-	-	-
F 159	*Scarus taeniopterus*	-	0.985	-	-	-	-	0.015	-	-
F 160	*Scarus vetula*	-	0.972	0.011	-	-	-	0.01	-	0.007
F 161	*Sparisoma aurofrenatum*	-	0.991	0.005	-	-	-	-	-	0.003
F 162	*Sparisoma chrysopterum*	-	1	-	-	-	-	-	-	-
F 163	*Sparisoma radians*	-	1	-	-	-	-	-	-	-
F 164	*Sparisoma rubripinne*	-	0.996	-	-	-	-	0.004	-	-
F 165	*Sparisoma viride*	-	0.998	0.001	-	-	-	0.001	-	-
F 166	*Equetus lanceolatus*	-	-	-	-	-	-	-	-	-
F 167	*Equetus punctatus*	-	-	-	-	-	0.141	-	-	-
F 168	*Odontoscion dentex*	-	-	-	-	-	0.391	-	-	-
F 169	*Pareques acuminatus*	-	-	-	-	-	0.472	-	-	-
F 170	*Euthynnus alletteratus*	-	-	-	-	-	-	-	-	-
F 171	*Scomberomorus cavalla*	-	-	-	-	-	-	-	-	-
F 172	*Scomberomorus regalis*	-	-	-	-	-	-	-	-	-
F 173	*Scorpaena brasiliensis*	-	-	-	-	-	-	-	-	-
F 174	*Scorpaena grandicornis*	-	-	-	-	-	-	-	-	-
F 175	*Scorpaena inermis*	-	-	-	-	-	-	-	-	-
F 176	*Scorpaena plumieri*	-	-	-	-	-	-	-	-	-
F 177	*Scorpaenodes caribbaeus*	-	-	-	-	-	-	-	-	-
F 178	*Alphestes afer*	-	-	-	-	-	-	-	-	-
F 179	*Cephalopholis cruentata*	-	-	-	-	-	-	-	-	-
F 180	*Cephalopholis fulva*	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
F 121	-	-	-	0.069	-	0.08	0.007	0.133	0.004	-	-	0.19	-	-
F 122	-	-	-	0.045	-	-	0.008	0.069	-	-	-	0.137	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	0.125	-	-	-
F 126	-	-	-	0.02	-	-	0.3	0.45	-	0.02	0.02	0.02	0.02	-
F 127	-	-	-	-	-	-	0.259	0.017	-	-	-	0.044	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	0.012	-	-
F 130	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	0.143	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	0.023	-	-	-	-	-	-	-
F 135	0.124	-	-	-	-	-	-	0.004	-	-	-	0.021	-	-
F 136	-	-	-	-	-	0.008	0.022	0.104	-	-	-	0.099	-	-
F 137	-	-	-	-	-	-	0.011	-	-	-	-	0.065	-	-
F 138	-	-	-	0.175	-	0.007	0.032	0.019	-	-	-	0.327	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	0.273	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	0.004	-	-	-	-	-	-	-	-	-	-	-
F 142	0.021	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	0.046	-	0.001	-	-	-	-	-	-	-	-	-	-	-
F 144	0.049	-	0.002	-	-	-	-	-	-	-	-	-	-	-
F 145	0.45	-	-	-	-	-	0.055	-	-	-	-	0.01	-	-
F 146	0.053	-	-	-	-	0.001	0.002	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	0.014	-	-	-	-	0.001	-	-	-	-	-	-	-
F 150	0.038	-	-	-	-	-	0.042	0.006	-	-	-	0.071	-	-
F 151		0.008	-	-	-	-	0.003	-	-	-	-	0.165	-	-
F 152	0 303	0.004	-	-	-	-	-	-	-	-	-	0.088	-	-
F 153	-	0.008	-	-	-	-	0.014	0.007	-	-	-	0.193	-	-
F 154	-	-	-	-	-	-	-	-	-	0.011	0.011	0.011	-	-
F 155	-	-	-	-	-	-	0.013	-	-	0.022	0.022	0.17	-	-
F 156	-	0.001	-	-	-	0.001	0.001	0.001	0.001	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	0.001	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	0.313	-	-
F 167	-	-	-	-	-	-	0.032	0.006	-	-	-	0.054	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	0.366	-	0.067	-	-
F 171	-	-	-	-	-	-	-	-	-	-	0.002	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	0.023	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	0.062	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	0.025	-	-	-
F 179	-	-	-	-	-	-	0.038	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	I20	I21	I22	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33
F 121	-	0.008	0.045	0.009	0.058	0.061	-	-	-	0.081	-	-	0.09	0.004
F 122	-	0.037	0.021	0.002	0.022	0.252	-	-	-	0.348	-	-	0.008	-
F 123	-	-	-	-	-	0.037	-	-	-	0.963	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	0.25	-	-	-	-
F 126	-	-	-	-	-	0.05	-	-	-	-	-	-	-	-
F 127	0.006	-	-	-	-	-	-	-	-	0.475	-	-	-	-
F 128	-	0.07	-	-	-	-	-	-	-	0.86	-	-	-	0.07
F 129	-	0.155	-	-	-	0.04	-	-	-	0.761	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	0.286	0.286	-	-	-	-	-	-	-	-
F 133	-	-	-	-	0.11	0.54	-	-	-	0.05	-	-	0.08	-
F 134	-	-	-	-	-	0.133	-	-	-	-	-	-	-	-
F 135	-	-	0.003	-	-	0.003	-	-	0.095	-	-	-	-	-
F 136	-	-	0.019	-	-	0.003	-	-	0.004	0.464	-	0.025	0.016	0.073
F 137	-	-	-	-	-	-	-	-	-	0.044	-	0.065	0.136	0.109
F 138	-	-	0.013	-	-	0.078	-	-	0.025	0.098	0.036	-	-	0.025
F 139	-	-	0.012	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	0.031	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	0.003	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	0.003	-	-	0.041	-	-	-	-	-	-	0.016	-
F 150	-	-	0.016	-	0.021	0.012	-	-	0.004	0.029	-	-	-	-
F 151	-	-	0.021	-	-	0.013	-	-	0.013	0.038	-	-	-	-
F 152	-	-	0.035	-	0.035	0.035	-	-	0.035	0.035	-	0.013	0.013	0.013
F 153	-	-	0.011	0.009	0.15	0.014	-	-	-	-	-	-	0.01	-
F 154	-	-	-	-	0.016	0.347	-	-	-	0.049	-	-	-	-
F 155	-	-	0.007	-	0.05	0.05	-	-	-	0.073	-	-	-	-
F 156	-	-	0.001	-	0.001	0.001	-	-	-	0.001	-	-	-	0.001
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	0.625	-	-	-	0.062	-	-	-	-
F 167	-	0.004	-	-	0.013	0.137	-	-	0.15	0.459	-	-	-	-
F 168	-	-	-	-	0.178	0.19	-	-	-	0.052	-	-	-	-
F 169	-	-	0.003	-	0.035	0.411	-	-	-	0.06	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	0.92	-	0.01	-	-	-	-	-	-
F 172	-	-	-	-	-	0.016	-	-	-	-	-	-	-	-
F 173	-	0.215	-	-	-	0.535	-	-	-	0.107	-	-	-	-
F 174	-		-	-	-	0.875	-	-	-	-	-	-	-	-
F 175	-	0.08	-	-	-	0.91	-	-	-	0.007	-	-	-	-
F 176	-	-	-	-	-	0.187	-	-	0.016	0.313	-	-	-	-
F 177	-	-	-	-	-	0.731	-	-	-	0.193	-	-	-	-
F 178	-	-	-	-	-	0.073	-	-	-	0.832	-	-	-	-
F 179	-	0.089	-	-	-	0.173	-	-	-	0.038	-	-	-	-
F 180	-	0.133	-	-	-	0.222	-	-	-	0.185	-	-	-	-

continued...

Table 8.6.2 continued

	I34	I35	R1	B1
F 121	-	-	-	-
F 122	-	-	-	-
F 123	-	-	-	-
F 124	-	-	-	-
F 125	-	-	-	-
F 126	-	-	-	-
F 127	-	-	-	-
F 128	-	-	-	-
F 129	-	-	-	-
F 130	-	-	-	-
F 131	-	-	-	-
F 132	-	-	-	-
F 133	-	-	-	-
F 134	-	0.377	-	-
F 135	-	0.21	-	-
F 136	0.027	0.047	-	-
F 137	0.207	0.213	-	-
F 138	-	0.073	-	-
F 139	-	-	-	-
F 140	-	-	-	-
F 141	-	0.009	-	-
F 142	-	-	-	-
F 143	-	0.105	-	-
F 144	-	0.048	-	-
F 145	-	-	-	-
F 146	-	-	-	-
F 147	-	-	-	-
F 148	-	-	-	-
F 149	-	-	-	-
F 150	-	0.002	-	-
F 151	-	0.038	-	-
F 152	0.013	-	-	-
F 153	-	-	-	-
F 154	-	-	-	-
F 155	-	-	-	-
F 156	-	-	-	-
F 157	-	-	-	-
F 158	-	-	-	-
F 159	-	-	-	-
F 160	-	-	-	-
F 161	-	-	-	-
F 162	-	-	-	-
F 163	-	-	-	-
F 164	-	-	-	-
F 165	-	-	-	-
F 166	-	-	-	-
F 167	-	-	-	-
F 168	-	-	-	-
F 169	-	-	-	-
F 170	-	-	-	-
F 171	-	-	-	-
F 172	-	-	-	-
F 173	-	-	-	-
F 174	-	-	-	-
F 175	-	-	-	-
F 176	-	-	-	-
F 177	-	-	-	-
F 178	-	-	-	-
F 179	-	-	-	-
F 180	-	-	-	-

continued...

Table 8.6.2 continued

	Predator/Prey	F0	F1	F2	F3	F4	F5	F6	F7	F8
F 121	*Mulloidichthys martinicus*	-	-	-	-	-	-	-	-	-
F 122	*Pseudupeneus maculatus*	0.022	-	-	-	-	-	-	-	
F 123	*Echidna catenata*	-	-	-	-	-	-	-	-	-
F 124	*Lycodontis moringa*	-	-	-	-	-	-	-	-	-
F 125	*Lycodontis vicinus*	-	-	-	-	-	-	-	-	-
F 126	*Aetobatus narinari*	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
F 127	*Ogcocephalus nasutus*	-	-	-	-	-	-	-	-	-
F 128	*Myrichthys acuminatus*	-	-	-	-	-	-	-	-	-
F 129	*Myrichthys oculatus*	0.032	-	-	-	-	-	-	-	-
F 130	*Ophichthus ophis*	-	-	-	-	-	-	-	-	-
F 131	*Opisthognatus aurifrons*	-	-	-	-	-	-	-	-	-
F 132	*Opisthognatus maxillosus*	0.227	-	-	-	-	-	-	-	-
F 133	*Opisthognatus whitehurstii*	0.22	-	-	-	-	-	-	-	-
F 134	*Acanthostracion polygonius*	-	-	-	-	-	-	-	-	-
F 135	*Acanthostracion quadricornis*	-	-	-	-	-	-	-	-	-
F 136	*Lactophrys trigonus*	-	-	-	-	-	-	-	-	-
F 137	*Rhinesomus bicaudalis*	-	-	-	-	-	-	-	-	-
F 138	*Rhinesomus triqueter*	-	-	-	-	-	-	-	-	-
F 139	*Pempheris schomburgki*	-	-	-	-	-	-	-	-	-
F 140	*Centropyge argi*	-	-	-	-	-	-	-	-	-
F 141	*Holacanthus ciliaris*	-	-	-	-	-	-	-	-	-
F 142	*Holacanthus tricolor*	-	-	-	-	-	-	-	-	-
F 143	*Pomacanthus arcuatus*	-	-	-	-	-	-	-	-	-
F 144	*Pomacanthus paru*	-	-	-	-	-	-	-	-	-
F 145	*Abudefduf saxatilis*	-	-	-	-	-	-	-	-	-
F 146	*Abudefduf taurus*	-	-	-	-	-	-	-	-	-
F 147	*Chromis cyanea*	-	-	-	-	-	-	-	-	-
F 148	*Chromis multilineata*	-	-	-	-	-	-	-	-	-
F 149	*Microspathodon chrysurus*	-	-	-	-	-	-	-	-	-
F 150	*Pomacentrus fuscus*	0.062	-	-	-	-	-	-	-	-
F 151	*Pomacentrus leucostictus*	0.093	-	-	-	-	-	-	-	-
F 152	*Pomacentrus planifrons*	-	-	-	-	-	-	-	-	-
F 153	*Pomacentrus variabilis*	-	-	-	-	-	-	-	-	-
F 154	*Priacanthus arenatus*	-	-	-	-	-	-	-	-	0.094
F 155	*Priacanthus cruentatus*	-	-	-	-	-	-	-	-	-
F 156	*Scarus coelestinus*	-	-	-	-	-	-	-	-	-
F 157	*Scarus croicensis*	-	-	-	-	-	-	-	-	-
F 158	*Scarus guacamaia*	-	-	-	-	-	-	-	-	-
F 159	*Scarus taeniopterus*	-	-	-	-	-	-	-	-	-
F 160	*Scarus vetula*	-	-	-	-	-	-	-	-	-
F 161	*Sparisoma aurofrenatum*	-	-	-	-	-	-	-	-	0.003
F 162	*Sparisoma chrysopterum*	-	-	-	-	-	-	-	-	-
F 163	*Sparisoma radians*	-	-	-	-	-	-	-	-	-
F 164	*Sparisoma rubripinne*	-	-	-	-	-	-	-	-	-
F 165	*Sparisoma viride*	-	-	-	-	-	-	-	-	-
F 166	*Equetus lanceolatus*	-	-	-	-	-	-	-	-	-
F 167	*Equetus punctatus*	0.004	-	-	-	-	-	-	-	-
F 168	*Odontoscion dentex*	0.189	-	-	-	-	-	-	-	-
F 169	*Pareques acuminatus*	0.019	-	-	-	-	-	-	-	-
F 170	*Euthynnus alletteratus*	-	-	-	-	-	-	-	-	0.142
F 171	*Scomberomorus cavalla*	-	-	-	-	-	-	-	-	-
F 172	*Scomberomorus regalis*	-	-	-	-	-	-	-	-	0.096
F 173	*Scorpaena brasiliensis*	0.143	-	-	-	-	-	-	-	-
F 174	*Scorpaena grandicornis*	0.125	-	-	-	-	-	-	-	-
F 175	*Scorpaena inermis*	0.003	-	-	-	-	-	-	-	-
F 176	*Scorpaena plumieri*	-	0.047	0.047	0.047	-	-	-	-	-
F 177	*Scorpaenodes caribbaeus*	-	-	-	-	-	-	-	-	-
F 178	*Alphestes afer*	-	0.012	0.012	0.012	-	-	-	-	-
F 179	*Cephalopholis cruentata*	-	-	-	-	-	-	0.047	0.047	-
F 180	*Cephalopholis fulva*	-	0.022	0.022	0.022	-	-	-	-	-

continued...

Table 8.6.2 continued

	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	0.001	-	-	0.001	0.001	0.001	-	-	-	0.001	-	0.001	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	0.094	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	0.047	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 172	0.032	-	-	-	-	0.016	0.016	0.016	0.016	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	0.065	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	-	-	-	0.001	0.001	-	-	-	-	-	-	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 172	-	-	-	0.064	-	-	0.064	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F37	F38	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	-	-	-	-	-	0.001	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	0.023	0.023
F 171	-	-	-	-	-	-	-	-	-	-	-	-	0.017	0.016
F 172	-	-	-	-	-	-	-	-	-	-	-	-	0.096	0.032
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	0.024	0.024	0.024	0.024	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	0.033	0.033	-	-	-

continued...

Table 8.6.2 continued

	F51	F52	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	0.001	0.001	-	-	-	-	-	0.001	0.001	-	-	-	0.001
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	0.047	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	0.073	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	0.12	0.023	-	-	-	-	-	-	-	0.047	0.047	-	-	-
F 171	0.017	0.016	-	-	-	-	-	-	-	-	-	-	-	-
F 172	0.064	0.064	-	-	-	-	-	-	-	0.032	0.032	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	0.141	-	0.14	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	0.034	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F65	F66	F67	F68	F69	F70	F71	F72	F73	F74	F75	F76	F77	F78
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	0.022	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	-	-	-	-	0.001	0.001	0.001	-	0.001	-	0.001	0.001	0.001
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	0.001	0.001	0.001	0.001
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	0.189	-	-	-	-	-	-	-	0.011	0.011	0.011	0.011
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F79	F80	F81	F82	F83	F84	F85	F86	F87	F88	F89	F90	F91	F92
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	-	-	-	-	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	0.001	0.001	0.001	0.001	0.001	0.162	0.362	-	-	-	-	-	-	-
F 172	-	-	-	-	-	-	0.064	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	0.011	0.011	0.011	0.011	0.011	-	-	-	0.092	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F93	F94	F95	F96	F97	F98	F99	F100	F101	F102	F103	F104	F105	F106
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	-	-	0.001	0.001	0.001	0.001	-	0.001	0.001	0.001	-	0.001	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	0.02	0.021
F 172	-	0.006	0.069	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F107	F108	F109	F110	F111	F112	F113	F114	F115	F116	F117	F118	F119	F120
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	-	-	-	0.001	-	-	-	-	-	-	-	0.001	0.001	0.001
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	0.02	0.021	0.02	0.021	0.02	0.021	-	-	-	-	-	-	-	0.049
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	0.065	0.065	-

continued...

Table 8.6.2 continued

	F121	F122	F123	F124	F125	F126	F127	F128	F129	F130	F131	F132	F133	F134
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	0.001	0.001	0.001	-	-	-	0.001	0.001	-	0.001	0.001	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	0.095	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F135	F136	F137	F138	F139	F140	F141	F142	F143	F144	F145	F146	F147	F148
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	-	-	-	-	0.001	-	-	-	-	-	0.001	0.001	0.001	0.001
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	-	-	0.064	0.064
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	0.038	0.038	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	0.092	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F149	F150	F151	F152	F153	F154	F155	F156	F157	F158	F159	F160	F161	F162
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	0.125	0.125	0.125	0.125	0.125	-	-
F 126	0.001	0.001	0.001	0.001	0.001	-	0.001	-	0.001	-	-	-	0.001	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	0.007	0.007	0.007	0.007	0.007	0.007	0.007

continued...

Table 8.6.2 continued

	F163	F164	F165	F166	F167	F168	F169	F170	F171	F172	F173	F174	F175	F176
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	-	-	0.001	0.001	0.001	0.001	-	-	-	-	0.001	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	-	-	-	-	-	-	0.04	0.008	0.008	-	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	0.007	0.007	0.007	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F177	F178	F179	F180	F181	F182	F183	F184	F185	F186	F187	F188	F189	F190
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	0.001	-	0.001	0.001	-	-	-	-	0.001	0.001	0.001	0.001	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	-	0.001	0.001	0.001	0.007	0.007	-	0.007	-	-	-	-	-	0.001
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F191	F192	F193	F194	F195	F196	F197	F198	F199	F200	F201	F202	F203	F204
F 121	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 122	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 123	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 124	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 125	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 126	-	-	0.001	-	-	-	-	0.001	-	-	-	-	-	-
F 127	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 128	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 129	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 131	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 132	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 133	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 135	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 136	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 137	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 138	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 139	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 141	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 142	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 143	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 144	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 145	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 146	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 147	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 148	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 149	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 150	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 151	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 152	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 153	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 154	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 155	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 156	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 157	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 158	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 159	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 160	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 161	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 163	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 164	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 165	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 166	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 167	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 168	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 169	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 170	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 171	0.001	0.001	0.001	-	-	-	-	-	-	-	-	-	-	-
F 172	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 173	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 174	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 175	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 177	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 178	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 179	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 180	-	-	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table 8.6.2 continued

	F205	F206	F207	F208	Sum
F 121	-	-	-	-	1
F 122	-	-	-	-	1
F 123	-	-	-	-	1
F 124	-	-	-	-	1
F 125	-	-	-	-	1
F 126	0.001	0.001	0.001	-	1
F 127	-	-	0.088	-	1
F 128	-	-	-	-	1
F 129	-	-	-	-	1
F 130	-	-	-	-	1
F 131	-	-	-	-	1
F 132	-	-	-	-	1
F 133	-	-	-	-	1
F 134	-	-	-	-	1
F 135	-	-	-	-	1
F 136	-	-	-	-	1
F 137	-	-	-	-	1
F 138	-	-	-	-	1
F 139	-	-	-	-	1
F 140	-	-	-	-	1
F 141	-	-	-	-	1
F 142	-	-	-	-	1
F 143	-	-	-	-	1
F 144	-	-	-	-	1
F 145	-	-	-	-	1
F 146	-	-	-	-	1
F 147	-	-	-	-	1
F 148	-	-	-	-	1
F 149	-	-	-	-	1
F 150	-	-	-	-	1
F 151	-	-	-	-	1
F 152	-	-	-	-	1
F 153	-	-	-	-	1
F 154	-	-	-	-	1
F 155	-	-	-	-	1
F 156	-	-	-	-	1
F 157	-	-	-	-	1
F 158	-	-	-	-	1
F 159	-	-	-	-	1
F 160	-	-	-	-	1
F 161	-	-	-	-	1
F 162	-	-	-	-	1
F 163	-	-	-	-	1
F 164	-	-	-	-	1
F 165	-	-	-	-	1
F 166	-	-	-	-	1
F 167	-	-	-	-	1
F 168	-	-	-	-	1
F 169	-	-	-	-	1
F 170	-	-	-	-	1
F 171	-	-	-	-	1
F 172	-	-	-	-	1
F 173	-	-	-	-	1
F 174	-	-	-	-	1
F 175	-	-	-	-	1
F 176	-	-	-	-	1
F 177	-	-	-	-	1
F 178	-	-	-	-	1
F 179	-	-	-	-	1
F 180	-	-	0.063	-	1

continued...

Table 8.6.2 continued

	Predator/prey	D1	A1	A2	A3	I1	I2	I3	I4	I5
F 181	*Epinephelus adscensionis*	-	-	-	-	-	-	-	-	-
F 182	*Epinephelus guttatus*	-	-	-	-	-	-	-	-	-
F 183	*Epinephelus itajara*	-	-	-	-	-	-	-	-	-
F 184	*Epinephelus striatus*	-	-	-	-	-	-	-	-	-
F 185	*Hypoplectrus aberrans*	-	-	-	-	-	0.008	-	-	-
F 186	*Hypoplectrus chlorurus*	-	-	-	-	-	-	-	-	-
F 187	*Hypoplectrus nigricans*	-	-	-	-	-	0.059	-	-	-
F 188	*Hypoplectrus puella*	-	-	-	-	-	0.089	-	-	-
F 189	*Mycteroperca bonaci*	-	-	-	-	-	-	-	-	-
F 190	*Mycteroperca tigris*	-	-	-	-	-	-	-	-	-
F 191	*Mycteroperca venenosa*	-	-	-	-	-	-	-	-	-
F 192	*Paranthias furcifer*	-	-	-	-	-	0.902	-	-	-
F 193	*Serranus tigrinus*	-	-	-	-	-	-	-	-	-
F 194	*Archosargus rhomboidalis*	-	0.834	-	-	-	0.035	-	-	-
F 195	*Calamus bajonado*	-	-	-	-	-	-	-	-	-
F 196	*Calamus calamus*	-	-	-	-	-	-	-	-	-
F 197	*Calamus pennatula*	-	-	-	-	-	-	-	-	-
F 198	*Diplodus caudimacula*	-	0.8	-	-	-	-	-	-	-
F 199	*Sphyraena barracuda*	-	-	-	-	-	0.019	-	-	-
F 200	*Sphyraena picudilla*	-	-	-	-	-	-	-	-	-
F 201	*Sphyrna lewini*	-	-	-	-	-	-	-	-	-
F 202	*Sphyrna tiburo*	-	-	-	-	-	-	-	-	-
F 203	*Synodus foetens*	-	-	-	-	-	-	-	-	-
F 204	*Synodus intermedius*	-	-	-	-	-	-	-	-	-
F 205	*Synodus synodus*	-	-	-	-	-	-	-	-	-
F 206	*Canthigaster rostrata*	0.011	0.172	0.018	-	-	0.013	0.167	0.012	-
F 207	*Sphoeroides spengleri*	0.018	0.07	-	-	-	0.031	-	-	-
F 208	*Mustelus canis*	-	-	-	-	-	-	-	-	-

continued...

	I6	I7	I8	I9	I10	I11	I12	I13	I14	I15	I16	I17	I18	I19
F 181	-	-	-	-	-	0.016	0.032	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	0.07	-	0.02	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	-	-	-	-	-	0.016	0.007	-	0.026	0.026	-	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	-	-	-	-	0.039	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	0.043	0.034	-	-	-	0.004	-	-
F 195	-	-	-	-	-	-	0.111	0.135	-	-	-	0.067	-	-
F 196	-	-	-	0.006	-	0.019	0.084	0.151	-	-	-	0.194	-	-
F 197	-	-	-	0.05	-	-	0.082	0.123	-	-	-	0.14	-	-
F 198	-	-	-	-	-	0.02	0.16	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	0.026	-	-	-
F 200	-	-	-	-	-	-	-	-	-	0.179	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F 202	-	-	-	-	-	-	-	0.05	-	-	0.25	-	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	0.05	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	0.087	0.058	-	-	-	0.131	-	0.013
F 207	-	-	-	-	-	0.015	0.098	0.164	-	-	-	0.078	-	-
F 208	-	-	-	-	-	0.05	0.05	0.05	0.05	0.05	0.05	-	-	-

continued...

Table 8.6.2 continued

	I20	I21	I22	I23	I24	I25	I26	I27	I28	I29	I30	I31	I32	I33
F 181	-	-	-	-	-	0.046	-	-	-	0.705	-	-	-	-
F 182	-	0.174	-	-	-	0.11	-	-	-	0.415	-	-	-	-
F 183	-	-	-	-	-	-	0.456	0.233	-	0.122	-	-	-	-
F 184	-	0.056	-	-	0.002	0.051	0.035	-	0.012	0.229	-	-	-	-
F 185	-	0.08	-	-	-	0.556	-	-	-	0.236	-	-	-	-
F 186	-	-	-	-	-	0.562	-	-	-	0.19	-	-	-	-
F 187	-	0.029	-	-	-	0.294	-	-	-	0.178	-	-	-	-
F 188	-	0.053	-	-	0.037	0.51	-	-	-	0.211	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	0.008	-	-	-	-	-	-	-	-
F 192	-	-	0.034	-	-	0.064	-	-	-	-	-	-	-	-
F 193	-	0.091	-	-	-	0.733	-	-	-	0.079	-	-	-	-
F 194	-	-	0.002	-	-	-	-	-	-	0.048	-	-	-	-
F 195	-	-	-	-	-	-	-	-	0.011	0.223	-	-	-	0.453
F 196	-	-	-	-	-	-	-	-	0.153	0.147	-	-	0.156	0.09
F 197	-	0.03	-	-	-	0.058	-	-	0.08	0.215	-	-	0.142	0.04
F 198	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-
F 202	-	-	-	-	-	0.25	-	-	-	0.25	-	-	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	0.005	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	0.039	-	-	0.037	-	-	0.029	0.122	-	0.042	-	0.042
F 207	-	-	0.058	-	0.011	0.056	-	-	0.009	0.209	0.035	-	0.061	0.071
F 208	-	-	-	-	-	-	0.1	0.1	-	0.2	-	-	-	-

continued...

	I34	I35	R1	B1
F 181	-	-	-	-
F 182	-	-	-	-
F 183	-	-	0.056	-
F 184	-	-	-	-
F 185	-	-	-	-
F 186	-	-	-	-
F 187	-	-	-	-
F 188	-	-	-	-
F 189	-	-	-	-
F 190	-	-	-	-
F 191	-	-	-	-
F 192	-	-	-	-
F 193	-	-	-	-
F 194	-	-	-	-
F 195	-	-	-	-
F 196	-	-	-	-
F 197	0.04	-	-	-
F 198	-	-	-	-
F 199	-	-	-	-
F 200	-	-	-	-
F 201	-	-	-	-
F 202	-	-	-	-
F 203	-	-	-	-
F 204	-	-	-	-
F 205	-	-	-	-
F 206	-	0.007	-	-
F 207	-	0.009	-	-
F 208	-	-	-	-

continued...

Table 8.6.2. continued.

	Predator/prey	F0	F1	F2	F3	F4	F5	F6	F7	F8
F 181	*Epinephelus adscensionis*	-	-	-	-	-	-	-	-	-
F 182	*Epinephelus guttatus*	-	-	-	-	-	-	-	-	-
F 183	*Epinephelus itajara*	-	-	-	-	-	-	-	-	-
F 184	*Epinephelus striatus*	-	0.005	0.005	0.005	-	-	-	-	0.007
F 185	*Hypoplectrus aberrans*	-	-	-	-	-	-	-	-	-
F 186	*Hypoplectrus chlorurus*	-	-	-	-	-	-	-	-	-
F 187	*Hypoplectrus nigricans*	-	-	-	-	-	-	-	-	-
F 188	*Hypoplectrus puella*	-	-	-	-	-	-	-	-	-
F 189	*Mycteroperca bonaci*	-	-	-	-	-	-	-	-	-
F 190	*Mycteroperca tigris*	-	0.095	0.024	0.095	-	-	-	-	0.036
F 191	*Mycteroperca venenosa*	-	0.048	-	-	-	-	-	-	0.024
F 192	*Paranthias furcifer*	-	-	-	-	-	-	-	-	-
F 193	*Serranus tigrinus*	0.097	-	-	-	-	-	-	-	-
F 194	*Archosargus rhomboidalis*	-	-	-	-	-	-	-	-	-
F 195	*Calamus bajonado*	-	-	-	-	-	-	-	-	-
F 196	*Calamus calamus*	-	-	-	-	-	-	-	-	-
F 197	*Calamus pennatula*	-	-	-	-	-	-	-	-	-
F 198	*Diplodus caudimacula*	-	-	-	-	-	-	-	-	-
F 199	*Sphyraena barracuda*	-	0.053	-	-	-	-	-	-	-
F 200	*Sphyraena picudilla*	0.821	-	-	-	-	-	-	-	0.08
F 201	*Sphyrna lewini*	-	-	-	-	-	-	-	-	0.02
F 202	*Sphyrna tiburo*	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
F 203	*Synodus foetens*	-	-	-	-	-	-	-	-	-
F 204	*Synodus intermedius*	-	-	-	-	-	-	-	-	0.079
F 205	*Synodus synodus*	1	-	-	-	-	-	-	-	-
F 206	*Canthigaster rostrata*	-	-	-	-	-	-	-	-	-
F 207	*Sphoeroides spengleri*	0.007	-	-	-	-	-	-	-	-
F 208	*Mustelus canis*	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003

continued...

	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	0.037	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	0.007	-	-	-	-	-	-	-	-	-	-	-	-	-
F 185	-	-	-	-	-	-	-	-	-	0.03	0.03	0.03	0.03	-
F 186	-	-	-	-	-	-	-	-	-	0.062	0.062	0.062	0.062	-
F 187	-	-	-	-	-	-	-	-	-	0.11	0.11	0.11	0.11	-
F 188	-	-	-	-	-	-	-	-	-	0.025	0.025	0.025	0.025	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	0.036	-	-	-	-	-	-	-	-	-	0.072	-	-	-
F 191	0.024	0.047	-	-	-	-	-	-	-	-	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	0.027	-	-	-	-	0.013	0.013	0.013	0.013	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	0.02	-	-	-	-	0.02	0.02	0.02	0.02	-	-	-	-	-
F 202	0.002	0.002	-	-	0.002	0.002	0.002	-	-	-	0.002	-	0.002	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	0.079	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	0.003	-	-	0.003	0.003	0.003	-	-	-	0.003	-	0.003	-

continued...

Table 8.6.2 continued

		F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36
F	181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	184	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	191	-	-	-	0.048	-	-	-	-	-	-	-	-	-	-
F	192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	199	-	0.024	0.024	0.024	0.059	0.006	0.006	0.006	0.006	-	-	-	-	-
F	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	201	-	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
F	202	-	-	-	-	-	0.002	-	-	-	-	-	-	-	-
F	203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	204	-	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	-	-	-	-
F	205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	208	-	-	-	-	-	0.003	-	-	-	-	-	-	-	-

continued...

		F37	F38	F39	F40	F41	F42	F43	F44	F45	F46	F47	F48	F49	F50
F	181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	184	-	-	-	-	-	-	-	-	-	-	-	-	0.015	-
F	185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	191	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	199	-	-	-	-	-	-	-	-	-	-	-	-	0.066	0.013
F	200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	201	0.02	0.02	-	0.02	0.02	-	-	-	-	-	-	-	0.02	0.02
F	202	-	-	-	-	-	0.002	0.002	0.002	0.002	0.002	-	0.002	0.002	0.002
F	203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	204	-	-	-	-	-	-	-	-	-	-	-	-	0.079	0.079
F	205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F	208	-	-	-	-	-	0.003	0.003	0.003	0.003	0.003	-	0.003	0.003	0.003

continued...

Table 8.6.2 continued

	F51	F52	F53	F54	F55	F56	F57	F58	F59	F60	F61	F62	F63	F64
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	0.036	-	-	-	-	-
F 183	-	-	-	-	0.067	-	0.033	0.033	-	-	-	-	-	-
F 184	0.015	-	-	-	-	-	-	-	-	0.015	0.014	-	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	0.5	-
F 190	0.072	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	0.066	0.013	-	-	-	-	0.027	0.027	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	0.02	0.02	-	-	0.02	-	-	-	-	0.01	0.01	-	-	-
F 202	0.002	0.002	0.002	-	-	-	-	-	0.002	0.001	0.001	-	-	0.002
F 203	-	-	-	-	-	-	-	-	-	0.5	0.5	-	-	-
F 204	0.156	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	0.003	0.003	-	-	-	-	-	0.003	0.002	0.001	-	-	0.003

continued...

Table 8.6.2 continued

	F65	F66	F67	F68	F69	F70	F71	F72	F73	F74	F75	F76	F77	F78
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	-	-	-	-	-	-	-	-	-	-	0.015	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	0.008	0.008	0.008	0.008
F 191	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	0.006	0.006	0.006	0.006
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 202	0.002	-	-	-	-	0.002	0.002	0.002	-	0.002	-	0.002	0.002	0.002
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	0.017	0.017	0.017	0.017
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	-	-	-	-	0.003	0.003	0.003	-	0.003	-	0.003	0.003	0.003

continued...

Table 8.6.2 continued

	F79	F80	F81	F82	F83	F84	F85	F86	F87	F88	F89	F90	F91	F92
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	0.014	-	-	-	-	-	-	0.003	0.003	0.003	0.017	0.003	0.015	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	0.078	0.008	0.008	0.008	0.008	-	-	-	-	-	-	-	-	-
F 191	0.047	-	-	-	-	-	-	0.017	0.017	0.017	0.017	0.017	0.007	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	0.006	0.006	0.006	0.006	0.006	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	0.02	0.02	-	-	-	-	-	-	-
F 202	0.002	-	-	-	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	0.017	0.017	0.017	0.017	0.017	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	-	-	-	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	-

continued...

	F93	F94	F95	F96	F97	F98	F99	F100	F101	F102	F103	F104	F105	F106
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	-	0.014	0.015	0.015	-	-	-	-	-	-	-	0.002	0.002
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	-	-	-	-	-	-	0.048	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 202	-	-	0.002	0.002	0.002	0.002	-	0.002	0.002	0.002	-	0.002	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	-	-	0.003	0.003	0.003	0.003	-	0.003	0.003	0.003	-	0.003	-	-

continued...

Table 8.6.2 continued

	F107	F108	F109	F110	F111	F112	F113	F114	F115	F116	F117	F118	F119	F120
F 181	-	-	-	-	-	-	-	-	-	-	-	0.101	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	0.036	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	0.002	0.002	0.002	0.002	0.002	0.015	-	-	-	-	-	0.015	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	0.072	-	-
F 191	-	-	-	-	-	-	-	-	0.01	0.01	0.01	0.01	0.01	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	0.053	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-
F 202	-	-	-	0.002	-	-	-	-	-	-	-	0.002	0.002	0.002
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	-	-	-	0.003	-	-	-	-	-	-	-	0.003	0.003	0.003

continued...

	F121	F122	F123	F124	F125	F126	F127	F128	F129	F130	F131	F132	F133	F134
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	0.036	-	-	0.018	0.018	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	0.015	0.015	0.028	0.015	-	-	-	-	-	-	-	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	0.053	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	0.02	-	-	-	-	-	-	-	-
F 202	0.002	0.002	0.002	0.002	-	-	-	0.002	0.002	-	0.002	0.002	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	0.003	0.003	0.003	-	-	-	0.003	0.003	-	0.003	0.003	-	-

continued...

Table 8.6.2 continued

	F135	F136	F137	F138	F139	F140	F141	F142	F143	F144	F145	F146	F147	F148
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	0.015	-	-	-	-	-	-	-	-	-	-	0.017	0.016
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	-	-	-	-	-	-	-	-	-	0.047	-	0.048	0.047
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 202	-	-	-	-	0.002	-	-	-	-	-	0.002	0.002	0.002	0.002
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	-	-	-	-	0.003	-	-	-	-	-	0.003	0.003	0.003	0.003

continued...

	F149	F150	F151	F152	F153	F154	F155	F156	F157	F158	F159	F160	F161	F162
F 181	-	-	-	-	-	-	-	-	-	-	-	-	0.02	0.02
F 182	-	-	-	-	-	-	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	0.017	0.016	0.002	0.002	0.002	-	0.015	0.004	0.004	0.004	0.004	0.02	0.017	0.017
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	0.072	-	0.072	-	-	-	0.009	0.009	0.009	0.009	0.009	0.019	0.019
F 191	-	0.059	0.012	0.059	0.012	-	-	0.005	0.053	0.005	0.005	0.052	0.005	0.005
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 202	0.002	0.002	0.002	0.002	0.002	-	0.002	-	0.002	-	0.002	-	0.002	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	0.003	0.003	0.003	0.003	-	-	0.003	-	0.003	-	0.003	-	0.003

continued...

Table 8.6.2 continued

	F163	F164	F165	F166	F167	F168	F169	F170	F171	F172	F173	F174	F175	F176
F 181	0.02	0.02	0.02	-	-	-	-	-	-	-	-	-	-	-
F 182	0.003	0.003	0.003	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	0.001	0.001	0.001	-	-	-	-	-	-	-	-	-	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	0.019	0.019	0.019	-	-	0.072	-	-	-	-	-	-	-	-
F 191	0.005	0.005	0.005	-	-	-	-	-	-	-	-	-	-	-
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	0.005	0.005	0.005	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	0.02	0.02	0.02	-	-	-	-
F 202	0.002	-	-	0.002	0.002	0.002	0.002	-	-	-	-	0.002	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	-	-	0.003	0.003	0.003	0.003	-	-	-	-	0.003	-	-

continued...

	F177	F178	F179	F180	F181	F182	F183	F184	F185	F186	F187	F188	F189	F190
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	-	-	0.015	-	-	-	-	-	-	-	0.014	-	-
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	-	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 202	0.002	-	0.002	0.002	-	-	-	-	0.002	0.002	0.002	0.002	-	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	0.003	-	0.003	0.003	-	-	-	-	0.003	0.003	0.003	0.003	-	-

continued...

Table 8.6.2 continued

	F191	F192	F193	F194	F195	F196	F197	F198	F199	F200	F201	F202	F203	F204
F 181	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 183	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 184	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.02
F 185	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 186	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 188	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 189	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 190	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 191	0.003	0.003	0.003	-	-	-	-	-	-	-	-	-	-	0.048
F 192	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 193	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 194	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 195	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 196	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 197	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 198	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 199	-	-	-	-	-	-	-	-	-	0.053	-	-	0.018	0.018
F 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 201	-	-	-	-	-	-	-	-	0.02	0.02	-	0.02	-	-
F 202	-	0.002	0.002	-	-	-	-	0.002	-	-	-	-	0.002	-
F 203	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 204	-	-	0.158	-	-	-	-	-	-	-	-	-	-	-
F 205	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 206	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 207	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F 208	-	0.003	0.003	-	-	-	-	0.003	-	-	-	-	0.003	-

continued...

Table 8.6.2 continued

	F205	F206	F207	F208	Sum
F 181	-	-	-	-	1
F 182	-	-	-	-	1
F 183	-	-	-	-	1
F 184	0.005	-	-	-	1
F 185	-	-	-	-	1
F 186	-	-	-	-	1
F 187	-	-	-	-	1
F 188	-	-	-	-	1
F 189	-	-	-	-	1
F 190	-	-	-	-	1
F 191	-	-	-	-	1
F 192	-	-	-	-	1
F 193	-	-	-	-	1
F 194	-	-	-	-	1
F 195	-	-	-	-	1
F 196	-	-	-	-	1
F 197	-	-	-	-	1
F 198	-	-	-	-	1
F 199	0.018	0.053	-	-	1
F 200	-	-	-	-	1
F 201	-	-	-	0.02	1
F 202	0.002	-	0.002	-	1
F 203	-	-	-	-	1
F 204	-	-	-	-	1
F 205	-	-	-	-	1
F 206	-	-	-	-	1
F 207	-	-	-	-	1
F 208	0.003	-	0.003	-	1

Table 8.6.3. Summary of publications used for the construction of the diet composition matrix of nonfish taxa.

ID	Species group	Publication
D1	Detritus	
A1	Benthic algae/ spermatophytes	
A2	Symbiotic algae	
A3	Phytoplankton	
I1	Microfauna	Sorokin (1987)
I2	Zooplankton	Gottfried and Roman (1983), Sorokin (1987), Jarre et al. (1989)
I3	Sponges	Reiswig (1971), Wilkinson (1987)
I4	Hydrozoans	Lewis (1982), Minchin (1983), Sorokin (1987)
I5	Gorgonians	Lewis (1982), Minchin (1983), Sebens and Koehl (1984), Sorokin (1987)
I6	Zoantharians	Lewis (1982), Minchin (1983), Sebens and Koehl (1984), Sorokin (1987)
I7	Scleractinians	Meinkoth (1981), Lewis (1982), Minchin (1983), Sorokin (1987)
I8	Bryozoans	Meinkoth (1981), Kaminski (1984), Winston (1986)
I9	Sipunculid worms	Meinkoth (1981)
I10	Priapuloids	Meinkoth (1981)
I11	Chitons	Lewis (1982), Steneck and Watling (1982), Nishihama et al. (1986)
I12	Gastropods	Kasinathan et al. (1975), Engstrom (1977), Hoffman et al. (1978), Milera and Cortes (1979), Kohn (1980), Broom (1981), Garrity and Levings (1981), Griffiths (1981), Behrens-Yamada (1982), Brawley and Adey (1982), Creese and Underwood (1982), Lewis (1982), Maes (1982), Rietsma et al. (1982), Salvat and Denizot (1982), Steneck (1982), Taylor (1982), Tsikhon-Lukanina (1982), VanMontfrans et al. (1982), Anon. (1983), Broom (1983), Fujioka and Yamazato (1983), McKillup and Butler (1983), Penney and Griffiths (1983), Thangavelu and Muthiah (1983), Berry (1984), Boggs et al. (1984), Morgan and Kitting (1984), Robertson and Schutt (1984), Tomita and Mizushima (1984), Underwood (1984), Watanabe (1984), Hardison and Kitting (1985), Hawkins (1985), Hughes (1985a, 1985b), Kitting (1985), Kotaki et al. (1985), Perron et al. (1985), Steinberg (1985), Winter and Hamilton (1985), Borja (1986), DSouza (1986), Kohlmeyer and Bebout (1986), Mook (1986), Taylor (1987), Berry (1988)
I13	Bivalves	Berg and Alatalo (1981), Schmid and Schaerer (1981), Pohlo (1982), Tsikhon-Lukanina (1982), Fehlbeck (1983), Shafir and Loya (1983), Graham (1984), Reid (1985), Chang et al. (1988), Davenport (1988), Scott (1988)
I14	Scaphopods	Poon (1987)
I15	Squids	Nigmatullin and Toporova (1982), OSullivan and Cullen (1983), Nemoto et al. (1984), Maurer and Bowman (1985), Nicol and ODor (1985), Vovk (1985), Guo-Xin et al. (1986), Yang et al. (1986), Chesalin (1987), Lipinski and Linkowski (1988)
I16	Octopuses	Smale and Buchan (1981), Ambrose and Nelson (1983), Ambrose (1984), Nixon and Budelmann (1984), Lam and Chiu (1985), Kobayashi (1986)
I17	Polychaetes	Fauchald and Jumars (1979), Vreeland and Lasker (1989)
I18	Echiuroids	Schembri and Jaccarini (1978), Ohta (1984)
I19	Pycnogonids	Meinkoth (1981), Bamber and Davis (1982), Child and Harbison (1986), Staples and Watson (1987)
I20	Barnacles	Lewis (1981), Meinkoth (1981), Tsikhon-Lukanina et al. (1986), Sorokin (1987)
I21	Stomatopods	Giovanardi and Piccinetti (1984), Dominguez and Reaka (1988)
I22	Amphipods	Zimmerman et al. (1977), Zimmerman (1979), Brawley and Adey (1981), Howard (1982), Nielsen and Kofoed (1982), Gunnill (1983), Hendler and Miller (1984), Miller (1984), Stuart et al. (1985), Yamashita et al. (1985), SainteMarie (1986), Brawley and Fei (1987), Buschmann and Santelices (1987), Baerlocher et al. (1988), Morrisey (1988)
I23	Tanaids	Johnson and Attramadal (1983), Delille et al. (1985)
I24	Isopods	Waegele (1982), Sandifer and Kerby (1983), Segal (1987)
I25	Shrimps	Corredor and Criales (1977), Balasubramanian et al. (1979), Guitart and Hondares (1980), Chong and Sasekumar (1981), Moriarty and Barcley (1981), Reed et al. (1982), Beal (1983),

continued...

Table 8.6.3 continued

ID	Species group	Publication
		Glynn (1983), Kim et al. (1983), Criales (1984), Howard (1984), Motoh (1985), Primavera and Gacutan (1985), Cockcroft and Mclachlan (1986), Figueras (1986), Oya (1987), Scott et al. (1988), Stoner and Zimmerman (1988)
I26	Spiny lobsters	Brito Perez and Diaz Iglesia (1983), Joll and Phillips (1984)
I27	Scyllarid lobsters	Meinkoth (1981), Suthers and Anderson (1981), Rudloe (1983), Lau (1987)
I28	Hermit crabs	Gibbons (1984a, 1984b), Wicksten (1988)
I29	Crabs	Prahl (1978), Patel et al. (1979), Kropp (1981), Meinkoth (1981), Nelson (1981), Paul (1981), Robertson and Pfeiffer (1981), Schembri (1981), Drummond-Davis et al. (1982), Laughlin (1982), McDonald (1982), Seiple and Salmon (1982), Williams (1982), Klumpp and Nichols (1983), McLean (1983), Morales and Antezana (1983), Saisho et al. (1983), DuPreez (1984), Kotaki et al. (1985), Lawton and Hughes (1985), Signor (1985), Chilton and Bull (1986), Choy (1986), Kilar and Lou (1986), Matsui et al. (1986), Kurihara and Okamoto (1987), Wear and Haddon (1987), Coen (1988), Perez and Bellwood (1988), Winfree and Weinstein (1989)
I30	Hemichordates	Dilly (1985), Lester (1985)
I31	Asteroids	Schembri and Jaccarini (1978), Bitter et al. (1980), Town (1981), Freitas (1982), Harrold (1982), Scheibling (1982), Bitter and Penchaszadeh (1983), Penchaszadeh and Molinet (1983), Shivji et al. (1983), Bitter Soto (1984), Chiu et al. (1985), Dearborn and Edwards (1985), McClintock and Lawrence (1985)
I32	Ophiuroids	Chartock (1983), Lee et al. (1983), Clements and Stancyk (1984), Hensen (1984), Pearson and Gage (1984)
I33	Echinoids	Roushdy and Hansen (1960), Carpenter (1981), Drifmeyer (1981), McClintock et al. (1982), Regis and Thomassin (1982), Vadas et al. (1982), Gomez et al. (1983), Hughes et al. (1985), Andrew and Stocker (1986), Coyer et al. (1987), Downing and El-Zahr (1987), Foster (1987), Jafari and Mahasneh (1987), Briscoe and Sebens (1988), Dean et al. (1988), Stevenson (1988)
I34	Holothurians	Akhmeteva et al. (1982), Moriarty (1982), Hammond (1983), Hammond and Wilkinson (1985), Massin and Doumen (1986), Sisak and Sander (1987)
I35	Tunicates	Meinkoth (1981), Stuart and Klumpp (1984)
R1	Sea turtles	Witzell (1983), Acevedo et al. (1984), Meylan (1988)
B1	Sea birds	Polovina (1984)

Appendix 8.7

Table 8.7.1. Characteristics of 27 fish species groups (extended version).

Group no.	Family	Species	L (cm)	W (g)	W_{mean} (g)	Density ($N \cdot m^{-2}$)	Biomass ($g \cdot m^{-2}$)	Aspect ratio	Food type	Q/B% day^{-1}	Q/B $year^{-1}$	Natural mortality	Weighing factor	Level
1	Carcharhinidae	*Galeocerdo cuvier*	457	672,000	173,376	1.25E-04	21.6720	7 *	0	1.2	4.4	0.19	95.357	4
	Ginglymostomatidae	*Ginglymostoma cirratum*	430	500,000 *	129,000	1.25E-04	16.1250	7 *	0	1.2	4.5	0.24	73.144	1
	Sphyrnidae	*Sphyrna lewini*	420	400,853	103,420	1.25E-05	1.2928	7 *	0	1.3	4.7		6.131	4 1
	Carcharhinidae	*Carcharhinus falciformis*	350 Lmax	350,000	90,300	1.25E-05	1.1288	7 *	0	1.3	4.9		5.502	4
	Carcharhinidae	*Carcharhinus longimanus*	350 Lmax	350,000	90,300	1.25E-05	1.1288	7 *	0	1.3	4.9		5.502	4
	Carcharhinidae	*Carcharhinus leucas*	350 Lmax	350,000	90,300	1.25E-05	1.1288	7 *	0	1.3	4.9	0.24	5.502	4 1
	Myliobatidae	*Aetobatus narinari*	370 Len	230,000	59,340	1.25E-05	0.7418	7 *	0	1.5	5.3		3.935	4 3 2 1
	Dasyatidae	*Dasyatis americana*	300	122,000 *	31,476	1.25E-03	39.3450	7 *	0	1.7	6.0		237.243	1
	Carcharhinidae	*Carcharhinus limbatus*	247 Lmax	116,000	29,928	1.25E-05	0.3741	7 *	0	1.7	6.1	0.28	2.279	4
	Carcharhinidae	*Negaprion brevirostris*	284	110,000	28,380	1.25E-04	3.5475	7 *	0	1.7	6.2	0.25	21.842	2 1
	Carcharhinidae	*Carcharhinus perezi* (springeri)	230 Lmax	100,000	25,800	1.25E-04	3.2250	7 *	0	1.7	6.3		20.242	1
	Carcharhinidae	*Carcharhinus acronotus*	200 Lmax	90,000	23,220	1.25E-05	0.2903	7 *	0	1.8	6.4	0.33	1.861	1 *
#	Megalopidae	*Tarpon atlanticus*	250	160,000	41,280	1.38E-04	5.6760	3	0	1.0	3.7	0.19	20.772	4
2	Sphyrnidae	*Sphyrna tiburo*	150	18,000 *	4,644	1.25E-04	0.5805	7 *	0	2.4	8.9	0.27	5.150	1
	Triakidae	*Mustelus canis*	150	15,000 *	3,870	1.25E-05	0.0484	7 *	0	2.5	9.2	0.31	0.445	1
	Carcharhinidae	*Rhizoprionodon porosus*	107	5,020	1,295	1.25E-04	0.1619	7 *	0	3.1	11.5		1.858	1 2 3 4
	Scombridae	*Scomberomorus cavalla*	137 FL	34,285	8,846	1.38E-04	1.2163	6.3	0	2.0	7.4	0.37	8.985	4
	Scombridae	*Euthynnus aletteratus*	93 FL	12,200	3,148	1.25E-04	0.3935	6.3	0	2.5	9.1		3.573	4
	Scombridae	*Scomberomorus regalis*	83.5 FL	4,900	1,264	1.37E-03	1.7380	6.2	0	3.0	10.8	0.47	18.763	4
3	Carangidae	*Seriola dumerili*	194	80,000	20,640	1.25E-05	0.2580	4.5	0	1.4	5.2	0.26	1.347	4 2 1
	Carangidae	*Seriola rivoliana*	97	24,000	6,192	1.25E-05	0.0774	4.5 *	0 *	1.8	6.7	0.79	0.516	4 1
	Carangidae	*Trachinotus falcatus*	105 FL	36,000	9,288	1.25E-05	0.1161	3.9	0	1.6	5.7		0.661	4 1
4	Carangidae	*Caranx lugubris*	80	6,554	1,691	1.25E-05	0.0211	5.5	0	2.6	9.6		0.203	3
	Carangidae	*Trachinotus goodei*	50	3,900 *	1,006	1.25E-04	0.1258	5	0	2.8	10.2		1.279	3 *
	Carangidae	*Alectis ciliaris*	91 TL/	10,700	2,761	1.25E-05	0.0345	4.8	0 *	2.2	8.1		0.281	2 4
	Carangidae	*Elagatis bipinnulatus*	107 FL	10,500	2,709	1.25E-05	0.0339	4.5 *	0 *	2.2	7.9		0.267	4 3
	Carangidae	*Caranx latus*	80	6,250	1,613	2.50E-04	0.4033	4.5	0	2.4	8.7		3.517	2 3
	Carangidae	*Caranx ruber*	56	3,160	815	3.87E-02	31.5813	4.5	0	2.8	10.1	1.17	317.673	2
	Carangidae	*Caranx crysos*	58 TL	2,314	597	1.38E-04	0.0821	4.2	0	2.8	10.3		0.846	3 1
	Carangidae	*Caranx bartholomaei*	81 TL	9,862	2,544	1.25E-04	0.3180	4.1	0	2.1	7.6		2.405	1 2
5	Carangidae	*Decapterus macarellus*	35 SL	750 *	194	1.25E-05	0.0024	3.8	0	3.4	12.3	0.93	0.030	4
	Carangidae	*Decapterus punctatus*	32	573	148	1.25E-04	0.0185	3.7	0	3.5	12.7	0.83	0.235	4
	Carangidae	*Selar crumenophthalmus*	40 TL	1,240	320	1.25E-04	0.0400	3.5	0	2.9	10.7		0.428	3 2
	Elopidae	*Elops saurus*	47	444	115	1.25E-04	0.0144	3.4	0 *	3.5	12.9	0.62	0.186	4
6	Sparidae	*Calamus bajonado*	64	4,500	1,161	2.50E-05	0.0290	3	0	2.1	7.6	0.221	1	
	Lutjanidae	*Ocyurus chrysurus*	75 TL	3,570	921	2.75E-02	25.3275	3	0	2.2	7.9	0.60	199.830	2
	Haemulidae	*Haemulon album*	65 FL	5,300	1,367	2.62E-04	0.3588	2.8	0	1.9	7.0	0.79	2.527	1
	Haemulidae	*Anisotremus surinamensis*	63 TL	4,770	1,231	1.38E-04	0.1693	2.7	0	1.9	7.0		1.192	1
	Ephippidae	*Chaetodipterus faber*	90	9,000	2,322	2.50E-04	0.5805	3.1	0.07	2.0	7.3		4.261	2
	Pomacanthidae	*Pomacanthus arcuatus*	60	12,407	3,201	2.51E-03	8.0425	2.9	0.08	1.8	6.7	0.63	53.932	1
	Balistidae	*Canthidermis sufflamen*	56 +	4,783	1,234	1.25E-05	0.0154	1.7	0.025	1.6	5.8		0.089	4
	Albulidae	*Albula vulpes*	82	7,150	1,845	1.25E-05	0.0231	2.2 *	0 *	1.6	5.9		0.136	1
	Lutjanidae	*Lutjanus analis*	74 FL	5,511	1,422	2.62E-04	0.3733	2.1	0	1.6	6.0	0.33	2.236	2
	Lutjanidae	*Lutjanus apodus*	59 FL	3,502	904	1.50E-02	13.5600	2	0	1.8	6.5	0.54	87.655	2
	Balistidae	*Balistes vetula*	45 FL	2,586	667	1.37E-03	0.9171	2	0.01	1.9	6.9	0.56	6.356	1
	Ostraciidae	*Lactophrys trigonus*	46 +	3,052	787	1.28E-03	1.0034	1.9	0.05	1.9	6.8		6.871	1
7	Belonidae	*Tylosurus acus*	135 SL	2,800 *	722	1.25E-04	0.0903	3 *	0	2.3	8.3		0.753	4
	Belonidae	*Tylosurus crocodilus*	107 SL	1,400 *	361	1.25E-03	0.4513	3.1	0	2.7	9.8		4.415	4
	Clupeidae	*Opisthonema oglinum*	26	730	188	1.25E-02	2.3500	3.1	0	3.1	11.2		26.283	4

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Table 8.7.1 continued

Group no.	Family	Species	L (cm)	W (g)	W_{mean} (g)	Density ($N \cdot m^{-2}$)	Biomass ($g \cdot m^{-2}$)	Aspect ratio	Food type	Q/B% day^{-1}	Q/B $year^{-1}$	Natural mortality	Weighing factor	Level
	Belonidae	*Ablennes hians*	87	751	194	1.25E-05	0.0024	3 *	0	3.0	10.9		0.026	4 *
	Hemiramphidae	*Hemiramphus balao*	40	614	158	1.25E-03	0.1975	2.7	0	3.0	10.8		2.130	4
	Clupeidae	*Sardinella aurita*	29	1,000 *	258	1.25E-02	3.2250	3 *	0.2 *	3.6	13.2	0.68	42.614	4
	Carangidae	*Oligoplites saurus*	31 FL	334	86	1.25E-02	1.0750	3.1	0	3.6	13.1		14.060	3 *
	Emmelichthyidae	*Inermia vittata*	23 (SL)	282	73	1.25E-02	0.9125	2.9	0	3.6	13.1		11.924	3
	Belonidae	*Platybelone argalus*	51 /	150 *	39	1.25E-03	0.0488	2.65	0	3.9	14.1		0.688	4
	Clupeidae	*Harengula clupeola*	18	240 *	62	1.25E-01	7.7500	2.7	0	3.5	12.8	0.91	99.489	4
	Clupeidae	*Harengula humeralis*	22	440 *	114	1.39E-01	15.8175	2.9	0.03	3.4	12.4	0.66	195.804	4
8 #	Gerreidae	*Gerres cinereus*	40	690	178	1.39E-02	2.4698	3.9	0	3.5	12.7		31.336	1
	Sparidae	*Calamus calamus*	38	1,541	398	2.50E-04	0.0995	3.2	0	2.7	9.7		0.965	1
	Sparidae	*Calamus pennatula*	39	1,700 *	439	1.38E-04	0.0604	3	0	2.5	9.3		0.561	1
	Haemulidae	*Haemulon plumieri*	42	1,360	351	1.51E-02	5.3089	2.9	0	2.6	9.4	0.67	50.025	1
	Haemulidae	*Haemulon carbonarium*	38	861	222	1.25E-04	0.0278	2.8	0	2.8	10.3		0.286	1
	Haemulidae	*Anisotremus virginicus*	30 /	850	219	1.38E-04	0.0301	2.8	0	2.8	10.3		0.310	1
	Haemulidae	*Haemulon macrostomum*	45	1,795	463	1.25E-05	0.0058	2.7	0	2.4	8.6		0.050	1
	Synodontidae	*Synodus foetens*	46	1,100 *	284	1.25E-04	0.0355	2.65	0	2.6	9.5		0.336	1
	Sphyraenidae	*Sphyraena picudilla*	50	1,300 *	335	1.25E-05	0.0042	2.6	0	2.5	9.1		0.038	2
	Holocentridae	*Holocentrus ascensionis*	37 TL	838	216	2.53E-03	0.5454	2.6	0	2.7	10	0.74	5.437	1
	Haemulidae	*Haemulon parrai*	41	1,265 *	326	1.25E-03	0.4075	2.5	0	2.5	9.0		3.655	1
	Haemulidae	*Haemulon sciurus*	41	1,185	306	3.87E-03	1.1858	2.5	0	2.5	8.9	0.68	10.606	1
	Haemulidae	*Pomadasys crocro*	33	890 *	230	1.25E-05	0.0029	2.5 *	0 *	2.6	9.6		0.028	1
	Synodontidae	*Synodus intermedius*	46	1,103	285	1.37E-03	0.3919	2.4	0	2.4	8.9		3,504	1
	Serranidae	*Paranthias furcifer*	37	1,100	284	1.25E-05	0.0036	2.3	0	2.4	8.7	0.63	0.031	2 3
	Lutjanidae	*Lutjanus griseus*	55	1,590	410	1.50E-02	6.1500	2.1	0	2.1	7.7	0.54	47.340	2
	Lutjanidae	*Lutjanus mahagoni*	40	980 *	253	1.50E-02	3.7950	2.05	0	2.3	8.5		32.136	2
	Lutjanidae	*Lutjanus synagris*	43 FL	1,213	313	2.50E-03	0.7825	2	0.03	2.3	8.3	0.59	6.461	2
	Ostraciidae	*Lactophrys triqueter*	30	1,394	360	2.51E-03	0.9045	2	0.02	2.2	8.0		7.199	1
	Ogcocephalidae	*Ogcocephalus nasutus*	28 /	641	165	1.25E-04	0.0206		0.1	-	-		0.185	1
	Holocentridae	*Neoniphon marianus*	19	163	42	2.62E-04	0.0110	3	0	4.1	14.9	1.93	0.164	1
#	Holocentridae	*Holocentrus coruscus*	13	57	15	1.51E-03	0.0227	3	0	5.0	18.4	3.52	0.418	1
	Holocentridae	*Sargocentron vexillarium*	18 -	181	47	1.40E-03	0.0658	2.7	0	3.7	13.6	2.1	0.895	1
	Haemulidae	*Haemulon chrysargyreum*	24	251	65	1.37E-03	0.0894	2.6	0	3.4	12.6		1.125	1 3
	Haemulidae	*Haemulon flavolineatum*	27 /	480	124	1.50E-01	18.6000	2.5	0	2.9	10.7	0.90	199.904	1
	Holocentridae	*Myripristis jacobus*	23	397	102	3.87E-04	0.0395	2.5	0	3.1	11.2		0.441	1
	Haemulidae	*Pomadasys corvinaeformis*	25	386	100	1.25E-05	0.0013	2.5 *	0 *	3.1	11.3		0.014	1
	Haemulidae	*Haemulon bonariense*	30 FL	385	99	1.25E-05	0.0012	2.5	0 *	3.1	11.2		0.014	1
	Chaetodontidae	*Chaetodon ocellatus*	16.8	200 *	52	1.25E-05	0.0007	2.5 *	0 *	3.5	12.9	1.55	0.008	1
	Chaetodontidae	*Chaetodon capistratus*	14.2	120 *	31	2.50E-03	0.0775	2.5	0	3.9	14.4	2.02	1.117	1
	Synodontidae	*Synodus synodus*	33	400 *	103	1.25E-03	0.1288	2.4	0	3.0	11.0		1.413	1
	Haemulidae	*Haemulon aurolineatum*	23 FL	188	49	1.26E-02	0.6186	2.4	0	3.5	12.9	2.37	8.010	1
	Chaetodontidae	*Chaetodon striatus*	15.8	164	42	1.25E-05	0.0005	2.4	0	3.6	13.1	1.70	0.007	1
	Mullidae	*Mulloidichthys martinicus*	35	440	114	1.5E-02	1.7100	2.3	0	2.9	10.5	0.98	17.915	1
	Mullidae	*Pseudupeneus maculatus*	28 /	393	101	5.00E-03	0.5050	2.3	0	3.0	10.8	0.95	5.455	1
	Chaetodontidae	*Chaetodon sedentarius*	14.7	130 *	34	1.25E-05	0.0004	2.3	0	3.7	13.5	1.91	0.006	1
	Pempheridae	*Pempheris schomburgki*	15	100 *	26	1.25E-03	0.0325	2.3	0	3.9	14.2		0.461	1 2
	Holocentridae	*Holocentrus rufus*	32	583	150	1.39E-02	2.0831	2.2	0	2.7	9.8	2.71	20.459	1
	Pomacentridae	*Abudefduf saxatilis*	20	483	125	1.25E-03	0.1563	3	0.1	3.6	13.3		2.075	1
9	Hemiramphidae	*Hemiramphus brasiliensis*	32.5	298	77	1.25E-04	0.0096	3.2	0.8	10.4	37.8	1.23	0.364	4
	Hemiramphidae	*Hyporamphus unifasciatus*	27	167	43	1.25E-04	0.0054	3 *	0.8 *	11.1	40.4		0.217	4
10	Kyphosidae	*Kyphosus sectatrix*	80	9,139	1,579	1.37E-03	2.1711	2.9	1	6.2	22.8		52.919	1
	Kyphosidae	*Kyphosus incisor*	70	6,122	2,358	2.50E-03	5.8950	2.8	1	6.7	24.4		134.155	1

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Table 8.7.1 continued

Group no.	Family	Species	L (cm)	W (g)	W_{mean} (g)	Density ($N \cdot m^{-2}$)	Biomass ($g \cdot m^{-2}$)	Aspect ratio	Food type	Q/B% day^{-1}	Q/B $year^{-1}$	Natural mortality	Weighing factor	Level
11 #	Balistidae	*Balistes capriscus*	31	611	158	1.25E-05	0.0020	2.4	0.5 *	5.2	19.2	0.94	0.038	1
	Balistidae	*Melichthys niger*	36	960 *	248	1.25E-04	0.0310	2.3	0.75	6.4	23.2		0.719	2
	Sparidae	*Diplodus caudimacula*	28	600 *	155	1.38E-04	0.0213	2.9	0.8	8.4	30.8		0.655	1
	Sparidae	*Archosargus rhomboidalis*	35	1,200 *	310	1.50E-04	0.0465	2.5	0.8	7.0	25.5		1.184	
#	Mugilidae	*Mugil curema*	38	767	198	1.38E-04	0.0272	2.7	1	9.9	36.3	0.59	0.989	1
	Pomacentridae	*Microspathodon chrysurus*	20	412	106	1.25E-02	1.3250	1.9	0.8	7.1	25.8		34.140	1
	Acanthuridae	*Acanthurus bahianus*	25 FL	288	74	3.75E-02	2.7750	2.2	0.9	9.4	34.4	1.00	95.409	1
	Pomacentridae	*Abudefduf taurus*	25	900 *	232	1.25E-04	0.0290	2	0.9	7.6	27.9		0.809	1
	Acanthuridae	*Acanthurus coeruleus*	32 FL	983	254	2.50E-02	6.3500	1.9	0.9	6.7	24.4	0.70	154.811	1
	Acanthuridae	*Acanthurus chirurgus*	33 FL	820	212	1.50E-02	3.1800	1.8	0.9	6.8	24.7	0.71	78.701	1
12 #	Lutjanidae	*Lutjanus cyanopterus*	160	70,000	18,060	1.25E-05	0.2258	2.2	0	1.0	3.7		0.834	2
	Lutjanidae	*Lutjanus jocu*	83	13,380	3,452	1.25E-04	0.4315	2.1	0	1.4	5.0		2.173	2
	Serranidae	*Mycteroperca tigris*	102	17,043	4,397	1.25E-04	0.5496	1.8	0	1.2	4.5	0.42	2.451	1
	Sphyraenidae	*Sphyraena barracuda*	178	57,800	14,912	1.50E-03	22.3680	1.6	0	0.9	3.3	0.25	73.386	2 3
	Serranidae	*Epinephelus striatus*	100	23,800	6,140	2.50E-04	1.5350	1.6	0	1.1	3.9		5.956	1
	Rachycetridae	*Rachycentron canadum*	160	33,400	8,617	1.25E-05	0.1077	1.6	0	1.0	3.6	0.40	0.390	2 3 4
	Fistulariidae	*Fistularia tabacaria*	183	10,800 *	2,786	1.25E-04	0.3483	1.7	0	1.3	4.7		1.649	1
	Labridae	*Lachnolaimus maximus*	86	7,728	1,994	1.25E-05	0.0249	1.5	0	1.3	4.8		0.119	1
	Diodontidae	*Diodon holocanthus*	51	11,300 *	2,915	1.25E-02	36.4739	1.4	0	1.2	4.2		153.250	1
	Serranidae	*Mycteroperca rubra*	70	10,719	2,766	1.25E-05	0.0346	1.2	0 *	1.1	4.0		0.137	1
	Diodontidae	*Diodon hystrix*	60	18,446	4,759	1.25E-04	0.5949	1.1	0	0.9	3.4		2.012	1
	Serranidae	*Mycteroperca venenosa*	86 FL	12,270	3,166	1.25E-05	0.0396	1.1	0	1.0	3.7	0.36	0.145	1
	Muraenidae	*Gymnothorax funebris*	190	12,000	3,096	1.25E-04	0.3870	0.7 *	0	0.8	2.9		1.137	1
13	Balistidae	*Xanthichthys ringens*	25	320 *	83	1.25E-04	0.0104	1.9	0 *	2.8	10.3		0.107	1 3
	Gerreidae	*Eucinostomus argenteus*	30	290 *	75	1.25E-02	0.9394	1.9	0	2.9	10.5		9.893	1
	Priacanthidae	*Heteropriacanthus cruentatus*	30	700 *	181	1.25E-04	0.0226	1.8	0	2.3	8.5		0.191	2
	Labridae	*Clepticus parrae*	25	447	115	1.25E-02	1.4375	1.8	0	2.6	9.4		13.515	3
	Haemulidae	*Haemulon melanurum*	30 FL	427	110	1.25E-05	0.0014	1.8	0 *	2.6	9.3		0.013	1
	Pomacentridae	*Chromis multilineata*	20 SL	339	87	1.25E-02	1.0875	1.8	0	2.7	9.8		10.631	1 3
	Aulostomidae	*Aulostomus maculatus*	76 /	777	200	2.50E-03	0.5000	1.7	0	2.2	8.1		4.032	2
	Sciaenidae	*Odontoscion dentex*	25	318	82	2.50E-04	0.0205	1.7	0	2.6	9.6		0.197	1 2
	Serranidae	*Cephalopholis fulva*	34	640	165	1.37E-03	0.2269	1.5	0	2.1	7.8	0.78	1.765	1
	Serranidae	*Diplectrum formosum*	31	550 *	142	1.25E-05	0.0018	1.5	0 *	2.2	8.1	0.78	0.014	1
	Grammistidae	*Rypticus saponaceus*	29.5 (SL)	685	177	1.25E-02	2.2147	1.4	0	2.0	7.4		16.408	
	Sciaenidae	*Equetus punctatus*	28	460	119	1.25E-04	0.0149	1.25	0	2.1	7.7		0.114	
	Serranidae	*Cephalopholis cruentata*	34	691	178	1.25E-04	0.0223	1.2	0	1.9	7.0	0.64	0.155	1
	Priacanthidae	*Priacanthus arenatus*	40	1,653	426	1.25E-04	0.0533	1.8	0	2.0	7.2		0.383	2
	Labridae	*Halichoeres radiatus*	46	2,283	589	1.25E-04	0.0736	1.6	0	1.7	6.3		0.460	1
	Dactylopteridae	*Dactylopterus volitans*	45 +	1,825	471	1.25E-02	5.8875	1.6	0	1.8	6.6		38.668	1
	Serranidae	*Epinephelus morio*	71	5,010	1,293	1.25E-05	0.0162	1.5	0	1.4	5.1	0.39	0.083	1
	Serranidae	*Epinephelus adscensionis*	50	1,981	511	2.50E-04	0.1278	1.5	0	1.7	6.3		0.808	1
	Diodontidae	*Chilomycterus antennatus*	26.3	1,420	366	1.38E-04	0.0503	1.4	0	1.8	6.5		0.325	1
	Diodontidae	*Chilomycterus antillarum*	26.3	1,420 *	366	1.25E-05	0.0046	1.4 *	0 *	1.8	6.5		0.030	1 *
	Malacanthidae	*Malacanthus plumieri*	61 /	1,126	291	1.27E-02	3.7103	1.4	0	1.9	6.8	0.42	25.309	1
	Serranidae	*Mycteroperca interstitialis*	70	4,000	1,032	1.25E-05	0.0129	1.3	0	1.4	5.0		0.065	1
	Ostraciidae	*Acanthostracion polygonius*	41	2,200 *	568	1.28E-03	0.7242	1.2	0	1.5	5.4		3.895	1
	Labridae	*Bodianus rufus*	40	1,560	402	2.50E-04	0.1005	1.2	0	1.6	5.9		0.588	1
	Serranidae	*Alphestes afer*	33	1,202	310	6.25E-05	0.0194	1.2	0	1.7	6.2		0.119	1
	Bothidae	*Bothus lunatus*	46 /	3,000 *	774	1.25E-04	0.0968	1.1	0	1.4	4.9	0.75	0.478	1
	Scorpaenidae	*Scorpaena plumieri*	43 /	4,330	1,117	1.38E-04	0.1536	1	0	1.2	4.3	0.44	0.665	1
	Serranidae	*Epinephelus guttatus*	58	2,919	753	2.50E-03	1.8825	1	0	1.3	4.8	0.68	8.976	1
	Scorpaenidae	*Scorpaena brasiliensis*	36 /	1,600	413	1.25E-03	0.5163	1	0	1.5	5.4	0.59	2.775	1
	Muraenidae	*Gymnothorax vicinus*	122 /	3,000 *	774	1.25E-04	0.0968	0.7 *	0	1.1	3.9		0.376	1
	Ophichthidae	*Ophichtus ophis*	135	2,091	540	1.25E-03	0.6750	0.7 *	0	1.1	4.2		2.821	1
	Muraenidae	*Lycodontis moringa*	100	950	245	1.25E-05	0.0031	0.7 *	0	1.3	4.9		0.015	1

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Table 8.7.1 continued

Group no.	Family	Species	L (cm)	W (g)	W_{mean} (g)	Density ($N \cdot m^{-2}$)	Biomass ($g \cdot m^{-2}$)	Aspect ratio	Food type	Q/B% day^{-1}	Q/B $year^{-1}$	Natural mortality	Weighing factor	Level
	Muraenidae	*Enchelycore nigricans*	100	900 *	232	1.25E-05	0.0029	0.7 *	0 *	1.4	5.0		0.014	1
	Ophichthidae	*Myrichthys ocellatus*	91 /	640 *	165	1.25E-05	0.0021	0.7 *	0	1.5	5.3		0.011	
	Ophichthidae	*Myrichthys breviceps*	91 +	640 *	165	1.25E-05	0.0021	0.7 *	0	1.5	5.3		0.011	1
	Muraenidae	*Echidna catenata*	71	600 *	155	1.25E-05	0.0019	0.7 *	0	1.5	5.4		0.010	1
14	Pempheridae	*Pempheris poeyi*	10 /	30 *	8	1.25E-04	0.0010	2 *	0 *	4.6	16.9		0.017	1 2
	Pomacentridae	*Chromis cyanea*	13 /	93	24	1.25E-02	0.3000	1.8	0	3.5	12.7	1.6	3.817	1 3
	Serranidae	*Hypoplectrus nigricans*	15	90 *	23	1.25E-04	0.0029	1.8	0	3.5	12.7		0.037	1
	Serranidae	*Hypoplectrus aberrans*	12	50 *	13	1.25E-04	0.0016	1.8	0	4.0	14.6		0.024	1
	Holocentridae	*Plectrypops retrospinis*	13	57 *	15	1.50E-03	0.0225	1.7	0	3.8	13.8		0.310	1
	Serranidae	*Hypoplectrus puella*	13 SL	64	17	1.25E-03	0.0213	1.6	0	3.5	12.9		0.273	1
	Serranidae	*Hypoplectrus chlorurus*	13	64 *	17	1.25E-05	0.0002	1.5	0	3.5	12.6		0.003	1
	Labridae	*Xyrichtys splendens*	14	50 *	13	1.25E-02	0.1625	1.5	0	3.6	13.1		2.122	15
	Tetraodontidae	*Sphoeroides spengleri*	15	92	24	1.39E-03	0.0333	1.6	0.1	3.6	13.2		0.438	1
	Labridae	*Xyrichtys novacula*	23	230 *	59	1.25E-02	0.7375	1.5	0	2.6	9.6		7.084	1
	Bothidae	*Bothus ocellatus*	18	180 *	46	1.25E-05	0.0006	1.5	0	2.8	10.2	3.35	0.006	1
	Labridae	*Halichoeres garnoti*	19	132	34	1.25E-03	0.0425	1.4	0	2.9	10.6		0.450	1
	Sciaenidae	*Pareques acuminatus*	24	280 *	72	1.25E-05	0.0009	1.3	0	2.4	8.8		0.008	
	Labridae	*Halichoeres bivittatus*	23	230 *	59	1.38E-02	0.8113	1.3	0	2.4	8.9		7.207	1
	Clinidae	*Labrisomus nuchipinnis*	20	137	35	1.25E-02	0.4375	1.3	0	2.7	9.9		4.347	1
	Clinidae	*Labrisomus guppyi*	20 *	137 *	35	1.25E-02	0.4375	1.3 *	0 *	2.7	9.9		4.347	1
	Labridae	*Halichoeres poeyi*	20	150 *	39	1.26E-02	0.4924	1.2	0	2.6	9.4		4.604	1
	Serranidae	*Serranus tabacarius*	18	141	36	1.25E-05	0.0005	1.2	0	2.6	9.7	0.41	0.004	1
	Antennariidae	*Antennarius multiocellatus*	15 (-)	70 *	18	1.25E-05	0.0002	1.2	0	3.0	11.0		0.002	1
	Opisthognathidae	*Opistognathus macrognathus*	20 -	240 *	62	1.25E-05	0.0008	1.1	0	2.3	8.3		0.006	1
	Labridae	*Thalassoma bifasciatum*	17	97	25	2.50E-02	0.6250	1.1	0	2.6	9.7	1.73	6.038	1
	Sciaenidae	*Equetus lanceolatus*	25	325	84	1.25E-04	0.0105	1	0	2.0	7.2		0.076	1 2
	Scorpaenidae	*Scorpaena grandicomis*	18 /	212	55	6.25E-05	0.0034	1	0	2.2	8.1	1.76	0.028	1
	Scorpaenidae	*Scorpaenodes caribbaeus*	13 /	80 *	21	1.25E-04	0.0026	1	0	2.7	9.8		0.026	1
	Gobiidae	*Bathygobius soporator*	15	70 *	18	1.38E-04	0.0025	0.9	0 *	2.6	9.5	0.81	0.024	1
	Antennariidae	*Antennarius striatus*	15 /	70 *	18	1.25E-04	0.0023	0.8	0	2.4	8.9		0.020	1
	Opisthognathidae	*Opistognathus maxillosus*	13 /	65 *	17	6.25E-04	0.0106	0.8	0	2.4	8.8		0.093	1
	Muraenidae	*Gymnothorax miliaris*	50	201	52	1.25E-05	0.0007	0.7 *	0 *	1.8	6.7		0.004	1
	Congridae	*Heteroconger halis*	48	150 *	39	1.25E-02	0.4875	0.7 *	0	1.9	7.1		3.467	1
15	Belonidae	*Strongylura timucu*	46 /	110 *	28	1.25E-03	0.0350	1.7	0	3.3	11.9		0.417	3
	Clupeidae	*Jenkinsia lamprotaenia*	6.8	13 *	3	1.39E+00	4.1625	2.2	0 *	5.7	21.0		87.213	4
	Atherinidae	*Atherinomorus stipes*	9 +	16	4	1.25E-01	0.5000	1.9	0	5.1	18.6	3.21	9.299	3
	Atherinidae	*Allanetta harringtonensis*	8 /	11	3	1.25E-01	0.3754	1.7	0	5.2	19.1	3.87	7.177	3
16	Engraulidae	*Anchoa hepsetus*	15	50	13	1.25E-03	0.0163	2 *	0.7	10.1	36.8	1.53	0.599	3
	Engraulidae	*Anchoa lyolepis*	8	8 *	2	1.25E-03	0.0025	1.8	0.7 *	13.7	50.0	4.14	0.125	3
17	Chaetodontidae	*Chaetodon aculeatus*	9.5	19	5	1.25E-05	0.0001	1.9	0	4.9	17.8	3.82	0.001	1
#	Apogonidae	*Apogon conklini*	5 SL/	3.3	1	1.26E-02	0.0126	1.7	0	6.7	24.4	12.5	0.308	1
	Serranidae	*Serranus tortugarum*	8	12 *	3	1.25E-04	0.0004	1.6	0	4.9	18.0	1.5	0.007	
	Apogonidae	*Apogon maculatus*	10 /	37	10	1.25E-03	0.0125	1.5	0	3.9	14.1	4.16	0.177	1
	Cirrhitidae	*Amblycirrhitus pinos*	8 (SL)	15	4	1.38E-04	0.0006	1.5	0	4.6	16.9		0.009	1
	Serranidae	*Serranus tigrinus*	10	21	5	1.37E-03	0.0069	1.45	0	4.2	15.4	1.05	0.106	1
	(Serranidae)	*Gramma melacara*	10 -	30 *	8	1.25E-04	0.0010	1.4	0	3.8	13.9		0.014	1
	Labridae	*Halichoeres maculipinna*	11	25 *	6	1.25E-03	0.0075	1.3	0	3.8	13.8		0.103	1
	Grammidae	*Gramma loreto*	8 +	15 *	4	1.25E-03	0.0050	1.1	0	4.0	14.5		0.072	1
	Scorpaenidae	*Scorpaena inermis*	>7	10 *	3	1.25E-03	0.0038	1 *	0	4.0	14.8		0.055	1
	Opisthognathidae	*Opisthognathus aurifrons*	10 -	30 *	8	1.25E-03	0.0100	0.8	0	3.0	10.8		0.108	1
	Opisthognathidae	*Opisthognathus whitehurstii*	8	15 *	4	1.25E-03	0.0050	0.8	0	3.4	12.3		0.061	1
18	Serranidae	*Epinephelus itajara*	228	381,644	98,464	1.25E-04	12.3080	1.3	0	0.5	2.0		24.502	1
	Serranidae	*Mycteroperca bonaci*	120	90,000	23,220	2.50E-04	5.8050	1.2	0	0.7	2.6	0.37	15.114	1

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Table 8.7.1 continued

Group no.	Family	Species	L (cm)	W (g)	W_{mean} (g)	Density ($N \cdot m^{-2}$)	Biomass ($g \cdot m^{-2}$)	Aspect ratio	Food type	Q/B% day^{-1}	Q/B $year^{-1}$	Natural mortality	Weighing factor	Level
19	Ostraciidae	*Acanthostracion quadricornis*	46 /	3,050 *	787	1.50E-04	0.1181	1.1	0.1	1.5	5.7		0.667	1
	Ostraciidae	*Lactophrys bicaudalis*	45	5,572	1,438	1.50E-04	0.2157	1.2	0.15	1.5	5.5		1.196	1
	Monacanthidae	*Cantherines macrocerus*	44	2,700 *	697	1.25E-05	0.0087	1.5	0.03	1.6	6.0		0.052	1 *
	Monacanthidae	*Aluterus scripta*	76	2,941	759	1.25E-05	0.0095	0.7	0.4	1.9	6.8		0.064	1
	Pomacanthidae	*Pomacanthus paru*	43	2,769	714	2.50E-04	0.1785	1.8	0.135	2.1	7.6	0.62	1.365	1
	Pomacanthidae	*Holacanthus tricolor*	36	1,306	337	2.50E-04	0.0843	1.65	0.008	2.0	7.2	0.55	0.609	1
	Pomacanthidae	*Holacanthus ciliaris*	46	1,988	513	1.27E-02	6.5407	1.3	0.014	1.6	5.9	0.43	38.581	1
20	Monacanthidae	*Monacanthus ciliatus*	20	448	116	1.25E-02	1.4500	1.2	0.3	3.2	11.7		17.014	1
	Monacanthidae	*Cantherines pullus*	19	220	57	1.25E-04	0.0071	1.5	0.4	4.5	16.4		0.117	2 *
	Monacanthidae	*Stephanolepis setifer*	19	220 *	57	1.25E-04	0.0071	1.25	0.4 *	4.0	14.7		0.105	2
	Pomacentridae	*Stegastes variabilis*	10 +	54	14	1.25E-02	0.1750	1.5	0.45	6.3	23.1	1.6	4.047	2 *
	Pomacentridae	*Stegastes fuscus*	15 /	168	43	1.26E-01	5.4288	1.8	0.5	5.9	21.7	1.6	117.620	2 *
21	Canthigasteridae	*Canthigaster rostrata*	11 (SL)	82	21	1.26E-02	0.2651	1.5	0.2	4.1	15.0		3.985	1
	Pomacentridae	*Stegastes leucostictus*	10	50 *	13	1.25E-02	0.1625	1.3	0.2	4.3	15.8	1.6	2.563	1 *
	Pomacentridae	*Stegastes planifrons*	11 TL	68	18	1.25E-02	0.2250	1.4	0.25	4.4	16.2	1.41	3.636	1 *
	Monacanthidae	*Monacanthus tuckeri*	10	24	6	1.26E-03	0.0076	1.4	0.3	5.9	21.5		0.163	1 *
22 #	Gobiidae	*Coryphopterus glaucofraenum*	8 (SL)	10.5	3	2.50E-02	0.0750	1.1	0.4	7.4	26.8	2.2	2.012	1
	Gobiidae	*Gnatholepis thompsoni*	6 SL/	4.1	1	1.26E-02	0.0126	1	0.65	10.7	39.1	3.48	0.494	1
	Blenniidae	*Parablennius marmoreus*	8	10 *	3	1.25E-03	0.0038	1.3	0.7	10.9	39.7	2.53	0.149	1
	Pomacanthidae	*Centropyge argi*	7	10 *	3	1.25E-04	0.0004	1.4	0.75	12.6	45.9		0.017	1
	Blenniidae	*Entomacrodus nigricans*	8.5	13 *	3	1.25E-03	0.0038	1	0.8	11.2	40.7		0.153	1
23	Scaridae	*Scarus guacamaia*	99	23,000	5,934	1.26E-02	74.9168	1.2	1	3.3	12.0	0.61	895.357	1
	Scaridae	*Scarus coelestinus*	80	8,556	2,207	1.25E-04	0.2759	1.1	1	3.7	13.5		3.733	1
	Scaridae	*Scarus vetula*	54 SL	5,558	1,434	1.38E-02	19.7175	1.05	1	3.9	14.4	1.09	283.385	1
24	Scaridae	*Scarus coeruleus*	62	3,720	960	1.25E-04	0.1200	1.5	1 *	5.3	19.3	0.70	2.312	1 *
	Scaridae	*Sparisoma rubripinne*	46.5	2,734	705	1.25E-03	0.8813	1.5	1	5.7	20.8	1.11	18.303	1
	Scaridae	*Sparisoma viride*	50 FL	2,430	627	1.37E-03	0.8621	1.4	1	5.7	20.7		17.812	1
	Scaridae	*Sparisoma chrysopterum*	42 FL	1,510	390	1.38E-02	5.3625	1.4	1	6.3	22.8	1.38	122.349	1
	Scaridae	*Scarus taeniopterus*	35 FL	1,102	284	1.25E-04	0.0355	1.1	1	5.7	20.8	1.20	0.739	1
	Monacanthidae	*Aluterus schoepfii*	51 /	1,892	488	1.25E-03	0.6100	0.7	1	4.1	15.1		9.205	1 3
25	Scaridae	*Scarus iserti*	20 FL	141	36	2.50E-03	0.0900	1.4	1	10.1	36.8		3.313	1
	Scaridae	*Sparisoma aurofrenatum*	26 FL	324	84	1.25E-03	0.1050	1.3	1	8.1	29.5	0.94	3.094	1
	Scaridae	*Sparisoma radians*	20	150 *	39	1.25E-01	4.8799	1.3	1	9.3	33.9		165.353	1
26	Blenniidae	*Scartella cristata*	11	27 *	7	1.25E-04	0.0009	1.2	0.9	10.8	39.3		0.034	1
	Blenniidae	*Ophioblennius atlanticus*	12 /	35 *	9	1.25E-03	0.0113	0.9	0.9	9.0	32.9	2.84	0.370	1
27	Gobiidae	*Gobiosoma horsti*	5 (SL)	3.1	0.8	1.25E-01	0.1001	0.85 *	0 *	4.7	17.2	3.14	1.721	1
	Gobiidae	*Gobiosoma evelynae* (sp.)	5 (SL)	2.2	0.6	1.25E-01	0.0751	0.8	0	4.8	17.7	3.14	1.329	1

Symbol:
= single species grouped outside cluster analysis.
* = estimated values.
1 = demersal, 2 = off bottom, 3 = midwater, 4 = pelagic.

Appendix 8.8. Food intake and electivity indices for each consumer and all models.

Table 8.8.1. The 50-box model.

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator: (1)	LGSHARKS/RAYSC				
1. LGSHARKS/RAYSC	(0' Cycle)	0.010	0.01	0.988	0.029
2. SHARKS/SCOMBRID		0.010	0.01	0.984	-0.134
3. LGJACKSC		0.003	0.00	0.976	-0.315
4. IMJACKSC		0.050	0.07	0.987	-0.013
5. SMJACKSC		0.004	0.01	0.906	-0.778
6. IMREEF FISHC1		0.100	0.15	0.988	0.025
7. LGIMSCHOOLFISHP		0.010	0.01	0.638	-0.946
8. IMREEF FISHC2		0.010	0.01	0.722	-0.908
9. HEMIRAMPHIDAEH		0.002	0.00	0.799	-0.895
10. KYPHOSIDAEH		0.060	0.09	0.984	-0.121
11. IMREEF FISHH		0.052	0.08	0.929	-0.712
12. LGREEF FISHC		0.030	0.04	0.967	-0.457
13. IMREEF FISHC3		0.025	0.04	0.891	-0.806
14. SMREEF FISHC1		0.020	0.03	0.916	-0.752
15. SMSCHOOLFISHPEL		0.049	0.07	0.921	-0.738
16. ENGRAULIDAEH		0.028	0.04	0.954	-0.583
17. SMREEF FISHC2		0.006	0.01	0.918	-0.748
18. LGGROUPERSC		0.093	0.14	0.997	0.626
19. IMREEF FISHC4		0.020	0.03	0.972	-0.390
20. SMREEF FISHO1		0.025	0.04	0.946	-0.638
21. SMREEF FISHO2		0.004	0.01	0.907	-0.776
22. SMREEF FISHO3		0.001	0.00	0.680	-0.937
23. LGSCARIDAEH		0.025	0.04	0.739	-0.921
24. IMSCARIDAEH		0.002	0.00	0.294	-0.978
25. SMSCARIDAEH		0.001	0.00	-0.003	-0.988
28. SEABIRDS		0.020	0.03	1.000	0.986
29. SQUIDS		0.005	0.01	0.888	-0.812
30. SEATURTLES		0.005	0.01	0.961	-0.523
31. OCTOPUSES		0.020	0.03	0.846	-0.862
32. LOBSTERS		0.005	0.01	0.771	-0.909
33. CRABS		0.050	0.07	0.860	-0.848
34. SHRMP/HCRB/STOM		0.050	0.07	0.924	-0.730
37. ECHINOIDS		0.008	0.01	-0.425	-0.995
38. GASTROPODS		0.010	0.01	0.038	-0.987
40. POLY/PRIA/OPHIU		0.050	0.07	0.769	-0.910
41. HOL/SIP/ECH/HEM		0.050	0.07	0.584	-0.954
42. BIVALVES		0.067	0.10	0.512	-0.963
50. Detritus		0.020	0.03	-0.904	-0.999
TOTAL		1.000	1.47		
Predator: (2)	SHARKS/SCOMBRID				
2. SHARKS/SCOMBRID	(0' Cycle)	0.010	0.04	0.984	0.589
4. IMJACKSC		0.034	0.13	0.981	0.536
5. SMJACKSC		0.050	0.19	0.992	0.795
6. IMREEF FISHC1		0.015	0.06	0.923	-0.144
7. LGIMSCHOOLFISHP		0.176	0.67	0.975	0.421
8. IMREEF FISHC2		0.040	0.15	0.938	-0.035
9. HEMIRAMPHIDAEH		0.115	0.44	0.996	0.913
10. KYPHOSIDAEH		0.020	0.08	0.953	0.115
11. IMREEF FISHH		0.020	0.08	0.825	-0.527
12. LGREEF FISHC		0.014	0.05	0.931	-0.088
13. IMREEF FISHC3		0.084	0.32	0.966	0.281
14. SMREEF FISHC1		0.020	0.08	0.916	-0.189
15. SMSCHOOLFISHPEL		0.136	0.52	0.971	0.350
16. ENGRAULIDAEH		0.040	0.15	0.968	0.299
17. SMREEF FISHC2		0.020	0.08	0.975	0.411
19. IMREEF FISHC4		0.006	0.02	0.910	-0.226
20. SMREEF FISHO1		0.014	0.05	0.905	-0.254
21. SMREEF FISHO2		0.001	0.00	0.672	-0.738
23. LGSCARIDAEH		0.030	0.11	0.777	-0.618
24. IMSCARIDAEH		0.001	0.00	-0.044	-0.947
25. SMSCARIDAEH		0.002	0.01	0.331	-0.889
26. BLENNIIDAEH		0.001	0.00	0.788	-0.602

continued...

Table 8.8.1 continued

	Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
29. SQUIDS	0.010	0.04	0.942	0.005
31. OCTOPUSES	0.045	0.17	0.929	-0.106
32. LOBSTERS	0.005	0.02	0.771	-0.628
33. CRABS	0.020	0.08	0.683	-0.729
34. SHRMP/HCRB/STOM	0.050	0.19	0.924	-0.140
38. GASTROPODS	0.008	0.03	-0.074	-0.950
40. POLY/PRIA/OPHIU	0.006	0.02	-0.043	-0.947
42. BIVALVES	0.007	0.03	-0.511	-0.981
TOTAL	1.000	3.79		
Predator: (3) LGJACKSC				
4. IMJACKSC	0.150	0.15	0.996	0.948
6. IMREEF FISHC1	0.200	0.21	0.994	0.914
8. IMREEF FISHC2	0.160	0.17	0.984	0.732
11. IMREEF FISHH	0.044	0.05	0.917	0.039
13. IMREEF FISHC3	0.124	0.13	0.977	0.624
33. CRABS	0.010	0.01	0.453	-0.782
34. SHRMP/HCRB/STOM	0.015	0.02	0.767	-0.481
37. ECHINOIDS	0.082	0.08	0.611	-0.679
38. GASTROPODS	0.158	0.16	0.889	-0.114
42. BIVALVES	0.057	0.06	0.450	-0.784
TOTAL	1.000	1.03		
Predator: (4) IMJACKSC				
6. IMREEF FISHC1	0.001	0.01	0.251	-0.910
7. LGIMSCHOOLFISHP	0.056	0.84	0.924	-0.159
8. IMREEF FISHC2	0.110	1.64	0.977	0.435
10. KYPHOSIDAEH	0.015	0.22	0.938	-0.053
11. IMREEF FISHH	0.107	1.60	0.965	0.240
15. SMSCHOOLFISHPEL	0.110	1.64	0.964	0.229
16. ENGRAULIDAEH	0.107	1.60	0.988	0.670
17. SMREEF FISHC2	0.001	0.01	0.590	-0.802
19. IMREEF FISHC4	0.005	0.07	0.893	-0.331
20. SMREEF FISHO1	0.053	0.79	0.974	0.382
21. SMREEF FISHO2	0.053	0.79	0.993	0.801
22. SMREEF FISHO3	0.053	0.79	0.993	0.807
23. LGSCARIDAEH	0.016	0.24	0.619	-0.785
24. IMSCARIDAEH	0.073	1.09	0.971	0.325
25. SMSCARIDAEH	0.122	1.82	0.984	0.573
26. BLENNIIDAEH	0.053	0.79	0.996	0.889
29. SQUIDS	0.004	0.06	0.862	-0.446
33. CRABS	0.004	0.06	0.030	-0.942
34. SHRMP/HCRB/STOM	0.031	0.46	0.880	-0.383
38. GASTROPODS	0.004	0.06	-0.397	-0.976
46. ZOOPLANKTON	0.022	0.33	0.553	-0.821
TOTAL	1.000	14.91		
Predator: (6) IMREEF FISHC1				
6. IMREEF FISHC1 (0' Cycle)	0.001	0.02	0.251	-0.550
8. IMREEF FISHC2	0.009	0.19	0.750	0.108
10. KYPHOSIDAEH	0.003	0.06	0.724	0.051
11. IMREEF FISHH	0.004	0.08	0.353	-0.465
13. IMREEF FISHC3	0.057	1.18	0.951	0.778
14. SMREEF FISHC1	0.005	0.10	0.702	0.005
15. SMSCHOOLFISHPEL	0.062	1.28	0.937	0.714
17. SMREEF FISHC2	0.003	0.06	0.842	0.356
19. IMREEF FISHC4	0.003	0.06	0.827	0.311
20. SMREEF FISHO1	0.020	0.41	0.932	0.692
23. LGSCARIDAEH	0.030	0.62	0.777	0.174
24. IMSCARIDAEH	0.016	0.33	0.872	0.456
25. SMSCARIDAEH	0.016	0.33	0.882	0.490
29. SQUIDS	0.001	0.02	0.542	-0.258
31. OCTOPUSES	0.014	0.29	0.788	0.200
33. CRABS	0.090	1.86	0.920	0.638
34. SHRMP/HCRB/STOM	0.030	0.62	0.876	0.469
36. ASTEROIDS	0.001	0.02	-0.664	-0.932
37. ECHINOIDS	0.050	1.04	0.432	-0.388

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's elec-tivity index	Standardized forage ratio
38. GASTROPODS		0.017	0.35	0.294	-0.516
40. POLY/PRIA/OPHIU		0.006	0.12	-0.043	-0.725
41. HOL/SIP/ECH/HEM		0.003	0.06	-0.628	-0.924
42. BIVALVES		0.010	0.21	-0.368	-0.852
43. ASCI/BARN/BRYOZ		0.060	1.24	0.376	-0.444
44. SPONGES		0.200	4.14	0.116	-0.640
45. CORALS/ANEMONES		0.010	0.21	-0.411	-0.865
46. ZOOPLANKTON		0.250	5.18	0.951	0.776
49. Benthic prod.		0.029	0.60	-0.798	-0.962
TOTAL		1.000	20.71		
Predator: (5) SMJACKSC					
4. IMJACKSC		0.002	0.03	0.722	0.202
5. SMJACKSC	(0' Cycle)	0.001	0.01	0.669	0.099
7. LGIMSCHOOLFISHP		0.014	0.18	0.727	0.212
11. IMREEF FISHH		0.020	0.25	0.825	0.444
15. SMSCHOOLFISHPEL		0.006	0.08	0.498	-0.167
16. ENGRAULIDAEH		0.019	0.24	0.933	0.775
46. ZOOPLANKTON		0.938	11.73	0.987	0.984
TOTAL		1.000	12.50		
Predator: (7) LGIMSCHOOLFISHP					
7. LGIMSCHOOLFISHP	(0' Cycle)	0.003	0.42	0.151	-0.444
11. IMREEF FISHH		0.010	1.39	0.679	0.207
15. SMSCHOOLFISHPEL		0.047	6.51	0.918	0.768
16. ENGRAULIDAEH		0.006	0.83	0.802	0.461
34. SHRMP/HCRB/STOM		0.004	0.55	0.338	-0.269
40. POLY/PRIA/OPHIU		0.120	16.62	0.897	0.705
46. ZOOPLANKTON		0.722	100.02	0.983	0.979
49. Benthic prod.		0.088	12.19	-0.491	-0.824
TOTAL		1.000	138.53		
Predator: (8) IMREEF FISHC2					
4. IMJACKSC		0.001	0.07	0.512	-0.266
7. LGIMSCHOOLFISHP		0.001	0.07	-0.378	-0.845
8. IMREEF FISHC2	(0' Cycle)	0.020	1.34	0.879	0.507
10. KYPHOSIDAEH		0.003	0.20	0.724	0.085
11. IMREEF FISHH		0.004	0.27	0.353	-0.439
12. LGREEF FISHC		0.001	0.07	0.333	-0.457
13. IMREEF FISHC3		0.015	1.00	0.825	0.336
15. SMSCHOOLFISHPEL		0.067	4.48	0.942	0.752
16. ENGRAULIDAEH		0.002	0.13	0.505	-0.275
17. SMREEF FISHC2		0.001	0.07	0.590	-0.157
19. IMREEF FISHC4		0.003	0.20	0.827	0.342
23. LGSCARIDAEH		0.020	1.34	0.683	0.002
24. IMSCARIDAEH		0.030	2.01	0.930	0.700
25. SMSCARIDAEH		0.010	0.67	0.817	0.313
31. OCTOPUSES		0.050	3.34	0.936	0.725
32. LOBSTERS		0.001	0.07	0.214	-0.554
33. CRABS		0.100	6.69	0.927	0.691
34. SHRMP/HCRB/STOM		0.020	1.34	0.820	0.320
35. SMBENTHARTHROPO		0.031	2.07	0.844	0.392
37. ECHINOIDS		0.100	6.69	0.669	-0.024
38. GASTROPODS		0.035	2.34	0.581	-0.170
39. CHITONS/SCAPHOP		0.020	1.34	0.239	-0.535
40. POLY/PRIA/OPHIU		0.180	12.04	0.930	0.701
41. HOL/SIP/ECH/HEM		0.060	4.01	0.641	-0.075
42. BIVALVES		0.073	4.88	0.543	-0.225
43. ASCI/BARN/BRYOZ		0.050	3.34	0.295	-0.490
44. SPONGES		0.070	4.68	-0.387	-0.849
45. CORALS/ANEMONES		0.004	0.27	-0.714	-0.940
46. ZOOPLANKTON		0.018	1.20	0.479	-0.306
49. Benthic prod.		0.010	0.67	-0.925	-0.986
TOTAL		1.000	66.88		

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's elec- tivity index	Standardized forage ratio
Predator:	(9) HEMIRAMPHIDAEH				
15. SMSCHOOLFISHPEL		0.200	8.80	0.980	0.999
49. Benthic prod.		0.800	35.19	0.513	0.209
TOTAL		1.000	43.99		
Predator:	(10) KYPHOSIDAEH				
49. Benthic prod.		1.000	57.11	0.590	1.000
TOTAL		1.000	57.11		
Predator:	(11) IMREEF FISHH				
34. SHRMP/HCRB/STOM		0.004	0.99	0.338	0.927
38. GASTROPODS		0.001	0.25	-0.805	-0.032
40. POLY/PRIA/OPHIU		0.002	0.50	-0.531	0.468
45. CORALS/ANEMONES		0.002	0.50	-0.846	-0.161
49. Benthic prod.		0.533	131.94	0.348	0.930
50. Detritus		0.458	113.38	0.072	0.850
TOTAL		1.000	247.55		
Predator:	(12) LGREEF FISHC				
3. LGJACKSC		0.004	0.04	0.982	0.819
4. IMJACKSC		0.024	0.24	0.973	0.725
5. SMJACKSC		0.020	0.20	0.980	0.798
6. IMREEF FISHC1		0.030	0.30	0.961	0.604
7. LGIMSCHOOLFISHP		0.040	0.39	0.895	0.163
8. IMREEF FISHC2		0.040	0.39	0.938	0.418
10. KYPHOSIDAEH		0.003	0.03	0.724	-0.359
11. IMREEF FISHH		0.023	0.23	0.847	-0.044
12. LGREEF FISHC	(0' Cycle)	0.005	0.05	0.818	-0.138
13. IMREEF FISHC3		0.040	0.39	0.931	0.370
14. SMREEF FISHC1		0.001	0.01	0.066	-0.843
15. SMSCHOOLFISHPEL		0.059	0.58	0.934	0.393
16. ENGRAULIDAEH		0.001	0.01	0.206	-0.796
19. IMREEF FISHC4		0.003	0.03	0.827	-0.109
20. SMREEF FISHO1		0.017	0.17	0.921	0.306
21. SMREEF FISHO2		0.006	0.06	0.937	0.411
23. LGSCARIDAEH		0.010	0.10	0.453	-0.667
24. IMSCARIDAEH		0.010	0.10	0.803	-0.181
25. SMSCARIDAEH		0.008	0.08	0.777	-0.249
26. BLENNIIDAEH		0.001	0.01	0.788	-0.222
29. SQUIDS		0.001	0.01	0.542	-0.597
31. OCTOPUSES		0.009	0.09	0.688	-0.421
32. LOBSTERS		0.002	0.02	0.511	-0.624
33. CRABS		0.032	0.32	0.790	-0.217
34. SHRMP/HCRB/STOM		0.030	0.30	0.876	0.073
37. ECHINOIDS		0.100	0.98	0.669	-0.449
38. GASTROPODS		0.400	3.94	0.955	0.551
42. BIVALVES		0.075	0.74	0.552	-0.587
46. ZOOPLANKTON		0.006	0.06	-0.027	-0.868
TOTAL		1.000	9.85		
Predator:	(13) IMREEF FISHC3				
5. SMJACKSC		0.003	0.14	0.876	0.128
6. IMREEF FISHC1		0.010	0.46	0.887	0.177
7. LGIMSCHOOLFISHP		0.002	0.09	-0.051	-0.860
8. IMREEF FISHC2		0.010	0.46	0.772	-0.208
10. KYPHOSIDAEH		0.003	0.14	0.724	-0.310
11. IMREEF FISHH		0.009	0.42	0.650	-0.434
13. IMREEF FISHC3	(0' Cycle)	0.012	0.56	0.786	-0.173
14. SMREEF FISHC1		0.010	0.46	0.839	-0.016
15. SMSCHOOLFISHPEL		0.002	0.09	-0.002	-0.847
16. ENGRAULIDAEH		0.002	0.09	0.505	-0.595
17. SMREEF FISHC2		0.010	0.46	0.950	0.551
19. IMREEF FISHC4		0.003	0.14	0.827	-0.055
20. SMREEF FISHO1		0.040	1.86	0.966	0.681
21. SMREEF FISHO2		0.001	0.05	0.672	-0.401
22. SMREEF FISHO3		0.015	0.70	0.975	0.767

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
23. LGSCARIDAEH		0.055	2.55	0.872	0.110
24. IMSCARIDAEH		0.007	0.32	0.730	-0.299
25. SMSCARIDAEH		0.006	0.28	0.713	-0.332
26. BLENNIIDAEH		0.002	0.09	0.888	0.181
27. SMGOBIIDAEC		0.004	0.19	0.983	0.845
31. OCTOPUSES		0.030	1.39	0.895	0.215
33. CRABS		0.150	6.96	0.951	0.561
34. SHRMP/HCRB/STOM		0.100	4.64	0.961	0.642
35. SMBENTHARTHROPO		0.042	1.95	0.882	0.155
37. ECHINOIDS		0.060	2.78	0.504	-0.596
38. GASTROPODS		0.004	0.19	-0.397	-0.931
39. CHITONS/SCAPHOP		0.010	0.46	-0.102	-0.873
40. POLY/PRIA/OPHIU		0.050	2.32	0.769	-0.216
41. HOL/SIP/ECH/HEM		0.010	0.46	-0.135	-0.881
42. BIVALVES		0.023	1.07	0.030	-0.837
43. ASCI/BARN/BRYOZ		0.040	1.86	0.190	-0.782
44. SPONGES		0.070	3.25	-0.387	-0.929
45. CORALS/ANEMONES		0.003	0.14	-0.778	-0.979
46. ZOOPLANKTON		0.150	6.96	0.919	0.344
49. Benthic prod.		0.052	2.41	-0.664	-0.967
TOTAL		1.000	46.40		
Predator:	(14) SMREEF FISHC1				
7. LGIMSCHOOLFISHP		0.002	0.09	-0.051	-0.765
8. IMREEF FISHC2		0.002	0.09	0.217	-0.626
9. HEMIRAMPHIDAEH		0.002	0.09	0.799	0.152
14. SMREEF FISHC1	(0' Cycle)	0.003	0.13	0.548	-0.325
15. SMSCHOOLFISHPEL		0.002	0.09	-0.002	-0.744
16. ENGRAULIDAEH		0.002	0.09	0.505	-0.378
17. SMREEF FISHC2		0.002	0.09	0.772	0.079
20. SMREEF FISHO1		0.005	0.22	0.754	0.036
21. SMREEF FISHO2		0.002	0.09	0.821	0.215
22. SMREEF FISHO3		0.006	0.26	0.939	0.674
25. SMSCARIDAEH		0.002	0.09	0.331	-0.545
26. BLENNIIDAEH		0.006	0.26	0.961	0.795
27. SMGOBIIDAEC		0.002	0.09	0.966	0.823
33. CRABS		0.100	4.33	0.927	0.619
34. SHRMP/HCRB/STOM		0.040	1.73	0.906	0.520
35. SMBENTHARTHROPO		0.042	1.82	0.882	0.425
37. ECHINOIDS		0.110	4.76	0.695	-0.092
38. GASTROPODS		0.144	6.24	0.879	0.412
39. CHITONS/SCAPHOP		0.040	1.73	0.530	-0.347
40. POLY/PRIA/OPHIU		0.100	4.33	0.877	0.405
41. HOL/SIP/ECH/HEM		0.008	0.35	-0.242	-0.835
42. BIVALVES		0.060	2.60	0.470	-0.417
46. ZOOPLANKTON		0.260	11.26	0.952	0.746
49. Benthic prod.		0.058	2.51	-0.632	-0.936
TOTAL		1.000	43.31		
Predator:	(15) SMSCHOOLFISHPEL				
15. SMSCHOOLFISHPEL	(0' Cycle)	0.002	0.38	-0.002	-0.535
16. ENGRAULIDAEH		0.002	0.38	0.505	-0.033
34. SHRMP/HCRB/STOM		0.010	1.91	0.669	0.223
43. ASCI/BARN/BRYOZ		0.030	5.74	0.049	-0.498
46. ZOOPLANKTON		0.950	181.69	0.987	0.997
47. DECOMP/MICROFAU		0.006	1.15	0.338	-0.236
TOTAL		1.000	191.25		
Predator:	(16) ENGRAULIDAEH				
46. ZOOPLANKTON		0.200	28.86	0.939	0.892
48. Phytoplankton		0.700	101.01	0.978	0.985
50. Detritus		0.100	14.43	-0.597	-0.813
TOTAL		1.000	144.31		
Predator:	(17) SMREEF FISHC2				
8. IMREEF FISHC2		0.002	0.04	0.217	-0.639
11. IMREEF FISHH		0.001	0.02	-0.313	-0.862

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
14. SMREEF FISHC1		0.008	0.15	0.803	0.140
17. SMREEF FISHC2	(0' Cycle)	0.003	0.06	0.842	0.260
20. SMREEF FISHO1		0.001	0.02	0.176	-0.663
22. SMREEF FISHO3		0.004	0.08	0.909	0.519
26. BLENNIIDAEH		0.001	0.02	0.788	0.098
27. SMGOBIIDAEC		0.002	0.04	0.966	0.814
31. OCTOPUSES		0.020	0.38	0.846	0.275
33. CRABS		0.063	1.20	0.887	0.426
34. SHRMP/HCRB/STOM		0.150	2.86	0.974	0.864
35. SMBENTHARTHROPO		0.100	1.90	0.949	0.716
38. GASTROPODS		0.005	0.10	-0.299	-0.858
39. CHITONS/SCAPHOP		0.002	0.04	-0.720	-0.955
40. POLY/PRIA/OPHIU		0.079	1.50	0.847	0.277
41. HOL/SIP/ECH/HEM		0.001	0.02	-0.858	-0.979
42. BIVALVES		0.030	0.57	0.162	-0.672
46. ZOOPLANKTON		0.500	9.52	0.975	0.870
49. Benthic prod.		0.028	0.53	-0.804	-0.970
TOTAL		1.000	19.04		
Predator:	(18) LGGROUPERSC				
1. LGSHARKS/RAYSC		0.005	0.01	0.977	0.443
2. SHARKS/SCOMBRID		0.005	0.01	0.968	0.299
4. IMJACKSC		0.010	0.02	0.937	-0.040
5. SMJACKSC		0.010	0.02	0.961	0.207
6. IMREEF FISHC1		0.085	0.14	0.986	0.639
8. IMREEF FISHC2		0.090	0.15	0.972	0.362
10. KYPHOSIDAEH		0.020	0.03	0.953	0.112
11. IMREEF FISHH		0.020	0.03	0.825	-0.529
12. LGREEF FISHC		0.232	0.39	0.996	0.899
19. IMREEF FISHC4		0.010	0.02	0.945	0.026
23. LGSCARIDAEH		0.248	0.41	0.970	0.335
30. SEATURTLES		0.035	0.06	0.994	0.858
32. LOBSTERS		0.160	0.27	0.992	0.789
33. CRABS		0.070	0.12	0.898	-0.290
TOTAL		1.000	1.67		
Predator:	(19) IMREEF FISHC4				
33. CRABS		0.001	0.01	-0.580	0.124
34. SHRMP/HCRB/STOM		0.002	0.02	0.005	0.680
36. ASTEROIDS		0.002	0.02	-0.425	0.328
37. ECHINOIDS		0.003	0.03	-0.737	-0.161
40. POLY/PRIA/OPHIU		0.006	0.05	-0.043	0.651
41. HOL/SIP/ECH/HEM		0.006	0.05	-0.372	0.384
43. ASCI/BARN/BRYOZ		0.023	0.20	-0.084	0.624
44. SPONGES		0.921	7.91	0.706	0.968
45. CORALS/ANEMONES		0.007	0.06	-0.548	0.171
46. ZOOPLANKTON		0.001	0.01	-0.727	-0.141
49. Benthic prod.		0.028	0.24	-0.804	-0.319
TOTAL		1.000	8.59		
Predator:	(20) SMREEF FISHO1				
7. LGIMSCHOOLFISHP		0.003	0.17	0.151	-0.616
8. IMREEF FISHC2		0.003	0.17	0.400	-0.418
9. HEMIRAMPHIDAEH		0.003	0.17	0.862	0.423
14. SMREEF FISHC1		0.004	0.23	0.641	-0.104
15. SMSCHOOLFISHPEL		0.004	0.23	0.331	-0.482
16. ENGRAULIDAEH		0.004	0.23	0.717	0.040
17. SMREEF FISHC2		0.004	0.23	0.879	0.483
20. SMREEF FISHO1	(0' Cycle)	0.006	0.35	0.791	0.214
21. SMREEF FISHO2		0.004	0.23	0.907	0.587
22. SMREEF FISHO3		0.004	0.23	0.909	0.598
25. SMSCARIDAEH		0.004	0.23	0.598	-0.173
26. BLENNIIDAEH		0.004	0.23	0.942	0.739
27. SMGOBIIDAEC		0.003	0.17	0.977	0.912
33. CRABS		0.010	0.58	0.453	-0.362
34. SHRMP/HCRB/STOM		0.010	0.58	0.669	-0.054
35. SMBENTHARTHROPO		0.056	3.25	0.910	0.603

continued...

Table 8.8.1 continued

	Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
38. GASTROPODS	0.038	2.20	0.608	-0.159
40. POLY/PRIA/OPHIU	0.050	2.90	0.769	0.157
42. BIVALVES	0.020	1.16	-0.039	-0.721
43. ASCI/BARN/BRYOZ	0.020	1.16	-0.153	-0.772
44. SPONGES	0.020	1.16	-0.776	-0.957
45. CORALS/ANEMONES	0.020	1.16	-0.090	-0.745
46. ZOOPLANKTON	0.100	5.80	0.881	0.490
49. Benthic prod.	0.326	18.89	0.117	-0.637
50. Detritus	0.280	16.23	-0.172	-0.780
TOTAL	1.000	57.96		
Predator: (21) SMREEF FISHO2				
14. SMREEF FISHC1	0.003	0.05	0.548	-0.159
15. SMSCHOOLFISHPEL	0.003	0.05	0.198	-0.523
16. ENGRAULIDAEH	0.003	0.05	0.640	-0.015
17. SMREEF FISHC2	0.003	0.05	0.842	0.438
21. SMREEF FISHO2 (0' Cycle)	0.003	0.05	0.877	0.547
22. SMREEF FISHO3	0.003	0.05	0.881	0.559
26. BLENNIIDAEH	0.003	0.05	0.924	0.710
27. SMGOBIIDAEC	0.002	0.03	0.966	0.882
33. CRABS	0.050	0.79	0.860	0.492
34. SHRMP/HCRB/STOM	0.040	0.63	0.906	0.644
35. SMBENTHARTHROPO	0.035	0.55	0.860	0.494
36. ASTEROIDS	0.021	0.33	0.618	-0.052
37. ECHINOIDS	0.050	0.79	0.432	-0.305
38. GASTROPODS	0.035	0.55	0.581	-0.110
40. POLY/PRIA/OPHIU	0.100	1.58	0.877	0.547
41. HOL/SIP/ECH/HEM	0.005	0.08	-0.448	-0.852
42. BIVALVES	0.027	0.43	0.110	-0.585
43. ASCI/BARN/BRYOZ	0.020	0.32	-0.153	-0.733
44. SPONGES	0.080	1.27	-0.329	-0.809
45. CORALS/ANEMONES	0.100	1.58	0.613	-0.060
46. ZOOPLANKTON	0.109	1.73	0.890	0.590
47. DECOMP/MICROFAU	0.005	0.08	0.254	-0.477
49. Benthic prod.	0.200	3.17	-0.126	-0.720
50. Detritus	0.100	1.58	-0.597	-0.900
TOTAL	1.000	15.84		
Predator: (22) SMREEF FISHO3				
35. SMBENTHARTHROPO	0.008	0.30	0.506	0.540
40. POLY/PRIA/OPHIU	0.050	1.91	0.769	0.807
42. BIVALVES	0.071	2.71	0.533	0.567
46. ZOOPLANKTON	0.200	7.62	0.939	0.979
49. Benthic prod.	0.335	12.77	0.131	0.158
50. Detritus	0.336	12.81	-0.082	-0.060
TOTAL	1.000	38.11		
Predator: (23) LGSCARIDAEH				
44. SPONGES	0.002	0.51	-0.975	-0.727
45. CORALS/ANEMONES	0.001	0.26	-0.920	-0.310
49. Benthic prod.	0.997	255.49	0.589	0.999
TOTAL	1.000	256.26		
Predator: (24) IMSCARIDAEH				
44. SPONGES	0.001	0.11	-0.987	-0.852
49. Benthic prod.	0.999	114.22	0.590	1.000
TOTAL	1.000	114.33		
Predator: (25) SMSCARIDAEH				
49. Benthic prod.	1.000	172.04	0.590	1.000
TOTAL	1.000	172.04		

continued...

Table 8.8.1 continued

	Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator: (26) BLENNIIDAEH				
38. GASTROPODS	0.001	0.02	-0.805	0.142
46. ZOOPLANKTON	0.005	0.11	-0.118	0.843
49. Benthic prod.	0.497	10.77	0.317	0.956
50. Detritus	0.497	10.77	0.113	0.912
TOTAL	1.000	21.66		
Predator: (27) SMGOBIIDAEC				
35. SMBENTHARTHROPO	1.000	3.05	0.995	1.000
TOTAL	1.000	3.05		
Predator: (28) SEABIRDS				
2. SHARKS/SCOMBRID	0.020	0.03	0.992	0.758
3. LGJACKSC	0.010	0.01	0.993	0.790
4. IMJACKSC	0.060	0.08	0.989	0.685
5. SMJACKSC	0.030	0.04	0.987	0.621
6. IMREEF FISHC1	0.010	0.01	0.887	-0.391
7. LGIMSCHOOLFISHP	0.280	0.38	0.984	0.558
8. IMREEF FISHC2	0.040	0.05	0.938	-0.098
9. HEMIRAMPHIDAEH	0.100	0.14	0.996	0.877
11. IMREEF FISHH	0.010	0.01	0.679	-0.760
12. LGREEF FISHC	0.005	0.01	0.818	-0.586
13. IMREEF FISHC3	0.030	0.04	0.909	-0.291
14. SMREEF FISHC1	0.025	0.03	0.932	-0.140
15. SMSCHOOLFISHPEL	0.200	0.27	0.980	0.464
16. ENGRAULIDAEH	0.100	0.14	0.987	0.622
17. SMREEF FISHC2	0.008	0.01	0.938	-0.098
19. IMREEF FISHC4	0.005	0.01	0.893	-0.367
20. SMREEF FISHO1	0.005	0.01	0.754	-0.686
21. SMREEF FISHO2	0.003	0.00	0.877	-0.428
23. LGSCARIDAEH	0.002	0.00	-0.306	-0.973
24. IMSCARIDAEH	0.005	0.01	0.642	-0.787
25. SMSCARIDAEH	0.002	0.00	0.331	-0.902
46. ZOOPLANKTON	0.050	0.07	0.775	-0.659
TOTAL	1.000	1.36		
Predator: (29) SQUIDS				
7. LGIMSCHOOLFISHP	0.150	3.94	0.971	0.809
9. HEMIRAMPHIDAEH	0.015	0.39	0.971	0.807
15. SMSCHOOLFISHPEL	0.130	3.41	0.970	0.799
16. ENGRAULIDAEH	0.030	0.79	0.957	0.714
29. SQUIDS (0' Cycle)	0.010	0.26	0.942	0.622
34. SHRMP/HCRB/STOM	0.100	2.63	0.961	0.741
46. ZOOPLANKTON	0.565	14.83	0.978	0.860
TOTAL	1.000	26.25		
Predator: (30) SEATURTLES				
32. LOBSTERS	0.060	0.10	0.979	0.982
33. CRABS	0.025	0.04	0.738	0.440
34. SHRMP/HCRB/STOM	0.040	0.07	0.906	0.795
36. ASTEROIDS	0.020	0.04	0.603	0.210
37. ECHINOIDS	0.020	0.04	0.005	-0.456
38. GASTROPODS	0.025	0.04	0.459	0.006
42. BIVALVES	0.020	0.04	-0.039	-0.490
43. ASCI/BARN/BRYOZ	0.020	0.04	-0.153	-0.573
44. SPONGES	0.340	0.60	0.364	-0.110
45. CORALS/ANEMONES	0.016	0.03	-0.199	-0.604
49. Benthic prod.	0.414	0.72	0.233	-0.251
TOTAL	1.000	1.75		
Predator: (31) OCTOPUSES				
8. IMREEF FISHC2	0.002	0.11	0.217	-0.271
11. IMREEF FISHH	0.002	0.11	0.023	-0.445
12. LGREEF FISHC	0.001	0.06	0.333	-0.149
13. IMREEF FISHC3	0.003	0.17	0.353	-0.128

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
14. SMREEF FISHC1		0.007	0.40	0.778	0.512
17. SMREEF FISHC2		0.001	0.06	0.590	0.186
20. SMREEF FISHO1		0.002	0.11	0.481	0.031
21. SMREEF FISHO2		0.002	0.11	0.821	0.602
31. OCTOPUSES	(0' Cycle)	0.020	1.14	0.846	0.656
33. CRABS		0.025	1.42	0.738	0.436
34. SHRMP/HCRB/STOM		0.020	1.14	0.820	0.598
38. GASTROPODS		0.500	28.39	0.964	0.941
39. CHITONS/SCAPHOP		0.010	0.57	-0.102	-0.540
40. POLY/PRIA/OPHIU		0.005	0.28	-0.133	-0.562
42. BIVALVES		0.400	22.71	0.897	0.773
TOTAL		1.000	56.78		
Predator:	(32) LOBSTERS				
38. GASTROPODS		0.150	3.63	0.884	0.923
40. POLY/PRIA/OPHIU		0.050	1.21	0.769	0.806
42. BIVALVES		0.500	12.10	0.917	0.957
49. Benthic prod.		0.180	4.36	-0.177	-0.159
50. Detritus		0.120	2.90	-0.535	-0.525
TOTAL		1.000	24.20		
Predator:	(33) CRABS				
14. SMREEF FISHC1		0.010	2.66	0.839	0.784
17. SMREEF FISHC2		0.007	1.86	0.929	0.925
33. CRABS	(0' Cycle)	0.005	1.33	0.141	-0.089
34. SHRMP/HCRB/STOM		0.010	2.66	0.669	0.539
35. SMBENTHARTHROPO		0.005	1.33	0.312	0.095
37. ECHINOIDS		0.050	13.30	0.432	0.235
38. GASTROPODS		0.050	13.30	0.687	0.564
40. POLY/PRIA/OPHIU		0.004	1.06	-0.241	-0.447
41. HOL/SIP/ECH/HEM		0.001	0.27	-0.858	-0.910
42. BIVALVES		0.050	13.30	0.396	0.192
43. ASCI/BARN/BRYOZ		0.020	5.32	-0.153	-0.370
44. SPONGES		0.050	13.30	-0.520	-0.672
45. CORALS/ANEMONES		0.010	2.66	-0.411	-0.587
46. ZOOPLANKTON		0.030	7.98	0.651	0.514
47. DECOMP/MICROFAU		0.030	7.98	0.820	0.755
48. Phytoplankton		0.020	5.32	0.432	0.235
49. Benthic prod.		0.600	159.60	0.399	0.196
50. Detritus		0.048	12.77	-0.784	-0.860
TOTAL		1.000	266.00		
Predator:	(34) SHRMP/HCRB/STOM				
8. IMREEF FISHC2		0.010	2.69	0.772	0.358
14. SMREEF FISHC1		0.010	2.69	0.839	0.521
16. ENGRAULIDAEH		0.010	2.69	0.876	0.623
17. SMREEF FISHC2		0.005	1.35	0.902	0.699
29. SQUIDS		0.005	1.35	0.888	0.657
31. OCTOPUSES		0.025	6.72	0.875	0.620
32. LOBSTERS		0.005	1.35	0.771	0.355
33. CRABS		0.002	0.54	-0.306	-0.756
34. SHRMP/HCRB/STOM	(0' Cycle)	0.002	0.54	0.005	-0.581
35. SMBENTHARTHROPO		0.040	10.76	0.877	0.625
36. ASTEROIDS		0.010	2.69	0.338	-0.305
37. ECHINOIDS		0.110	29.59	0.695	0.198
38. GASTROPODS		0.080	21.52	0.792	0.405
39. CHITONS/SCAPHOP		0.010	2.69	-0.102	-0.648
40. POLY/PRIA/OPHIU		0.050	13.45	0.769	0.351
41. HOL/SIP/ECH/HEM		0.005	1.35	-0.448	-0.819
42. BIVALVES		0.212	57.03	0.815	0.459
46. ZOOPLANKTON		0.150	40.35	0.919	0.752
47. DECOMP/MICROFAU		0.055	14.80	0.897	0.685
49. Benthic prod.		0.084	22.60	-0.508	-0.843
50. Detritus		0.120	32.28	-0.535	-0.853
TOTAL		1.000	269.00		

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's elec-tivity index	Standardized forage ratio
Predator:	(35) SMBENTHARTHROPO				
43. ASCI/BARN/BRYOZ		0.050	83.14	0.295	0.571
44. SPONGES		0.060	99.77	-0.451	-0.168
45. CORALS/ANEMONES		0.040	66.51	0.251	0.535
46. ZOOPLANKTON		0.040	66.51	0.726	0.535
47. DECOMP/MICROFAU		0.040	66.51	0.862	0.961
49. Benthic prod.		0.600	997.73	0.399	0.652
50. Detritus		0.170	282.69	-0.400	-0.106
TOTAL		1.000	1,662.88		
Predator:	(36) ASTEROIDS				
33. CRABS		0.010	0.81	0.453	0.401
36. ASTEROIDS	(0' Cycle)	0.080	6.48	0.883	0.899
37. ECHINOIDS		0.070	5.67	0.559	0.519
38. GASTROPODS		0.135	10.94	0.871	0.884
39. CHITONS/SCAPHOP		0.005	0.41	-0.421	-0.488
40. POLY/PRIA/OPHIU		0.030	2.43	0.642	0.614
41. HOL/SIP/ECH/HEM		0.005	0.41	-0.448	-0.513
42. BIVALVES		0.145	11.74	0.740	0.728
43. ASCI/BARN/BRYOZ		0.020	1.62	-0.153	-0.231
44. SPONGES		0.020	1.62	-0.776	-0.808
45. CORALS/ANEMONES		0.012	0.97	-0.333	-0.404
47. DECOMP/MICROFAU		0.020	1.62	0.741	0.729
49. Benthic prod.		0.088	7.13	-0.491	-0.552
50. Detritus		0.360	29.16	-0.048	-0.126
TOTAL		1.000	81.00		
Predator:	(37) ECHINOIDS				
36. ASTEROIDS		0.006	2.22	0.096	0.764
37. ECHINOIDS	(0' Cycle)	0.015	5.55	-0.138	0.631
40. POLY/PRIA/OPHIU		0.004	1.48	-0.241	0.556
41. HOL/SIP/ECH/HEM		0.005	1.85	-0.448	0.360
42. BIVALVES		0.010	3.70	-0.368	0.445
44. SPONGES		0.050	18.50	-0.520	0.272
45. CORALS/ANEMONES		0.050	18.50	0.352	0.870
49. Benthic prod.		0.860	318.20	0.539	0.931
TOTAL		1.000	370.00		
Predator:	(38) GASTROPODS				
32. LOBSTERS		0.002	1.31	0.511	0.627
33. CRABS		0.002	1.31	-0.306	-0.177
34. SHRMP/HCRB/STOM		0.004	2.62	0.338	0.469
35. SMBENTHARTHROPO		0.006	3.93	0.391	0.519
38. GASTROPODS	(0' Cycle)	0.020	13.10	0.367	0.496
39. CHITONS/SCAPHOP		0.020	13.10	0.239	0.377
40. POLY/PRIA/OPHIU		0.050	32.76	0.769	0.851
41. HOL/SIP/ECH/HEM		0.015	9.83	0.067	0.209
42. BIVALVES		0.040	26.21	0.298	0.432
43. ASCI/BARN/BRYOZ		0.058	38.00	0.361	0.491
44. SPONGES		0.040	26.21	-0.597	-0.504
45. CORALS/ANEMONES		0.015	9.83	-0.230	-0.095
47. DECOMP/MICROFAU		0.030	19.66	0.820	0.894
49. Benthic prod.		0.400	262.08	0.217	0.355
50. Detritus		0.298	195.25	-0.141	-0.002
TOTAL		1.000	655.20		
Predator:	(39) CHITONS/SCAPHOP				
43. ASCI/BARN/BRYOZ		0.040	29.02	0.190	-0.181
44. SPONGES		0.020	14.51	-0.776	-0.889
45. CORALS/ANEMONES		0.008	5.80	-0.500	-0.730
47. DECOMP/MICROFAU		0.300	217.62	0.980	0.998
49. Benthic prod.		0.632	458.45	0.421	0.078
TOTAL		1.000	725.40		

continued...

Table 8.8.1 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(40) POLY/PRIA/OPHIU				
35. SMBENTHARTHROPO		0.015	30.49	0.702	0.705
38. GASTROPODS		0.010	20.33	0.038	-0.002
40. POLY/PRIA/OPHIU	(0' Cycle)	0.030	60.98	0.642	0.639
42. BIVALVES		0.030	60.98	0.162	0.125
43. ASCI/BARN/BRYOZ		0.040	81.31	0.190	0.155
44. SPONGES		0.050	101.64	-0.520	-0.554
45. CORALS/ANEMONES		0.010	20.33	-0.411	-0.449
46. ZOOPLANKTON		0.050	101.64	0.775	0.786
47. DECOMP/MICROFAU		0.050	101.64	0.888	0.913
48. Phytoplankton		0.100	203.28	0.853	0.874
49. Benthic prod.		0.245	498.04	-0.025	-0.066
50. Detritus		0.370	752.14	-0.034	-0.076
TOTAL		1.000	2,032.80		
Predator:	(41) HOL/SIP/ECH/HEM				
47. DECOMP/MICROFAU		0.100	22.26	0.942	0.996
48. Phytoplankton		0.010	2.23	0.116	0.263
49. Benthic prod.		0.130	28.93	-0.329	-0.197
50. Detritus		0.760	169.15	0.315	0.453
TOTAL		1.000	222.57		
Predator:	(42) BIVALVES				
47. DECOMP/MICROFAU		0.100	103.79	0.942	0.975
48. Phytoplankton		0.150	155.68	0.900	0.926
50. Detritus		0.750	778.41	0.309	0.276
TOTAL		1.000	1,037.88		
Predator:	(43) ASCI/BARN/BRYOZ				
46. ZOOPLANKTON		0.150	412.20	0.919	0.901
47. DECOMP/MICROFAU		0.100	274.80	0.942	0.941
48. Phytoplankton		0.200	549.60	0.924	0.909
50. Detritus		0.550	1,511.40	0.163	-0.097
TOTAL		1.000	2,748.00		
Predator:	(44) SPONGES				
47. DECOMP/MICROFAU		0.001	4.00	-0.496	0.735
50. Detritus		0.999	3,996.00	0.432	0.995
TOTAL		1.000	4,000.00		
Predator:	(45) CORALS/ANEMONES				
46. ZOOPLANKTON		0.150	163.35	0.919	0.939
47. DECOMP/MICROFAU		0.100	108.90	0.942	0.968
49. Benthic prod.		0.650	707.85	0.432	0.365
50. Detritus		0.100	108.90	-0.597	-0.657
TOTAL		1.000	1,089.00		
Predator:	(46) ZOOPLANKTON				
47. DECOMP/MICROFAU		0.600	3,168.00	0.990	0.995
48. Phytoplankton		0.200	1,056.00	0.924	0.719
50. Detritus		0.200	1,056.00	-0.329	-0.804
TOTAL		1.000	5,280.00		
Predator:	(47) DECOMP/MICROFAU				
49. Benthic prod.		0.050	1,425.00	-0.675	0.597
50. Detritus		0.950	27,075.00	0.411	0.997
TOTAL		1.000	28,500.00		
Predator:	(50) Detritus				
1. LGSHARKS/RAYSC		0.000	0.34	-0.602	0.002
2. SHARKS/SCOMBRID		0.000	0.81	-0.403	0.003
3. LGJACKSC		0.000	0.24	-0.546	0.002

continued...

Table 8.8.1 continued

	Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
4. IMJACKSC	0.000	4.11	-0.292	0.004
5. SMJACKSC	0.000	2.73	0.255	0.004
6. IMREEF FISHC1	0.000	4.54	-0.508	0.002
7. LGIMSCHOOLFISHP	0.001	28.06	-0.293	0.004
8. IMREEF FISHC2	0.001	13.93	-0.363	0.003
9. HEMIRAMPHIDAEH	0.000	8.95	0.268	0.012
10. KYPHOSIDAEH	0.001	12.02	0.039	0.008
11. IMREEF FISHH	0.002	51.76	0.077	0.008
12. LGREEF FISHC	0.000	2.27	-0.673	0.001
13. IMREEF FISHC3	0.000	10.09	-0.535	0.002
14. SMREEF FISHC1	0.000	8.99	-0.386	0.003
15. SMSCHOOLFISHPEL	0.002	45.68	-0.010	0.007
16. ENGRAULIDAEH	0.001	30.83	0.337	0.014
17. SMREEF FISHC2	0.000	4.38	-0.153	0.005
18. LGGROUPERSC	0.000	0.47	-0.755	0.001
19. IMREEF FISHC4	0.000	1.92	-0.547	0.002
20. SMREEF FISHO1	0.001	13.22	-0.102	0.006
21. SMREEF FISHO2	0.000	3.27	-0.164	0.005
22. SMREEF FISHO3	0.000	7.95	0.286	0.013
23. LGSCARIDAEH	0.003	61.97	-0.169	0.005
24. IMSCARIDAEH	0.001	25.37	0.001	0.007
25. SMSCARIDAEH	0.002	35.67	0.209	0.011
26. BLENNIIDAEH	0.000	4.58	0.249	0.012
27. SMGOBIIDAEC	0.000	0.64	-0.110	0.006
28. SEABIRDS	0.000	0.33	0.621	0.031
29. SQUIDS	0.000	5.46	-0.116	0.006
30. SEATURTLES	0.000	0.36	-0.730	0.001
31. OCTOPUSES	0.001	13.76	-0.474	0.003
32. LOBSTERS	0.000	4.97	-0.503	0.002
33. CRABS	0.002	55.07	-0.226	0.005
34. SHRMP/HCRB/STOM	0.002	55.24	0.092	0.009
35. SMBENTHARTHROPO	0.015	337.41	0.694	0.040
36. ASTEROIDS	0.001	16.65	-0.747	0.001
37. ECHINOIDS	0.005	112.68	-0.606	0.002
38. GASTROPODS	0.006	134.39	-0.231	0.004
39. CHITONS/SCAPHOP	0.006	147.06	-0.319	0.004
40. POLY/PRIA/OPHIU	0.018	420.53	0.470	0.020
41. HOL/SIP/ECH/HEM	0.002	46.25	-0.736	0.001
42. BIVALVES	0.010	228.85	-0.374	0.003
43. ASCI/BARN/BRYOZ	0.026	613.32	-0.014	0.007
44. SPONGES	0.073	1,700.82	-0.367	0.003
45. CORALS/ANEMONES	0.010	220.89	-0.431	0.003
46. ZOOPLANKTON	0.050	1,157.00	0.775	0.057
47. DECOMP/MICROFAU	0.250	5,787.20	0.976	0.603
48. Phytoplankton	0.031	726.88	0.596	0.028
49. Benthic prod.	0.475	11,023.57	0.297	0.013
TOTAL	1.000	23,193.50		

Table 8.8.2. The 20-box model as obtained by method 1 (cluster analysis + intuition).

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(1) SEA BIRDS				
2. SHARK/RAY/SCOMB		0.020	0.03	0.986	0.698
3. L-IMJACKSCARN		0.070	0.10	0.990	0.795
4. L-IMSCHOOLPEL		0.410	0.56	0.986	0.695
5. SMALLSCHOOLPEL		0.300	0.41	0.982	0.617
7. L-IMBENTHCARN		0.090	0.12	0.865	-0.395
8. SMALLBENTHCARN		0.041	0.06	0.632	-0.759
10. L-IMREEFFHERB		0.017	0.02	0.402	-0.865
11. SMALLREEFFHERB		0.002	0.00	0.207	-0.911
16. ZOOPLANKTON		0.050	0.07	0.775	-0.606
TOTAL		1.000	1.36		
Predator:	(2) SHARK/RAY/SCOMB				
1. SEA BIRDS		0.006	0.03	0.999	0.966
2. SHARK/RAY/SCOMB	(0' Cycle)	0.013	0.07	0.978	-0.132
3. L-IMJACKSCARN		0.039	0.21	0.982	-0.045
4. L-IMSCHOOLPEL		0.258	1.36	0.978	-0.154
5. SMALLSCHOOLPEL		0.148	0.78	0.965	-0.374
6. LGGROUPERSCARN		0.026	0.14	0.989	0.222
7. L-IMBENTHCARN		0.210	1.10	0.940	-0.585
8. SMALLBENTHCARN		0.105	0.55	0.838	-0.832
9. BENTHINVOMNI		0.027	0.14	0.261	-0.973
10. L-IMREEFFHERB		0.090	0.47	0.851	-0.818
11. SMALLREEFFHERB		0.003	0.02	0.391	-0.964
12. BENTHINVHERB		0.031	0.16	-0.108	-0.987
13. SEMISESSDETRIV		0.038	0.20	0.044	-0.983
20. Detritus		0.006	0.03	-0.970	-1.000
TOTAL		1.000	5.26		
Predator:	(3) L-IMJACKSCARN				
3. L-IMJACKSCARN	(0' Cycle)	0.010	0.16	0.931	0.241
4. L-IMSCHOOLPEL		0.056	0.89	0.901	0.043
5. SMALLSCHOOLPEL		0.203	3.24	0.974	0.679
7. L-IMBENTHCARN		0.140	2.23	0.911	0.105
8. SMALLBENTHCARN		0.130	2.07	0.867	-0.118
9. BENTHINVOMNI		0.014	0.22	-0.061	-0.909
10. L-IMREEFFHERB		0.200	3.19	0.930	0.236
11. SMALLREEFFHERB		0.212	3.38	0.988	0.883
12. BENTHINVHERB		0.010	0.16	-0.587	-0.972
13. SEMISESSDETRIV		0.004	0.06	-0.794	-0.988
16. ZOOPLANKTON		0.021	0.33	0.536	-0.694
TOTAL		1.000	15.95		
Predator:	(4) L-IMSCHOOLPEL				
4. L-IMSCHOOLPEL	(0' Cycle)	0.023	5.09	0.774	0.055
5. SMALLSCHOOLPEL		0.093	20.58	0.944	0.723
8. SMALLBENTHCARN		0.014	3.10	0.204	-0.659
9. BENTHINVOMNI		0.075	16.60	0.652	-0.205
10. L-IMREEFFHERB		0.007	1.55	-0.017	-0.769
16. ZOOPLANKTON		0.574	127.01	0.978	0.943
19. Benthic prod.		0.214	47.35	-0.092	-0.798
TOTAL		1.000	221.27		
Predator:	(5) SMALLSCHOOLPEL				
5. SMALLSCHOOLPEL	(0' Cycle)	0.002	0.67	-0.143	-0.813
12. BENTHINVHERB		0.006	2.01	-0.730	-0.958
14. SESSILEDETRIV		0.017	5.70	-0.832	-0.975
16. ZOOPLANKTON		0.628	210.73	0.980	0.958
17. DECOMP/MICROF		0.003	1.01	0.005	-0.756
18. Phytoplankton		0.301	101.00	0.949	0.754
20. Detritus		0.043	14.43	-0.804	-0.971
TOTAL		1.000	335.56		
Predator:	(6) LGGROUPERSCARN				
2. SHARK/RAY/SCOMB		0.010	0.02	0.972	0.779
3. L-IMJACKSCARN		0.010	0.02	0.931	0.433

continued...

Table 8.8.2 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
4. L-IMSCHOOLPEL		0.010	0.02	0.547	-0.566
7. L-IMBENTHCARN		0.612	1.02	0.979	0.851
10. L-IMREEFFHERB		0.288	0.48	0.951	0.585
12. BENTHINVHERB		0.070	0.12	0.291	-0.744
TOTAL		1.000	1.67		
Predator:	(7) L-IMBENTHCARN				
3. L-IMJACKSCARN		0.001	0.24	0.472	-0.156
4. L-IMSCHOOLPEL		0.004	0.94	0.154	-0.481
5. SMALLSCHOOLPEL		0.028	6.58	0.826	0.509
7. L-IMBENTHCARN	(0' Cycle)	0.058	13.64	0.798	0.436
8. SMALLBENTHCARN		0.050	11.76	0.688	0.190
9. BENTHINVOMNI		0.234	55.03	0.873	0.646
10. L-IMREEFFHERB		0.038	8.94	0.680	0.174
11. SMALLREEFFHERB		0.009	2.12	0.745	0.310
12. BENTHINVHERB		0.150	35.27	0.592	0.018
13. SEMISESSDETRIV		0.198	46.56	0.701	0.217
14. SESSILEDETRIV		0.116	27.28	-0.231	-0.726
15. CORALS		0.002	0.47	-0.845	-0.958
16. ZOOPLANKTON		0.057	13.40	0.800	0.441
19. Benthic prod.		0.043	10.11	-0.714	-0.919
20. Detritus		0.012	2.82	-0.941	-0.985
TOTAL		1.000	235.15		
Predator:	(8) SMALLBENTHCARN				
4. L-IMSCHOOLPEL		0.004	2.00	0.154	-0.445
5. SMALLSCHOOLPEL		0.007	3.51	0.448	-0.141
7. L-IMBENTHCARN		0.023	11.52	0.558	0.013
8. SMALLBENTHCARN	(0' Cycle)	0.040	20.04	0.624	0.120
9. BENTHINVOMNI		0.135	67.62	0.790	0.458
11. SMALLREEFFHERB		0.003	1.50	0.391	-0.211
12. BENTHINVHERB		0.150	75.14	0.592	0.066
13. SEMISESSDETRIV		0.151	75.64	0.626	0.123
14. SESSILEDETRIV		0.014	7.01	-0.860	-0.959
15. CORALS		0.002	1.00	-0.845	-0.955
16. ZOOPLANKTON		0.153	76.64	0.920	0.822
17. DECOMP/MICROF		0.038	19.03	0.855	0.625
19. Benthic prod.		0.119	59.61	-0.368	-0.772
20. Detritus		0.161	80.65	-0.422	-0.797
TOTAL		1.000	500.91		
Predator:	(9) BENTHINVOMNI				
8. SMALLBENTHCARN		0.004	10.75	-0.396	-0.644
9. BENTHINVOMNI	(O' Ccyle)	0.047	126.34	0.497	0.229
12. BENTHINVHERB		0.018	48.38	-0.363	-0.620
13. SEMISESSDETRIV		0.036	96.77	0.017	-0.310
14. SESSILEDETRIV		0.092	247.29	-0.337	-0.602
15. CORALS		0.006	16.13	-0.597	-0.777
16. ZOOPLANKTON		0.038	102.14	0.714	0.557
17. DECOMP/MICROF		0.045	120.96	0.876	0.851
18. Phytoplankton		0.076	204.29	0.811	0.727
19. Benthic prod.		0.286	768.73	0.052	-0.277
20. Detritus		0.352	946.17	-0.059	-0.379
TOTAL		1.000	2,687.98		
Predator:	(10) L-IMREEFFHERB				
8. SMALLBENTHCARN		0.001	0.68	-0.805	-0.306
9. BENTHINVOMNI		0.001	0.68	-0.881	-0.530
14. SESSILEDETRIV		0.001	0.68	-0.989	-0.950
16. ZOOPLANKTON		0.001	0.68	-0.727	-0.120
19. Benthic prod.		0.828	559.10	0.526	0.975
20. Detritus		0.168	113.44	-0.404	0.388
TOTAL		1.000	675.25		

continued...

Table 8.8.2 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(11) SMALLREEFFHERB				
9. BENTHINVOMNI		0.008	1.85	-0.328	0.027
12. BENTHINVHERB		0.001	0.23	-0.949	-0.902
13. SEMISESSDETRIV		0.012	2.78	-0.487	-0.171
16. ZOOPLANKTON		0.033	7.65	0.678	0.915
19. Benthic prod.		0.844	195.65	0.532	0.815
20. Detritus		0.102	23.64	-0.591	-0.314
TOTAL		1.000	231.81		
Predator:	(12) BENTHINVHERB				
8. SMALLBENTHCARN		0.003	9.07	-0.510	-0.743
9. BENTHINVOMNI		0.005	15.12	-0.519	-0.749
12. BENTHINVHERB	(0' Cycle)	0.007	21.17	-0.692	-0.848
13. SEMISESSDETRIV		0.006	18.15	-0.706	-0.855
14. SESSILEDETRIV		0.087	263.11	-0.362	-0.648
15. CORALS		0.025	75.61	0.025	-0.345
16. ZOOPLANKTON		0.025	75.61	0.595	0.325
17. DECOMP/MICROF		0.097	293.36	0.941	0.970
18. Phytoplankton		0.002	6.05	-0.597	-0.794
19. Benthic prod.		0.645	1,950.66	0.429	0.092
20. Detritus		0.098	296.38	-0.603	-0.798
TOTAL		1.000	3,024.28		
Predator:	(13) SEMISESSDETRIV				
17. DECOMP/MICROF		0.100	126.04	0.942	0.946
18. Phytoplankton		0.125	157.55	0.881	0.787
19. Benthic prod.		0.023	28.99	-0.836	-0.936
20. Detritus		0.752	947.80	0.310	-0.157
TOTAL		1.000	1,260.37		
Predator:	(14) SESSILEDETRIV				
16. ZOOPLANKTON		0.061	411.65	0.812	0.750
17. DECOMP/MICROF		0.041	276.68	0.865	0.846
18. Phytoplankton		0.081	546.62	0.822	0.768
20. Detritus		0.817	5,513.40	0.347	0.076
TOTAL		1.000	6,748.34		
Predator:	(15) CORALS				
16. ZOOPLANKTON		0.150	162.00	0.919	0.850
17. DECOMP/MICROF		0.100	108.00	0.942	0.921
19. Benthic prod.		0.650	702.00	0.432	-0.091
20. Detritus		0.100	108.00	-0.597	-0.852
TOTAL		1.000	1,080.00		
Predator:	(16) ZOOPLANKTON				
17. DECOMP/MICROF		0.600	3,168.00	0.990	0.987
18. Phytoplankton		0.200	1,056.00	0.924	0.406
20. Detritus		0.200	1,056.00	-0.329	-0.919
TOTAL		1.000	5,280.00		
Predator:	(17) DECOMP/MICROF				
19. Benthic prod.		0.050	1,425.00	-0.675	0.212
20. Detritus		0.950	27,075.00	0.411	0.992
TOTAL		1.000	28,500.00		
Predator:	(20) Detritus				
1. SEA BIRDS		0.000	0.33	0.619	0.038
2. SHARK/RAY/SCOMB		0.000	1.15	-0.480	0.003
3. L-IMJACKSCARN		0.000	4.48	-0.300	0.005
4. L-IMSCHOOLPEL		0.002	45.16	-0.202	0.006
5. SMALLSCHOOLPEL		0.003	76.69	0.107	0.011
6. LGGROUPERSCARN		0.000	0.47	-0.755	0.001
7. L-IMBENTHCARN		0.002	53.05	-0.480	0.003

continued...

Table 8.8.2 continued

	Diet composition	Food intake	Ivlev's elec-tivity index	Standardized forage ratio
8. SMALLBENTHCARN	0.004	103.78	-0.348	0.004
9. BENTHINVOMNI	0.024	556.60	0.206	0.014
10. L-IMREEFFHERB	0.007	151.22	-0.053	0.008
11. SMALLREEFFHERB	0.002	48.25	0.226	0.014
12. BENTHINVHERB	0.028	651.23	-0.156	0.007
13. SEMISESSDETRIV	0.012	276.03	-0.490	0.003
14. SESSILEDETRIV	0.100	2,314.37	-0.301	0.005
15. CORALS	0.011	253.59	-0.370	0.004
16. ZOOPLANKTON	0.049	1,148.09	0.773	0.070
17. DECOMP/MICROF	0.249	5,786.93	0.976	0.752
18. Phytoplankton	0.031	728.50	0.597	0.035
19. Benthic prod.	0.474	10,997.76	0.296	0.016
TOTAL	1.000	23,197.67		

Table 8.8.3. The 20-box model as obtained by method 2 (ECOPATH II aggregation routine).

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator: (1)	Agg. 26				
1. Agg. 26	(0' Cycle)	0.058	14.14	0.816	0.192
2. Agg. 24		0.051	12.29	0.830	0.236
3. Agg. 20		0.126	30.45	0.653	-0.187
4. Agg. 22		0.037	9.06	0.424	-0.483
5. ENGRAULIDAEH		0.009	2.25	0.868	0.371
6. Agg. 25		0.116	28.15	0.918	0.595
7. Agg. 21		0.076	18.35	0.783	0.095
8. SMBENTHARTHROPO		0.045	10.80	0.889	0.458
9. GASTROPODS		0.055	13.42	0.713	-0.071
10. CHITONS/SCAPHOP		0.015	3.57	0.091	-0.712
11. POLY/PRIA/OPHIU		0.085	20.47	0.856	0.329
12. BIVALVES		0.042	10.25	0.323	-0 568
13. ASCI/BARN/BRYOZ		0.027	6.64	0.004	-0.753
14. SPONGES		0.083	19.98	-0.315	-0.865
15. CORALS/ANEMONES		0.003	0.67	-0.792	-0.968
16. ZOOPLANKTON		0.143	34.59	0.915	0.578
19. Benthic prod.		0.029	6.97	-0.799	-0.969
20. Detritus		0.000	0.03	-0.999	-1.000
TOTAL		1.000	242.06		
Predator: (2)	Agg. 24				
1. Agg. 26		0.000	0.03	-0.977	-0.997
2. Agg. 24	(0' Cycle)	0.041	15.18	0.794	0.045
3. Agg. 20		0.001	0.39	-0.922	-0.990
4. Agg. 22		0.004	1.64	-0.547	-0.933
5. ENGRAULIDAEH		0.006	2.24	0.804	0.074
7. Agg. 21		0.014	5.09	0.198	-0.697
11. POLY/PRIA/OPHIU		0.045	16.62	0.747	-0.079
13. ASCI/BARN/BRYOZ		0.016	5.74	-0.272	-0.873
16. ZOOPLANKTON		0.836	308.27	0.985	0.978
17. DECOMP/MICROFAU		0.003	1.15	0.023	-0.778
19. Benthic prod.		0.033	12.19	-0.772	-0.970
TOTAL		1.000	368.53		
Predator: (3)	Agg. 20				
2. Agg. 24		0.009	8.80	0.296	0.728
3. Agg. 20	(0' Cycle)	0.005	5.55	-0.656	-0.287
4. Agg. 22		0.002	1.85	-0.785	-0.518
7. Agg. 21		0.002	2.22	-0.617	-0.224
11. POLY/PRIA/OPHIU		0.001	1.48	-0.635	-0.253
12. BIVALVES		0.004	3.70	-0.711	-0.382
14. SPONGES		0.019	19.13	-0.787	-0.523
15. CORALS/ANEMONES		0.019	18.76	-0.129	0.382
19. Benthic prod.		0.939	952.25	0.570	0.899
TOTAL		1.000	1,013.73		
Predator: (4)	Agg. 22				
7. Agg. 21		0.002	0.99	-0.642	-0.642
9. GASTROPODS		0.001	0.27	-0.888	-0.889
11. POLY/PRIA/OPHIU		0.001	0.50	-0.733	-0.733
15. CORALS/ANEMONES		0.001	0.50	-0.919	-0.920
16. ZOOPLANKTON		0.000	0.11	-0.933	-0.933
17. DECOMP/MICROFAU		0.045	22.26	0.877	0.973
18. Phytoplankton		0.005	2.23	-0.273	-0.263
19. Benthic prod.		0.349	171.64	0.151	0.182
20. Detritus		0.596	293.29	0.202	0.236
TOTAL		1.000	491.77		
Predator: (5)	ENGRAULIDAEH				
16. ZOOPLANKTON		0.200	28.86	0.939	0.742
18. Phytoplankton		0.700	101.01	0.978	0.963
20. Detritus		0.100	14.43	-0.597	-0.923
TOTAL		1.000	144.31		

continued...

Table 8.8.3 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator: (6)	Agg. 25				
1. Agg. 26		0.014	5.46	0.417	0.028
2. Agg. 24		0.001	0.45	-0.596	-0.810
3. Agg. 20		0.038	14.53	0.184	-0.236
4. Agg. 22		0.022	0.62	-0.804	-0.914
5. ENGRAULIDAEH		0.001	0.28	0.055	-0.359
6. Agg. 25	(0' Cycle)	0.010	3.65	0.321	-0.089
7. Agg. 21		0.012	4.42	0.114	-0.304
8. SMBENTHARTHROPO		0.014	5.43	0.690	0.437
9. GASTROPODS		0.042	16.10	0.641	0.354
11. POLY/PRIA/OPHIU		0.020	7.45	0.500	0.140
12. BIVALVES		0.046	17.63	0.364	-0.037
13. ASCI/BARN/BRYOZ		0.018	6.83	-0.204	-0.567
14. SPONGES		0.043	16.32	-0.573	-0.798
15. CORALS/ANEMONES		0.014	5.43	-0.253	-0.601
16. ZOOPLANKTON		0.061	23.12	0.811	0.667
17. DECOMP/MICROFAU		0.021	8.06	0.754	0.554
18. Phytoplankton		0.014	5.32	0.278	-0.137
19. Benthic prod.		0.514	195.15	0.332	-0.075
20. Detritus		0.114	43.39	-0.552	-0.786
TOTAL		1.000	379.66		
Predator: (7)	Agg. 21				
1. Agg. 26		0.017	7.52	0.493	-0.244
2. Agg. 24		0.003	1.34	-0.204	-0.765
3. Agg. 20		0.082	35.26	0.513	-0.219
4. Agg. 22		0.004	1.86	-0.556	-0.892
5. ENGRAULIDAEH		0.006	2.69	0.809	0.356
6. Agg. 25		0.007	2.99	0.168	-0.557
7. Agg. 21	(0' Cycle)	0.047	20.05	0.668	0.030
8. SMBENTHARTHROPO		0.025	10.76	0.810	0.357
9. GASTROPODS		0.150	64.48	0.883	0.591
10. CHITONS/SCAPHOP		0.008	3.66	-0.182	-0.755
11. POLY/PRIA/OPHIU		0.040	17.37	0.721	0.137
12. BIVALVES		0.240	103.59	0.835	0.431
13. ASCI/BARN/BRYOZ		0.004	1.62	-0.757	-0.946
14. SPONGES		0.004	1.62	-0.954	-0.991
15. CORALS/ANEMONES		0.002	0.97	-0.828	-0.963
16. ZOOPLANKTON		0.094	40.35	0.873	0.555
17. DECOMP/MICROFAU		0.038	16.41	0.855	0.495
19. Benthic prod.		0.079	34.08	-0.530	-0.884
20. Detritus		0.149	64.34	-0.453	-0.859
TOTAL		1.000	430.98		
Predator: (8)	SMBENTHARTHROPO				
13. ASCI/BARN/BRYOZ		0.050	83.14	0.295	0.174
14. SPONGES		0.060	99.77	-0.451	-0.567
15. CORALS/ANEMONES		0.040	66.51	0.251	0.123
16. ZOOPLANKTON		0.040	66.51	0.726	0.713
17. DECOMP/MICROFAU		0.040	66.51	0.862	0.904
19. Benthic prod.		0.600	997.73	0.399	0.295
20. Detritus		0.170	282.69	-0.400	-0.522
TOTAL		1.000	1,662.88		
Predator: (9)	GASTROPODS				
4. Agg. 22		0.015	9.83	-0.005	-0.260
6. Agg. 25		0.002	1.31	-0.424	-0.619
7. Agg. 21		0.006	3.93	-0.213	-0.448
8. SMBENTHARTHROPO		0.006	3.93	0.391	0.171
9. GASTROPODS	(0' Cycle)	0.020	13.10	0.367	0.141
10. CHITONS/SCAPHOP		0.020	13.10	0.239	-0.007
11. POLY/PRIA/OPHIU		0.050	32.76	0.769	0.703
12. BIVALVES		0.040	26.21	0.298	0.059
13. ASCI/BARN/BRYOZ		0.058	38.00	0.361	0.134
14. SPONGES		0.040	26.21	-0.597	-0.745
15. CORALS/ANEMONES		0.015	9.83	-0.230	-0.463
17. DECOMP/MICROFAU		0.030	19.66	0.820	0.786

continued...

Table 8.8.3 continued

	Diet composition	Food intake	Ivlev's elec-tivity index	Standardized forage ratio
19. Benthic prod.	0.400	262.08	0.217	-0.032
20. Detritus	0.298	195.25	-0.141	-0.386
TOTAL	1.000	655.20		
Predator: (10) CHITONS/SCAPHOP				
13. ASCI/BARN/BRYOZ	0.040	29.02	0.190	-0.576
14. SPONGES	0.020	14.51	-0.776	-0.955
15. CORALS/ANEMONES	0.008	5.80	-0.500	-0.886
17. DECOMP/MICROFAU	0.300	217.62	0.980	0.995
19. Benthic prod.	0.632	458.45	0.421	-0.376
TOTAL	1.000	725.40		
Predator: (11) POLY/PRIA/OPHIU				
8. SMBENTHARTHROPO	0.015	30.49	0.702	0.383
9. GASTROPODS	0.010	20.33	0.038	-0.443
11. POLY/PRIA/OPHIU (0' Cycle)	0.030	60.98	0.642	0.275
12. BIVALVES	0.030	60.98	0.162	-0.334
13. ASCI/BARN/BRYOZ	0.040	81.31	0.190	-0.308
14. SPONGES	0.050	101.64	-0.520	-0.800
15. CORALS/ANEMONES	0.010	20.33	-0.411	-0.743
16. ZOOPLANKTON	0.050	101.64	0.775	0.528
17. DECOMP/MICROFAU	0.050	101.64	0.888	0.791
18. Phytoplankton	0.100	203.28	0.853	0.704
19. Benthic prod.	0.245	498.04	-0.025	-0.493
20. Detritus	0.370	752.14	-0.034	-0.500
TOTAL	1.000	2,032.80		
Predator: (12) BIVALVES				
17. DECOMP/MICROFAU	0.100	103.79	0.942	0.937
18. Phytoplankton	0.150	155.68	0.900	0.820
20. Detritus	0.750	778.41	0.309	-0.188
TOTAL	1.000	1,037.88		
Predator: (13) ASCI/BARN/BRYOZ				
16. ZOOPLANKTON	0.150	412.20	0.919	0.764
17. DECOMP/MICROFAU	0.100	274.80	0.942	0.854
18. Phytoplankton	0.200	549.60	0.924	0.782
20. Detritus	0.550	1,511.40	0.163	-0.516
TOTAL	1.000	2,748.00		
Predator: (14) SPONGES				
17. DECOMP/MICROFAU	0.001	4.00	-0.496	0.434
20. Detritus	0.999	3,996.00	0.432	0.986
TOTAL	1.000	4,000.00		
Predator: (15) CORALS/ANEMONES				
16. ZOOPLANKTON	0.150	163.35	0.919	0.850
17. DECOMP/MICROFAU	0.100	108.90	0.942	0.921
19. Benthic prod.	0.650	707.85	0.432	-0.091
20. Detritus	0.100	108.90	-0.597	-0.852
TOTAL	1.000	1,089.00		
Predator: (16) ZOOPLANKTON				
17. DECOMP/MICROFAU	0.600	3,168.00	0.990	0.987
18. Phytoplankton	0.200	1,056.00	0.924	0.406
20. Detritus	0.200	1,056.00	-0.329	-0.919
TOTAL	1.000	5,280.00		

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Table 8.8.3 continued

		Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(17) DECOMP/MICROFAU				
19. Benthic prod.		0.050	1,425.00	-0.675	0.212
20. Detritus		0.950	27,075.00	0.411	0.992
TOTAL		1.000	28,500.00		
Predator:	(20) Detritus				
1. Agg. 26		0.002	53.07	-0.442	0.003
2. Agg. 24		0.004	81.93	-0.144	0.007
3. Agg. 20		0.011	256.67	-0.409	0.004
4. Agg. 22		0.004	102.59	-0.548	0.003
5. ENGRAULIDAEH		0.001	30.83	0.337	0.018
6. Agg. 25		0.003	79.87	-0.179	0.006
7. Agg. 21		0.004	90.62	-0.406	0.004
8. SMBENTHARTHROPO		0.015	337.41	0.694	0.048
9. GASTROPODS		0.006	134.39	-0.231	0.005
10. CHITONS/SCAPHOP		0.006	147.06	-0.319	0.005
11. POLY/PRIA/OPHIU		0.018	420.53	0.470	0.024
12. BIVALVES		0.010	228.85	-0.374	0.004
13. ASCI/BARN/BRYOZ		0.026	613.32	-0.014	0.008
14. SPONGES		0.073	1,700.82	-0.367	0.004
15. CORALS/ANEMONES		0.010	220.89	-0.431	0.003
16. ZOOPLANKTON		0.050	1,157.00	0.775	0.069
17. DECOMP/MICROFAU		0.250	5,787.20	0.976	0.734
18. Phytoplankton		0.031	726.88	0.596	0.035
19. Benthic prod.		0.475	11,023.57	0.297	0.016
TOTAL		1.000	23,193.50		

Table 8.8.4. The 11-box model as obtained by method 1 (cluster analysis + intuition).

			Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(1)	APEX PREDATORS				
1. APEX PREDATORS		(0' Cycle)	0.026	0.59	0.962	0.722
2. SCHOOLPELAGICS			0.320	7.22	0.966	0.761
3. BENTHCARNIVORES			0.279	6.30	0.892	0.198
4. BENTHINVOMNI			0.016	0.36	0.006	-0.859
5. BENTHHERBIVORES			0.328	7.40	0.645	-0.475
6. BENTHDETRITIVOR			0.012	0.27	-0.897	-0.992
7. ZOOPLANKTON			0.018	0.41	0.479	-0.646
11. Detritus			0.001	0.02	-0.995	-1.000
TOTAL			1.000	22.56		
Predator:	(2)	SCHOOLPELAGICS				
2. SCHOOLPELAGICS		(0' Cycle)	0.047	26.16	0.787	-0.185
3. BENTHCARNIVORES			0.006	3.34	-0.452	-0.944
4. BENTHINVOMNI			0.030	16.70	0.310	-0.743
5. BENTHHERBIVORES			0.006	3.34	-0.844	-0.987
6. BENTHDETRITIVOR			0.010	5.57	-0.913	-0.993
7. ZOOPLANKTON			0.607	337.84	0.979	0.930
8. DECOMP/MICROFAU			0.002	1.11	-0.195	-0.901
9. Phytoplankton			0.181	100.74	0.916	0.359
10. Benthic prod.			0.085	47.31	-0.504	-0.951
11. Detritus			0.026	14.47	-0.877	-0.990
TOTAL			1.000	556.57		
Predator:	(3)	BENTHCARNIVORES				
2. SCHOOLPELAGICS			0.018	13.28	0.525	-0.192
3. BENTHCARNIVORES		(0' Cycle)	0.077	56.80	0.657	0.028
4. BENTHINVOMNI			0.167	123.20	0.827	0.450
5. BENTHHERBIVORES			0.169	124.68	0.409	-0.338
6. BENTHDETRITIVOR			0.213	157.14	-0.017	-0.674
7. ZOOPLANKTON			0.122	90.00	0.901	0.720
8. DECOMP/MICROFAU			0.026	19.18	0.795	0.353
10. Benthic prod.			0.095	70.08	-0.461	-0.863
11. Detritus			0.113	83.36	-0.556	-0.893
TOTAL			1.000	737.73		
Predator:	(4)	BENTHINVOMNI				
3. BENTHCARNIVORES		(0' Cycle)	0.004	10.75	-0.598	-0.872
4. BENTHINVOMNI			0.0047	126.34	0.497	-0.066
5. BENTHHERBIVORES			0.024	64.51	-0.494	-0.830
6. BENTHDETRITIVOR			0.128	344.06	-0.265	-0.724
7. ZOOPLANKTON			0.038	102.14	0.714	0.320
8. DECOMP/MICROFAU			0.045	120.96	0.876	0.749
9. Phytoplankton			0.076	204.29	0.811	0.557
10. Benthic prod.			0.286	768.76	0.052	-0.526
11. Detritus			0.352	946.17	-0.059	-0.604
TOTAL			1.000	2,687.98		
Predator:	(5)	BENTHHERBIVORES				
3. BENTHCARNIVORES			0.002	10.02	-0.777	-0.937
4. BENTHINVOMNI			0.004	20.05	-0.596	-0.876
5. BENTHHERBIVORES		(0' Cycle)	0.019	95.22	-0.577	-0.869
6. BENTHDETRITIVOR			0.057	285.65	-0.589	-0.874
7. ZOOPLANKTON			0.049	245.56	0.771	0.429
8. DECOMP/MICROFAU			0.080	400.91	0.928	0.917
9. Phytoplankton			0.001	5.01	-0.776	-0.936
10. Benthic prod.			0.680	3,407.77	0.451	-0.153
11. Detritus			0.108	541.23	-0.572	-0.867
TOTAL			1.000	5,011.42		
Predator:	(6)	BENTHDETRITIVOR				
7. ZOOPLANKTON			0.051	408.43	0.779	0.457
8. DECOMP/MICROFAU			0.050	400.42	0.888	0.776

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Table 8.8.4 continued

	Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
9. Phytoplankton	0.088	704.74	0.835	0.610
10. Benthic prod.	0.004	32.03	-0.969	-0.992
11. Detritus	0.807	6,462.74	0.341	-0.277
TOTAL	1.000	8,008.36		
Predator: (7) ZOOPLANKTON				
8. DECOMP/MICROFAU	0.600	3,168.00	0.990	0.975
9. Phytoplankton	0.200	1,056.00	0.924	0.110
11. Detritus	0.200	1,056.00	-0.329	-0.957
TOTAL	1.000	5,280.00		
Predator: (8) DECOMP/MICROFAU				
10. Benthic prod.	0.050	1,425.00	-0.675	-0.105
11. Detritus	0.950	27,075.00	0.411	0.984
TOTAL	1.000	28,500.00		
Predator: (11) Detritus				
1. APEX PREDATORS	0.000	6.23	-0.304	0.005
2. SCHOOLPELAGICS	0.005	121.76	-0.032	0.009
3. BENTHCARNIVORES	0.007	157.94	-0.401	0.004
4. BENTHINVOMNI	0.024	553.56	0.203	0.015
5. BENTHHERBIVORES	0.048	1,106.77	-0.195	0.007
6. BENTHDETRITIVOR	0.112	2,588.50	-0.328	0.005
7. ZOOPLANKTON	0.050	1,151.63	0.774	0.077
8. DECOMP/MICROFAU	0.250	5,789.42	0.976	0.822
9. Phytoplankton	0.031	729.23	0.597	0.039
10. Benthic prod.	0.474	10,994.04	0.296	0.018
TOTAL	1.000	23,199.07		

Table 8.8.5. The 11-box model as obtained by method 2 (ECOPATH II aggregation routine).

			Diet composition	Food intake	Ivlev's electivity index	Standardized forage ratio
Predator:	(1)	Agg. 12				
1. Agg. 12		(0' Cycle)	0.090	94.00	0.639	-0.244
2. Agg. 20			0.063	66.10	0.413	-0.523
3. Agg. 15			0.169	176.06	0.650	-0.226
4. Agg. 11			0.130	135.01	0.447	-0.491
5. Agg. 13			0.029	30.44	-0.142	-0.825
6. SPONGES			0.021	21.60	-0.769	-0.967
7. ZOOPLANKTON			0.368	383.20	0.966	0.930
8. DECOMP/MICROFAU			0.017	17.56	0.700	-0.129
10. Benthic prod.			0.051	53.24	-0.669	-0.951
11. Detritus			0.062	64.37	-0.730	-0.961
TOTAL			1.000	1,041.58		
Predator:	(2)	Agg. 20				
1. Agg. 12			0.011	11.02	-0.293	0.084
2. Agg. 20		(0' Cycle)	0.005	5.55	-0.656	-0.409
3. Agg. 15			0.003	3.33	-0.832	-0.694
4. Agg. 11			0.004	3.70	-0.863	-0.747
5. Agg. 13			0.019	18.76	-0.355	0.008
6. SPONGES			0.019	19.13	-0.787	-0.618
10. Benthic prod.			0.939	952.25	0.570	0.920
TOTAL			1.000	1,013.73		
Predator:	(3)	Agg. 15				
1. Agg. 12			0.004	15.25	-0.645	-0.878
2. Agg. 20			0.004	14.53	-0.732	-0.911
3. Agg. 15		(0' Cycle)	0.047	166.91	0.133	-0.421
4. Agg. 11			0.065	231.24	0.135	-0.419
5. Agg 13			0.025	89.04	-0.217	-0.671
6. SPONGES			0.041	144.17	-0.593	-0.857
7. ZOOPLANKTON			0.035	124.87	0.694	0.331
8. DECOMP/MICROFAU			0.043	151.61	0.870	0.766
9. Phytoplankton			0.059	210.83	0.764	0.485
10. Benthic prod.			0.317	1,126.91	0.103	-0.447
11. Detritus			0.361	1,284.06	-0.047	-0.562
TOTAL			1.000	3,559.43		
Predator:	(4)	Agg. 11				
7. ZOOPLANKTON			0.112	441.06	0.893	0.495
8. DECOMP/MICROFAU			0.096	378.59	0.940	0.756
9. Phytoplankton			0.205	806.29	0.926	0.668
11. Detritus			0.586	2,304.24	0.193	-0.674
TOTAL			1.000	3,930.18		
Predator:	(5)	Agg. 13				
4. Agg. 11			0.032	112.16	-0.211	-0.777
5. Agg. 13		(0' Cycle)	0.021	72.32	-0.303	-0.814
6. SPONGES			0.033	114.28	-0.656	-0.924
7. ZOOPLANKTON			0.066	229.87	0.825	0.424
8. DECOMP/MICROFAU			0.113	393.04	0.949	0.926
10. Benthic prod.			0.622	2,164.03	0.415	-0.350
11. Detritus			0.113	391.59	-0.557	-0.897
TOTAL			1.000	3,477.28		
Predator:	(6)	SPONGES				
8. DECOMP/MICROFAU			0.001	4.00	-0.496	0.143
11. Detritus			0.999	3,996.00	0.432	0.974
TOTAL			1.000	4,000.00		
Predator:	(7)	ZOOPLANKTON				
8. DECOMP/MICROFAU			0.600	3,168.00	0.990	0.975
9. Phytoplankton			0.200	1,056.00	0.924	0.110
11. Detritus			0.200	1,056.00	-0.329	-0.957
TOTAL			1.000	5,280.00		

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Table 8.8.5 continued

	Diet composition	Food intake	Ivlev's elec-tivity index	Standardized forage ratio
Predator: (8) DECOMP/MICROFAU				
10. Benthic prod.	0.050	1,425.00	-0.675	-0.105
11. Detritus	0.950	27,075.00	0.411	0.984
TOTAL	1.000	28,500.00		
Predator: (11) Detritus				
1. Agg. 12	0.010	225.63	-0.343	0.005
2. Agg. 20	0.011	256.67	-0.409	0.004
3. Agg. 15	0.032	737.37	-0.061	0.009
4. Agg. 11	0.038	873.00	-0.136	0.007
5. Agg. 13	0.030	705.36	-0.122	0.008
6. SPONGES	0.073	1,700.82	-0.367	0.005
7. ZOOPLANKTON	0.050	1,157.00	0.775	0.078
8. DECOMP/MICROFAU	0.250	5,787.20	0.976	0.828
9. Phytoplankton	0.031	726.88	0.596	0.039
10. Benthic prod.	0.475	11,023.57	0.297	0.018
TOTAL	1.000	23,193.50		

Appendix 8.9. Summary statistics and flows between discrete trophic levels for the 20- and 11-box models from two methods.

Table 8.9.1. Summary statistics for a 20-box model of a Caribbean coral reef (method 1). PP = primary production.

Sum of all production	=	51,285	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all imports[a]	=	475	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all respiratory flows	=	32,525	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all flows into detritus	=	23,198	$g \cdot m^{-2} \cdot year^{-1}$
Total system throughput	=	107,483	$g \cdot m^{-2} \cdot year^{-1}$
Throughput cycled	=	20,459	$g \cdot m^{-2} \cdot year^{-1}$
Finn's cycling index	=	19.03%	of throughput
Input total net PP	=	20,500	$g \cdot m^{-2} \cdot year^{-1}$
Calculated total net PP	=	20,025	$g \cdot m^{-2} \cdot year^{-1}$

[a]Difference between input total net PP and calculated total net PP.

Table 8.9.2. Network flow indices for a 20-box model of a Caribbean coral reef (method 1).

Source	Ascendency flowbits	%	Overhead flowbits	%	Capacity flowbits	%
Input	0	0.0	0	0.0	0	0.0
Internal	90,203	22.4	209,148	51.9	299,351	74.3
Dissipation	52,951	13.1	50,589	12.6	103,540	25.7
Total	143,154	35.5	259,737	64.5	402,891	100.0

Table 8.9.3 Flows and transfer efficiencies for discrete trophic levels of a 20-box model (method 1).

Flows originating from the primary producers

Trophic level	Import	Export	Respi-ration	Through-put	Flow to detritus
I	0.000	480.000	0.000	0.000	11,726.258
II	0.000	0.000	5,226.313	7,818.739	1,748.263
III	0.000	0.000	550.389	844.163	194.366
IV	0.000	0.000	67.132	99.408	23.043
V	0.000	0.000	6.358	9.233	1.992
VI	0.000	0.000	0.602	0.883	0.192
VII	0.000	0.000	0.061	0.089	0.019
VIII	0.000	0.000	0.006	0.009	0.002
IX	0.000	0.000	0.001	0.001	0.000

Flows originating from the detritus

Trophic level	Import	Export	Respi-ration	Through-put	Flow to detritus
I	475.000	0.000	0.000	23,172.668	0.000
II	0.000	0.000	23,098.771	36,177.758	8,161.688
III	0.000	0.000	2,954.389	4,917.297	1,108.677
IV	0.000	0.000	563.005	854.232	215.283
V	0.000	0.000	53.000	75.944	16.284
VI	0.000	0.000	4.550	6.660	1.438
VII	0.000	0.000	0.457	0.671	0.146
VIII	0.000	0.000	0.046	0.068	0.015
IX	0.000	0.000	0.005	0.007	0.002

Table 8.9.4. Summary statistics for a 20-box model of a Caribbean coral reef (method 2). PP = primary production.

Sum of all production	=	51,282	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all imports[a]	=	475	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all respiratory flows	=	32,523	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all flows into detritus	=	23,193	$g \cdot m^{-2} \cdot year^{-1}$
Total system throughput	=	107,473	$g \cdot m^{-2} \cdot year^{-1}$
Throughput cycled	=	19,726	$g \cdot m^{-2} \cdot year^{-1}$
Finn's cycling index	=	18.35%	of throughput
Input total net PP	=	20,500	$g \cdot m^{-2} \cdot year^{-1}$
Calculated total net PP	=	20,025	$g \cdot m^{-2} \cdot year^{-1}$

[a]Difference between input total net PP and calculated total net PP.

Table 8.9.5. Network flow indices for a 20-box model of a Caribbean coral reef (method 2).

Source	Ascendency flowbits	%	Overhead flowbits	%	Capacity flowbits	%
Input	952	0.2	2,678	0.6	3,630	0.9
Internal	93,243	21.8	221,083	51.6	314,326	73.3
Dissipation	52,340	12.2	58,334	13.6	110,674	25.8
Total	146,535	34.2	282,095	65.8	428,630	100.0

Table 8.9.6. Flows and transfer efficiencies for discrete trophic levels of a 20-box model (method 2).

Flows originating from the primary producers

Trophic level	Import	Export	Respiration	Throughput	Flow to detritus
I	0.000	480.000	0.000	0.000	11,750.450
II	0.000	0.000	5,241.900	7,794.550	1,668.085
III	0.000	0.000	587.240	884.564	189.563
IV	0.000	0.000	73.484	107.762	23.132
V	0.000	0.000	7.547	11.145	2.394
VI	0.000	0.000	0.806	1.204	0.259
VII	0.000	0.000	0.093	0.139	0.030
VIII	0.000	0.000	0.011	0.016	0.003

Flows originating from the detritus

Trophic level	Import	Export	Respiration	Throughput	Flow to detritus
I	475.000	0.000	0.000	23,668.496	0.000
II	0.000	0.000	22,976.932	36,171.262	8,299.344
III	0.000	0.000	2,991.129	4,894.986	1,058.519
IV	0.000	0.000	580.908	845.338	182.146
V	0.000	0.000	56.716	82.284	17.643
VI	0.000	0.000	5.313	7.925	1.705
VII	0.000	0.000	0.606	0.906	0.195
VIII	0.000	0.000	0.070	0.105	0.023

Table. 8.9.7. Summary statistics for an 11-box model of a Carribbean reef (method 1). PP = primary production.

Sum of all production	=	51,285	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all imports[a]	=	475	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all respiratory flows	=	32,525	$g \cdot m^{-2} \cdot year^{-1}$
Sum of all flows into detritus	=	23,199	$g \cdot m^{-2} \cdot year^{-1}$
Total system throughput	=	107,484	$g \cdot m^{-2} \cdot year^{-1}$
Throughput cycled	=	20,900	$g \cdot m^{-2} \cdot year^{-1}$
Finn's cycling index	=	19.45%	of throughput
Input total net PP	=	20,500	$g \cdot m^{-2} \cdot year^{-1}$
Calculated total net PP	=	20,025	$g \cdot m^{-2} \cdot year^{-1}$

[a]Difference between input total net PP and calculated total net PP.

Table 8.9.8. Network flow indices for an 11-box model of a Caribbean coral reef (method 1).

Source	Ascendency flowbits	%	Overhead flowbits	%	Capacity flowbits	%
Input	0	0.0	0	0.0	0	0.0
Internal	88,466	23.5	194,187	51.5	282,653	75.0
Dissipation	52,947	14.0	41,325	11.0	94,272	25.0
Total	141,413	37.5	235,512	62.5	376,925	100.0

Table 8.9.9. Flows and transfer efficiencies for discrete trophic levels of an 11-box model (method 1).

Flows originating from the primary producers

Trophic level	Import	Export	Respi-ration	Through-put	Flow to detritus
I	0.000	480.000	0.000	0.000	11,723.268
II	0.000	0.000	5,221.518	7,821.728	1,759.426
III	0.000	0.000	549.314	840.784	192.542
IV	0.000	0.000	66.822	98.928	22.744
V	0.000	0.000	6.411	9.363	2.037
VI	0.000	0.000	0.624	0.915	0.200
VII	0.000	0.000	0.062	0.091	0.020
VIII	0.000	0.000	0.006	0.009	0.002

Flows originating from the detritus

Trophic level	Import	Export	Respi-ration	Through-put	Flow to detritus
I	475.000	0.000	0.000	23,174.063	0.000
II	0.000	0.000	23,098.945	36,179.004	8,154.590
III	0.000	0.000	2,963.081	4,925.468	1,118.325
IV	0.000	0.000	560.205	844.063	207.598
V	0.000	0.000	52.484	76.260	16.565
VI	0.000	0.000	4.923	7.210	1.572
VII	0.000	0.000	0.487	0.715	0.156
VIII	0.000	0.000	0.049	0.071	0.016

Table 8.9.10. Summary statistics for an 11-box model of a Caribbean coral reef (method 2). PP = primary production.

Sum of all production	=	51,282	$g \cdot m^{-2} year^{-1}$
Sum of all imports[a]	=	475	$g \cdot m^{-2} year^{-1}$
Sum of all respiratory flows	=	32,523	$g \cdot m^{-2} year^{-1}$
Sum of all flows into detritus	=	23,193	$g \cdot m^{-2} year^{-1}$
Total system throughput	=	107,473	$g \cdot m^{-2} year^{-1}$
Throughput cycled	=	20,117	$g \cdot m^{-2} year^{-1}$
Finn's cycling index	=	18.70%	of throughput
Input total net PP	=	20,500	$g \cdot m^{-2} year^{-1}$
Calculated total net PP	=	20,025	$g \cdot m^{-2} year^{-1}$

[a]Difference between input total net PP and calculated total net PP.

Table 8.9.11. Network flow indices for an 11-box model of a Caribbean coral reef (method 2).

Source	Ascendency flowbits	%	Overhead flowbits	%	Capacity flowbits	%
Input	952	0.2	2,678	0.7	3,630	0.9
Internal	90,229	22.7	205,030	51.5	295,259	74.2
Dissipation	52,313	13.1	46,835	11.8	99,148	24.9
Total	143,494	36.0	254,543	64.0	398,037	100.0

Table 8.9.12. Flows and transfer efficiencies for discrete trophic levels of an 11-box model (method 2).

Flows originating from the primary producers					
Trophic level	Import	Export	Respiration	Throughput	Flow to detritus
I	0.000	480.000	0.000	0.000	11,750.449
II	0.000	0.000	5,237.327	7,794.550	1,668.588
III	0.000	0.000	589.595	888.635	190.385
IV	0.000	0.000	74.016	108.655	23.315
V	0.000	0.000	7.692	11.325	2.439
VI	0.000	0.000	0.805	1.194	0.259
VII	0.000	0.000	0.087	0.130	0.028
Flows originating from detritus					
Trophic level	Import	Export	Respiration	Throughput	Flow to detritus
I	475.000	0.000	0.000	23,668.494	0.000
II	0.000	0.000	22,991.117	36,171.262	8,299.580
III	0.000	0.000	2,977.325	4,880.564	1,055.676
IV	0.000	0.000	577.533	847.562	181.747
V	0.000	0.000	60.478	88.282	18.856
VI	0.000	0.000	6.053	8.947	1.934
VII	0.000	0.000	0.647	0.961	0.209

ICLARM

INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT

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Caribbean coral reef fishery resources. J.L. Munro, Editor. 1983. ICLARM Stud. Rev. 7, 276 p. US$16 surface, $33 airmail, P200 (paperback); $19.50 surface, $37 airmail, P250 (cloth).

FishBase 96: concepts, design and data sources. R. Froese and D. Pauly, Editors. 1996. ICLARM. 179 p. Distributed with one CD-ROM disk for US$95 (airmail). Available free of cost for collaborators of the FishBase project. Available only from the FishBase Project, ICLARM, MCPO Box 2631, 0718 Makati City, Philippines.

ReefBase: a global database on coral reefs and their resources. ReefBase. 1996. CD ROM. User's guide, 144 p. US$95 for CD and guide, including airmail cost.

ECOPATH 3.0 (Windows version). V. Christensen and D. Pauly. 1996. ICLARM Software 6. Distributed free in two 3-1/2" diskettes. This version has a very extensive help message system. ECOPATH II (version 2.22) will continue to be distributed to those who prefer a DOS version. Contact V. Christensen for details at v.christensen@cgnet.com.

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