Fundy Model Forest

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The Parlee Brook Stream Restoration Project

Final report 1993-1996

Joint project of the Université de Moncton

and Sussex Fish and Game

Submitted to the Fundy Model Forest

by

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Introduction

The Parlee Brook Project was initiated in 1993. Although stream restoration had already established a history in the United States, mainly in Wisconsin (Hunt 1988), such projects were relatively unknown in Atlantic Canada. Stream restoration includes any number of remedial measures that result in improved water conditions or availability of fish habitat. In most cases habitat improvement is specifically aimed at making conditions more favorable for fish but in principle could be applied to invertebrates and plants.

The project was to a large extent experimental and intended to serve as a demonstration site for communities based groups or small woodlot owners interested in improving aquatic habitat. Several criteria were of primary importance, the identification of a stream in need of habitat restoration within the Fundy Model Forest and secondly, accessibility of the site to the general public. As noted by Hunt (1988) many restoration projects failed to monitor the response of fish to the habitat improvement measures. To address this concern, the abundance of fish in Parlee Brook was determined both prior to and following stream alteration. In addition, a control site was selected several kilometers downstream from the restoration site to insure that any improvement noted was the result of remedial measures and not a general improvement in fish population throughout the brook.

Stream restoration is intended to improve existing conditions. However, if structures are improperly placed more harm than good can result. Persons interested in stream restoration are advised to consult the excellent manuals listed in the reference section found at the end of this report and are encourages to visit existing sites and talk to the people involved with the project. In addition, any type of stream alteration in New Brunswick requires a permit from the Department of the Environment.

Most commonly, fish abundance is determined by electrofishing. This procedure uses electricity to stun fish and should only be conducted by qualified operators. Electrofishing requires a special permit from Fisheries and Oceans. A list of contacts for New Brunswick is provided at the end of this report.

This manuscript provides an overall evaluation of the project from its conception in 1993 to 1996. An overview of each successive year is provided, followed by a more detail discussion of certain elements of the project. Progress reports are available in each year of the project and can be obtained from the Fundy Model Forest or directly from the author.

1993

Site selection

Selection of an appropriate site within the Fundy Model Forest was based on inspection of topographical maps, consultation with local residents and onsite visits. Accessibility by road was a key consideration if the project was to serve its function as a demonstration site. A number of potential sites were identified in the Sussex area, with Parlee Brook finally being selected as the

site meeting most of the requirements (Figure 1). The stream was initially surveyed by walking and photographing most of its length and noting the state of the watercourse. The stream profile including width, depth and current velocity were noted in the area selected to undergo restoration. This area was characterized by lack of pools, absence of within and overhead cover, shallow depth and few fish.

Water samples were taken from four locations in the watershed, before (1) and after (2) a small community bordering the stream, half-way between the restoration site (3) and the main highway (4) located downstream and where the main highway intersects the stream (Figure 2). Analysis of temperature pH, calcium, carbon dioxide, dissolved oxygen, hardness, magnesium, nitrate, phosphate and silica. None of the values indicated the presence of water quality problems. This was an essential step, as poor quality would negate any benefits derived from installation of within stream structures to improve the availability of fish habitat.

Electrofishing was conducted in the area to be restored as well as a control section located several kilometers downstream. Fish were captured, measured, the adipose fin clipped and then released. A standard 38.5 m section was electrofished in both areas on October 15, 1993, using a single sweep. Fewer juvenile salmon (21) and brook trout (26) were found in the area to be restored compared to the control section that was in better condition (juvenile salmon 90, brook trout 34). Results from the electrofishing in all years of the project will be dealt with in greater detail in another section of this report. Electrofishing results supported this visual assessment that the area selected for enhancement was deficient in habitat requirements resulting in low fish abundance.

Based on assessment of both physical and biological characteristics, Parlee Brook was recommended to the Fundy Model Forest in the fall of 1993 as being a suitable site for stream restoration. The corrective measures to be employed were the installation of digger logs and deflectors (Figure 2). Digger logs consist of tree trunks placed across the stream at a 30° angle to the streambank. In combination digger logs and deflectors narrow the stream and increase current flow. In addition, digger logs result in the creation of pools on the downstream side of the logs and deposit of gravel on the upstream side. Pools provide essential over wintering habitat for brook trout. Gravel of correct consistency is essential for the spawning of salmon and brook trout in the fall. In the summer, pools provide shelter for brook trout and provide refuge from warmer temperatures that may occur in shallower parts of the stream.

Digger logs are placed at intervals between five and six times the width of the stream. This pattern is dictated by the pull of the moon which influences the frequency at which rivers and streams oscillate back and forth on their way to the sea. Historically, many rivers and streams loss this pattern when they were straightened for log drives. The key to proper placement of digger logs is finding a section that has undergone little change, from there the natural pattern of the river can be determined. In some cases it is possible to find old natural digger logs that have been buried under the gravel. The presence of old digger logs can help confirm observations based on other aspects of the stream. Some degree of in field experience with a person acquainted with the method is usually required before being able to determine the natural flow patterns without assistance.

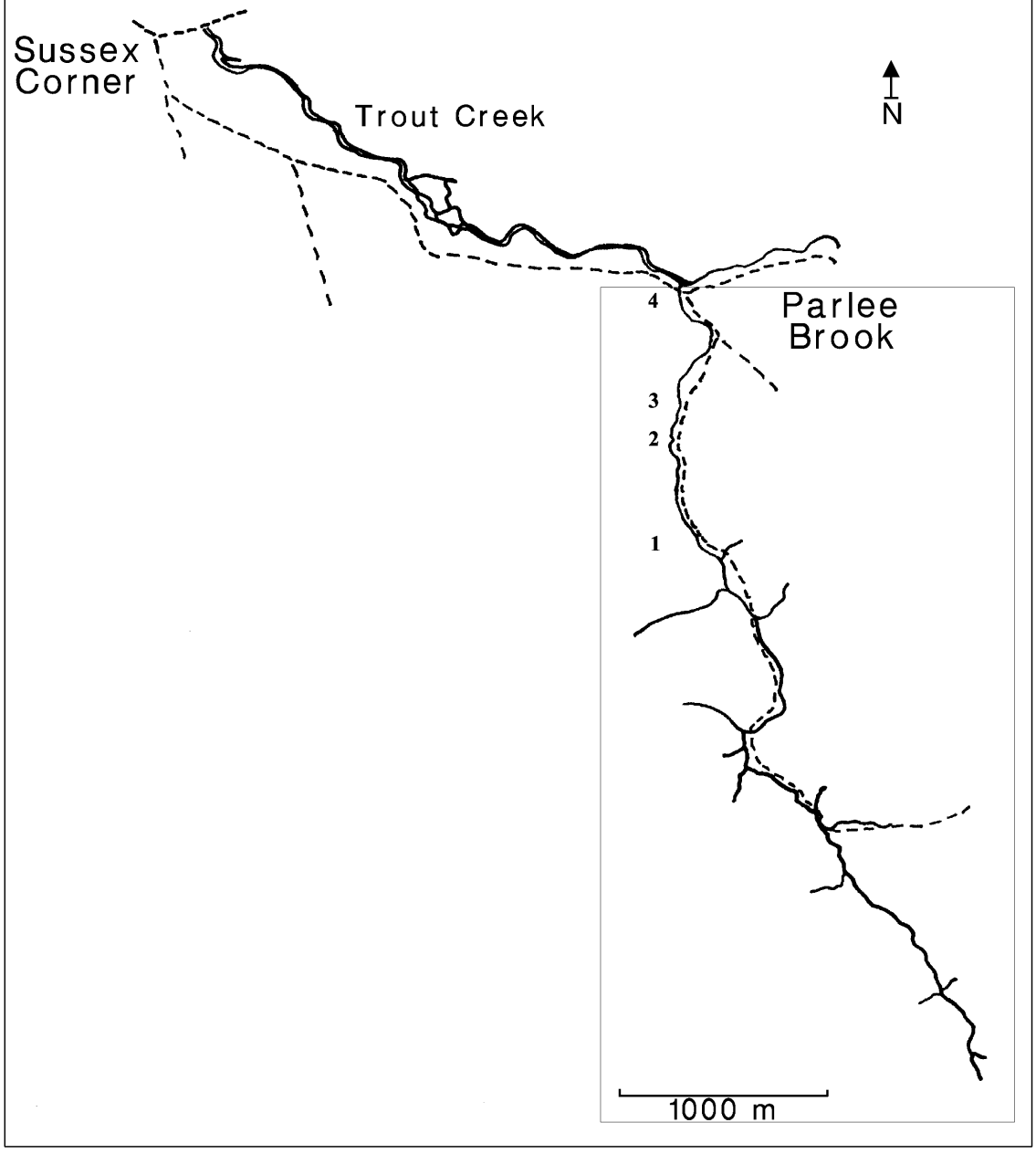

Figure 1. Location of Parlee Brook in southeastern, New Brunswick, Canada.

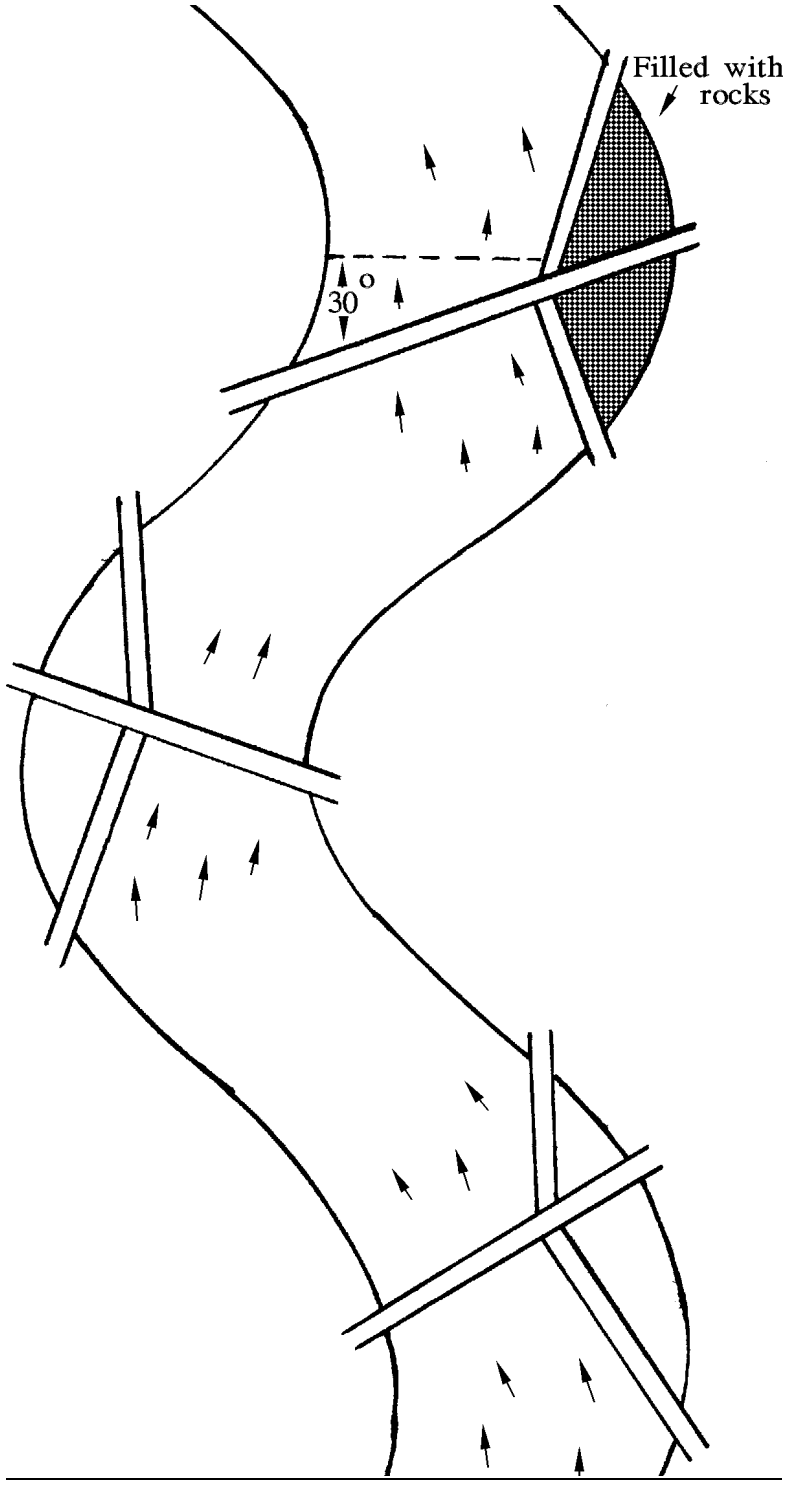

Figure 2. Digger log placement.

Landowners

In February of 1994, landowners residing along Parlee Brook were sent an information package in the mail advising them of the project. Two different packages were mailed, one to the owners bordering the restoration site, seeking permission to cut trees on their property for the digger logs and a second form to those bordering the control site, seeking permission to cross their property. Residents responded positively in both cases, with one landowner taking the time to call to complement us on this initiative. In June, a newsletter was sent to all residents advising them that the work would commence in the summer of 1994 and to provide them with a second opportunity to voice any concerns. We received no calls or letters of concern at any stage of the project.

Electrofishing

On August 16, 1994, the areas electrofished in 1993 were electrofished again prior to the installation of the digger logs and deflectors. Results were very similar to those obtained in 1993, indicating lower numbers of fish in the poorer habitat.

Installation of digger logs

In August 3, 1994, 3 men and 1 women were hired to undertake the installation of the digger logs. Tim Nye a consultant from the Fort Folly Indian Band was hired for a day to verify the exact locations for the digger logs and deflectors. The consultant was appointed by the Department of Fisheries and Oceans, Scotia Fundy Region. The sites were flagged and pegged off prior to installation.

Little maple was found on the surrounding hillsides, the preferred material for digger logs, so ash was used instead. Tree sections varied in length from 5 to 7 m and 12 to 23 cm in diameter. To eliminate possible contamination from oil and gas, an electrical winch was used to haul the logs to the riverbank. In retrospect, the electrical winch provided poor performance, a gas operated winch may be more suitable but care should be taken to prevent any spill of gas or oil. Logs were anchored into the river bed using 1 m sections of rebar. Except for using an attachment for the chainsaw to bore holes in the logs for the rebar, all work was done by hand. All digger logs except the last were installed without filter fabric. Rocks used to fill the deflectors were obtained from the surrounding area but several truck loads were brought in during the month of October. A total of 6 digger logs were installed. In addition, a single rock deflector was installed just upstream from the first digger log. In September it was noticed that water currents were undercutting two of the digger logs. These were repaired by filling the gaps with more rocks. As an experiment the last digger log installed that summer was underlain with filter fabric. The idea was to retain more of the smaller size cobble and rock thus preventing tunneling of water down under the digger logs.

1995

Overview of work.

In general, the structures weathered the winter very well in spite of loosing one digger log. Ice conditions were extreme that winter and flow at times were exceedingly high. The digger log that was loss had been problematic in the previous fall and had to be repaired several times as water was tunneling down under the log. It is also believed that low water levels in the summer contributed to undercutting of the log on the downstream side. Under low water flows, water tends to roll over the log and curl under, washing away the fine gravel. Eventually support from under the log is lost and the structure collapses.

The lost digger log was reinstalled in 1995. Chicken wire was used instead of filter fabric was used to underlay the reinstalled digger log, so as to reduce the loss of gravel and render the structure more solid. Chicken wire is less permanent than filter fabric, but unlike filter fabric allows better flow of water. A certain flow of water through the gravel is essential for survival of fish eggs and certain families of aquatic invertebrates. Considerable effort was expended in 1995 to fill in the deflectors with rock. A final digger log was installed in 1995 at the downstream end making a total count of seven digger logs.

Signs

In 1995, two signs were installed. One sign consisted of a wood carving which identified the project and the names of the partners. The second gave information on the purpose of digger logs. In combination they assured that the project was highly visible from the road.

Visitation

The Parlee Brook site was visited by a number of interest groups in 1995 and was highlighted in a number of newspaper articles. All trails to the digger logs indicated high usage, a good indicator of the success of the project in attracting interest in the Fundy Model Forest.

Electrofishing

The control and the restoration site were electrofished on August 21, 1995. Number of fish captured in 1995 represent the first year following restoration. Results suggested an increase in the abundance of brook trout subsequent to digger log installation. Overall, there was a slight increase in the average length of brook trout and salmon at all sites from 1993 to 1995, except for brook trout that showed no increase at the control site between 1994 and 1995. The increase in the number of brook trout at the digger log site combined with a slight increase in mean length suggested that the project was successful in creating new habitat suitable for brook trout. In other words, the increase in the number of brook trout was not at the expense of lower growth rate which would result if competition for food or space were intense.

However, Atlantic salmon in the same year demonstrated no significant change at any of the sites. These results are in general agreement with the findings that trout prefer pool habitat whereas Atlantic salmon prefer the riffles and runs. Overall the total number of salmonids, both trout and salmon, increased at the digger log sites in 1995 (1993, 46; 1994, 45; 1995, 115), whereas a decrease was noted at the control sites for the same period (123, 116, 94).

Electrofishing results are likely to underestimate the success of the project. Digger logs attract fishers and as such fish mortality is more likely to be higher at these locations than other area of the brook.

1996

Overview of work

During the winter the seventh digger log installed in 1995 was washed out. The stream at this point is very wide and it was felt that reinstalling the digger log would be ill-advised. A deflector of rock was installed in its place. Being more stable and not subject to the full force of the stream, it was felt that the deflector stood a better chance of staying in place, yet serve a function similar to a digger log in that it would narrow the brook at that location. No other structures were loss. Considerable effort in 1996 was expended in filling in the deflectors with additional rock.

Comment box

In 1996, a comment box was placed onsite next to digger log, in proximity to the signs announcing the project. All comments were very positive (Appendix A). No negative comments of any kind were received. This supports the contention that the project was very popular with the visiting public and efforts designed to improve aquatic habitat were well appreciated.

Electrofishing

Sites were electrofished on September 30, 1996. In 1996, juvenile salmon and brook trout showed a marked decline in numbers at the restoration site and the control site. Declines in other species of fish in the same area suggest a physical cause that affected the whole brook. Brook trout were still more abundant at the restoration site than the control site as in previous year but the difference was less marked. Details of the electrofishing results for all years are provided in the following section.

Electrofishing results from 1993-1995

Results from electrofishing are given in Table 1 and in Figure 3. In 1995, brook trout became particularly abundant at the digger log site, increasing to four times the number observed in 1994. There was also an increase in brook trout at the control site rising from 22 to 31 but far less dramatic in comparison to the digger log site. In all year except 1996, salmon were more

abundant at the control site than at the digger log site. This can be explained by better habitat conditions at the control site than at the digger log site.

In 1996, the number of brook trout and salmon decreased dramatically compared to 1995 (Table 1 and Figure 3). There were also dramatic decreases in cottids (Slimy sculpin, Cottus cognatus) and cyrinids (Creek chub, Semotilus atromaculatus; and blacknose dace, Rhinichthys atratulus) at the same sites (Table 2 and Figure 4). This strongly suggests an environmental cause that was species independent. It is not possible to identify the causative agent from this study but a particularly harsh winter with lots of ice or extremely dry and warm weather conditions during the summer could result in an increase in mortality. Interestingly, 1995 was also a good year for cyrinids at both sites and for cottids at the digger log site. Although not conclusive, it suggests that brook trout in 1995 may have benefited from the same conditions that increased the abundance of cottids and cyprinids but it does not explain why salmon did not respond as well. Regardless, the presence of greater numbers of brook trout at the restoration site on Parlee Brook than at the control site following digger log installation points to the success of the project in creating salmonid habitat. It should also be noted that electrofishing results are an underestimate as fishing mortality in unknown.

Table 1. Number of fish captured in each year of the study. bt = brook trout, s = salmonid, r = restored, c = control.

Year	bt.r	s.r	bt.c	s.c
1993	27	21	34	90
1994	22	24	22	97
1995	85	31	31	66
1996	17	13	14	9

Length of salmonids

An increase in the abundance of brook trout at the digger log site in 1995 could have been achieved at the expense of growth rate. In principle, digger logs could have attracted more trout but without improved habitat conditions more fish would be competing for the same amount of food and space. Greater competition would result in a decrease in growth rate. To verify this, the mean length of brook trout and salmon was plotted for each of the sites in each year of the study (Figure 5).

Figure 5 suggests little change in average length of fish except for salmon at the control site which appear to have increased in length. This increase in length could be achieved by an overall increase in length of all fish or the loss of the younger age classes. By example, if all the young in any particular year die, the remaining fish would give the impression that the overall size of the remaining fish had increased. To verify this, frequency histograms of the lengths of salmon and brook trout were constructed for both sites for all years of the study (Figure 6).

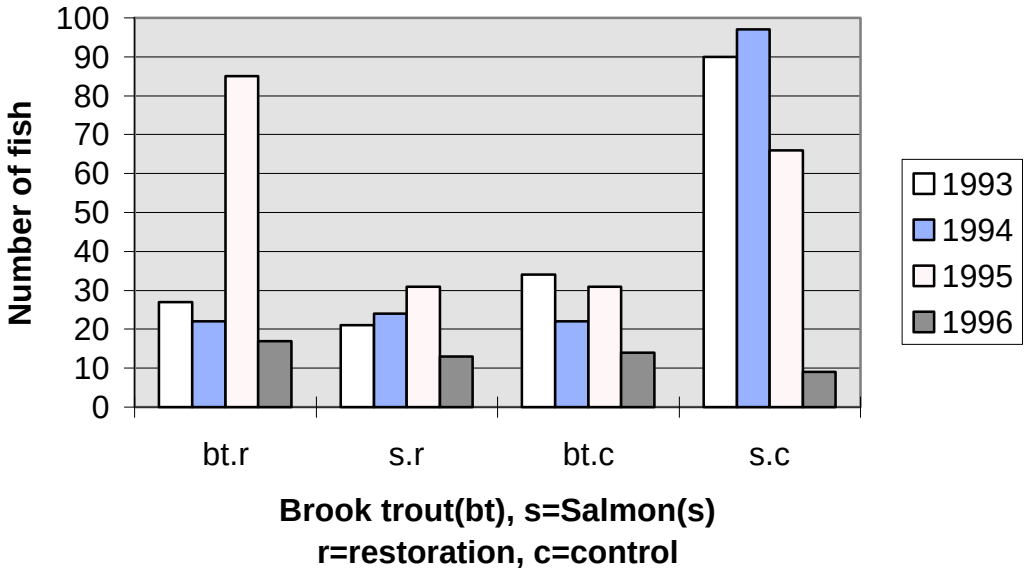

Figure 3. Number of brook trout and salmon captured at control and digger log sites from 1993 to 1995. bt = brook trout, s = salmonid, r = restored, c = control.

Table 2. Number of cyprinids and cottids captured at control and digger log sites from 1993 to 1996. Cyp = cyprinides, cott = cottids, r = restoration, c = controls

Year	cyp.r	cyp.c	cott.r	cott.c
1993	179	262	541	587
1994	148	236	289	911
1995	1008	1140	1051	281
1996	72	75	347	90

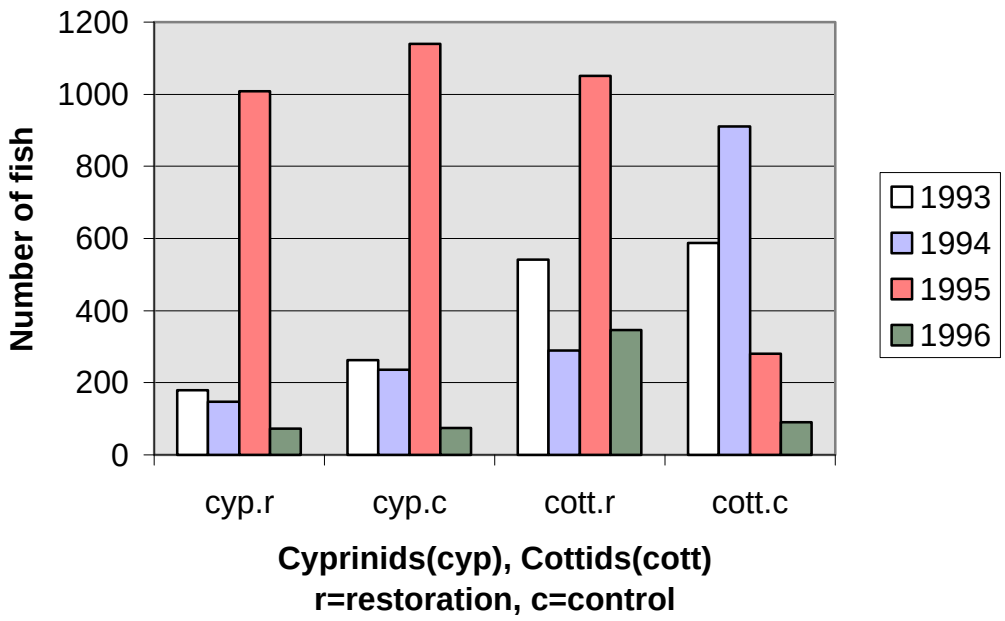

Figure 4. Number of Cyprinids and Cottids captured at control and digger log sites from 1993 to 1996. Cyp = cyprinides, cott = cottids, r = restoration, c = controls

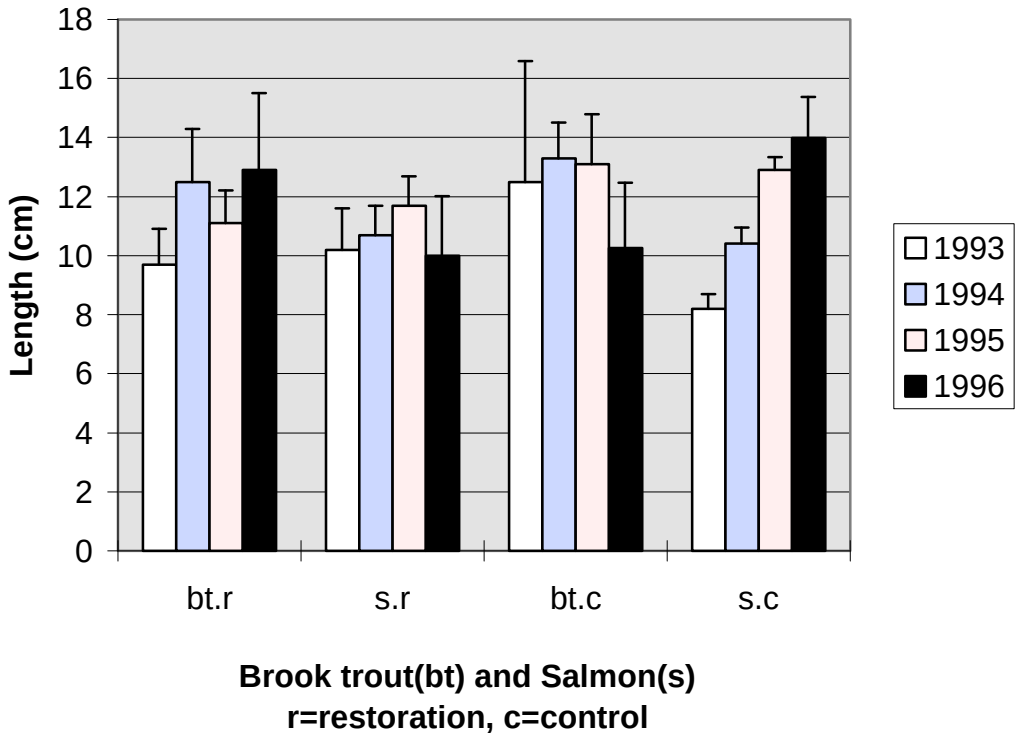

Figure 5. Mean length of brook trout and salmon at each of the study sites from 1993 to 1996. Vertical bars represent 95% limits on the means. Total number of fish is given in Table 1.

The information in Figure 6 points to two important findings. The first is for brook trout at the digger logs sites. The large increase in the number of brook trout at this site in 1995 was due to an increase in the number of young fish. This is evident in the large bar present in the upper left panel of Figure 6. This is the desired result, an increase in recruitment to the population.

The increase in the length of salmon at the control site in successive years is due to fewer smaller fish in the population (Figure 6, lower right panel). This suggests that the large decrease in salmon at the control site was due to a recruitment failure of the younger age classes and not an overall decrease in the size of salmon.

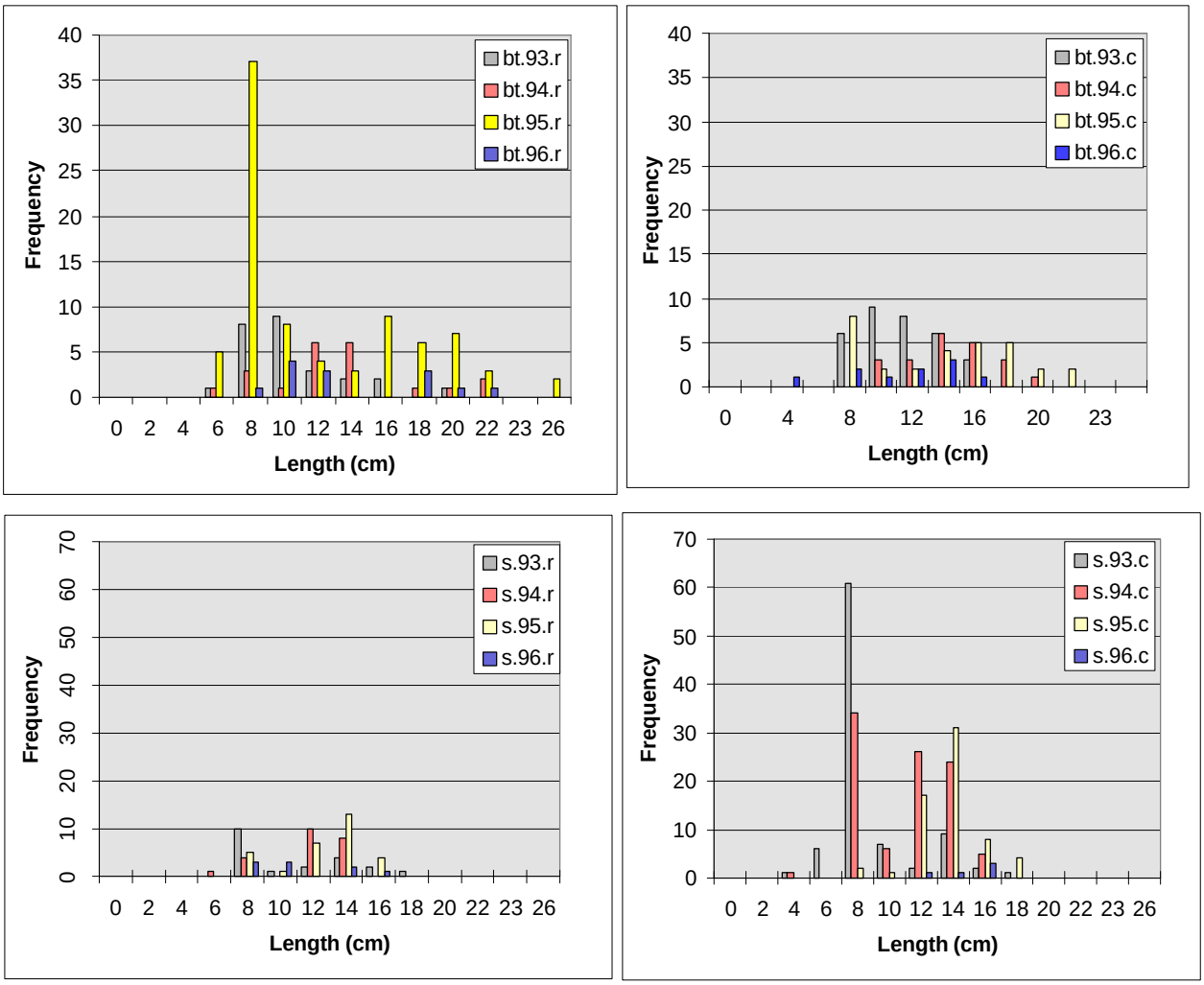

Figure 6. Frequency histograms for brook trout and salmon and both study sites from 1993 to 1995. bt = brook trout, s = salmonid, r = restored, c = control.

Recommendations

Valuable experience was gained from this study. Since its inception, stream restoration projects have extended to other areas in the vicinity of Parlee Brook, namely Wards Creek. The following recommendations are based on the experienced gained from this study and are suggested as guidelines only. The interested person is advised to consult the reference section in this report and visit as many sites as possible and speak to the individuals involved.

1. Parlee Book was at the upper size limit for use of digger logs and deflectors. Streams two meters and under are best suited to this technique.

2. Underlay the upstream section of the digger log with chicken wire if the stream consist of course gravel or cobble. This will prevent tunneling of water under the digger logs.

3. Consider deflectors alone as a means of narrowing the stream when deep pools are not a priority. Compared to digger logs, deflectors are easier to install and are more resistant to current and ice conditions in the winter.

4. Record the presence of all species of fish and not just salmonids. This information was essential in deterring that an environmental change and not an increase in fishing pressure was responsible for a decrease in the abundance of salmonids in Parlee Brook.

5. Digger logs worked very well in Parlee Brook. However, this prescription may not be suited to all streams. Study the water course before deciding.

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Newbury, R.W. and Gaboury, M.N. 1993. Stream analysis and fish habitat design. Afield manual. Newbury Hydraulics Ltd. Box 1173. Gibsons, BC, Canada VON 1V0. 256 p.

Contacts

If your watercourse flows into the Gulf of St. Lawrence

Fisheries and Oceans
Gulf Region, Science Branch
Fish Habitat and Enhancement Division
P.O. Box 5030, Moncton, N.B., E1C 9B6

If your watercourse flows into the Bay of Fundy

Fisheries and Oceans
Box 550
Scotia Fundy Region
Halifax, N.S., B3J 2S7

New Brunswick Department of the Environment
364 Argyle St.
Fredericton, N.B. E3B 1T9

Appendix 1

Comments received from visitors to the Parlee Brook site in 1996.

September 2, 1996

Very good idea. We don't have much fish in streams and this helps a lot with spawning of the fish. Very accessible to the road. Keep up with the good ideas. Thanks!

September 2, 1996

Very picturesque. Lovely idea.

September 7, 1996

Think this is a great idea this brook has been fished out for a long time. It is nice to come back and see they are doing something to improve the brooks. I grew up here as a lad and am glad to see the improvement that has taken place. Have place now to bring my grandchildren to fish. Thanks.

September 8, 1996

We think this is a very good idea to help the environment and fish population.

September 15, 1996

A peaceful spot, lots of little fish. Nice work!

September 15, 1996

We think this is a good idea because we think that you improved the fish population already. Keep up the good work.

October 26, 1996

Well done, congratulations on your effort to conserve the fish population. It is nice to see good stewardship of God's creation! Especially in such a beautiful spot as this one. Good way to make people aware of fish reproduction!

October 27, 1996

Great idea, doing something for this generation and those to come. Good Work!!
October 27, 1996

The logs look like they will do the job that you wanted don

October 27, 1996

I like it!

October 13, 1996

Very nice place. Keep up the good work, nice place for the fish.

October 27, 1996

Job well done, and the workers this summer worked real hard.

October 27, 1996

Government doing something positive with my tax dollars. Excellent and about time!!!

November 3, 1996

Snowing a bit. Interesting project. Great idea.
P.S. Will bring the kids next time. Good education.

November 17, 1996

Great work but these comments should be moved from here by the end of November. Keep up the good work.

November 30, 1996

Great Stuff!!

November 30, 1996

Pretty cool.