COMPARISON AND DYNAMICS OF THE BENTHIC MACROINVERTEBRATE COMMUNITY OF LOWER GRANITE, LITTLE GOOSE AND LOWER MONUMENTAL RESERVOIRS

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INTRODUCTION

The experimental drawdown of 1992 in Lower Granite and Little Goose reservoirs exposed extensive areas of substrate to desiccation. Benthic communities were probably severely impacted as *Corbicula* and crayfish mortalities were high. Shoreline areas of Lower Granite Reservoir were desiccated by the receding water levels examined during the drawdown and numerous benthic organisms either died or modified normal behavior patterns. For example, chironomids, an abundant and important forage organism for numerous species of fish in Lower Granite Reservoir (Bennett and Shrier 1986) had a survival strategy of migrating deeper into the substrate to avoid desiccation.

Current discussions by fishery managers indicate further drawdowns may be suggested as a proposed solution to increase survival of downstream-migrating salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) smolts. As a result, the resident fish and benthic communities in all lower Snake River reservoirs may be further impacted by future drawdowns.

Benthic communities afford several advantages as indicators of impacts on reservoirs subjected to drawdown. They are more easily and precisely sampled and seem to experience less "natural" variation in abundance than fish communities. Unfortunately, limited information exists on the benthic communities of the lower Snake River reservoirs.

Shortly after impoundment, Dorband (1980) sampled the benthic communities in Lower Granite Reservoir. He found the hard substrate benthic community was dominated by Trichoptera, Ephemeroptera, and Diptera. Soft sediment benthic communities were similar throughout Lower Granite, Little Goose, and Ice Harbor reservoirs and consisted of tubificid oligochaetes and chironomids. No known sampling was conducted until 1985 when Bennett and Shrier (1986) collected dredge samples in shallow (< 20 ft, < 6 m), mid-depth (20-60 ft, 6-18 m) and deep (> 60 ft, > 18 m) water habitats. Sampling has continued for several years in Lower Granite Reservoir to describe the benthic community associated with the dredging and in-water disposal of sediments in the reservoir (Bennett et al. 1988, 1990, 1991). Results of these studies have shown the benthic community has been relatively stable during those years with little difference in species composition, density, and standing crops among water ranging in depth from < 20 to > 100 ft (< 6 m to > 30 m) and location in the reservoir. Cushing (1993) conducted limited sampling in Little Goose Reservoir to evaluate the influence of the 1992 drawdown on the benthic community, but comparisons were restricted by a lack of baseline data.

This project will provide further baseline data on the benthic macroinvertebrate community in Lower Granite, Little Goose, and Lower Monumental reservoirs in anticipation of the proposed drawdowns to aid in assessing the impacts to resident aquatic communities if a drawdown was implemented.

GOAL

To develop a baseline of the benthic macro-invertebrate community including species composition, relative abundance, density, and standing crops in Lower Monumental, Little Goose, and Lower Granite reservoirs.

OBJECTIVES

1. *To compare benthic macroinvertebrate community structure, density, and standing crops horizontally and temporally in Lower Monumental, Little Goose, and Lower Granite reservoirs;*

2. *To assess temporal changes in the benthic macroinvertebrate community including changes in density and standing crops;*

3. *To determine the association between substrate size, organic content, and benthic macroinvertebrate structure and abundance; and,*

4. *To evaluate benthic macroinvertebrate community recolonization and recovery in Lower Granite and Little Goose reservoirs following the 1992 test drawdown.*

STUDY AREA

Benthic macroinvertebrates are being sampled in at each of three to four locations in each reservoir, Lower Granite, Little Goose, and Lower Monumental, located on the lower Snake River in southeastern Washington (Figures 1-3). Sampling locations are generally located in upper, mid and lower reservoir locations. Lower Granite Reservoir is the uppermost reservoir, extending from the confluence of the Snake and Clearwater rivers at river mile (RM) 139 (river kilometer, RKM, 222.4) across from the city of Lewiston in west-central Idaho to Lower Granite Dam at RM 107.5 (RKM 172). Little Goose Reservoir lies directly below Lower Granite Dam and extends downstream to Little Goose Dam at RM 70.5 (RKM 112.8), followed by Lower Monumental Reservoir extending downstream to Lower Monumental Dam at RM 41 (RKM 65.6). The main uses of these dams and reservoirs are electrical power generation, navigation, and recreation.

Three sites within each reservoir were randomly selected from a list of all river miles in 1.5 mile intervals (2.4 km). A selected site qualified as a sampling station if it possessed shallow (< 20 ft, < 6 m), mid-depth (< 20-60 ft, 6-18 m), and deep

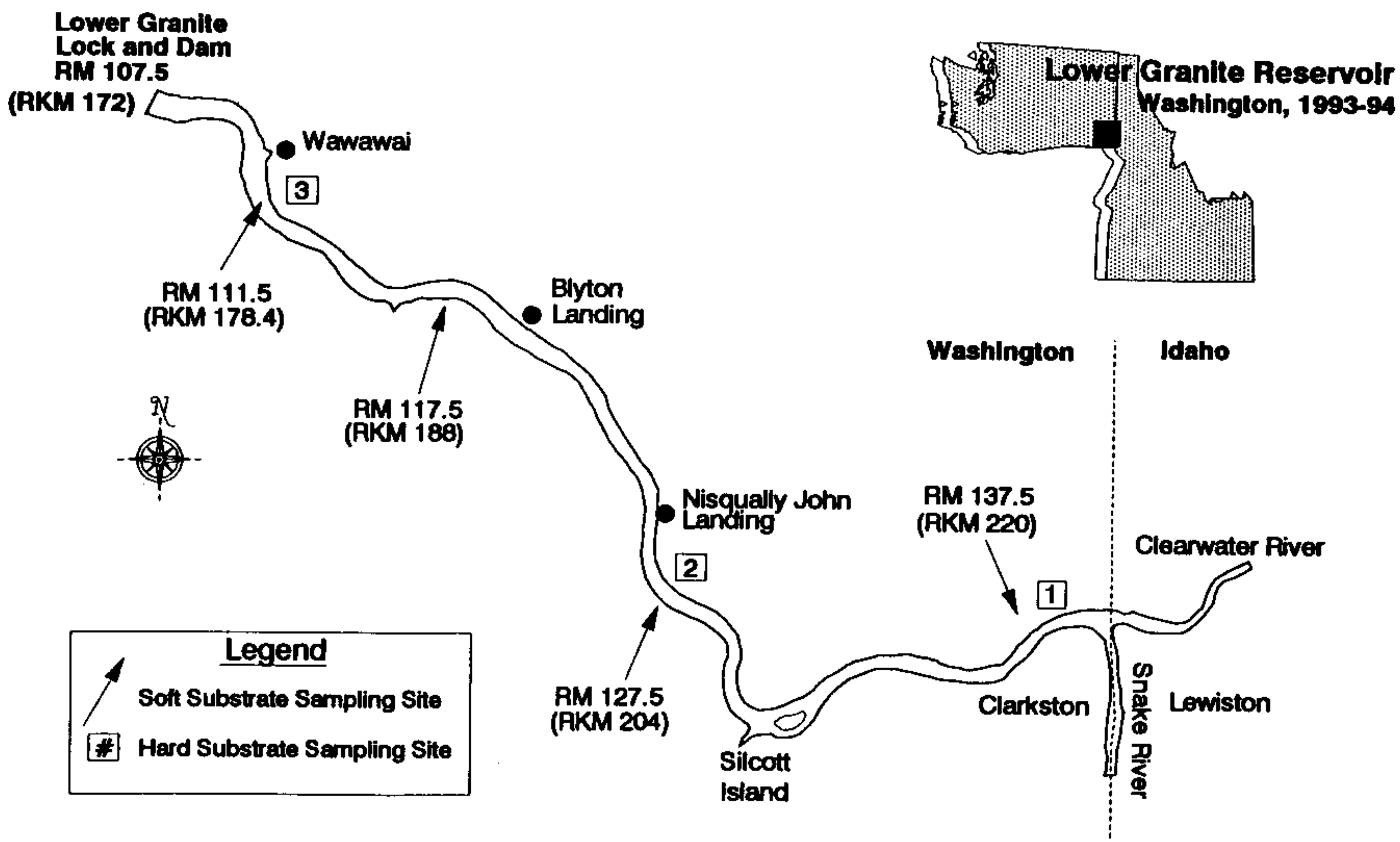

Figure 1. Map of benthic collection stations, Lower Granite Reservoir, Washington, 1993 -1994 (RM indicates river mile; RKM, river kilometer).

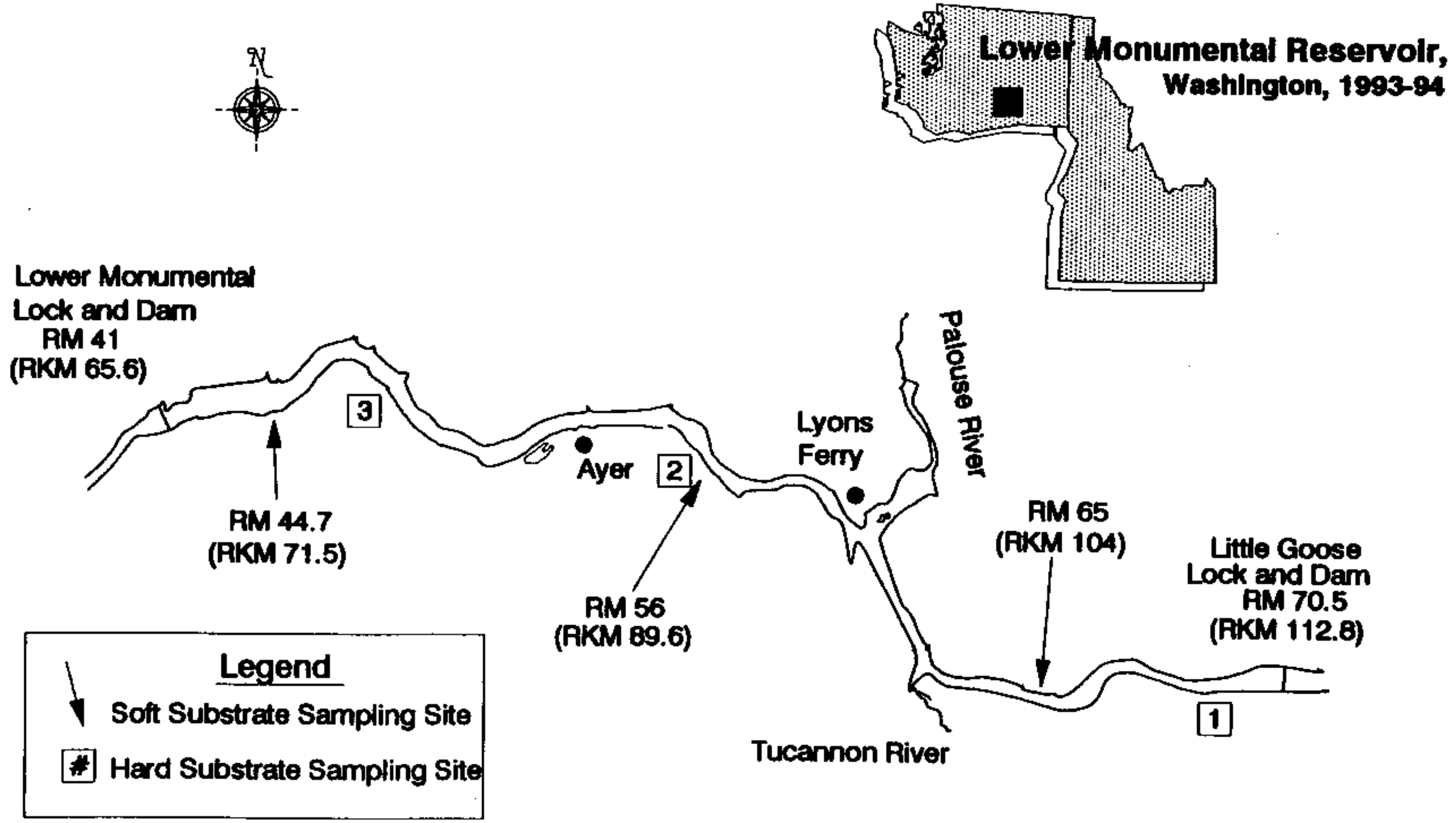

Figure 3. Map of benthic collection stations, Lower Monumental Reservoir, Washington, 1993-1994 (RM indicates river mile; RKM, river kilometer).

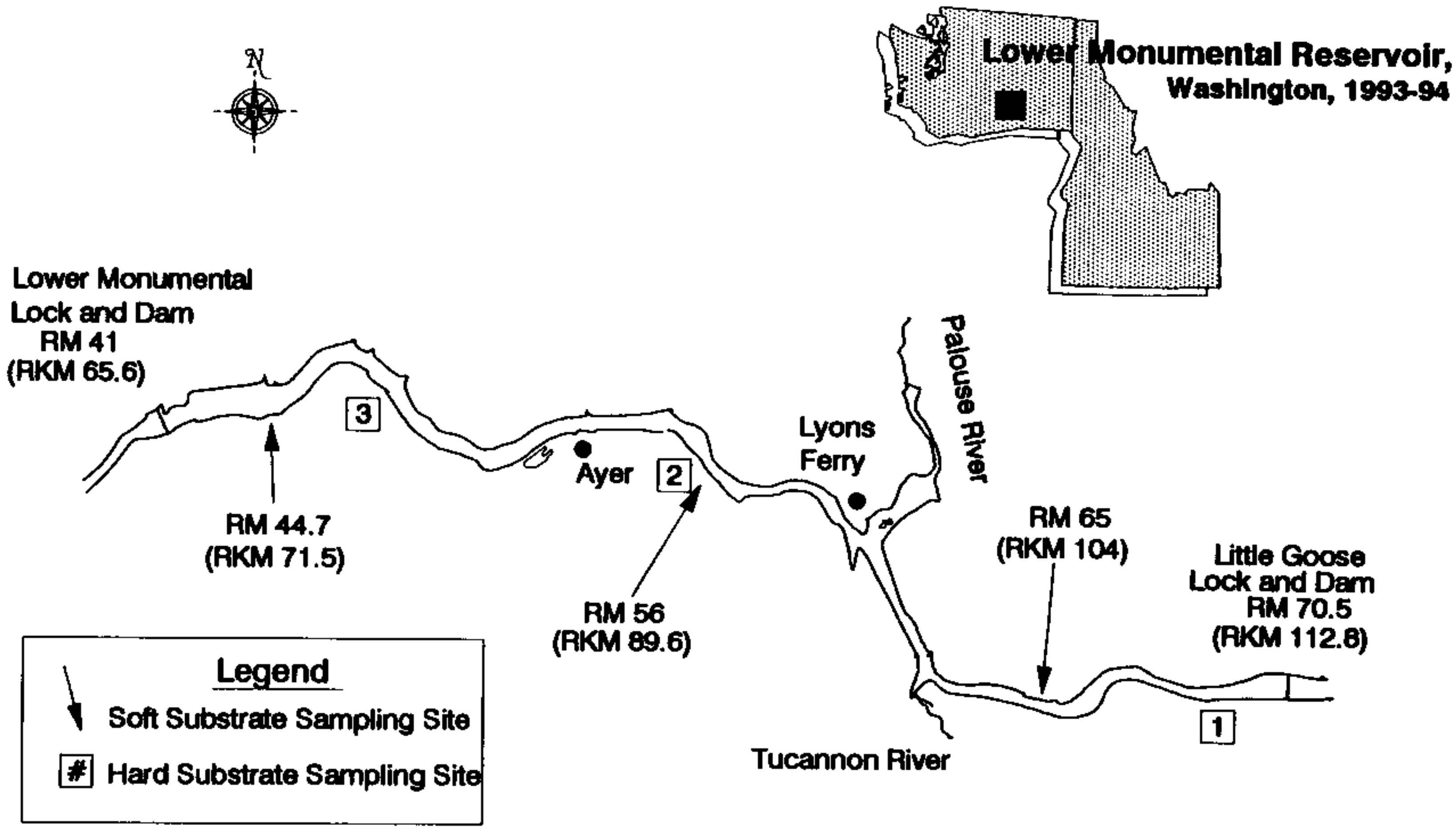

Figure 3. Map of benthic collection stations, Lower Monumental Reservoir, Washington, 1993-1994 (RM indicates river mile; RKM, river kilometer).

(> 60 ft, > 18 m) water habitats. The sites selected are identified by the river mile on which they are located (Figures 1-3).

Objective 1. To compare benthic macroinvertebrate community structure, density, and standing crops horizontally and temporally in Lower Monumental, Little Goose, and Lower Granite reservoirs.

METHODS

Soft Substrates

Samples were taken using a Shipek dredge (1,072.5 cm^2). Thirty-six dredge samples were taken at each station, 12 at each depth strata. Samples were taken in June, September, and February from each of the three reservoirs, resulting in 108 samples/season/reservoir. Sampling procedures closely followed those previously used in Lower Granite Reservoir (Bennett et al. 1990, 1993). Shipek samples were collected along two transects located over a depth strata, washed through a 0.595 mm sieve bucket (#30) and preserved in plastic containers with 10% formalin containing rose bengal dye (Mason and Yevich 1967). The samples were then stored until processed in the laboratory.

In the laboratory, samples are processed twice which includes sorting, identifying, counting and weighing organisms. When sorting a sample, small portions are emptied into a 0.25 mm (#20) sieve screen and rinsed clean of formalin and residue. The portion is then washed into a white enamel sorting tray where the dyed organisms are picked from the debris and placed in an 8 ounce specimen container filled with 10% formalin. Sorting is often aided by the use of illuminated magnifying lamps. The smaller portions of the sample are sorted until the whole sample is completed. The specimen container is then labeled with all pertinent information and stored until identification can be made.

In the identifying process of the laboratory work, sorted samples are separated into major taxonomic groups, enumerated, and weighed. The sample is first emptied into a fine sieve screen and rinsed of formalin. The organisms are then washed into a Pyrex watchglass, placed under a dissecting microscope and separated into major taxonomic groups. Most organisms are separated into orders, but occasionally some organisms can be separated by family or even genus. The organisms in each group are then enumerated, with the exception of those groups whose members are easily fragmented (eg. Oligochaeta) and, therefore, difficult to count. A wet weight is taken for each group by first placing the organisms between two paper towels and lightly pressing the excess moisture from them. Blotted organisms are then placed directly on a Mettler balance and weighed to the nearest ten-thousandths of a milligram. Sample weights and numbers are then expanded (x 9.32) for density (No./m^2) and standing crop (g/m^2) estimates.

Hard Substrates

Barbecue baskets are a well-used method for artificial substrate sampling. This sampling is useful for collecting data from habitats difficult to sample by other methods (Rosenberg and Resh 1982). The artificial substrate design used for this study follows that used by Benfield et al. (1974). Concrete cones were used for artificial substrate to standardize the surface area available for colonization in each basket. The cones were formed in 192.2 ml (6.5 oz) styrofoam cups filled with redimix concrete. Each cone possesses approximately 171.8 cm^2 of surface area. After the cement hardened, cones were soaked for 3 days in 1% phosphoric acid to remove leachates and then an additional 3 days in water.

The sampling units consist of wire barbecue baskets (Char-broil, Columbus, GA) measuring 10 in x 6.5 in (25.4 cm x 16.5 cm) filled with 10 concrete cones which are attached to concrete anchor-weights by green polypropylene rope. Three sets of two replicate baskets are placed at each site, one shallow set extending 10 ft (3 m) from the anchor and one deep set extending 30 ft (9 m). Three sampling sites were chosen in each of the three reservoirs (Figures 1-3) providing a total of 18 baskets per reservoir.

The baskets were removed every 8 weeks resulting in six sampling periods per year for each of the four seasons. Artificial substrates are emptied from the baskets into plastic buckets, brushed clean of invertebrates and debris with a small, soft paintbrush, and returned to the baskets. The baskets are then returned to the water for another 8 weeks. Contents of the buckets are poured through a 0.595 mm sieve bucket (#30), preserved in 10% formalin with rose bengal dye and taken to the laboratory for identification. Laboratory procedure is similar to that used for soft substrate.

Species composition and structure, relative abundance, density, and standing crops were quantified for both shallow and deep waters. Sample numbers and weights are expanded by 5.82 for density (No./m^2) and standing crop (g/m^2) estimates.

RESULTS

Soft Substrates

Standing crop estimates for sampling in Lower Monumental Reservoir in June and July, 1993 ranged from 0.13 g/m^2 in deep stratum at RM 65 to 9.15 g/m^2 in the deep stratum at RM 44.7 (Figure 4). The highest standing crop was in the deep stratum of RM 44.7 (9.15 g/m^2); 77% of the biomass was oligochaetes. The second highest standing crop was at the mid-depth stratum of RM 65 (6.32 g/m^2); 97% of the weight was Pelecypoda (clams). Standing crop estimates for sampling in September, 1993 ranged from 0.06 g/m^2 in deep stratum at RM 65 to 9.79 g/m^2 in

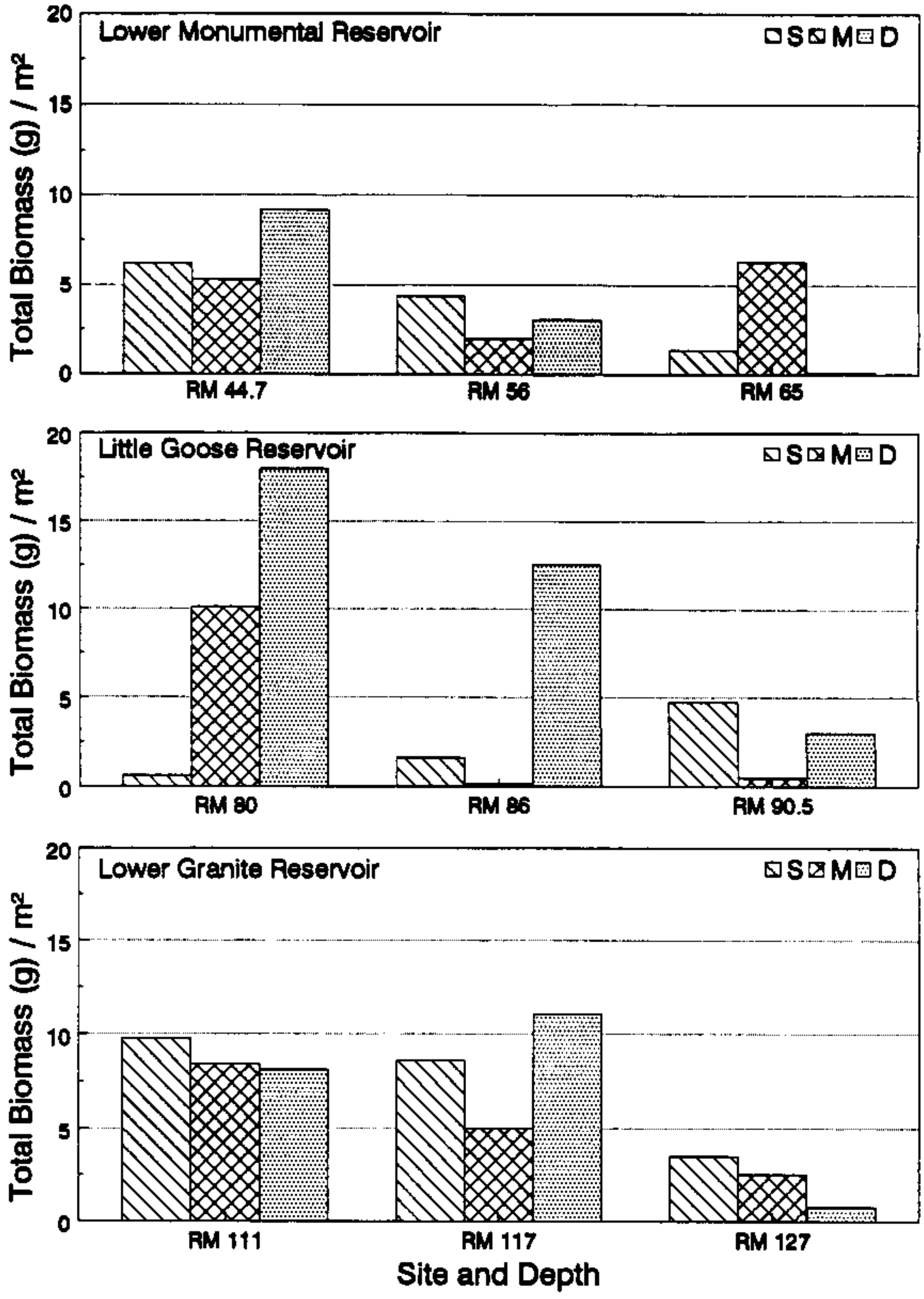

Figure 4. Standing crop estimates of the benthic macroinvertebrate community sampled in Lower Monumental (top), Little Goose (middle), and Lower Granite (bottom) reservoirs, Washington in June/July, 1993. RM indicates river mile; S, shallow; M, mid-depth; D, deep.

the deep stratum at RM 44.7 (Figure 5). The highest standing crop was in the deep stratum of RM 44.7 (9.79 g/m^2); 55% were oligochaetes and 43% were chironomids. Standing crop estimates between June/July and September were similar among sites and depths, with exception to the mid-depth stratum at RM 65 (Figure 6).

Standing crop estimates for sampling in Little Goose Reservoir in June, 1993 ranged from 0.15 g/m^2 in mid-depth stratum at RM 86 to 17.95 g/m^2 in the deep stratum at RM 80 (Figure 4). The highest standing crop was in the deep stratum at RM 80 (17.95 g/m^2); 43% were oligochaetes and 45% were chironomids. The second highest standing crop was at the deep stratum at RM 86 (12.57 g/m^2) and 53% was Pelecypoda. Standing crop estimates for sampling in September, 1993 ranged from 2.84 g/m^2 in the shallow stratum at RM 86 to 53.04 g/m^2 in the mid-depth stratum at RM 90.5 (Figure 5). The highest standing crop was in the deep stratum of RM 90.5 (53.04 g/m^2); 90% were Pelecypoda. The second highest standing crop was at the deep stratum at RM 90.5 (24.36 g/m^2) with 72% Pelecypoda. Standing crop estimates between June and September were similar among the sites and depths, with exception to all depth strata at RM 90.5 (Figure 6), which are considerably higher.

Standing crop estimates for sampling in Lower Granite Reservoir in June, 1993 ranged from 0.77 g/m^2 in deep stratum at RM 127 to 11.08 g/m^2 in the deep stratum at RM 117 (Figure 4). The highest standing crop was in the deep stratum of RM 117 (11.08 g/m^2); 43% of the biomass was oligochaetes and 42% Pelecypoda. The second highest standing crop was at the shallow stratum at RM 111 (9.81 g/m^2); 86% were Pelecypoda (clams). Standing crop estimates for sampling in September, 1993 ranged from 0.88 g/m^2 in shallow stratum at RM 111 to 10.57

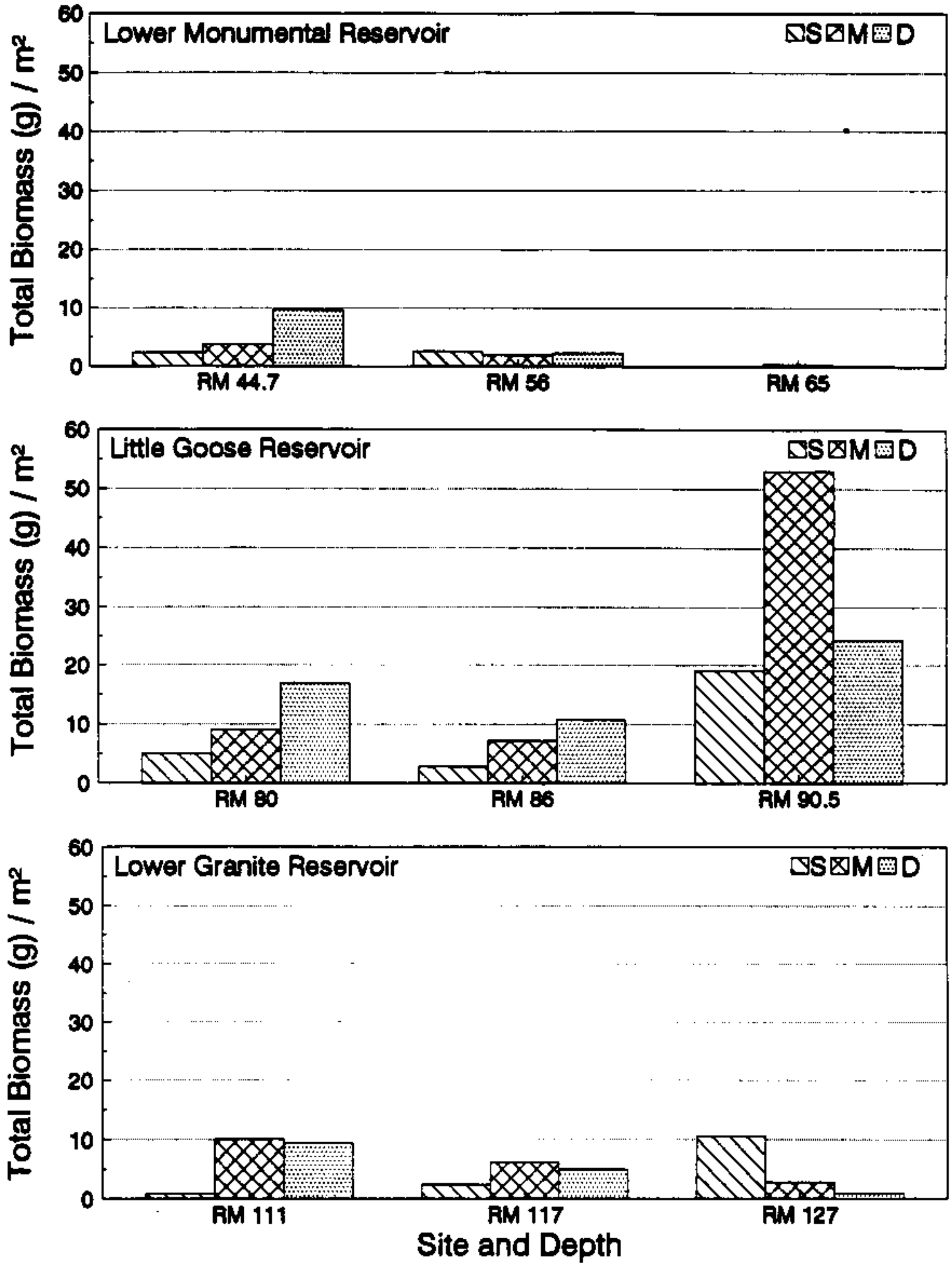

Figure 5. Standing crop estimates of the benthic macroinvertebrate community sampled in Lower Monumental (top), Little Goose (middle), and Lower Granite (bottom) reservoirs, Washington in September, 1993. RM indicates river mile; S, shallow; M, mid-depth; D, deep.

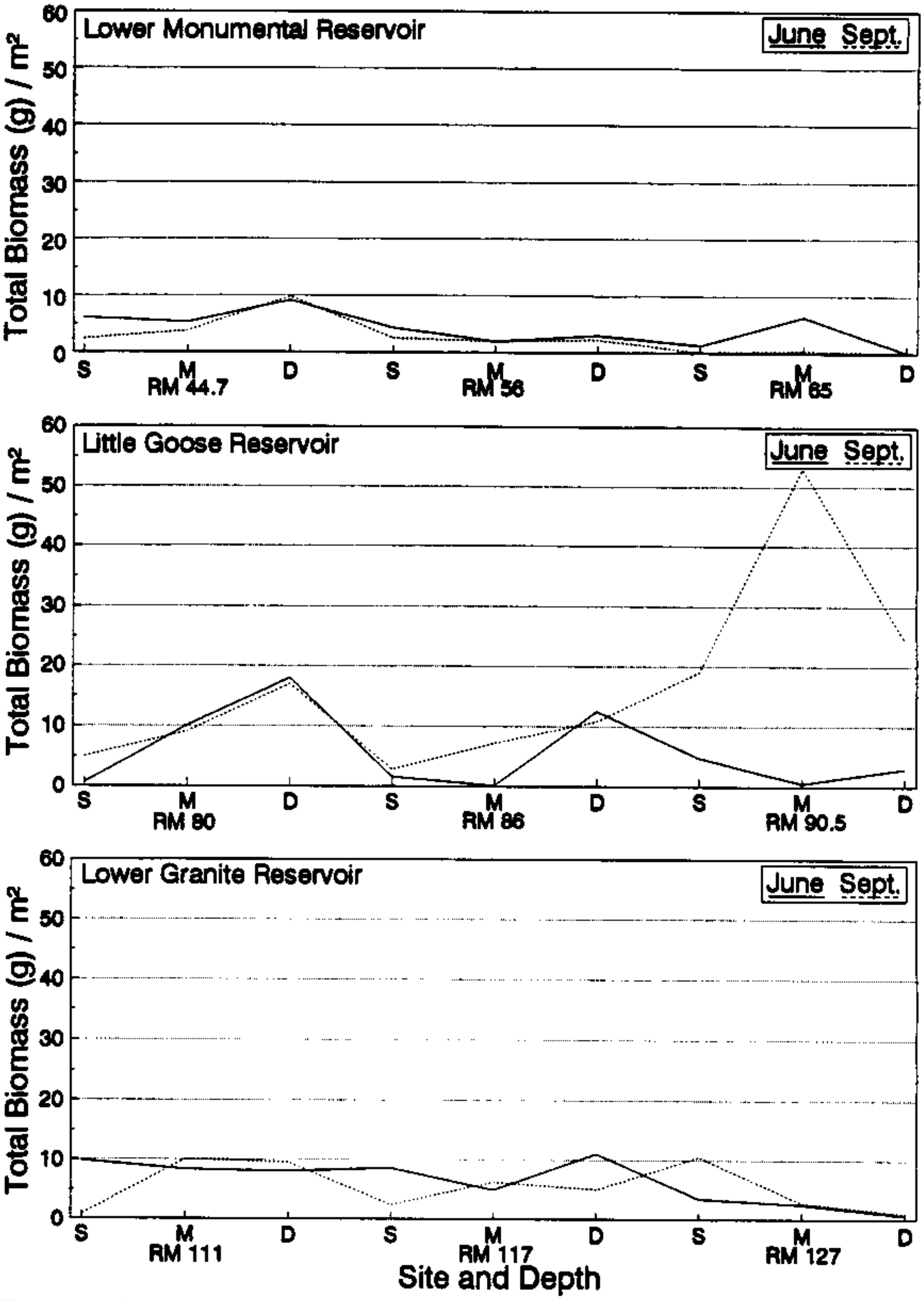

Figure 6. Comparisons of standing crop estimates of the benthic macroinvertebrate community sampled in Lower Monumental (top), Little Goose (middle), and Lower Granite (bottom) reservoirs, Washington in June and September, 1993. RM indicates river mile; S, shallow; M, mid-depth; D, deep.

g/m^2 in the shallow stratum at RM 127 (Figure 5). The highest standing crop was in the shallow stratum at RM 127 (10.57 g/m^2); 62% were oligochaetes. The second highest standing crop was at the mid-depth stratum at RM 111 (10.11 g/m^2); 75% were chironomids. Standing crop estimates between June and September varied in shallow strata (Figure 6). Shallow strata at RM 111 and RM 117 show a decrease in biomass from June to September, while the shallow stratum at RM 127 showed an increase in biomass.

Standing crops estimates for the three reservoirs and the nine sites for June/July, 1993 ranged from 2.28 g/m^2 at RM 127 to 9.56 g/m^2 at RM 80, and for September, 1993 ranged from 0.18 g/m^2 at RM 65 to 32.16 g/m^2 at RM 90.5 (Figure 7).

In general, standing crop estimates increased downstream within a reservoir. Estimates between June/July and September were similar, with exception to RM 90.5 (Figure 8) which experienced a large increase in Pelecypoda, from 8% in June to 77% in September mostly due to an extremely large individual collected in a sample.

Hard Substrates

Sorting, identifying, and enumeration of hard substrate samples continues. Our personal observations from collection and sorting of samples indicate that artificial substrates colonized during the late spring to early fall season appear to have the highest numbers and biomass, while those samples collected during the winter have the fewest invertebrates. A large number of amphipods, particularly the amphipod *Corophium*, appear around November, while Trichopterans from the family Polycentropodidae become the most abundant organism during summer.

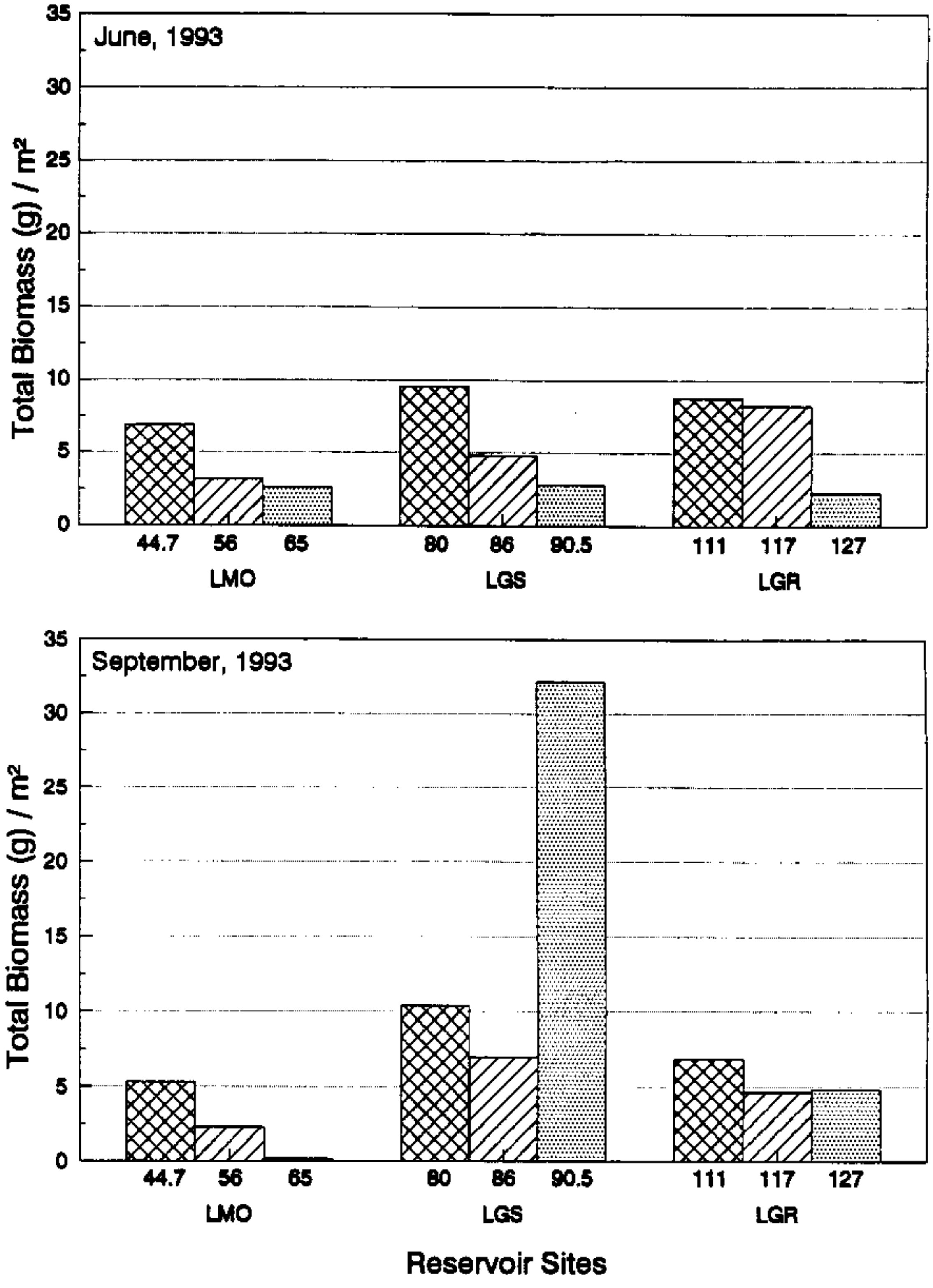

Figure 7. Standing crop estimates of the benthic macroinvertebrate community sampled in June (top) and September (bottom), 1993 in Lower Monumental (LMO), Little Goose (LGS), and Lower Granite (LGR) reservoirs, Washington.

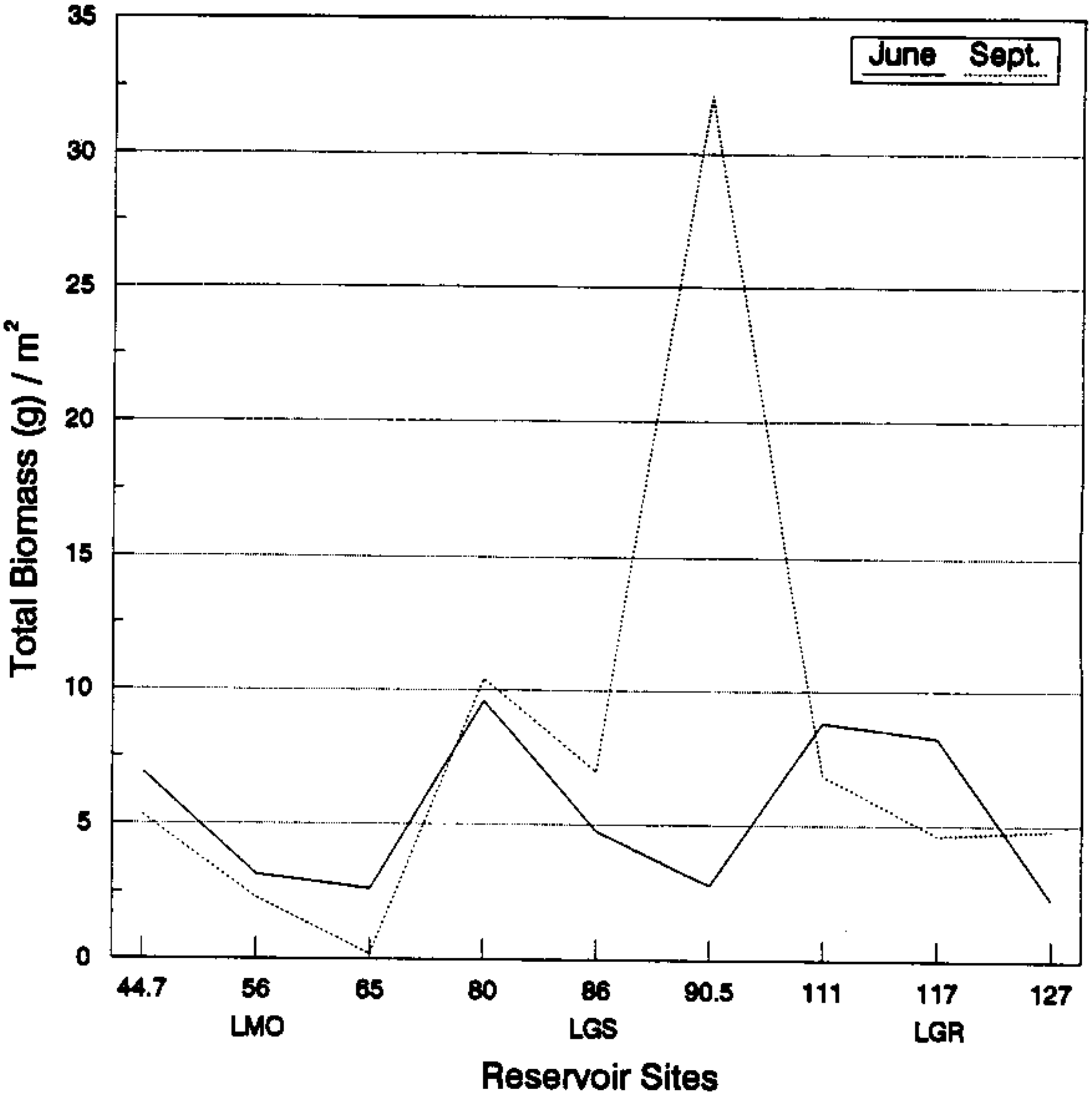

Figure 8. Comparisons of standing crop estimates of the benthic macroinvertebrate community sampled in Lower Monumental (LMO), Little Goose (LGS), and Lower Granite (LGR) reservoirs, Washington in June and September, 1993.

Objective 2. To assess temporal changes in the benthic macroinvertebrate community including changes in density and standing crops.

METHODS

Soft Substrates

Two sites in Lower Granite Reservoir, RM 111 and 117, were selected for monthly sampling. Fifteen Shipek dredge samples were collected at mid-depth (6-18 m) at the end of each month for 1 year. Samples were collected and processed as described earlier under Objective 1.

Hard Substrates

Rosenburg and Resh (1982) defined the time necessary for colonization of hard substrates to reach a state of equilibrium as the "duration of exposure required to achieve optimal colonization." A standard exposure time of 8 weeks was chosen for basket samplers, although a second set of baskets samplers are being used.

Basket sampler design is identical to that previously described. Three replicate baskets filled with 10 concrete cones are extended from the rip-rip at RM 127.5 (RKM 204) with 10 ft (3 m) polypropylene rope to make up one sampling unit. Seven units are placed in the water on the same day. One unit is removed after exposure for 1, 2, 4, 6, 8, 12, and 20 weeks. Sampling for a 20-week period will occur two times over the year's study, from late summer to winter and from winter to spring. Field processing of the samples and laboratory procedures is similar to those described previously.

RESULTS

Soft Substrates

Standing crop estimates for RM 111 sampled from August, 1993 through January, 1994 ranged from 1.13 g/m^2 in January to 10.11 g/m^2 in September (Figures 9 and 10). The peak in biomass occurred in September; 75% of all organisms were chironomids and 24% were oligochaetes. Standing crop estimates at RM 117 sampled from August, 1993 through January, 1994 ranged from 3.31 g/m^2 in January to 8.56 g/m^2 in October (Figure 9). The peak in biomass occurred in October; about 54% of all organisms were chironomids and 46% were oligochaetes. Standing crop estimates for August, December, and January were low and similar.

The 15 samples taken from RM 111 and RM 117 in October and January were also used calculate sample variance as a function of sample size to test whether the sample size of 15 used for this study was large enough. Results show that the sample size of twelve used in Objective 1 provides a good estimate with a nearly constant variance (Figures 11-14).

Hard Substrates

Sorting, identifying, and enumeration of samples continues at this time.

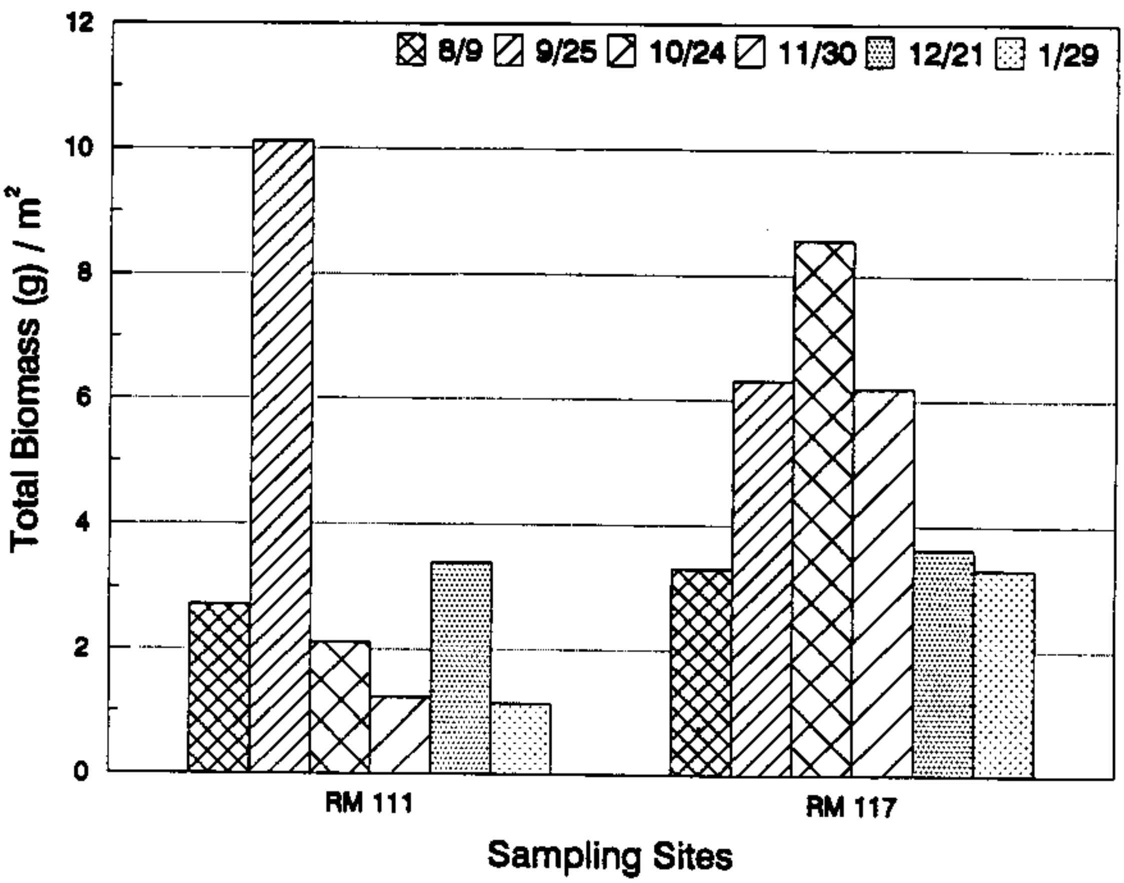

Figure 9. Standing crop estimates of the benthic macroinvertebrate community sampled monthly in Lower Granite Reservoir, Washington from August, 1993 through January, 1994. RM indicates river mile.

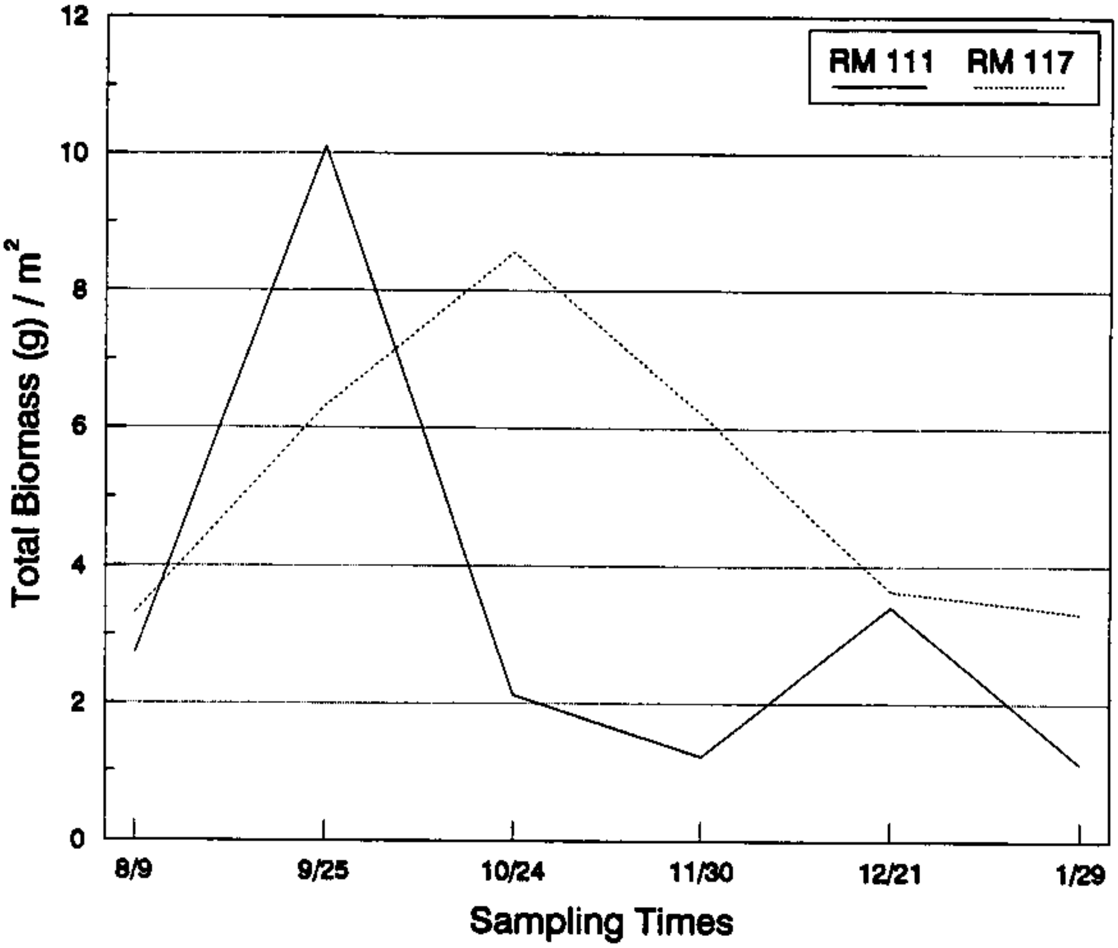

Figure 10. Comparisons of standing crop estimates of the benthic macroinvertebrate community sampled monthly in Lower Granite Reservoir, Washington from August, 1993 through January, 1994. RM indicates river mile.

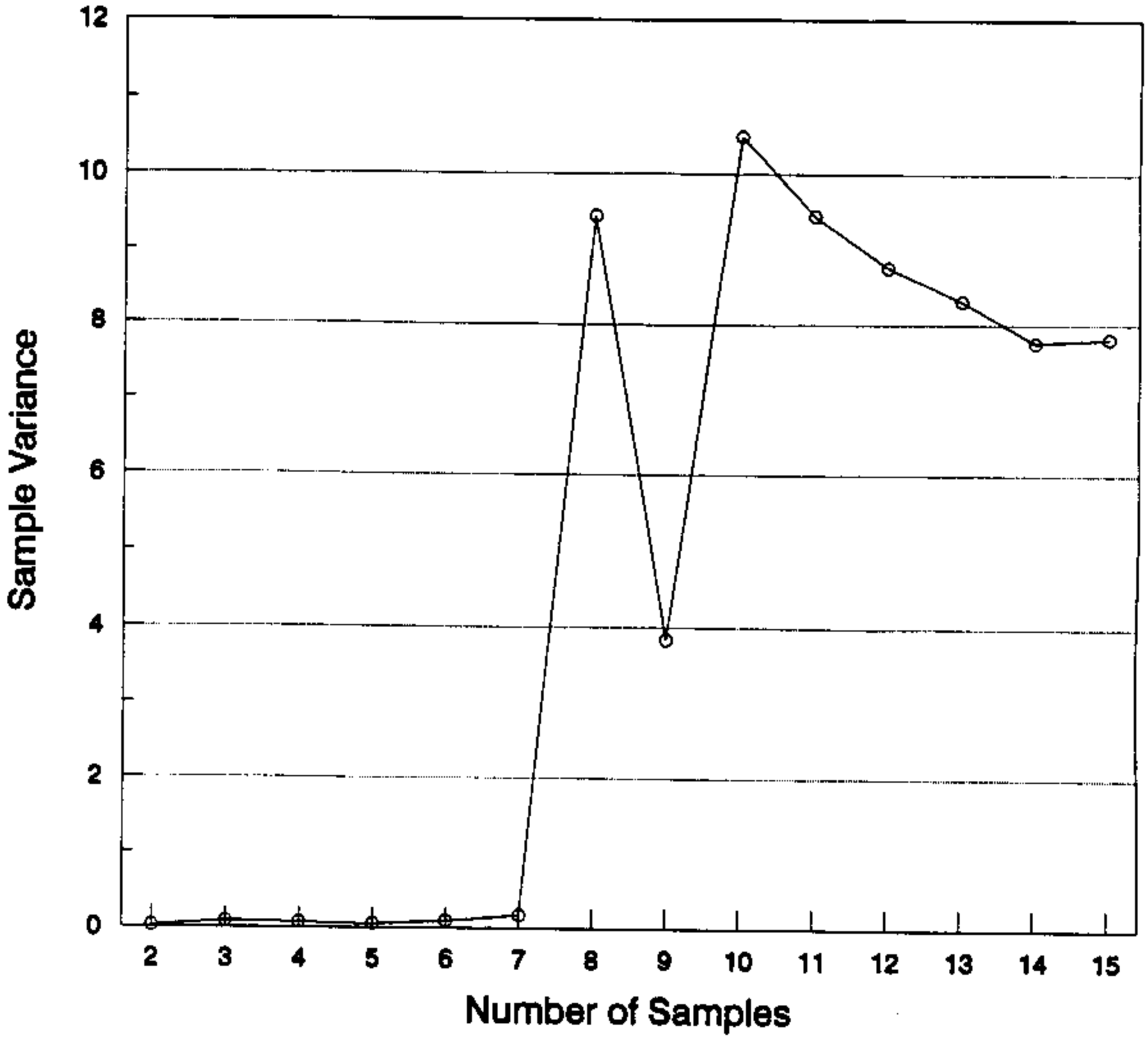

Figure 11. Sample variance as a function of sample size for standing crop estimates of the benthic macroinvertebrate community in Lower Granite Reservoir, Washington at River Mile 111 in October, 1993.

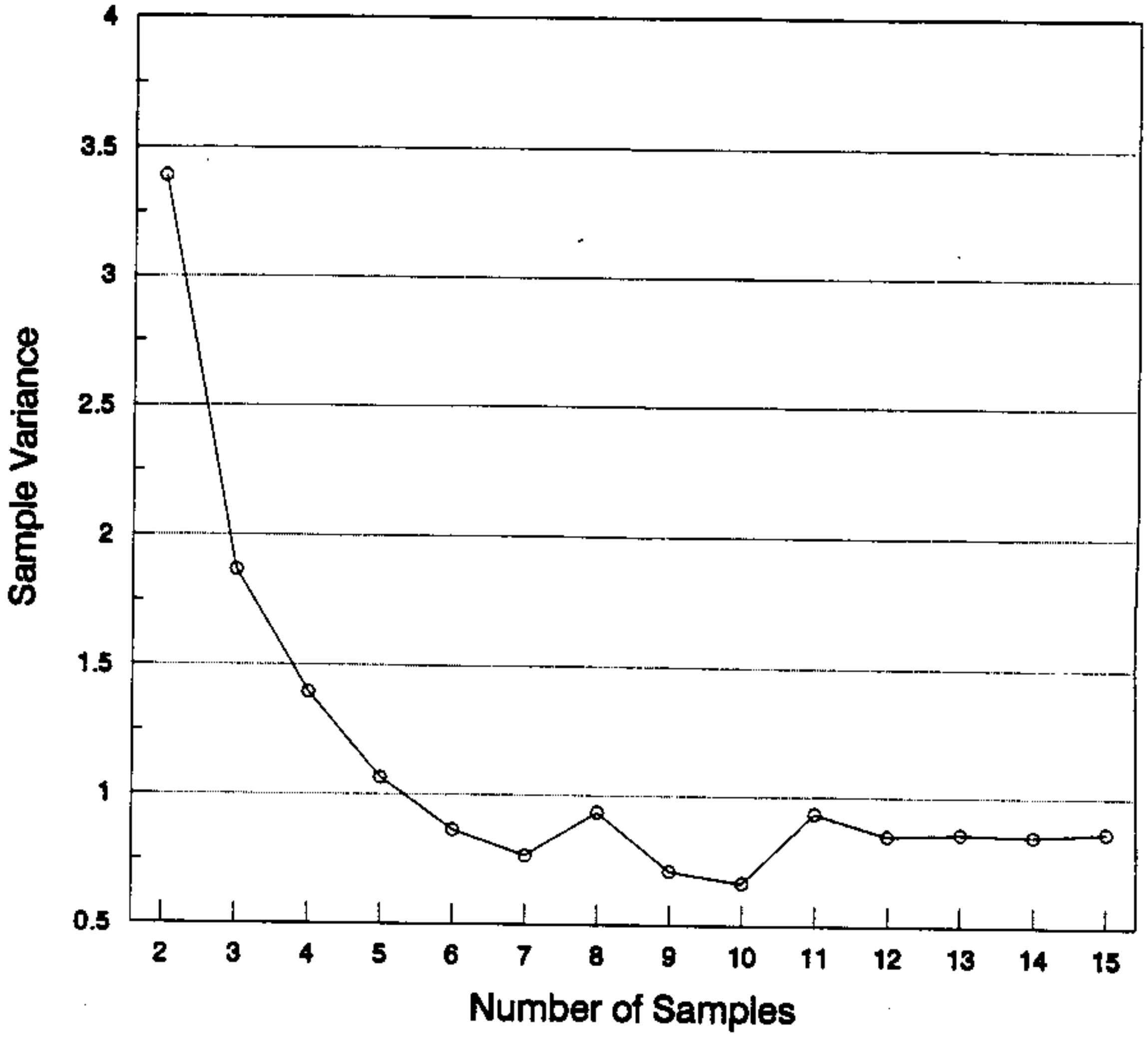

Figure 12. Sample variance as a function of sample size for standing crop estimates of the benthic macroinvertebrate community in Lower Granite Reservoir, Washington at River Mile 111 in January, 1994.

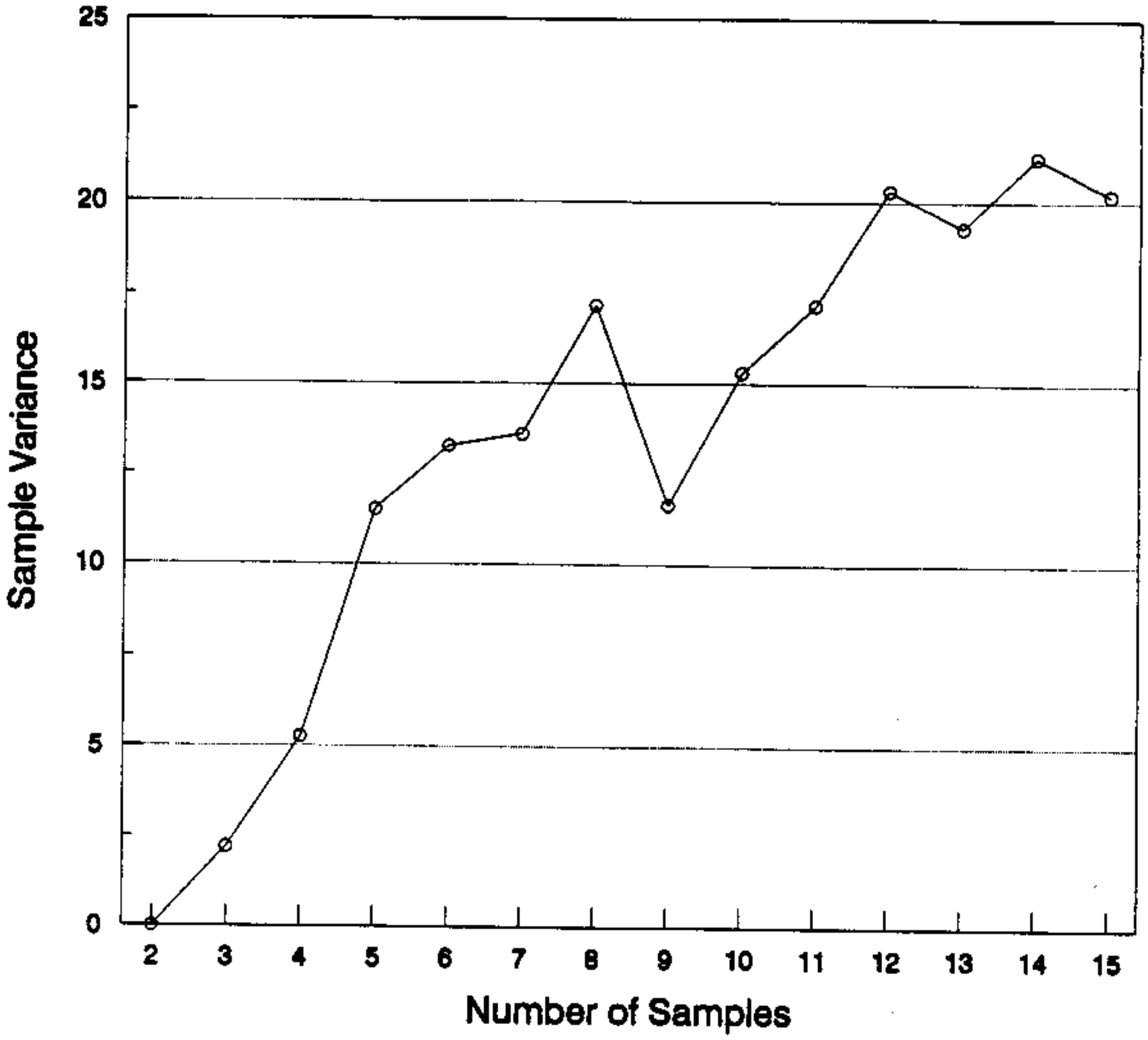

Figure 13. Sample variance as a function of sample size for standing crop estimates of the benthic macroinvertebrate community in Lower Granite Reservoir, Washington at River Mile 117 in October, 1993.

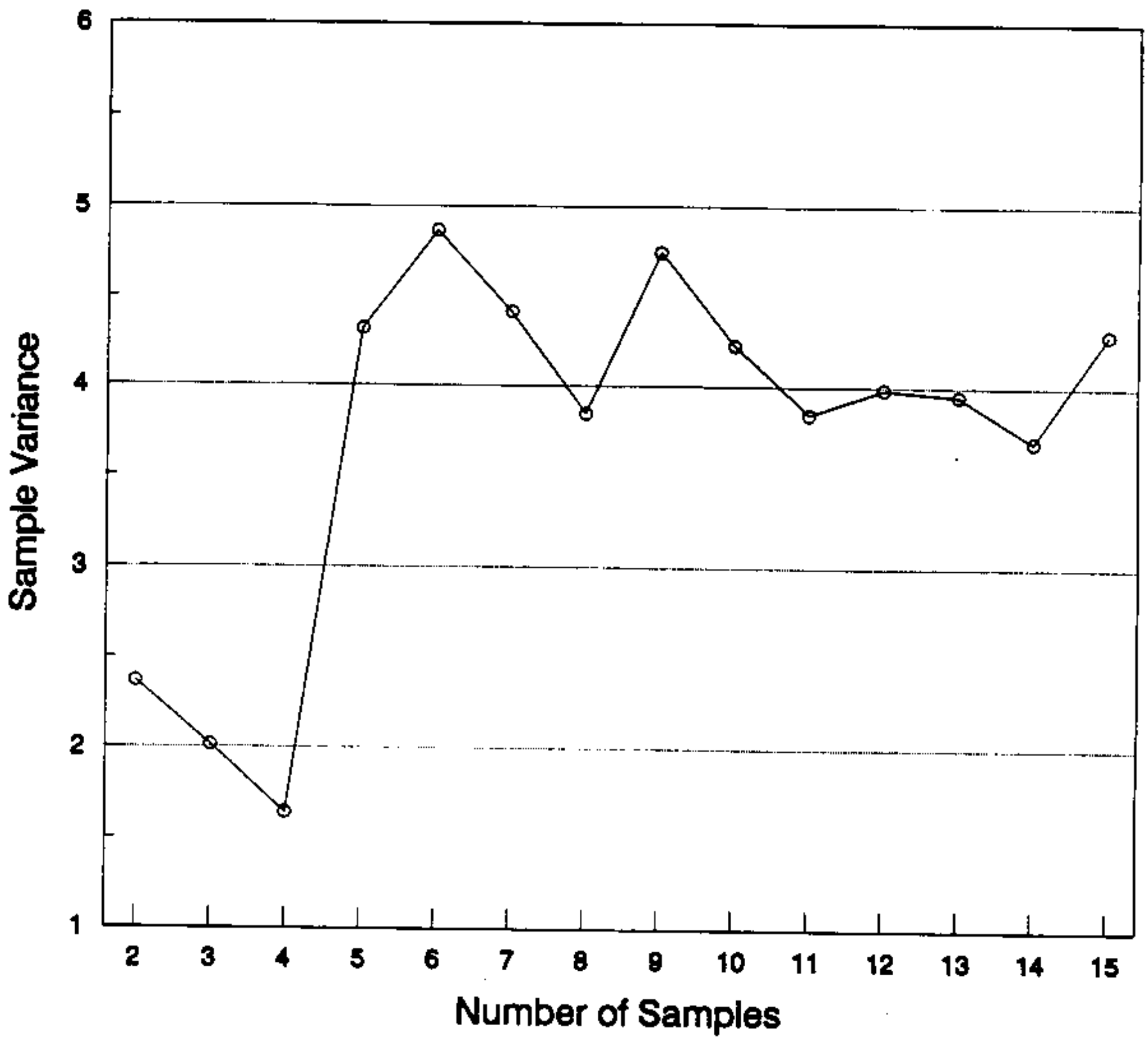

Figure 14. Sample variance as a function of sample size for standing crop estimates of the benthic macroinvertebrate community in Lower Granite Reservoir, Washington at River Mile 117 in January, 1994.

Objective 3. To determine the association between substrate size, organic content, and benthic macroinvertebrate structure and abundance.

METHODS

Samples of soft substrate were taken in conjunction to the sampling described in Objective 1. Three to four separate Shipek dredge samples were taken at each depth strata at each station. Contents of the dredge were emptied into a metal tub, mixed by hand, and sub-sampled. The sub-sample is being dried at 100° C and shaken through a series of sieves to separate the sediment into coarse gravels (10-80 mm), fine gravels (2-10 mm), and sand, silt, and clays (< 2 mm). Particles under 2 mm will be analyzed using the Bouyoucos procedure (Bouyoucos 1962) to find the percentage of sand (2.0-0.0625 mm), silt (0.0625-0.002 mm), and clay (< 0.002 mm). The percentage of organics will be determined by measuring the weight loss of a 50 g oven-dried sample after incineration for 8 hours at 275° C, rehydrated, and oven-dried again for 12 hours.

RESULTS

We have made several trial runs of the methods and data are being analyzed.

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