INTERNAL REPORT 12

Consumer Modeling Status Report
Round 1

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During the four meetings of the consumer modeling committee, discussion centered on the formation of systems models and the problems they will pose for researchers concerned with consumer populations. Two coarse models were developed from these discussions, a compartment model (Figure 1) and a process model (Figure 2). The compartments are defined along functional trophic lines with materials or energy, or both, flowing between them. The process model is used to define the processes that govern the rate of flow between compartments.

These flows are the couplings that join compartments and may be represented by a set of external variables. The internal structure of the submodels representing actions within a compartment would be determined by the sets of external variables. Before further work on submodels can be done, sets of compatible external variables must be formed. To make such a list of relevant external variables, the objectives of the overall systems model must be reviewed. The primary purpose of the model is to understand the operations of the ecosystem, with the ultimate hope of predicting the consequences of perturbations. The importance of any component of the ecosystem, therefore, must be judged not only on criteria of biomass and energy transfer but also on its influence as a controlling factor of other aspects of ecosystem operation. Thus, external variables related to components with postulated control functions must be included along with those related to components that make up large amounts of the biomass or that have rapid energy-turnover rates.

The consumer modeling committee drew up a list of external variables they believe to be relevant. The list pertains to terrestrial, above-ground consumers.

Inputs from primary producers
- Structure:
  - Trees (Douglas-fir, western redcedar, western hemlock, and miscellaneous species)
    - Succulent vegetative parts
      - Characterized by age
    - Persistent vegetative parts
      - Bark
        - Inner
        - Outer
      - Wood
        - Heartwood
        - Sapwood
      - Reproductive structures
        - Female cones
        - Seeds

Shrubs
Succulent parts
Persistent vegetative parts
Forbs
Grasses
Epiphytes
Analysis:
Biomass
Nutrient content (N, P, etc.)
Energy content

In addition to the variables listed, stand characteristics such as aspect, elevation, trees per acre, and tree heights would be needed. The list of variables presented is probably incomplete and will be modified after committees have met and discussed the external variables for other compartments.

Outputs to detritus
Structure:
Vertebrates
Mammals (deer, small mammals, others)
Bones
Soft parts
Excrement
Birds (major species)
Bones
Soft parts
Excrement
Herps (amphibians, reptiles)
Bones
Soft parts
Excrement
Invertebrates (major taxa)
Exoskeletons
Soft parts
Excrement
Analysis:
Biomass-particle size
Nutrient content (N, P, etc.)
Energy content

The possibility of using material spectra rather than separating outputs by taxa was also discussed.

A few species may require a more detailed study than an overall systems model would afford. These species may need to be modeled separately, allowing the rest of the system to act as part of their environment.

From the discussion of the internal structure of the consumer submodel arose some critical problems that require further discussion.

Temporal considerations

Consumers in all categories do not have uniform generation times and this poses a problem as to when a population fix should be made to assess the status of a particular species population.

One way to resolve this problem is to partition populations into single generation per year species (including those whose generation time is greater than one year) and species with multiple generations per year as opposed to a vertebrate-invertebrate stratification. Thus, for all populations, a primary resolution to estimate population status will be one year with a common anniversary date. To provide population status data for between anniversary dates, as needed by other subsystem components, other times must be established for the collection of this data.

Spatial considerations

Habitat preferences of species and populations and vegetational types within the system usually will delineate spatial stratifications. In some instances, habitat preferences will cut across vegetational types, which will thus consitute subhabitat strata.

Species considerations

Of necessity, only a few species can be considered separately for precise, fine-resolution information. Other species will have to be lumped. No more than 12 invertebrate species (or other closely related functional groups), 6 bird species, 6 reptile and amphibian species, and 6 mammal species should be considered. Which species to separate and which to group will not be easy to decide, and we may not be able to apply *a priori* reasoning to this problem. The role of consumers, no less than recognition of the dominant taxa, in forest ecosystems is so little known that "proper" selection may well be impossible.

Closed vs. open systems

A watershed system, the working unit for our biome study, is not one that is biologically meaningful for most consumer species. To a consumer, a watershed is an open system. Because of this, consumer researchers are concerned with an "edge effect" and with relating off-watershed to on-watershed population conditions. The sampling problems--and biological ones--associated with this may be difficult to achieve in a short time.

Genetic variability

The genotypic and phenotypic structure of populations is known to change considerably from one generation to the next, and with multigeneration-per-year species, this could be an important control variable. This internal feature could not only influence how producer-variables are responded to, but also change the inputs utilized by the detritus component. This internal variable is unlikely to be assessed, but it should not be ignored.

Inventory considerations

Inventory of some taxa will be easier than others, and it will be especially difficult for invertebrates and microorganisms. The volume of material will be great for invertebrate species and the sorting alone will be a tremendous problem. Identification of dominant taxa (biomass?) should be done early. Less money for inventory may be available in years three and four, however, so some of us are faced with the critical problem of determining dominant taxa before any collecting. This problem needs urgent attention.

Population dynamics

Studies of the temporal dynamics of any one species-population ary probably precluded by the anticipated length of the biome program. Techniques to interpret population change for less than five generations are lacking, and usually these come after an adequate sampling program has been developed. To talk of population dynamics studies in years 3 and 4 appears to be somewhat naive, and it is unlikely such will be undertaken. Studies will undoubtedly be confined to review of published material.

Perturbations

Has it been decided whether consumers are to be considered both as perturbators and perturbatees? If so, what species shall we follow? Short term perturbations can have long-term consequences. We are, apparently, to be concerned with only short-term effects. Are perturbations other than clearcutting to be considered? Such as?

General considerations

Many of the consumer researchers are concerned by the apparent ignorance of the biome-framers as to what data can be obtained in a short time. The consumer research will be a a coarse level of resolution throughout the biome study, apparently. At best, perhaps, we will be able to provide some information to the detritus compartment. How much use can be made of the producer-inputs as control functions of consumer response is hard to conceive, as is how consumers may exert a control function on the producers. This aspect of the biome study, that is, what the consumer researcher is going to be able to do in the field, needs a thorough discussion before year two of the study.

Several specific tasks or questions have been defined that require immediate attention. Members of the consumer modeling subcommittee are urged to consider the first four before Round 2.

1. Cross check compatibility of external variables with other subsystems.

2. Specify the taxonomic groups conforming to the species resolution suggested in Round 1 and critically appraise this suggestion.

3. Identify prototype groups from the above list which represent the spectrum of dynamic properties.

4. Identify for each prototype group the important ecological and life-history properties and interactions.

5. Build a compartment/process model of the consumer subsystem.