AN OVERVIEW OF THE ECOPATH MODEL

by

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Recent trends in ecosystem modeling have produced complex simulation models which are very data intensive (Andersen and Ursin 1977; Laevastu and Larkins 1981). However, in many situations the construction of a biomass budget for a box model of an ecosystem is relatively simple and can provide important information about the ecosystem standing stock and energy flow (Walsh 1981; Pauly 1982; Polovina in press).

The ECOPATH model is an analytical procedure to estimate a biomass budget for a box model of an ecosystem given inputs which specify the components of the ecosystem, together with their mortality, diet, and energetics value. A computer program for ECOPATH has been written in BASIC-80, version 5.21, by Microsoft[1] (CP/M version) and a listing and users manual is available from the author.

The ECOPATH model produces estimates of mean annual biomass, annual biomass production, and annual biomass consumption for each of the user specified species groups. The species groups represent aggregations of species with similar diet and life history characteristics and which have a common physical habitat. The ECOPATH model is not a simulation model with a time component as are some more complex ecosystem models. It estimates a biomass budget for the marine ecosystem in a static situation under the assumption that the ecosystem is at equilibrium conditions.

Equilibrium conditions are defined to exist when the mean annual biomass for each species group does not change from year to year. This condition results in a system of biomass budget equations which, for species group i, can be expressed as:

Production of biomass for species i - all predation on species i - nonpredatory biomass mortality for species i - fishery catch for species i = 0, for all i ...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. The mean annual biomass estimates are obtained by solving the system of simultaneous linear equations.

ECOPATH requires the following input data:

A. The species groups or "boxes" of the ecosystem are to be specified by the user. These species groups are typically aggregates of species at the same trophic level with similar life history and population parameters. Species groups can be as restrictive as "tunas" or as aggregated as "pelagics" depending on the levels of detail of the following input data and intent of the user.

B. For each species group the following must be specified:

   1. Annual production to biomass ratio (P/B). Where growth follows a von Bertalanffy curve, and mortality is negative exponential, the P/B value for many species groups is the annual

1 Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

instantaneous mortality (Z) while for primary and secondary producers whose growth is more likely to be linear the P/B value can be taken to be the reciprocal of the mean age (Allen 1971).

2. Diet composition (DC). For a given species group this is the fraction, by weight, of each species group it consumes. These data typically are obtained from analysis of stomach contents (Macdonald and Green 1983).
3. Total annual food required (FR). This is the amount the average individual of a species group must consume annually as a multiple of the mean individual body weight.
4. Ecotrophic efficiency (EE). This is the fraction of total production removed annually by fishing and predation mortality. Typically in the range of 0.75-0.95 (Ricker 1969).
5. Habitat area (HA). The total area of habitat for each species group.
6. Annual fishery catch data (catch). The annual fishery yield for any species group for which there is substantial fishery mortality. If there is no fishery catch data then the mean annual biomass (B) for at least one species group must be inputed to insure that there is a unique solution to the set of biomass equations.

The ECOPATH model was applied to a coral reef ecosystem with 15 species groups. The output of ECOPATH simplified to 12 species groups was used to construct the biomass and production budget for the coral reef ecosystem given in Figure 1.

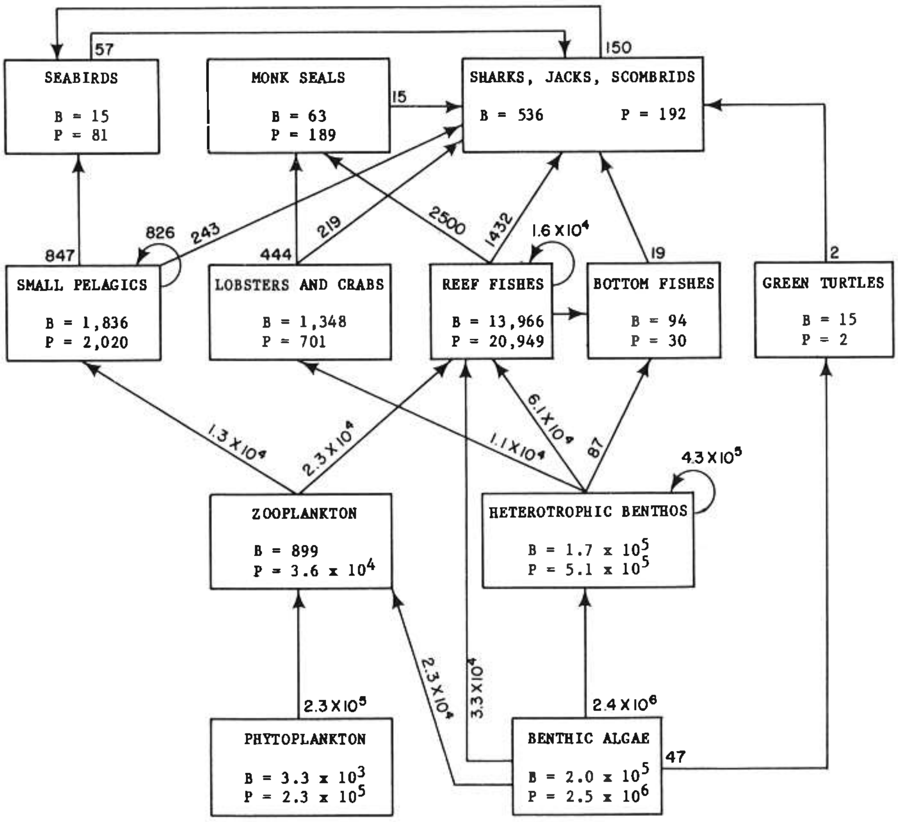

Fig. 1. Biomass budget for major prey-predator pathways. Annual production denoted as P and mean annual biomass as B with values in units of kg/km^2 based on a habitat area of 1,200 km^2.

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NOTES ON THE COMPLETION OF FAO FORM FISHSTAT NS1 (NATIONAL SUMMARY)

by

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These notes are addressed primarily to fisheries statisticians (or those who have drawn the short straw and been given the FAO form to complete) working in countries with a mainly subsistence fishery and with little or no staff to collect data.

1. It is important to bear in mind that every other statistician is lying, intending to lie, cannot help lying or has been told to lie. If your own statistics are a model of truth or are painfully arrived at estimates, it will be impossible to test their honesty; it will be assumed that you too, are lying (lying means, of course, data management - a scientific and administrative technique which may be familiar to readers. The concept of 'creative truth' is, perhaps, preferable).

2. Avoid ending in zeros, this is clearly the result of glib oversimplification. Figures that end in uneven numbers suggest that care has been taken to achieve the final total.

3. Check the previous year's figures with this year's 'estimate', there should be no suggestion of any discernable pattern since this indicates that a formula has been used. If you do use a formula, remember to finish off your final 3, 4 or 5 digits (depending on the size of your fishery) with a random number. It is statistically sound to use a random number table; open the page, close your eyes and drop a pencil down onto the page - use that number.

4. Each year's estimate should be larger than the previous year's