INTRODUCTION

Lotic benthic invertebrate dynamics and the role of detrital materials in the Cedar River have been under investigation since 1971. Information gathered here will be compared with similar data obtained from other streams under investigation in the Coniferous Forest Biome. These data will be assimilated and incorporated into a model simulating the lotic ecosystem. Our investigations have been coordinated with concurrent studies at Oregon State University and other studies of the Cedar River. Our objectives are to determine the general ecology and dynamics of the invertebrate riffle communities at six stations in the Cedar River, determine the community relationship to some of the assumed more important environmental factors, both terrestrial and aquatic, and to model the invertebrate riffle community of the Cedar River from available literature data and data we have accumulated. This report summarizes work completed in the three years this project has been in progress.

Study Area

The Cedar River is a unique natural stream system. It is divided into three discrete sections where six invertebrate sampling stations were established (Figure 1). All stations were located in riffle areas at or closely adjacent to established USGS gaging stations. Two stations were located on the two major tributaries to Lake Chester Morse, one on the Cedar River (Station 1) and the other on the Rex River (Station 2). The river below the reservoir is separated into the two sections by the City of Seattle water supply diversion dam at Landsburg. Sockeye salmon (Oncorhynchus nerka) and other anadromous species spawn in the lower section but are excluded from the river above Landsburg. Two stations were located in each of these two sections of the river. In the section above the diversion, stations were established near Cedar Falls (Station 3) and near Landsburg (Station 4); in the section below the diversion, stations were established near Cedar Grove (Station 5) and near Renton (Station 6).

The watershed above Landsburg is managed by the City of Seattle as the principal water supply for municipal and industrial use. Water level of the lake and downstream flow below Lake Chester Morse is regulated to some extent by means of the Masonry Pool Dam and the water supply diversion. Masonry Pool Dam has a fixed spillway that does not allow manipulation of the lake level. However, there is an associated power house at Cedar Falls where water is piped from the reservoir and released into the river.
Two Pelton water wheel generators each pass up to 350 cfs of water, the volume depending on the water level of the reservoir. Flow is regulated at the water supply diversion by removal of up to 372 cfs of water for municipal use.

MATERIALS AND METHODS

Benthic Invertebrates

Sampling was conducted by three methods for varying periods of time. A general survey of the invertebrate populations at each of the six stations was conducted during the first three months of the study. Samples were collected each month beginning in July 1971 by a 0.25-m² quadrat sampler similar in design to, but larger than the one used by Surber (1937). This information helped determine the dominant taxa at each station. To standardize stream invertebrate sampling methods with those used at Oregon State University, sampling was conducted using screen pots which were buried in the substrate with only the surface exposed (Coleman and Hynes 1970). This method was used from September 1971 through October 1972. Pot sampling below Landsburg was discontinued after 6 mo because of vandalism, and quadrat sampling was conducted instead for benthos at Stations 5 and 6. Drift samples were collected once a month at each station for a 24-hr period. The samplers were of the design described by Miller (1961) and were constructed of 16.6-cm-diameter fiberglass pipe constricted at the mouth to 11.5 cm and fitted with a 1.6-m length of 351-μm-mesh netting. These samplers were held in position in the river by two steel fence posts. Water velocities were measured at the sampling sites with a Price-Gurley current meter. Drifting benthic invertebrates were sampled because the size of the river did not allow recovery of benthic samples during periods of high run-off. Drift samples will provide an alternate basis for determining biomass and production (Dimond 1967, Heaton 1966, Peterson 1966).

Benthos and drift samples containing invertebrates, detritus, and inorganic materials were preserved in the field with 70% ethanol. The sample was first separated from inorganic materials by elutrition. Invertebrate organisms were then separated from the detrital materials by individuals aided by illuminated magnifiers. Further separation of invertebrates into the finest taxonomic groups feasible and subsequent measurement was accomplished using a dissecting microscope. Drift samples were treated somewhat differently in that they were subsampled with a Jones type riffle sampler before the invertebrates were removed.

Benthic production will be calculated by the method proposed by Hynes and Coleman (1968) and later modified by Hamilton (1969). In this method production of the benthic community is estimated, rather than production for each species. Standing crop data were converted to production estimates by the use of size-class measurements as an index of growth and mortality. Calculation of drift production will be determined similarly by a method proposed by Bishop and Hynes (1969).

Allochthonous Material

In an attempt to determine the importance of allochthonous material as an energy source for the benthic invertebrates, detrital material present in
the benthic samples as well as the organic matter in drift net samples was retained for quantification. This material will be sieved into several size categories. The percent composition of different materials in each size category will be estimated and the material will then be dried and weighed. Detrital materials have been shown to serve as very important food for aquatic invertebrates (Chapman and Demary 1963), and a strong correlation has been demonstrated between the abundance of detritus present and the standing crop of aquatic insects that are not filter feeders (Eglishaw 1964).

Aquatic Environmental Quality

Temperature was monitored continuously with 8-day recording thermographs in the Cedar River above and below Lake Chester Morse and at Renton, Stations 1, 3, and 6, respectively. Temperature was also routinely recorded at Landsburg by the USGS. Discharge was recorded at the USGS gaging stations at Stations 1, 2, 3, 4, and 6. Routine measurements of water chemistry, (alkalinity, dissolved oxygen, hardness, pH, and specific conductance) were determined in the field with a Hach Laboratory Model DR-EL. A detailed anion-cation analysis was conducted quarterly by the City of Seattle Water Quality Laboratory according to Standard Methods (1971).

Gravel sampling was conducted following the procedure outlined by Koo (1964). A core-type sampler was used to collect gravel samples from the streambed. Each of three samples collected at a station were separated into size categories using a series of variable pore size screens and a settling cone which retained all particles smaller than the smallest pore size. The gravel remaining in each screen after sieving was measured by water displacement volume, including particles in the settling cone. Sieving of the substrate of all pot samplers remaining in the stream on the last sampling date was also conducted.

RESULTS AND DISCUSSION

Benthic and Drifting Invertebrates

Preliminary estimates of standing crop, biomass, and production of Tipulidae and Simuliidae were calculated for a 4-mo period, September-December 1971. For a full discussion and tabulation of these data see Coniferous Forest Biome Internal Report 93. It was found that production generally increased from upper to lower stations with the highest production occurring below Chester Morse Lake.

Production, biomass, and standing crop estimates for the other invertebrate groups are not yet available. The sorting of invertebrates from benthic and drift samples has been completed. We are now concentrating on identification and measurement of invertebrates. Invertebrate data at this time is in notebook form pertaining to the invertebrates separated into large taxonomic groups for most samples. The level of taxonomic distinction planned for the orders of aquatic insects is as follows: (1) Plecoptera-genera or species, (2) Ephemeroptera-general or species, (3) Trichoptera-family or genera (possibly species of Rhyacophila), (4) Diptera-family (although identification of individual specimens to genera is planned), other orders-family or genera.
Progress to date includes identification and measurement of some of the *Ephemera*
(Ephemeroptera), of which we have identified 16 species. The data obtained has not been converted to actual lengths and so is not presented. Identification and measurement of Plecoptera is being conducted at the University of Utah by Dr. Arden Gaufin. The identification and measurement of this group is almost complete, however, Dr. Gaufin has only compiled and presented us with a portion of this data. The data we received is for *Alloperla* and is presented in part in Figures 2 and 3. This genus contains at least 12 species in the Cedar River, but with further data and with the help of Dr. Gaufin we hope to break this genus into groups of three or four species for production, standing crop, and other ecological analysis.

**Allochthonous Materials**

Analysis of allochthonous materials will be completed during the next few months. This information will be recorded on 80-column data forms for direct computer analysis and compilation.

**Environmental Quality**

Summarization and tabulation of data concerning environmental quality was presented in the Coniferous Forest Biome Internal Report 93 and will not be presented here. All physicochemical water quality data has been entered on the Coniferous Forest Biome data bank. Data collected concerning substrates at the sampling stations are summarized in the same internal report. Substrate data is not available in the data bank but is on computer output.

**Sampling Dates**

Sampling dates were tabulated in Internal Report 93 and will not be repeated in this report. In general sampling was conducted from June 1971 through October 1972. Other information available are contour maps of each of the sampling stations. This is on computer output and not available in the data bank.

**LITERATURE CITED**


CHAPMAN, D. W., and R. DEMARY. 1963. Seasonal changes in the food ingested by aquatic insect larvae and nymphs in two Oregon streams. Ecol. 44:140-146.


Figure 1. Map of the Cedar River basin showing sampling stations.
Fig. 2. Number and length of *Alloperla* occurring in samples from the Rex River, Washington (Station 2).
Fig. 3. Number and length of Alloperla occurring in samples from the Cedar River near Landsburg, Washington (Station 4).