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INTERNAL REPORT 29

REPORT OF THE AQUATIC MODELING GROUP--ROUND ONE

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The aquatic modeling group, consisting of Davis, Donaldson, Hall, Higley, Lyford, McIntire, Mullooly, Overton, Strand, Waring, and Warren, met in four 2-hour sessions from July 7 to July 26. The charge to the group was: 1. Define an appropriate internal structure for the aquatic subsystem; 2. Define significant couplings between the aquatic and terrestrial systems; and 3. Begin to evaluate the present program with the above as background.

In general, the discussion centered around stream systems, and specifically around the Lookout Creek drainage on the H. J. Andrews Forest, site of most of the Oregon field research. Much consideration was given to the best means of incorporating data from earlier studies on Berry Creek, the Drift Creek streams (Alsea Watershed Study), and the Oak Creek Experimental Streams into present modeling efforts. Higley is charged with the responsibility of bringing together a listing of the pertinent publications and theses that might be most applicable to this effort. A tentative listing is included with this report.

INTERNAL STRUCTURE

Discussion on internal structure centered on two main concepts, a rough compartment model for the Lookout Creek system (Figure 1) and an energy budget model that has been outlined by Cummins for an eastern woodland stream (Figure 2). We agreed that a combination of both approaches would have value in the early stages of modeling, although we have reservations about each one.

COUPLINGS BETWEEN TERRESTRIAL AND AQUATIC SYSTEMS

In keeping with an objective of studying all important interconnections between the terrestrial and aquatic systems, the major part of the discussion was centered on identifying these couplings and trying to evaluate their significance. The importance of maintaining a close connection between the terrestrial and aquatic programs was one of the major points, relative to the aquatic program, in the review by the NSF Site Visit Team. The concensus was that the most important couplings and influences lead from the terrestrial to the aquatic system, and that the stream appears to have little influence on the terrestrial system. A few pathways, however, have the potential to funnel energy and nutrients back onto the land from the stream and these should be measured, at least generally. In general, we believe that the stream itself probably contributed little to the conservation of nutrients in the ecosystem, because biomass levels are low and export is a pervasive feature of streams, particularly during the freshet season. In keeping with the overall goal of studying mechanisms maintaining productivity in forest systems, however, such an evaluation should be part of the aquatic modeling effort.

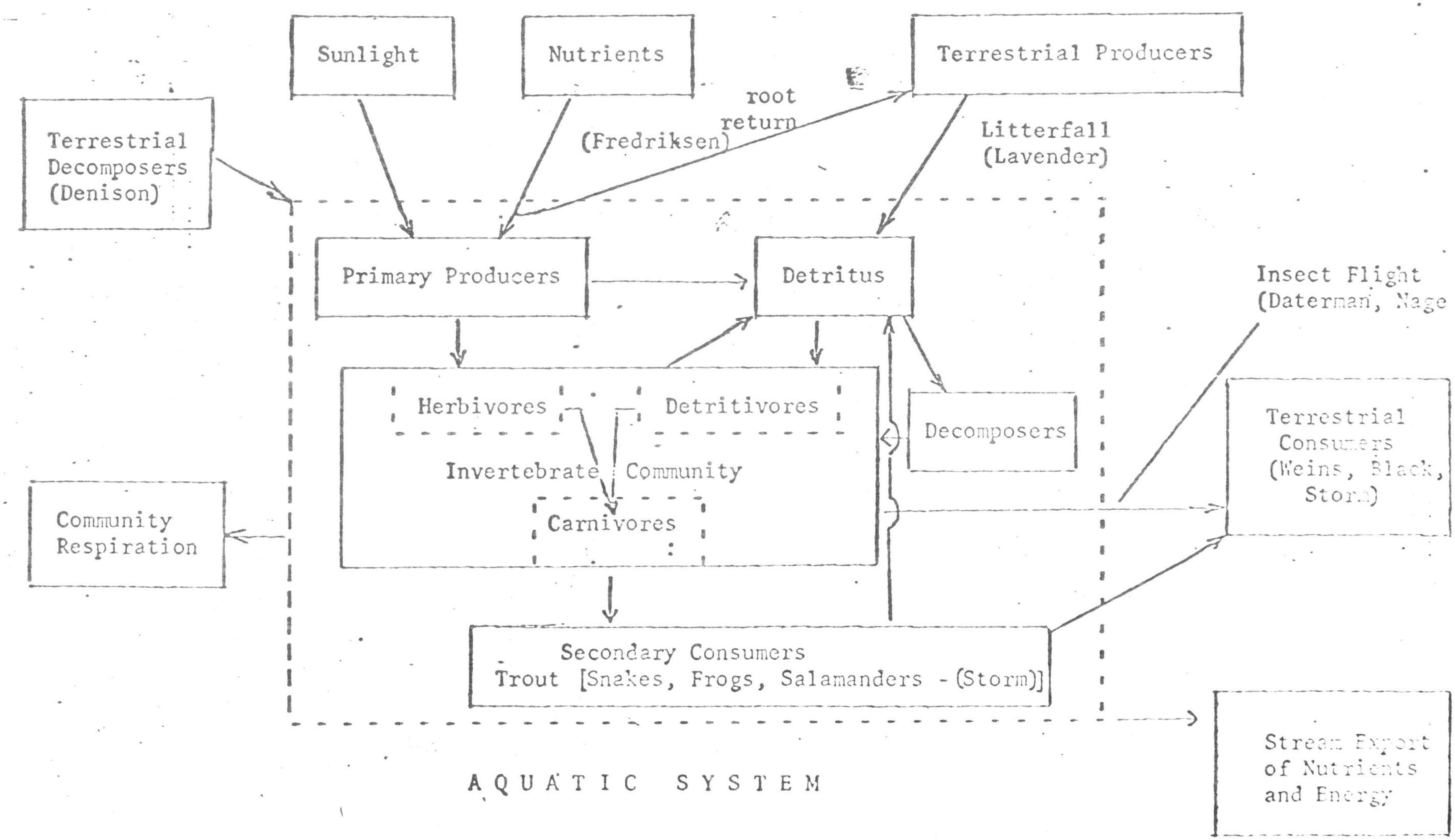

Figure 1. A tentative structure for the stream system at the H. J. Andrews Experimental Forest.

AVERAGE DAILY ENERGY BUDGET FOR A WOODLAND STREAM

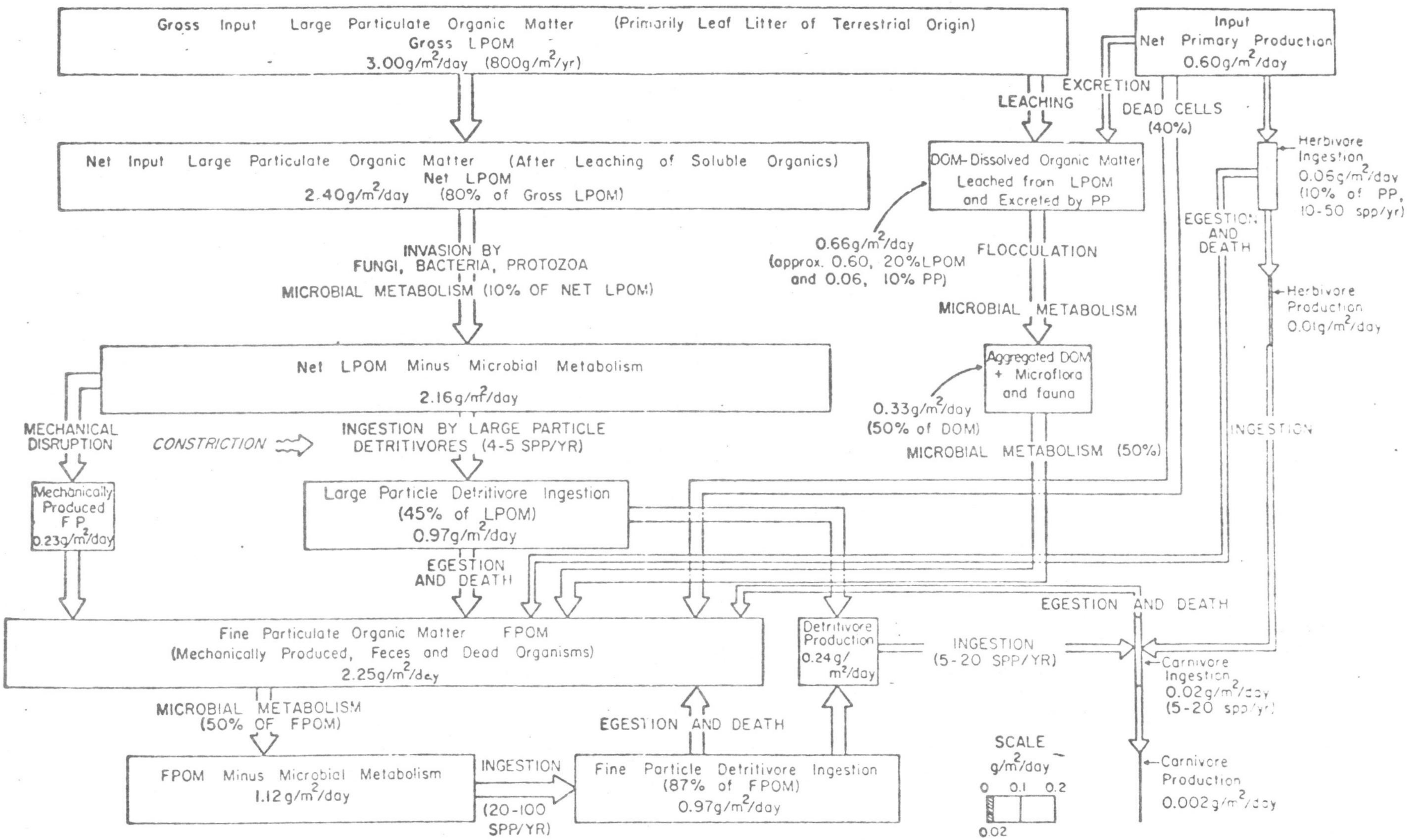

Figure 2. An estimated energy budget for a typical woodland or heterotrophic stream. Data and "impressions" from Coffman, Cummins, Fisher, Hall, Howard, Hynes, Kaushik, Petersen, Roff, Ross, Triska, Ulfstrand, Vannote, Warren, and Wuycheck. (see Directory).

The terrestrial-aquatic couplings that were believed to be most important in the Lookout Creek system are identified in Figure 1 and further catalogued in Table 1, according to temporal and spatial resolution and precision. This listing should be regarded as preliminary, with considerable effort needed to refine it during Round Two in light of the input-output listings prepared by the other modeling groups. As a result of preliminary review several problems are evident:

1) Hydrology, nutrient cycling, and aquatic groups need to consider further the spatial resolution and structure of the stream system. The former groups are presently concerned mainly with watersheds 2 and 10; We need some additional gaging and nutrient work in the larger tributaries of Lookout Creek, (particularly Mack Creek) and in main Lookout Creek itself. These stations could be temporary, on a sampling basis, and at a lower level of time resolution than work on the small watersheds.
2) More detail is now being put into nutrient analyses in stream waters than seems necessary from the point of view of aquatic productivity. This resolution may be desirable for other reasons, but it must be defended on the basis of the needs of the terrestrial group. A tentative listing of the minimum nutrient analysis that would be desired for the aquatic program is listed in Table 1. The work on nitrogen (nitrate) and total phosphorus should be carefully examined for sensitivity and variation, because of the low levels present and the expense of the analyses. The view was advanced that total dissolved solids or electrical conductivity might be as useful in prediction of aquatic productivity.
3) Return of nutrients through the roots of streamside vegetation now appears to be the major pathway of nutrient conservation. Whether it is of significance or not is unknown and we have no definitive work outline to estimate its magnitude. The work by Donaldson in Berry Creek, with labeled elements (calcium and phosphorus) in salmon carcasses, could provide some information, but the radiation level will probably be too low to be very sensitive.
4) Considerable discussion between hydrology and the aquatic groups is needed in the area of sediment. The concensus was that sediment is the most significant disruptive influence on the stream caused by forest management activities, yet there is little work proposed in this area in Biome 02. In addition, the role of sediment as a carrier of nutrients for stream production needs clarification.

A WORKING MODEL

The most progress in a working computer model was reported by McIntire as a result of his work at the Quantitative Science Center, University of Washington, last year. His model, written in MIMIC, could provide a strong basis on which to build the aquatic model for our program. The modular nature of the computer program, allowing easy modification of individual segments, is particularly desirable. Consideration should be given to representation by means of difference equations rather than the present structure of differential equations.

Table 1. A tentative listing of inputs, outputs, and environmental variables for the H. J. Andrews stream study.

Subsystem - Aquatic

I. Inputs	Resolution (Time)	Resolution (Space)	Precision	Notes
a. Streamflow (from Hydrology)	During flood-flows period: Instantaneous peak from each "storm" plus daily flow in liters /day Low flow period: average flow for 2-week periods liters/day	Outlets of WS 2, 10, Mack Creek, Lookout Creek	± 10%	"Storms" to be defined by Hydrology group Need to coordinate spatial resolution w/ Hydrology & Nutrient Cycling groups
b. Sediment (from Hydrology?)	During flood-flow period: Bedload & suspended load transported past gaging station during each "storm".	Same as above	± 10-20%	
	During trout spawning season: Accumulation or loss of sediment from intragravel spaces on weekly basis	Several areas of spawning gravel	± 10-20%	
	During low-flow period: Accumulation or loss of sediment from bottom of pools	Study sections in Mack Creek & Lookout Creek	± 10-20%	
c. Nutrients Total Dissolved solids, Electrical Conductivity, Total N, Total P, Total Dissolved Organics, CO_2 (from Alkalinity, pH, and temp.)	Average concentration over 2-week intervals in mg/liter	WS 2 & 10, Headwaters, Mack Creek, Mack Creek below clearcut, main Lookout at Mack Creek, Lookout at Gage	± 10%	Additional sampling stations needed, at least for initial survey may be discontinued later
d. Radiation				
1) Photosynthetically active & reaching stream, in cal/cm^2	a) hourly totals	At photosynthesis measuring points during respirometer experiments	± 10%	Need relationship between density of foliage & % of radiation reaching stream
	b) daily totals	Integrated over stream sections	± 10%	
2) Net radiation (heat input) in cal/cm^2	daily totals	Integrated over stream sections	± 10%	

I. (cont.)	Resolution (time)	Resolution (space)	Precision	Notes
e. Detritus (leaves, needles, twigs reaching stream)	Weekly total Minimum definition: conifer-deciduous desired: by species	Selected sampling stations in 5 stream sections	± 10%	Post-doctoral will develop sampling methods. Input from Lavender?
f. Decomposer organisms	Weekly total by species?	"	?	Need to coordinate with detritus sampling. Post-doc will organize. Help from decomposer group?
II. Environmental Variables				
a. Water temp.	hourly (from recording thermographs)	WS 2, 10 2 or 3 stations in Mack Cr. 2 stations in Lookout	± 0.5°C	Need additional thermograph stations
b. Current velocity	?	?	± 10%	Spot measurements by interested investigator:
III. Outputs				
a. Gross photosynthesis by aquatic plants & algae as a group (no species resolution)	2-week intervals during growing season	WS 2, 10 ? Mack Creek Lookout Creek	± 20%	
b. Community respiration	2-week intervals during growing season	Same as above	± 20%	
c. Standing biomass of aquatic plants and algae (some resolution at least by major groups - diatoms, filamentous algae, mosses, etc.	Same	Same		
d. Standing biomass of invertebrates by major taxa - (order - family)	Monthly during April - October	Same	low	

	Resolution (time)	Resolution (space)	Precision	Notes
e. Standing biomass of vertebrates by species	Monthly April-October	MackCreek Lookout Creek	± 20%	
f. Growth & production of cutthroat trout	Monthly April-October	Mack Creek Lookout Creek	± 10%	
g. Export of organic matter downstream	By storms	Mack Creek Lookout Creek	?	
h. Return of nutrients to terrestrial system via roots of streamside vegetation	?	?	?	Donaldson will get some info from Berry Cr. w/ Ca and P - other investigator on HJA
i. Return of nutrients to terrestrial system by consumption of aquatic organisms	?	?	?	

EVALUATION OF PRESENT PROGRAM

Little time was available to spend on evaluation of the present program during Round One. That should be one of the tasks of Round Two. In addition, a progress report from the modeling project of Warren and Calvin should be included in the Round Two report.

PUBLICATIONS

Preliminary list of publications and theses from work at Berry Creek, Oak Creek, and Alsea Watershed Study that might be applicable to stream modeling.

BROCKSEN, R. W., G. E. DAVIS, and C. E. WARREN. 1968. Competition food consumption, and production of sculpins and trout in laboratory stream communities. J. Wildl. Manage. 32(1):51-75.

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BROCKSEN, R. W. 1966. Influence of competition on the food consumption and production in laboratory stream communities. M.S. thesis, Oreg. State Univ., Corvallis, Oreg. 82 p.

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CARLINE, R. F. 1968. Laboratory studies on the food consumptions, growth, and activity of juvenile coho salmon. M.S. thesis, Oreg. State Univ., Corvallis, Oreg. 75 p.

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