C10E

Effect of riparian zone management

on brook trout (Salvelinus fontinalis)

The Hayward and Holmes Brook watershed study

Report for the 1997 extended year of study

Submitted to the Fundy Model Forest

FUNDY

MODEL FOREST NETWORK

RÉSEAU DE FORÊTS MODÈLES

May 12, 1998

by

Dr. Alyre Chiasson

Université de Moncton
Département de biologie
Moncton, New Brunswick
Canada E1A 3E9

Phone 506-858-4030
FAX 506-858-4541

Introduction

In 1997 funding was granted to continue the Hayward and Holmes Brook ***Fish Community Study*** for a final and concluding year. In 1996, results had indicated a decline in the number of brook trout (Salvelinus fontinalis) following experimental harvesting. However, only one year of post-harvesting data was available in contrast to two years of pre-harvest data. Conclusions were therefore speculative. This report presents the results from 1997 and includes electrofishing, habitat analysis, substrate composition and woody debris. Trapping was not conducted in 1997, due to funding restrictions.

Material and methods

The 1997 report (Chiasson 1997) describes in detail the methods used in conducting this study. With the exception of trapping, all other methods were identical to previous years. However, a brief review of methods is provided.

Location

The study sites were located on the Hayward and Holmes Brooks situated in the Fundy Model Forest, New Brunswick Canada. Two 30 and 60 m riparian zones as well as two controls were assigned as in Figure 1. Each site was approximately 1 km long.

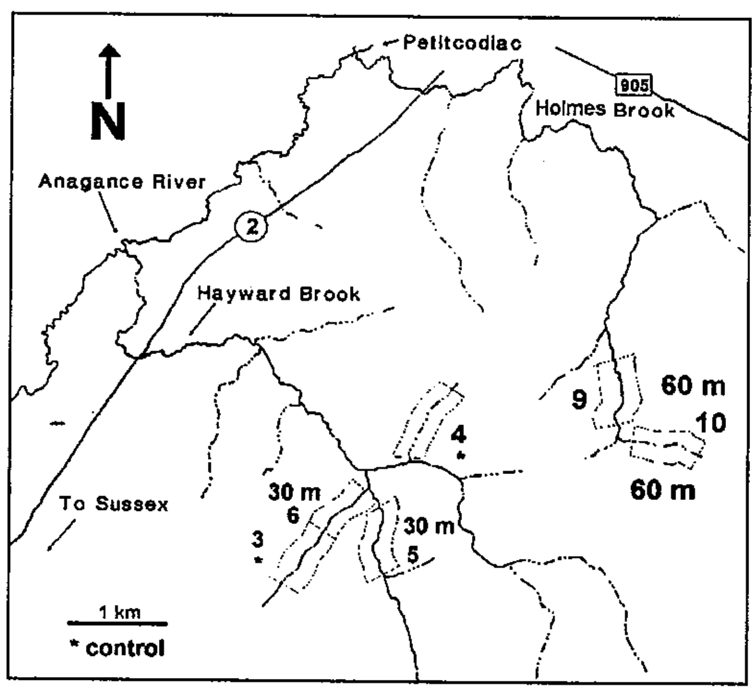

Figure 1. Map of study site, New Brunswick, Canada. Sites 4 and 3 are controls.
Sampling

The general schedule of activities are listed in Table 1.

Electrofishing was conducted in early and mid-summer Table 2a and 2b. A standard 50 m section was electrofished three consecutive times after placing barrier nets upstream and downstream of the area to be fished. Number of fish captured were too low to provide population estimates using maximum likelihood, instead the total number of fish per 100 m^2 is reported.

Physical description of habitat was conducted in 1997 as in previous years since 1994. Substrate composition, in pools was measured visually, using a 1 m x 1 m grid divided in 16 equal quadrants. Substrate types were divided into: 1) large cobble, > 5 cm; 2) small cobble, >2 < 5 cm; 3) gravel; 4) sand; 5) vegetation, macrophytes; and 6) small woody debris. Length, width and depth of traps sites in previous years were measured again in August 1997 to detect habitat changes. Large woody debris was assessed by sketching all pieces of wood greater than 0.5 m in three 100 m sections located downstream, mid-stream and upstream within sites 5 and 3.

Table 1. Calendar of activities from 1994-97

Dates	Activity
1994 and 1995	pre-harvest data
Fall1995 and winter 1996	Road construction and harvesting
1996 and 1997	post-harvesting data

Table 2a . Pre-harvest electrofishing dates.

Tributary	1994	1995
C1 - 3	July 19	June 28 and July 19
C2 - 4	July 21	June 29 and July 29
E30a - 5	July 18	June 7 and July 18
E30b - 6	July 20	June 7 and July 18
E60a - 9	July 22	June 20 and July 20
E60b - 10	* no data	June 30 and July 22

* Electrofishing was not conducted in E60b, due to inaccessibility before 1995.
(C=control, E=experimental, 30 and 60 m riparian zones, sites done in replicate).

Table 2b . Electrofishing dates.

Tributary	1996	1997
C1	June12 and July 25	June 23 and July 15
C2	June 14 and July 25	June 23 and July 15
E30a	June 13 and July 23	June 20 and July 14
E30b	June 11 et le July 23	June 20 and July 14
E60a	June 14 and July 26	June 24 and July 16
E60b	June 13 and July 26	June 24 and July 16

*1997 fall dates in above order: Oct. 8, Oct. 8, Oct. 6, Oct. 6, Oct. 9 and Oct. 10)

Results

One of the more unusual results in 1997 was the presence of marked fish from the previous year in the first electrofishing sample taken in early summer 1997 (Table 3). In prior years, the number of fish recaptured by this method at the same time of year was zero. The somewhat larger number of fish marked in 1996 (633) is a result of a change in methodology. All fish captured in 1996, either by trap or electrofishing were adipose fin-clipped with the exception of the fall samples. In previous years with the exception of 1994, only the late sample was fin-clipped. However, based on a direct proportion at least 10-11 marked fish should have been present in electrofishing samples in 1995 and 1996.

Table 3. Fish marked and recaptured in first electrofishing sample of subsequent year.

Year captured	Marked (previous year)	recaptured
1997	633	14
1996	470	0
1995	474	0

The distribution of recaptured fish also appears to be related to the width of the riparian zone. (Table 4). With the exception of one fish recaptured at site 6 all other fish were captured at either control sites or at sites with 60 m riparian zones. The sites with the 30 m riparian zones had only one return. Of the fish marked with "Floy" tags in 1996, (visible external tag) only one was recaptured in July at site 10 in 1997. Only fish greater than 10 cm were marked with Floy tags in 1996.

Table 4. Distribution of recaptured fish in 1997.

Site	Recaptured fish
3 (control)	4
4 (control)	1
5 (30 m buffer)	0
6 (30 m buffer)	1
9 (60 m buffer)	5
10 (60 m buffer)	3

The presence of recaptures in 1997 appears to contradict the continued decline of fish at most sites since1995. In 1997, all sites with the exception of site 10, showed a decline in number of fish captured in the early sampling (Figure 2a). Late sampling faired somewhat better with noticeable declines only at sites 3 and 5 (Figure 2b). Surprising, one of the sites that showed the greatest decline in number of fish captured was site 3, the site with the second largest return of recaptured fish.

The decline in the number of fish captured in 1997 was not attributable to loss of any particular age class (Figure 4). Although a small number of large fish present in the 1996 sample are absent in the 1997 sample, all age classes seem to be affect. This suggests density independent mortality. A physical, rather than a biological cause is most likely responsible for the decline.

Electrofishing results in the fall of 1997 were more similar to 1996, than comparisons of summer observations for the same period (Figure 3). Virtually no changes were noted at sites 3, 6 and 9, an increase at sites 4 and 10 and a decrease at site 5. However, none of the results reached values observed in 1995. There is some reservation regarding interpretation of site 4. In late summer 1996, the upper reaches of site 4 ran dry and a beaver dam was located just downstream of the site. The beaver dam may have impounded brook trout, especially in the second sample later in the summer when the upper reaches started to run dry.

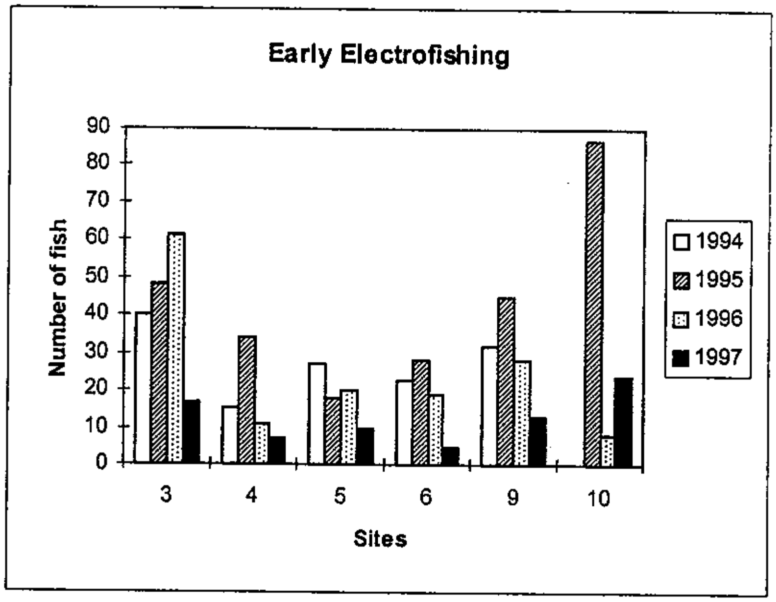

Figure 2a. Electrofishing results from 1995 to 1997. Number of fish are reported per 100 m^2.

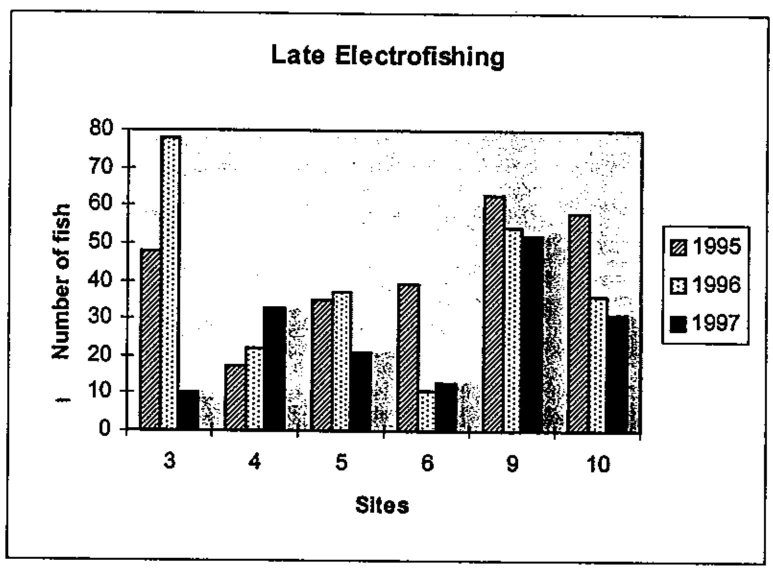

Figure 2b. Electrofishing results from 1995 to 1997. Note that no late electrofishing was conducted in 1994. Number of fish are reported per 100 m^2.

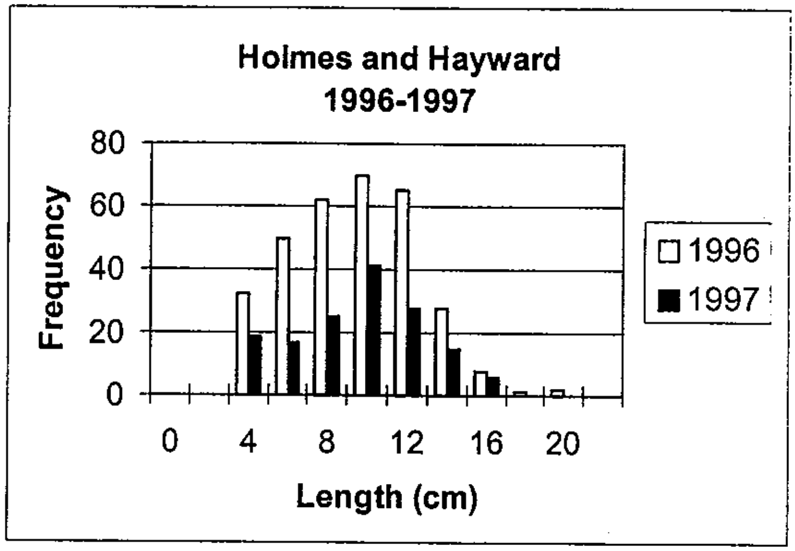

Figure 3. Length frequency histogram of brook trout captured during the summer of 1996 and 1997.

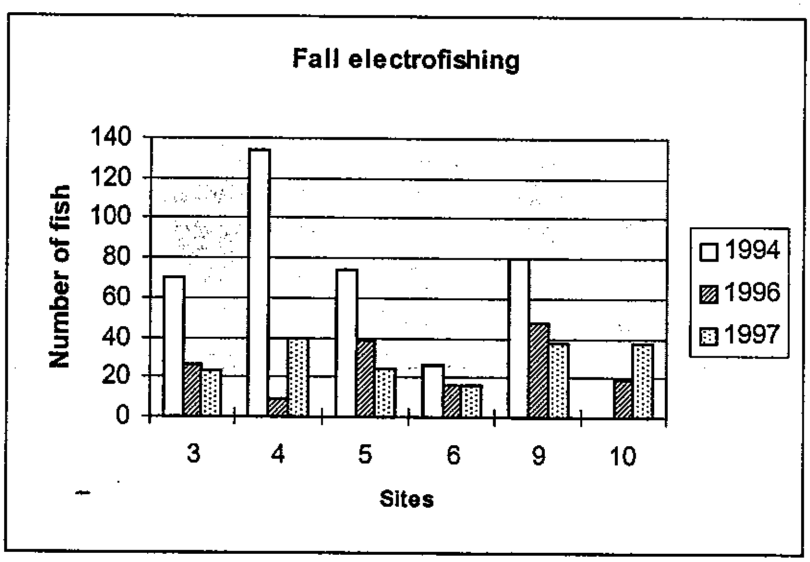

Figure 4. Fall electrofishing results for 1994 to 1997. Number of fish are per 100 m^2.

Following road construction in 1995, all sites showed a decrease in volume of pools, runs and riffles with exception of riffles at site 9 (Figures 5 to 7). Comparing 1997 and 1996 values, volume of pools decreased at sites 4, 6 , 9 and 10, runs at 4, 9 and 10 and riffles at 4. Of all habitat types pools appear to showed the greatest decrease in volume subsequent to 1994. Pools are most susceptible to infilling in the presence of suspended or transported solids as they provide area of decreased current flow.

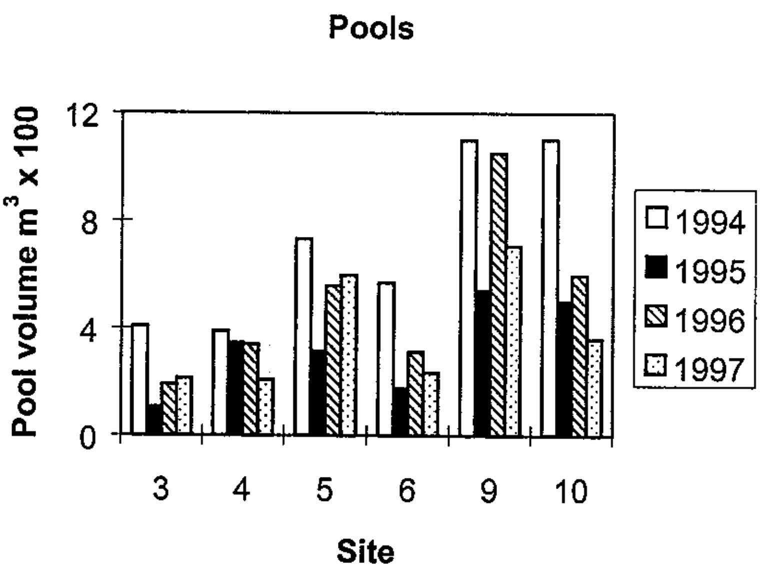

Figure 5. Volume of pools in m^3 at study sites from 1994 to 1997.

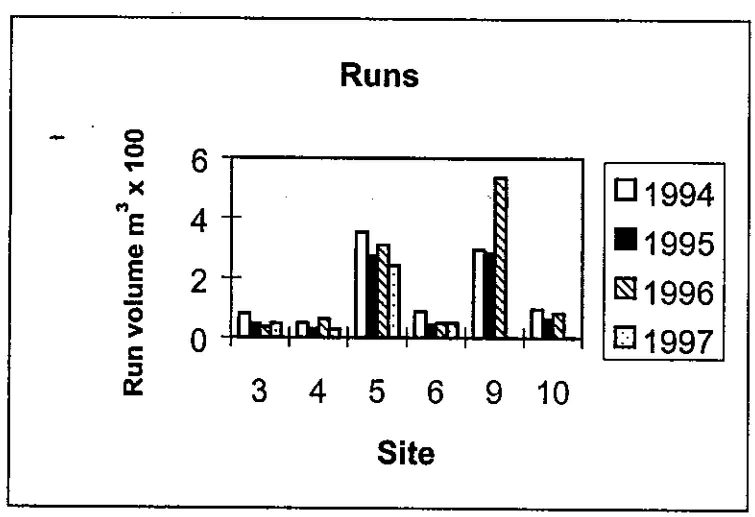

Figure 6. Volume of runs in m^3 at study sites from 1994 to 1997.

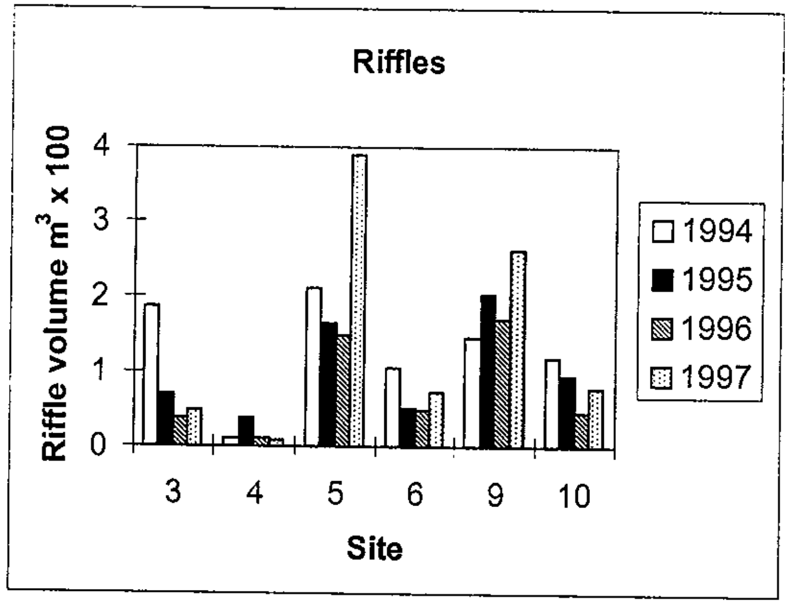

Figure 7. Volume of riffles in m^3 at study sites from 1994 to 1997.

With the exception of 1994, substrate composition in pools showed little change in the subsequent three years (Figure 8). Between 1994 and 1995, the large cobble fraction disappeared and the sand component becomes a dominant feature at all sites.

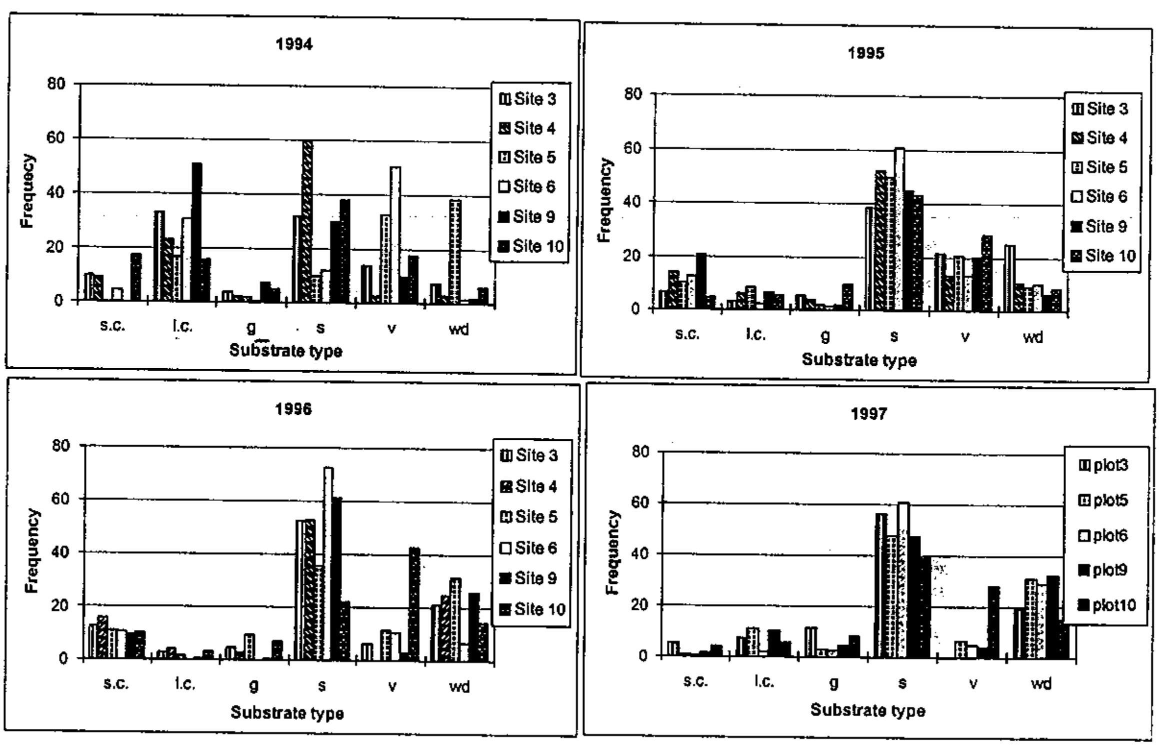

Figure 8. Substrate composition in the first 10 pools. (s.c. = small cobble, l.c.= large cobble, g. = gravel, s. = sand, v = vegetation and wd = wood debris).

Woody debris has remained stable since the beginning of the study. Consistently there has been a greater number of pieces of woody debris between 61 and 90 degrees than the other two categories. In general, this category represents pieces that have been lodged transversally into either one or both banks of the watercourse. Pieces that are aligned with the stream flow tend to get swept downstream and are therefore less numerous. Major changes in volume of stream flow would be required to dislodge woody debris. However, a decrease could also occur due to a reduction in input over a longer time scale.

Discussion and conclusions

In general, 1997 results indicated a further decline in fish populations compared to previous years. Unlike 1996, which indicated an increase in fish at control site 3, 1997 results showed a decline in both early and late electrofishing dates. The other control, site 4, appears to be substantially different from site 3. In retrospect site 4 was a poor choice as a control, at least in regards to a fish study. Subject to some siltation even before harvesting; low volume flows especially in late summer, and a beaver dam just downstream of the site may have contributed to conflict results both within seasons and between controls. However, based on electrofishing results from site 3, it cannot be concluded that harvesting has had an effect on brook trout populations.

The reasons for the decline are not apparent. A comparison of fish lengths in 1997 to those of 1996, indicate that all size classes were affected. The absence of 3 individuals above 18 cm in the 1997 samples is judged too small to draw a conclusion that larger size fished were more affected in 1997. Increases in the number of fish in the early electrofishing samples of 1995 compared to 1994, tend to discard the hypothesis than capture or fin-clipping resulted in greater mortality. In Parlee Brook, located in Sussex County, New Brunswick, both juvenile salmon and brook trout showed a decline in abundance between 1995 and 1996. This suggests that winter survival has been poor in recent years.

Despite the previous arguments, the large number of marked fish in the early electrofishing sample in 1997 is puzzling. Overall, fish numbers decreased at the same time as recaptures increased. One possible explanation is that fish at site 3 did not migrate or could not migrate from the site as in previous years due to low water conditions that isolated fish to small pools or areas of springs. Such a reduction in availability of habitat, especially for over-wintering, could have resulted in high mortality but a greater number of fish appearing in sampling in the following year. Although conjecture, it would appear unlikely that the greater number of recaptures from site 3 would be due to better survival of fin-clipped fish at this site than others, as dramatic decline compared to the previous year was still evident.

Changes in pool volume could explain some of the declines noted in fish abundance. Following 1994, pools volumes declined and never returned to previous levels even in the following 3 years. It should be noted that some remedial measures were taken after road construction, following visual observations of heavy silt loads following rainfall. Pools provide critical winter habitat for brook trout. Small pools decrease the physical space available to brook trout and increase the probability of freezing to the bottom. However, this affect appears to be related to road construction rather than harvesting.

Changes in substrate composition lends support to the argument that road construction has been the dominant effect to date. Subsequent to 1994, the large cobble fraction decreased at 5 out of 6 sites and sand became dominant at all sites. The loss of large cobble reduces the habitat available to invertebrates, one of the food sources for brook trout. Large amount of sand in pools can also contribute to fish population declines by decreasing spawning areas which require a good flow of water through the substrate.

To date woody debris has show no change (Figure 9). This is not a surprising result as no major changes in stream flow have been noted and riparian zones are present at all sites. The presence of woody debris itself also lends stability to the water course.

Further analysis

The major finding of the study have been provided in this report. The data also contains information dealing more with the biology of the species than the different harvesting practices. A Master's thesis by Terrance Melason based on this information is also in preparation as well as drafting of manuscripts for publication

Major conclusions

1) Further declines in fish populations occurred in 1997. The decline is not size selective. However, it cannot be directly related to harvesting as the number of fish also declined at control site 3. The remaining control site 4 did not follow the same pattern of results as site 3 but can be explained by low volume flows in late summer.

2) The recapture of brook trout from the previous year suggests a lower emigration from certain sites before the winter of 1997. However, winter survival appears to have been poor.

3) Changes in volume of pools and loss of the large cobble fraction appear to be related to road construction. Further improvement in retention of silt from road runoff is recommended.

4) There is no evidence to suggest that sites with a 60 m riparian zone performed better than those with 30 m.

5) The continued presence of fish at site 4, despite low flows and even absence of water in the upper reach indicates that these sites are still used during part of the season and can even be subject to recolonization. It is recommended that even ephemeral sites be accorded the same protect as small streams having more regular flows.

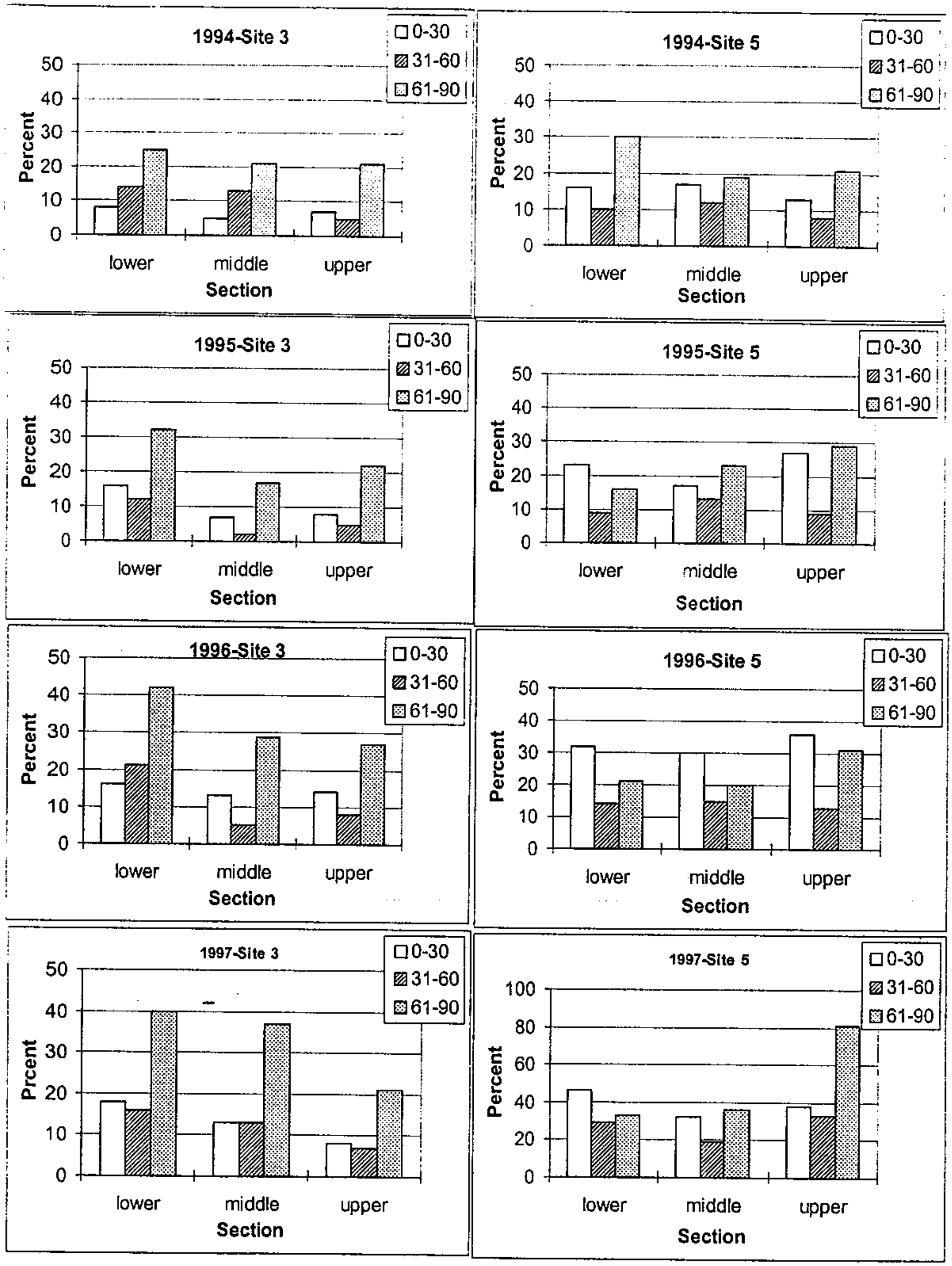

Figure 9. Large woody debris at sites 3 (control) and site 5 (30 m buffer). Legends refer to angle of woody debris with the banks of the brook. All pieces are in excess of 0.5 m.

Financial statement

Salaries

Student and assistant	$ 6,942.00
Pension contribution	$ 156.24
Unemployment assurance	$ 281.40
Accident compensation	$ 9.73
Total	$ 7,389.63

Equipment -Supplies

Office and field	$ 1,361.28
Administrative fees	$ 500.00 Charged by UDM
Travel	$ 1,085.10
Total	$ 2,946.38

Forthcoming costs

Journal publication	$ 500.00 Journal publication costs (NAJFM, CJFAQ)
	$ 600.00 Travel costs to present study results at conferences
	$ 150.00 Thesis production costs
Total	$ 1,250.00

Grand Total	$11,586.01
Amount of contract	$11,850.00
Balance	$ 263.99