Insect Colonization Rates in Near-Shore Regions Subjected to Hydroelectric Power Peaking Flows[a]

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ABSTRACT

Studies were conducted in near-shore regions of the Clearwater River, Idaho, to determine benthic insect colonization rates. Dworshak Dam, located on the North Fork of the Clearwater River, subjects downstream shores to daily dewatering, thereby, influencing the benthic insect and algal communities. Continuously watered test and control substrates were sampled weekly to determine insect colonization rates. At least 47 days were required to establish near normal insect carrying capacity on test substrates.

INTRODUCTION

Hydroelectric dams have greatly affected flow regimes of major rivers throughout the world. The effects of hydroelectric power peaking on benthic invertebrates have been reported by Radford and Hartland-Rowe (1971), Spence and Hynes (1971), Fisher and LaVoy (1972), Brusven et al. (1974), Trotsky and Gregory (1974), Brusven and Trihey (1978), Ward and Short (1978) and Ward and Stanford (1979). Changes in the invertebrate communities below hydrolectric facilities have been largely attributed to regulated flows and temperature alterations. Periodic watering and dewatering of near-shore stream substrates potentially result in dramatic changes in diversity and productivity of benthic insect communities in a river system. The integrity of these communities is of concern in rivers subjected to regulated flows because of the intermediate position of invertebrates in the food chain.

Dworshak Dam, on the North Fork of the Clearwater River, in Idaho, subjects downstream reaches of the river to water fluctuations ranging from 30 to >300 cms during most seasons of the year. Thus, the Clearwater River provided an opportunity for investigating the vulnerability of benthic insects to differentially watered substrates under natural and hydroelectric power peaking flows.

[a]Research supported in part by the U.S. Department of the Interior as authorized under the Water Resources Act of 1964, Public Law 88-379. Published with the approval of the Director of the Idaho Agriculture Experiment Station as Research Paper No. 8162.

Journal of Freshwater Ecology, Volume 1, Number 2 • August, 1981

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METHODOLOGY

Insect colonization rates on test rocks were determined by establishing rock grids in regulated and unregulated reaches of the Clearwater River during August 1977 and 1978. Test rocks from the Clearwater River were autoclaved at 121°C for two hours to eliminate insects and epilithic algae. A test grid consisted of 20 rocks (displacement/rock ≃ 404 cc ± 88 cc), individually placed approximately 30-45 cm apart in four transects of five rocks each. The grid was established at a depth of 0.3 m at low flow to insure against dewatering; each rock was marked with a fluorescent spot to aid in relocation. A single row of five rocks was sampled weekly, beginning with a downstream transect to avoid upstream disturbances to the grid from displaced sediments or accidental movement of other rocks in the grid. A nylon organdy net (250 μ mesh size) was located immediately downstream from each rock sampled to insure capture of dislodged insects. Upon removal from the grid each rock was placed in the net and thoroughly scrubbed with a brush.

On each sampling day, five control rocks, similar in size and imbeddedness to test rocks, were sampled from the substrate in near proximity to the grid. Control rocks were not subjected to dewatering, therefore, were assumed to support epilithic algal and benthic invertebrates at or near carrying capacity.

An ANOVA was performed on data derived from the rock grids. A least square means comparison was made on the basis of treatment, day and site. Regression analysis was performed on the data to predict colonization rates of sterile substrates, i.e. the time necessary for test substrates to approximate carrying capacity as reflected by standing crop on control substrates.

RESULTS AND DISCUSSION

Insect colonization during August 1977 and 1978, at flow regulated and unregulated sites, demonstrated that the control mean densities were similar throughout the test, except at the regulated site in 1978, where the density increased slightly; whereas, the densities on test rocks noticeably increased with time (Fig. 1). Appreciable differences in density were noted between years; lower mean densities were recorded in 1978 than in 1977. We attribute these differences to inherent population fluctuations which occur in most naturally occurring ecosystems. At the end of 28 days, densities on the test rocks approached the standing crop of control rocks, however, test and control densities remained significantly different ($P<.05$) at both sites. Dominant insects on the rocks were chironomid dipterans, principally *Chironomus* sp., *Orthocladius* sp. and *Procladius* sp. (Fig. 1). Trichopterans, second in abundance, included *Brachycentrus* sp., *Cheumatopsyche* sp., *Hydropsyche* sp. and *Glossosoma* sp. During both years small densities of Ephemeroptera and Plecoptera colonized the rocks, especially *Ephemerella infrequens* (McDunnough), *Baetis tricaudatus* (Dodds), *Rhithrogena hageni*

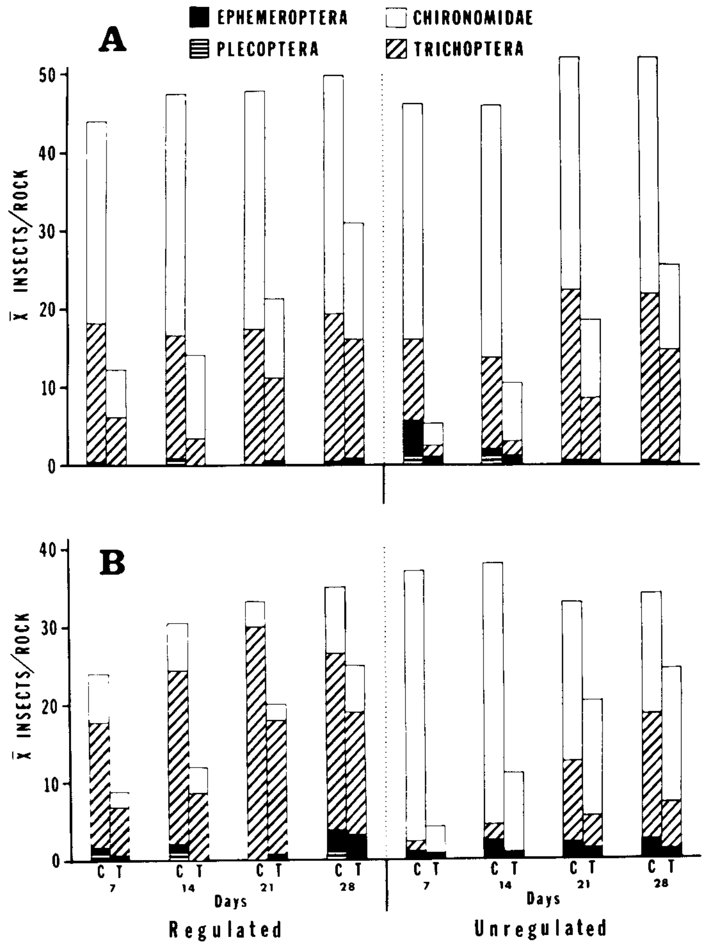

Fig. 1. Insect colonization rates on test and control rocks during August (A) 1977 and (B) 1978, at regulated and nonregulated reaches, Clearwater River, Idaho. C = Control, T = Test

(Eaton), and Calineuria californica (Banks).

The most significant increases in benthic insect colonization on test rocks were apparent on day 21; however, test densities did not attain carrying capacity during the 28-day study period. Colonization tests longer than 28 days were not possible because of the power peaking cycles emanating from Dworshak Dam during the summer and fall months. In order to predict an intercept point between test and control insect densities, a regression analysis was used to estimate the time necessary for the test rocks to approach carrying capacity (Figs. 2, 3). Approximately 66 days would be needed for test substrates to reach carrying capacity at the flow regulated site, and 47 days at the

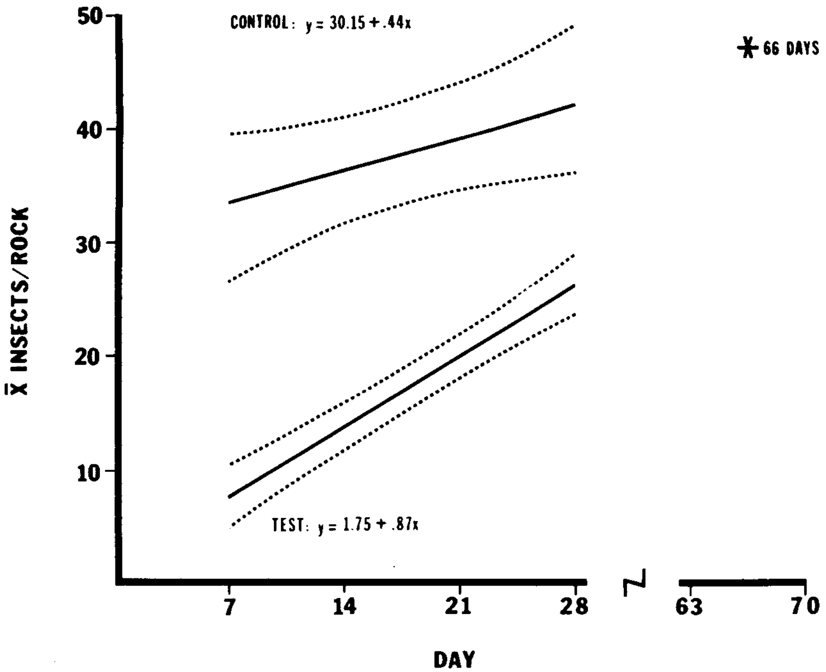

Fig. 2. Predicted insect colonization rates (95% C.I.) for combined samples, August 1977 and 1978, at a flow regulated reach, Clearwater River, Idaho.
* = test densities approach carrying capacity.

unregulated site. These colonization estimates are similar to those of Shaw and Minshall (1980), obtained for benthic insects colonizing pebbles. In our study, the predicted carrying capacity of the control substrates at the unregulated site was relatively contant over the 28-day period (b = 0.02), whereas, the predicted carrying capacity at the regulated site increased over the same period (b = 0.44). We contend that these differences were likely due to flow fluctuations and colder water temperatures from Dworshak Dam. Some differences in community composition were noted between the test and control sites and appreciable differences in phenology were noted among several of the dominant insects (unpublished data).

Employing the functional classification of invertebrates proposed by Merritt and Cummins (1978), the dominant insects on the rock grids were primarily collector-filterers and gatherers. Scrapers and shredders have been found in the Clearwater system, but were not prevalent in the river during August of 1977 and 1978; predators were relatively uncommon.

This study provides a management criterion for assessing the

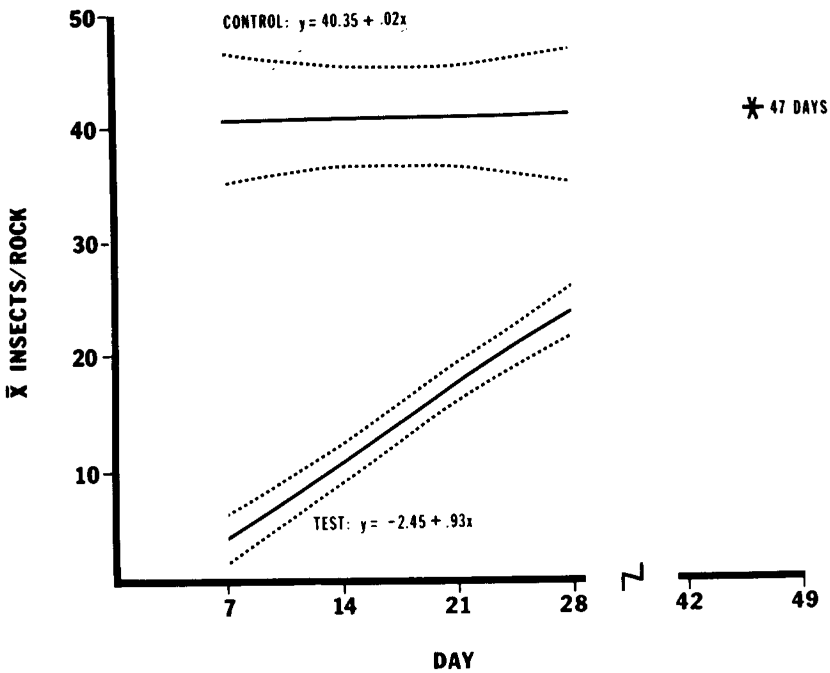

Fig. 3. Predicted insect colonization rates (95% C.I.) for combined samples, August 1977 and 1978, at an unregulated reach, Clearwater River, Idaho. * = test densities approach carrying capacity.

effects of various hydroelectric power peaking schedules on benthic insects in fluctuating near-shore regions of a river. Management decisions concerned with enhancing secondary production should consider: 1) benthic insect colonization rates, 2) the time needed for colonization to reach carrying capacity, and 3) the effects of prolonged watering on insect colonization in areas experiencing flow fluctuations. Dewatering of unstable shorelines after prolonged watering may adversely affect secondary productivity within the river. Careful planning of time and frequency of water fluctuations from hydroelectric dams might avoid or minimize losses in secondary production.

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