R.P. Griffith & Associates
1855 John Road, Sidney, B.C. V8L 5S8 Telephone / Fax : (250) 655-0074

Assessment of Fish Habitat and Production in Downton Lake Reservoir Relative to Hydroelectric Operations

Final Report

by:

R.P.Griffith, Fisheries Biologist

for:

B.C. Hydro
Kamloops, B.C.

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This document meets with the approval of the

Downton Lake Reservoir Technical Committee

Bryan W. Hebden, RPBio
B.C. Hydro and Power Authority

Kamloops, B.C.

Ian MacGregor, RPBio
B.C. Ministry of Environment, Lands and Parks
Kamloops, B.C.

Date

ABSTRACT

Downton Lake Reservoir is a large glacier-fed hydroelectric reservoir in southwestern British Columbia. Following a brief investigation of this reservoir at drawdown, in May 1996, a broader assessment of fish and fish habitat within the drainage was conducted during October 7-26, 1996. This was complimented by an associated study, monitoring limnological conditions in the reservoir itself, from fall 1996 to summer 1997.

Throughout the October 1996 field investigations, the reservoir was close to full pool. Streamflows were low, as usual for that time of year. Rainbow trout was the only fish species captured anywhere in the drainage, during these investigations. The majority of sampling effort was expended on an evaluation of habitat and associated populations of fish in tributary streams, above full pool. Generally speaking, spawning habitat appeared to be limited and/or inaccessible in most streams. In addition to the predominantly small and steep tributaries along the north and south sides of the reservoir, this also applied to the upper Bridge River, a moderately large system, and predecessor to the reservoir itself. In sampling of the upper Bridge River system, rainbow fry were only captured in a discrete network of side channels approximately 2.5 km upstream of the reservoir, at full pool. In addition to superior spawning substrates, these channels also offered clear flows and warmer temperatures, compared to the highly turbid and cold waters of the Bridge River mainstem, and McParlon Creek, a major tributary to it. In the numerous smaller tributaries to the reservoir, steep gradient and/or specific barriers to fish passage frequently limit (or preclude) access to streamlength above the full pool level. Other than the Bridge River side channels noted above, only one other stream section (in a smaller tributary to the reservoir) was found to contain significant numbers of fry.

Despite an apparent limitation in spawning habitat above full pool, recruitment does not appear to be limiting to fish production within Downton Lake Reservoir. In three years of sampling by gill net (October 1994 to October 1996), the reservoir has consistently produced impressive catches of well conditioned rainbow trout. Scale analyses for reservoir captures in 1996 suggested that very close to half of the total catch had entered the reservoir as fry. Given the low numbers and narrow distribution of fry captured in stream habitats in October 1996, it is possible that a major emigration of 1996 fry had occurred prior to the October sampling. It might also be possible that some level of spawning/recruitment occurs in historic sections of tributaries within the reservoir basin, exposed during drawdown. It is further possible that low fry numbers in some streams in October 1996 may have been related to the extreme drawdown of the reservoir in the spring of 1996. However, this would not seem to apply to the upper Bridge River system, at least. The survival and production of rainbow trout in Downton Lake Reservoir is likely favoured by protracted spawning of the species that is evidenced both here and in other drainages nearby, presumably in response to the harsh (cold) conditions of the region.

Limnological monitoring during 1996-97 has confirmed that the Downton Lake Reservoir system is a harsh environment, exhibiting both riverine and lacustrine characteristics. Primary and secondary production are limited by cold temperatures, high turbidity, and low water retention times. Water chemistry is complex, and an unusual finding was nitrogen limitation within the reservoir. However, primary production appears to be low, consistent with other cold oligotrophic reservoirs. Zooplankton densities were particularly low during the monitoring period, and a contributing factor appeared to be displacement and entrainment within the bulk water transport through the reservoir. However, it seems likely that benthic production is the principal source of aquatic food for trout in the reservoir, and may be the most important ecological factor in the production of fish within the system, overall. It is likely that reservoir operations exert major influences in this regard, but investigation of benthic production was beyond the scope of the 1996-97 monitoring program.

During the May 1996 investigations, at extreme drawdown, there was apparently widespread stranding of rainbow trout in pockets of water within the drained reservoir bottom. It is also likely that some fish were (and are regularly) lost to entrainment through the dam. However, there were no observed mortalities or remains; and if there were any unusual losses of fish due to the extreme drawdown in 1996, this was not evident in the October 1996 gill netting results, compared to previous years. There was evidence of reproductive stress in mature and near-mature fish at drawdown, in May 1996. In addition, some streams were inaccessible due to subsurface flows within alluvial deposits below the full pool level, at this time. Spawning in these streams may have been hampered or precluded, if only temporarily. However, spawning habitat remained accessible in the upper Bridge River at least.

If the above or any other impacts of hydroelectric operations are ultimately deleterious to the production of rainbow trout in Downton Lake Reservoir, or if there are any verifiable mitigation requirements for this species, this is not evident in the findings to date. There may be specific concerns for the status of bull trout. Low numbers of this species were captured in gill netting of Downton Lake Reservoir in August 1995, but none were encountered in any sampling in 1996. However, it would be premature to assume any decline in the numbers of these fish at this point, since the species was also absent in the October 1994 gill netting of the reservoir. The catch of bull trout in August 1995 was at a single sampling location near the western end of the reservoir, and may have been attributable to seasonal influences on fish distribution not applying to the month of October in either 1994 or 1996. Nonetheless, future investigations are strongly recommended in order to determine the status, distribution and behaviour of this species, within the drainage.

With respect to rainbow trout, the most immediate needs are also for further information to enable more confident interpretation of fish production within this extraordinary system, and the effects of hydroelectric operations upon it. Specifically, further investigations should be undertaken to determine the following: 1) the timing and distribution of rainbow trout spawning within the system; 2) benthic production and related importance as food for fish; and 3) direct assessment of fish losses to entrainment and stranding during drawdown. Until more is known about these key issues, it is not possible to evaluate the associated effects of reservoir operations, either in normal years, or under the extreme conditions of 1996.

ACKNOWLEDGEMENTS

Great appreciation is extended to the following indiduals for their contributions to this study: Bryan Hebden (B.C. Hydro, Kamloops); Harry Brownlow (B.C. Hydro, Burnaby); Chris Perrin (Limnotek Research and Development Inc.); Ian McGregor, Rob Bison, and Brian Chan (B.C. Ministry of Environment, Lands and Parks, Kamloops); Laura Campo (Environment Canada, Vancouver); Ivan Stefanov (I.D. Stefanov and Associates, Victoria); Doug MacKay, Alison Griffith, and Drew Faford (R.P. Griffith and Associates, Sidney). Particular thanks are extended to Ainsworth Lumber Company Ltd. (Lillooet Division, Lillooet) for provision of recent mapping for the upper Bridge River system, and access to roads. Special thanks also go to the many residents in the Gold Bridge area, for their time, their interest, and their valuable information regarding Downton Lake Reservoir, and the rest of the Bridge River system.

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1.0 INTRODUCTION

Downton Lake Reservoir is part of the Bridge River system, and is located immediately west of the town of Gold Bridge, approximately 70 km west of Lillooet (Fig. 1). It is formed and regulated by LaJoie Dam, which was completed in 1948 for the purposes of hydroelectric storage, and was later equipped with generating facilities. Part of the Bridge River valley has been flooded to form the basin of the reservoir, to which the remainder of the upper Bridge River (flowing from the west) is the largest tributary.

Carpenter Lake Reservoir is another large hydroelectric impoundment on the Bridge River system, and it is located immediately downstream of Downton Lake Reservoir (Fig. 1). On behalf of B.C. Hydro, an assessment of fish habitat and production in the Carpenter Lake Reservoir drainage was completed by *R.P. Griffith and Associates*, in association with *Limnotek Research and Development Inc.*, in 1995-96 (Griffith, 1996*a*; Perrin and Macdonald, 1997).

Due to budgetary constraints, Downton Lake Reservoir and its tributaries were not included in the terms of reference for the Carpenter Lake Reservoir study (B. Hebden[1], *pers. comm.*). However, in late April 1996, B.C. Hydro requested *R.P. Griffith and Associates* to conduct an investigation of fish stranding in Downton Lake Reservoir at maximum drawdown (May 1996), following similar assessment in Carpenter Lake Reservoir. Persuant to this, and as a logical extension of studies completed for Carpenter Lake Reservoir, B.C. Hydro scheduled a broader fisheries assessment of Downton Lake Reservoir to commence in the fall of 1996.

The main objectives were the same as those for the Carpenter Lake Reservoir studies conducted during the previous year[2]. These objectives were to investigate the following, to the extent possible in a single year of assessment:

- *present distribution, abundance, and status (relative to theoretical habitat capability) of fish populations within the study area;*
- *the effects of hydroelectric operations on fish and their habitat; and*
- *feasible/practical restoration or enhancement opportunities for fish production within the system.*

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1. Environmental Biologist, B.C. Hydro, Kamloops.

2. B.C. Hydro Standing Purchase Order No. PPL600311. *Downton Reservoir Drawdown Impact*. Issued to R.P. Griffith and Associates. August 13, 1996.

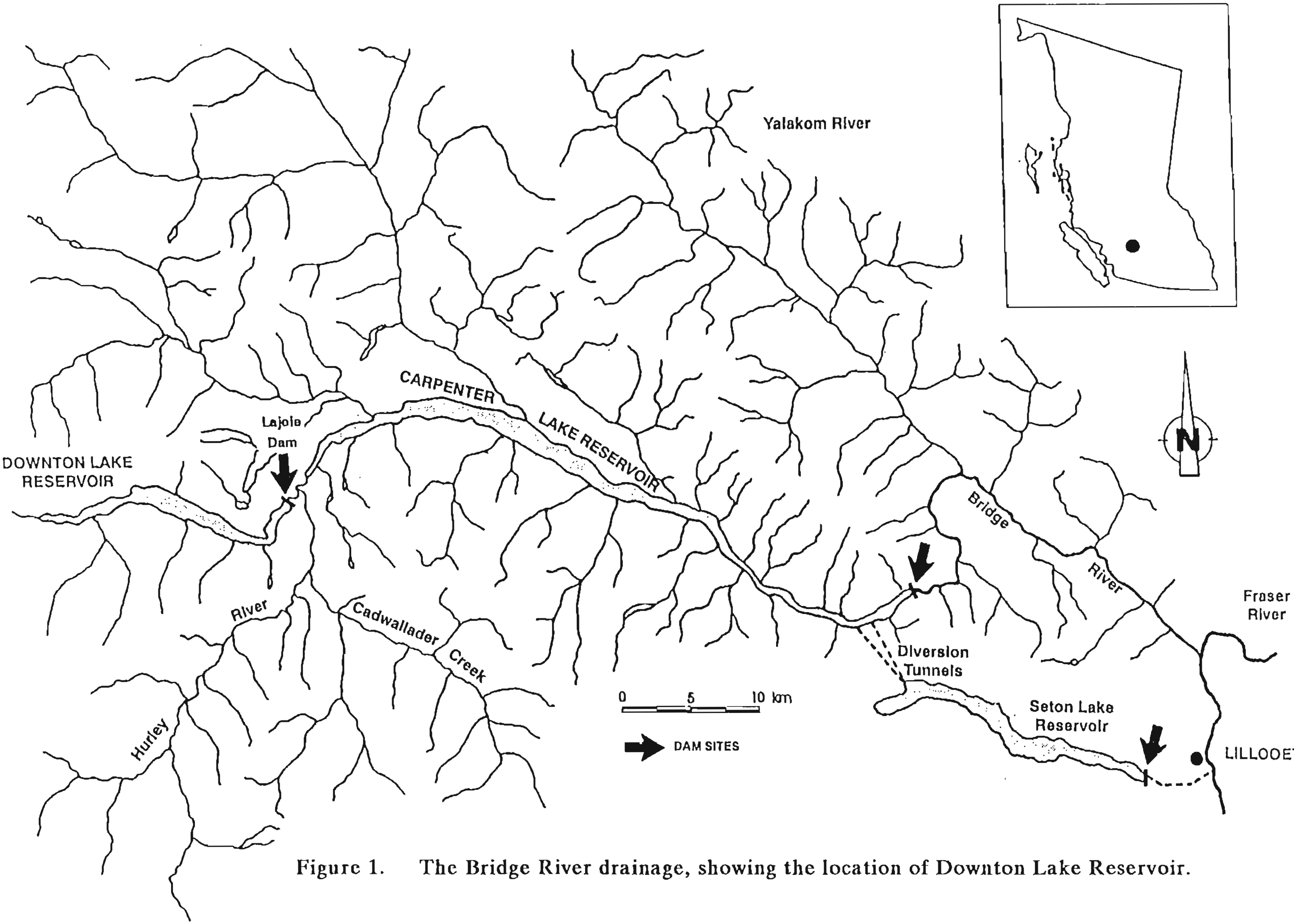

Figure 1. The Bridge River drainage, showing the location of Downton Lake Reservoir.

The study consisted of two major components: 1) assessment of fish populations and fish habitat throughout the drainage; and 2) monitoring of limnological conditions within the reservoir.

The assessment of fish populations in the field was scheduled for completion during the early fall of 1996, to coincide with lower stream discharges, and the end of the growing season for fish. These conditions are essential for the application of standard assessment methodologies, developed by the B.C. Fisheries Branch, specifically for fish in B.C. streams (Ptolemy, 1992; Anon. 1995). Consistent with the Carpenter Lake Reservoir studies, limnological monitoring of the reservoir was to be continued over the course of a year, ending in the fall of 1997.

In August 1996, a contract to complete the Downton Lake Reservoir investigations was again awarded to *R.P. Griffith and Associates*, in association with *Limnotek Research and Development Inc.* As in the case of Carpenter Lake Reservoir, the latter firm was responsible for limnological monitoring of the reservoir, and interpretation of associated productive capabilities and constraints. *R.P. Griffith and Associates* was responsible for assessment of fish and fish habitat throughout the drainage, and integration of limnological findings, to evaluate the implications with respect to fish production within the system, as a whole.

2.0 BACKGROUND

2.1 Study Area

The total area of the Downton Lake Reservoir drainage is in the order of 650 km^2. At full pool, the reservoir is approximately 2,350 ha in area, and 26.5 km in length, oriented east to west (Fig. 1). Upstream of this, the upper Bridge River extends for another 35 km to the west.

Based on a study of the Hurley River drainage, located immediately to the south (Fig. 1), the geology of the area is dominated by bedded volcanics and sediments (HKP[3.], 1994). Throughout the Downton Lake Reservoir drainage, the terrain is steep and mountainous, and isolated perrenial snowpack and icefields are the ultimate source of flows in the upper Bridge River, the major tributary to the reservoir.

There are numerous smaller tributaries which flow directly to Downton Lake Reservoir, down predominately steep valley walls along both the north and south sides of the reservoir (Fig. 2). Most of these are relatively small (< 5 km in length), and many of them only flow intermittently, with seasonal meltwater and/or rainfall. However, some also appear to be fed by perrenial snowpack and icefields, particularly towards the western end of the reservoir.

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3. Hallam Knight Piésold Ltd., 1994.

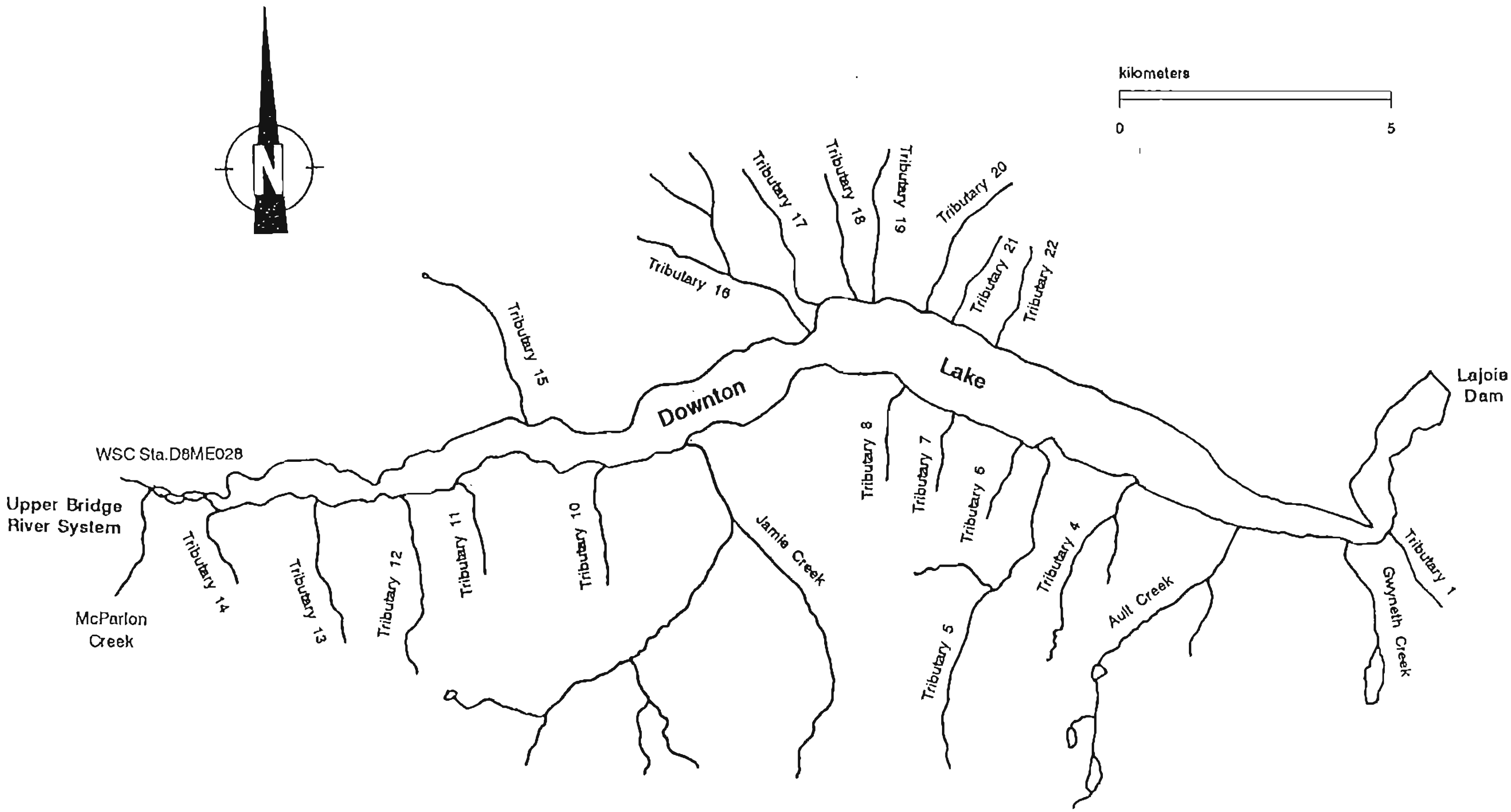

Figure 2. Tributaries to Downton Lake Reservoir scheduled for investigation during October 1996.

Three larger streams flow into Downton Lake Reservoir from the south; these are Gwyneth Creek, Ault Creek, and Jamie Creek (Fig. 2). All three of these tributary systems include small lakes. Jamie Creek, the largest (approx. 12 km in length), is also headed by the Surfusion Glacier, and other large icefields to the north of Mount Thiassi.

Likening the weather conditions in the Downton Lake Reservoir drainage to those of the neighbouring Hurley River system, the climate may be viewed as transitional between the moderate temperatures and wet conditions of the coast, and the extreme temperatures and dry conditions of the interior (HKP, *op. cit.*). Annual precipitation has been estimated at 550 mm at the eastern end of the drainage, but areas to the west may receive considerably more (*ibid.*).

Water Survey of Canada has recently installed a stream discharge gauging station in the upper Bridge River, approximately 1.5 km upstream of the western extremity of the reservoir (Sta. 06ME028; Fig. 2). Mean monthly discharges at this station during 1996 are shown in Figure 3, and illustrate the prevailing pattern of natural runoff within the system (daily records are provided in Appendix 1).

Flows are minimal during winter, due to freeze-up, and peak during the early summer, as a result of thaw and snowmelt. After this peak, there is a steady decline as annual snowpack diminishes, but there is also the progressive influence of perennial snowpack and/or glacial meltwater during the warmest periods.

2.2 Hydroelectric Development

As noted above, Downton Lake Reservoir was formed with the construction of LaJoie Dam by the British Columbia Electric Company in 1948 (Triton, 1992). The dam was initially for storage only, but was redeveloped with generating facilities in 1957. It is an earth-fill structure 87 m in height and 1033 m in length (B.C. Hydro, 1995*a*).

The purpose of the dam is two-fold: 1) to provide power generation at the accompanying LaJoie Generating Station; and 2) to provide additional storage for Carpenter Lake Reservoir. Water from the latter reservoir is transported through tunnels at its eastern end to the Bridge River generating facility, at Shalalth, on Seton Lake (Fig. 1).

At full pool, the elevation of the water surface in Downton Lake Reservoir is 749.81 m, regulated by a 100 m free crest weir and spillway at LaJoie Dam. However, the crest elevation of the dam itself is 753.47 m, and the maximum operating level for the reservoir is 751.94 m (B.C. Hydro, *op. cit.*). The minimum operating level is 700.13 m (*ibid.*).

However, records since 1960 reveal that the minimum elevation in most years is generally between 715 m and 725 m (Appendix 2). As shown in Figure 4, the average is in the region of 718 m. Recent (1996) 1:2,500 bathymetric mapping of Downton Lake Reservoir (Survey and

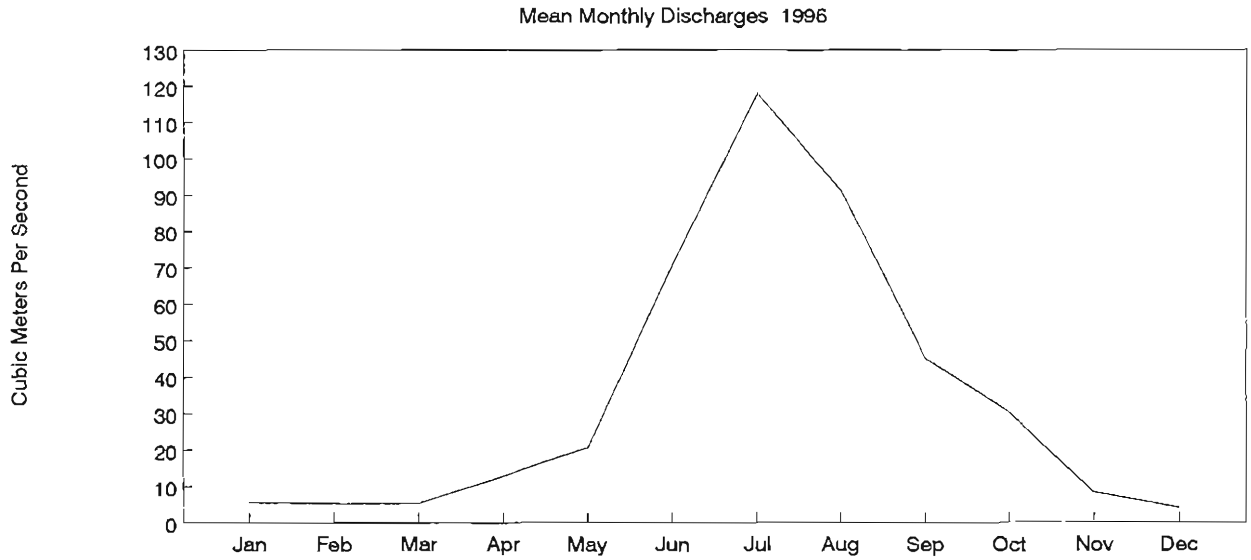

Figure 3. Summary of discharges for the upper Bridge River (WSC Sta.08ME028), upstream of Downton Lake Reservoir, in 1996.

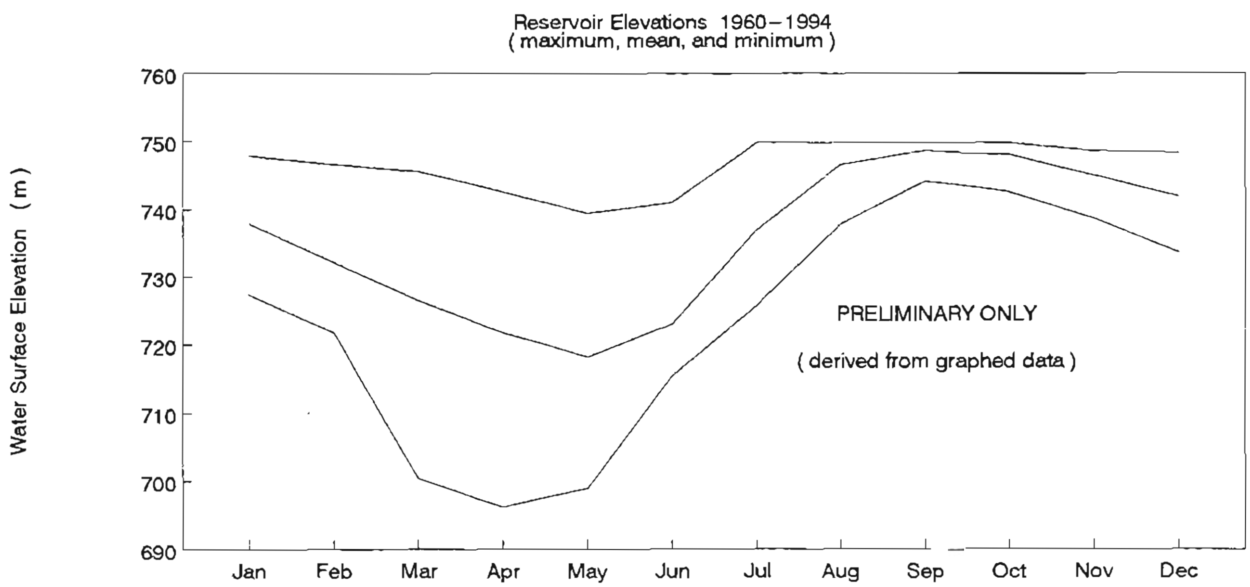

Figure 4. Summary of monthly records for water elevations in Downton Lake Reservoir, 1960–1994 (B.C. Hydro data).

Photogrammetry Department, B.C. Hydro, Burnaby) indicates that the main water body (pelagic zone) extends to the vicinity of Tributary 16, in Figure 2, at this elevation.

For all portions of the reservoir further upstream (ie. above the minimum elevation), the bottom of the basin becomes exposed, with the upper Bridge River flowing through it, in its historic channel. At full pool, Downton Lake Reservoir is extremely scenic (Fig. 5); however, at drawdown much of it consists of exposed mudflats (Fig. 6).

In addition to the flowing Bridge River channel, these mudflats also contain numerous pockets of standing water, within various depressions (Fig. 6). Many of these become isolated with progressive draining of the reservoir; shallow ones may dry out completely.

The occurrence of fish stranding in these pockets of water was investigated at maximum drawdown of Downton Lake Reservoir, in May 1996 (Griffith, 1996*b*). The degree of drawdown in this year was exceptionally great (elev. 698.32 m, on May 1; Langer, 1996), and was required for the safe and successful inspection of the dam intake gate guides and sills (Hanlon, 1996). Various results of the fisheries investigations conducted at this time will be addressed later in this document.

2.3 Other Development

Initial development of the Bridge River drainage stemmed from the Fraser River gold rush in the 1850s. The geology of the drainage contains polymetallic deposits, including considerable amounts of gold and silver (Triton, 1992). The most notable is the Bralorne-Pioneer deposit, on Cadwallader Creek, a major tributary to the Hurley River, the watershed immediately to the south of the Downton Lake drainage (Fig. 1). Initially the emphasis was on placer mining, including the Gold Bridge area, and the largest and most notable claim was at the confluence of the Hurley and Bridge rivers, immediately downstream of Downton Lake Reservoir (*ibid.*).

A small number of placer claims have been authorized within the eastern extremity of the Downton Lake Reservoir drainage. Otherwise, there appears to have been surprisingly little mining activity within the Downton Lake watershed. This is particularly true for hard-rock mining, which commenced in the area in 1898 (Pioneer Mine, Bralorne). As of 1992, there was no record of past or proposed hard-rock mining within the Downton Lake Reservoir drainage (Triton, *op. cit.*).

Forest harvesting has been the only significant development within the drainage, other than mining and hydroelectric development. However, even forest harvesting appears to have been surprisingly limited, especially compared to the extensive logging in the Hurley River drainage (Griffith, 1997*a*). Until recent years, road access only extended 7 km (approx.) along the south side of Downton Lake Reservoir, and 12 km (approx.) along the north side.

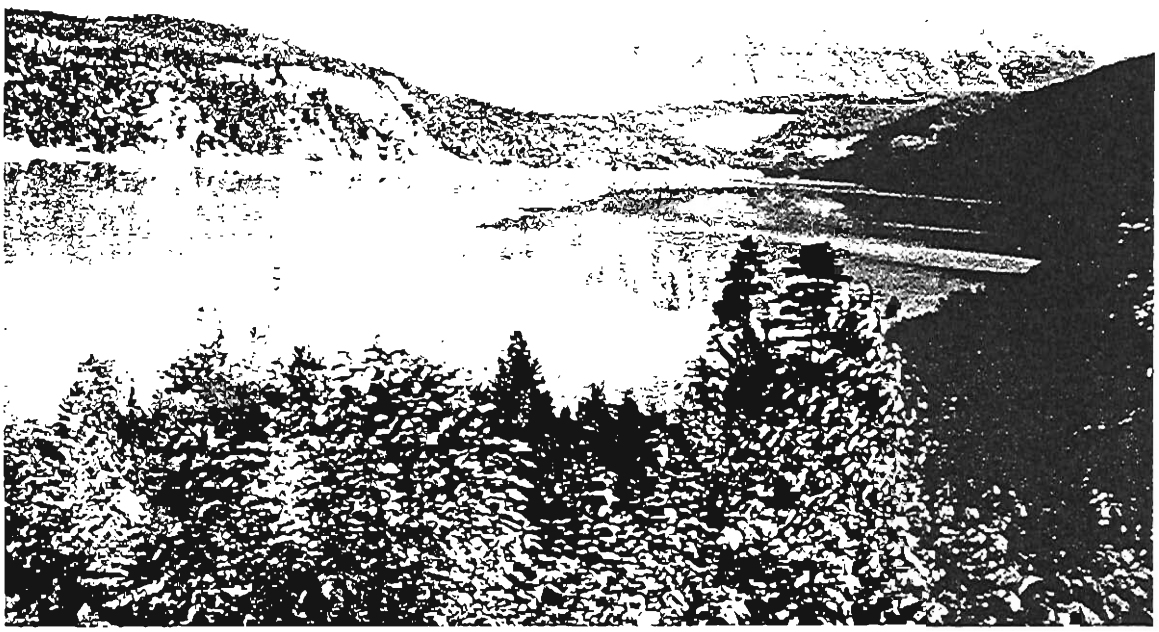

Figure 5. Downton Lake Reservoir, looking east from the vicinity of Tributary 5, near full pool in October 1996.

Figure 6. Downton Lake Reservoir, in the same vicinity as Figure 5, at drawdown in May 1996.

The road to the south has now been extended along the full length of the reservoir, to enable forest harvesting in the Jamie Creek watershed, the upper Bridge River drainage (including McParlon Creek), and hillslopes above Downton Lake Reservoir itself (Triton, *op. cit.*).

At the time of the investigations in the fall of 1996, road construction along the south side of the system extended approximately 8 km up the Bridge River mainstem, beyond the western end of the reservoir (at full pool). Mainlines had also been established up both Jamie Creek and McParlon Creek; and extensive logging appeared to be underway in all of these areas, especially along the upper Bridge River itself.

In addition to these developments along the south side of the system, road access was also being improved and extended along the north side of the reservoir, at the time of the fall 1996 investigations.

2.4 Fish Resources

Prior to the mid-1990s, information regarding fish populations in the Downton Lake Reservoir drainage appears to have been largely anecdotal. Due to high glacial turbidity of the reservoir, it was generally assumed that stock abundance and growth were poor (Triton, 1992), and local interest has been focused on the fish in the far more accessible Carpenter Lake Reservoir, immediately downstream[4].

Earlier documents have suggested the presence of the following fish species in Downton Lake Reservoir (Acres, 1990; Triton, *op. cit.*): rainbow trout (*Oncorhynchus mykiss*), bull trout (*Salvelinus confluentus*)[5], kokanee salmon (*O. nerka*), and mountain whitefish (*Prosopium williamsoni*). However, in the first concerted sampling of the reservoir, employing gill nets, in October 1994, only rainbow trout and kokanee were captured (B.C. Hydro, 1994*a*). The vast majority were rainbow (68 of the total 70 fish captured). In replicate sampling conducted in August 1995, 8 bull trout were captured, in addition to 165 rainbow and 7 kokanee (B.C. Hydro, 1995*b*).

Findings of the May 1996 sampling of Downton Lake Reservoir, at drawdown (Griffith, 1996*b*), raised doubts about the earlier captures of kokanee. Rainbow trout was the only species captured in the May 1996 sampling. More importantly, however, some of these trout were extremely silvery, and could conceivably have been mistaken for kokanee.

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4. Comments obtained at a meeting of the Gold Bridge Rod and Gun Club in September 1995, during investigations of Carpenter Lake Reservoir (Griffith, 1996*a*).

5. Previously referred to as Dolly Varden (*S. malma*).

This prompted re-examination of scale samples and other records from the 1994 and 1995 captures. This was conducted through the Department of Zoology, University of British Columbia, and it was ultimately determined that all specimens previously identified as kokanee were in fact rainbow trout (B. Hebden, *pers. comm.*). On the other hand, the correct identification of bull trout was confirmed, for the 1995 capture (*ibid.*).

In 1948, the Mission Dam was constructed on the Bridge River, to form Carpenter Lake Reservoir, downstream of Downton Lake Reservoir (Fig. 1). This terminated any historic migrations of anadromous fish stocks in the Bridge River drainage, above the Mission Dam. Prior to this development, it is reported that chinook salmon and steelhead trout production may have extended as far upstream as Cadwallader Creek, in the Hurley River system (Triton, *op. cit.*).

However, there does not appear to be any record of migrations to/within the part of the system that is now the Downton Lake Reservoir drainage. Natural falls were present at the location where LaJoie Dam has been constructed. Local opinion is that these falls constituted a natural barrier to fish migrations (see footnote 4).

3.0 METHODS

All field work in the fall 1996 assessment of fish populations in the Downton Lake Reservoir drainage was conducted during the period October 7-26. As noted earlier, this timing was scheduled to coincide with lower stream discharges (Fig. 3), and the end of the growing season for fish, as required for the application of standard B.C. Fisheries Branch methodologies.

Field investigations completed by R.P. Griffith and Associates consisted of 3 major components: 1) description and evaluation of fish habitat in streams tributary to Downton Lake Reservoir; 2) assessment of existing fish production (distribution and standing stock) within these streams, relative to theoretical habitat capability (modelling); and 3) further repetition of earlier gill netting in the reservoir itself.

The limnological monitoring of the reservoir itself was conducted by *Limnotek Research and Development Inc.*, over an 11 month period from November 1996 to September 1997.

3.1 Description and Evaluation of Stream Habitat

Following procedures established jointly by the Federal Department of Fisheries and Oceans, and the B.C. Ministry of Environment (DFO/MOE, 1989), a total of 35 detailed stream habitat descriptions (habitat surveys) were completed, addressing the following: 1) the upper Bridge River mainstem, and associated side channels; 2) McParlon Creek, and three smaller tributaries within the upper Bridge River system; and 3) a total of 16 smaller tributaries to Downton Lake Reservoir, including Gwyneth Creek, Ault Creek, and Jamie Creek.

Investigation of the Bridge River system extended to the end of road access, approximately 8 km upstream of Downton Lake Reservoir. With one exception, all of the other 22 tributaries to the reservoir, shown on 1:50,000 topographic mapping (NTS Map Nos. 92/J/14, 15), were also investigated. All of these streams flow down the steep valley walls of the reservoir (Fig. 2), greatly limiting the usable streamlength for fish. Accordingly, investigations of most of these streams focused on their lowermost sections, immediately upstream of the reservoir.

For the streams located along the south side of Downton Lake Reservoir, access and inspection was by the road which closely borders the southern shore, at most locations. For the streams along the north side of the reservoir, access and inspection was by boat. The only stream that could not be inspected was Tributary 15 (Fig. 2). This was scheduled for completion on October 17, but a severe wind and snow storm occurred on that date, precluding safe boating to the site[6].

Due to the severity of conditions, field operations were suspended altogether, until the resumption of more stable weather on October 23. However, this was short-lived, and once again inspection of Tributary 15 was preempted by concentration on gill netting in the reservoir.

A total of 5 tributaries shown in Figure 2 were found to be totally dry in October 1996, and accordingly habitat descriptions were not completed. In the 35 locations where surveys *were* completed, the description and evaluation of fish habitat addressed the full wetted width of the given stream. In addition to this, descriptions were also completed for the habitat specifically sampled at all electrofishing sites in streams. In accordance with standard procedures, these descriptions followed deLeeuw (1981), with some modifications associated with the modelling of standing stock capability (noted below).

Wherever possible, all habitat measurements were by tape and staff. Notable exceptions were the Bridge River mainstem, McParlon Creek, and Jamie Creek, where the depth and turbulence of flows, and high turbidity, precluded such means. In such cases, widths were taken by rangefinder, and depth measurements were limited to what was safely possible.

3.2 Fish Sampling in Streams

Fish sampling in streams, by electrofishing, was conducted at a total of 40 different sites within the Downton Lake Reservoir drainage during the October 1996 investigations. At all of these sites, procedures followed those for full population estimates, employing the 2-capture removal method, with sites fully contained by small-mesh stopnets (deLeeuw, *op. cit.*). Prior to sampling, these nets were installed as unobtrusively as possible, employing anchors and/or guylines, as required by specific flow velocities and/or turbulence.

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6. This storm sadly took the lives of 3 hunters who *did* attempt to cross the reservoir by boat.

Generally speaking, electrofishing sites are normally selected to be as closely *representative*, as possible, of *average* habitat conditions for a given stream or stream section. However, due to the narrow distribution of fish in stream habitats within the Downton Lake Reservoir drainage, sampling was skewed towards superior habitats, as a more rigorous test of fish presence or absence. Where fish were not captured at a given site, additional *spot-shocking* (without nets) was routinely conducted, to confirm the initial findings. In 2 cases, large supplemental sites were completed, employing downstream nets only.

In most of the smaller tributaries, the full wetted width was contained and sampled, between upstream and downstream nets. The same applies to most of the side channels associated with the Bridge River mainstem. However, in the Bridge River mainstem itself, McParlon Creek, and Jamie Creek, sampling was restricted to only part of the full wetted width, due to high water velocities, turbulence, and/or depths, and the associated logistical constraints to installing and maintaining stopnet enclosures. At one site in McParlon Creek, the downstream net let go before the final inspection of it, for fish.

At all electrofishing sites, water depth and velocity transects were completed in order to assess the hydraulic suitability (for fish) at each site. In each case, transect location/orientation was aimed at typifying the given conditions throughout the area sampled. Wherever possible, these transects were oriented across the wetted width to provide an estimate of stream discharge. However, in some cases the orientation was diagonal, or even longitudinal, if so required to best reflect hydraulic makeup of the site.

Fork length and weight measurements were obtained from all fish captured by electrofishing. In order to assist age identification (and delineation), scale samples were obtained from a total of 40 specimens, addressing all size classes. As warranted, individuals were occasionally sacrificed in order to determine the status of reproductive development, to assist in aging and the interpretation of life history patterns.

3.3 Estimation and Evaluation of Standing Stock Capability in Streams

The habitat capability model for juvenile salmonids developed by the B.C. Fisheries Branch (Ptolemy, 1992) was used to assess the 1996 fish densities in all sampled streams within the Downton Lake Reservoir drainage (Appendix 3). All entries and results relate to conditions at the end of the growing season for fish, and resultant standing stock capability (carrying capacity) estimates are expressed in terms of potential fish numbers per unit area of suitable/usable habitat for a given species/size of fish, at low flows (ie. minimum volume of habitat).

At any given sampling site, the proportion of the area that is actually usable for different species/cohorts may vary widely. Consequently, in order to compare sampling results to corresponding capability estimates, it is necessary to adjust the former, relative to the specific degree of suitability/usability of each site, for each species/cohort of fish. This adjustment is based on probability-of-use procedures, introduced by Bovee and Cochnauer (1977), using water depth and velocity as the principal delineators of habitat partitioning (and use) for juvenile fish.

In order to express initial electrofishing results (based on total site area) as densities within *suitable habitat only* (consistent with the capability model), the mean weighted *hydraulic suitability* of each site was determined, by applying species-specific and age/size-specific probability-of-use criteria to the hydraulic transect data. This is accomplished by spreadsheet, also developed specifically for salmonids in B.C. streams (Bech *et al.*, 1994).

Provided that a given transect is representative of hydraulic conditions throughout a sampling site, the mean composite (depth $\times$ velocity) probability-of-use for the transect provides the requisite estimate of the degree to which the total hydraulic habitat is actually usable for a given species/cohort of fish. Accordingly, this enables adjustment of the initial sampling results for direct comparison to capability estimates (ie. what was found in suitable/usable habitat *vs.* the theoretical maximum for fish, in such habitat).

All of the preceding relates specifically to the influence of water depth and velocity only. In order to assess the absolute suitability of habitat conditions at each site, an attempt was also made to evaluate any potential limitation related to the type and complexity of bed materials, and/or other cover for fish (eg. woody debris, cutbanks, vegetation, etc.). As noted above, habitat descriptions were completed at each electrofishing site, concentrating on these elements.

For bed materials, an estimate was made of the proportion of total site area containing suitable sizes and complexity for salmonid fry and parr[7] (with separate estimates for each). As a rule, suitable materials for fry (ie. cover) were deemed to range from large gravel to moderate size boulders. For parr, the general range was from large cobble to large boulders. Specific area measurements were obtained by tape. Water depth and velocity conditions, which are addressed separately by the transects, are disregarded in the cover measurements.

In order to generally assess water quality in stream habitats, and more specifically to enable capability modelling (Ptolemy, 1992), water samples were collected from a total of 20 different streams and/or stream sections, including all of those found to contain fish.

3.4 Fish Sampling in the Reservoir

In consultation with the B.C. Hydro project leader (B. Hebden, Kamloops), it was elected to further repeat the earlier (1994, 1995) gill netting of Downton Lake Reservoir, during the 1996 investigations. Installations were to occur at the same 3 locations used in both 1994 and 1995, employing one sinking net and one floating net at each site.

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7. This size/age category may include small resident adults.

All nets were standard 91m multi-mesh (25mm-89mm) experimental nets, as specified by the B.C. Fisheries Branch (Anon., 1995). Sinking nets were installed at right angles to the reservoir shoreline; floating nets were installed parallel to the shoreline, commencing at the outer end of the sinking net. An electronic sounder was employed to determine depths for sinking nets, and to help avoid entanglements with large woody debris.

In each case, sets were deployed in the afternoon, were left in place overnight, and were retrieved the next day. The following data were obtained from all fish captured in the gill netting: 1) species; 2) length; 3) weight; 4) sex; 5) stage of sexual development; 6) amount of food in gut; 7) type of food in gut (to the extent possible); 8) any other characteristics of specific interest; and 9) a sample of scales, to assist in the interpretation of fish age and life history characteristics.

Gut analyses were conducted in the field, at the time of capture, and were aided only by small pocket magnifiers. Only those items that could clearly be identified were recorded specifically. Otherwise, general descriptors were employed, to characterize the contents as a whole.

Initial scheduling for the gill netting was aimed at replicating the timing of the 1994 sampling (October 11-14), as closely as possible. However, with deteriorating weather conditions commencing on October 12 in 1996, completion of all electrofishing was the first priority. With the exception of Tributary 15, this was achieved by October 17; but as noted earlier, a severe storm on this date forced temporary cessation of all further field activities, and ultimately delayed the 1996 gill netting until October 23-26.

3.5 Limnological Monitoring

As noted in the introduction to this document, the monitoring of limnological conditions in the Downton Lake Reservoir drainage during 1996-97 was conducted by *Limnotek Research and Development Inc.*, and all aspects of the program have been reported separately (Kiffney and Perrin, 1998). Reviewers are referred to the latter document for any and all details regarding specific procedures and/or findings. The following is a general outline of the studies completed, and the methods employed, for the purposes of the present document.

The monitoring program was conducted over the 11 month period from November 1996 to September 1997. During this period, field sampling was conducted on 4 occasions, corresponding to different limnological seasons, as follows: November 12, 1996 (fall); April 29, 1997 (winter); June 17, 1997 (spring); and September 2, 1997 (summer).

In addition to the reservoir itself, sampling was also conducted within the Bridge River, both upstream and downstream of the reservoir. Two stations were located upstream of the reservoir. The uppermost was located at the Water Survey of Canada gauging station (D8ME028) on the upper Bridge River, just downstream of McParlon Creek (Fig. 2).

The second was a roving site which was located at the downstream end of the fluvial habitat, in the reservoir drawdown zone, immediately upstream of where it entered the standing water of the reservoir body itself (wherever that was on the given occasion, and attendant level of storage). Only one station was addressed downstream of the reservoir. This was in the Bridge River, below LaJoie Dam, but upstream of the Bridge and Hurley rivers confluence.

Two stations were addressed in Downton Lake Reservoir itself. One was located towards the western end of the reservoir (10 km east of the western boundary at full pool). The other was located close to the dam, at the eastern extremity of the reservoir.

On each sampling occasion, at both reservoir stations, dissolved oxygen and temperature profiles were obtained from the surface to the bottom. Profiles of photosynthetically active radiation were also completed. Water samples were collected at the surface, and 2 m from the bottom, at each station.

Biological sampling consisted of vertical phytoplankton and zooplankton hauls at the reservoir stations, and was limited to June and September, when peak biomass of plankton might be expected. This is the most useful time for the purposes of interpretation of results, especially with respect to food availability for fish.

On each sampling occasion, water samples were collected from all stations, and were analysed for the following: soluble reactive phosphorus; total phosphorus; total dissolved phosphorus; particulate phosphorus; ammonia; nitrates; Kjeldahl nitrogen; total alkalinity; total dissolved solids; non-filterable residues; soluble reactive silica; true colour; turbidity; conductivity; and pH.

Water temperatures within the Bridge River were measured and recorded hourly, by digital temperature loggers, at stations both upstream and downstream of Downton Lake Reservoir.

4.0 RESULTS

4.1 Weather and Streamflow Conditions During the October Field Investigations

Prior to the turn in the weather, commencing October 12 (noted above), the summer and early fall of 1996 were particularly dry in southern British Columbia (Griffith, 1997*b*). During the Downton Lake investigations, conditions were mostly sunny from October 7-12. Slight showers commenced on October 12, continued on October 13, and developed into heavy showers on both October 14 and 15.

As evidenced by the discharge records for the Bridge River mainstem (Appendix 1), these developments did not appear to have any influence on streamflows, although they did cause concern with respect to future feasability/safety of electrofishing. Conditions on October 17 precluded further activities, all involving boating on the reservoir; however, with respect specifically to gill netting, the heavy snowfall on October 17 raised the further concern that even if nets could be set under such conditions, it might not be possible to retrieve them for an extended period of time. With return to the system on October 23, conditions were improved, but remained threatening. Accordingly, all effort was focused on expeditious completion of the reservoir gill netting, as previously noted.

4.2 Turbidity and the Influence of Glacial Meltwater

The upper Bridge River system is the principal source of the high glacial turbidity of Downton Lake Reservoir. A water sample obtained at a recently constructed bridge crossing of the river, 7 km (approx.) upstream of the reservoir, revealed 72.5 mg/L inert (non-volatile) suspended solids [8] (Appendix 4). At the Water Survey gauging station, 5.5 km further downstream (1.5 km upstream of the reservoir), the concentration was somewhat lower, at 61.5 mg/L.

A similar pattern was observed in the Hurley River in September 1995 (Griffith, 1997*a*). In this system, it was possible to sample much closer to the headwaters, where the concentration of inert solids was by far the highest (212 mg/L; *ibid.*). This dropped to 48.7 mg/L, approximately 10 km downstream, and ultimately to 22.3 mg/L near the mouth, a further 20 km (approx.) downstream.

As in the Hurley River, the high turbidity in the Bridge River mainstem thwarted proper evaluation of various habitat characteristics, most notably instream cover and the composition of streambed materials, including spawning substrates (Appendix 5). To the extent possible, the composition and proportions of bed materials and instream cover were estimated by visible features at (or above) the stream margins, and/or by *feel* (hand, foot, or staff). The same applies to McParlon Creek (48.7 mg/L inert suspended solids; Appendix 4), but to a lesser extent, due to the considerably smaller size of this stream (Appendix 5).

High turbidity, and associated implications (above) also applied to Jamie Creek, and at a comparable level to McParlon Creek. However, water analyses indicate that the concentration of suspended solids in Jamie Creek was only 6 mg/L (Appendix 4). On the other hand, the result for Tributary 16, which was clear-flowing, was 31.3 mg/L (*ibid.*).

Incorrect labeling is not an explanation, as the latter sample was collected on October 11, and the Jamie Creek sample on October 17 (dates recorded on lab submission sheet). However, the date given for the lab report for Tributary 16 is October 17 (Appendix 4). Consequently, it can only be concluded that the two samples were somehow confused in the laboratory.

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8. Also referred to elsewhere as *non-filterable residues*, consistent with the terminology employed in the Ptolemy (1992) standing stock capability model.

4.3 Description and Evaluation of Fish Habitat in Streams

4.3.1 Bridge River mainstem

Habitat surveys were completed at a total of 19 sites in the Bridge River system, upstream of Downton Lake Reservoir. The location of these surveys is shown in Figure 7, and the full descriptions at each site are provided in Appendix 5. Key results are summarized in Table 1.

The upper Bridge River is a moderately large system (> 40 m channel width), with high glacial turbidity being its most pronounced feature in October 1996, as noted above, and as evidenced in Figures 8 to 11. According to Water Survey records for the gauging station near McParlon Creek (Fig. 7), mainstem flows averaged 32 m^3/s to 34 m^3/s during inspection on October 12-14, 1996 (Appendix 1).

The first 7 km upstream of the reservoir was viewed to represent the first reach of the river, and it was characterized by substantial braiding, particularly in the lowermost 1.5 km, downstream of McParlon Creek (Fig. 7). This section varied in gradient from approximately 1% close to the reservoir (habitat survey 1), to 1.5% near McParlon Creek (survey 2; Fig. 7).

At the lower site, riffle habitat was marginally dominant (Table 1), but there was also abundant glide/run habitat (Fig. 8). To the extent that it could be determined, much of this appeared to be suitable for both fry and parr (Table 1), although instream complexity was not great, due to the relatively small size of bed materials (Fig. 8).

With the increase in gradient, hydraulic conditions were more swift and turbulent at survey site 2 (Fig. 9), just downstream of McParlon Creek (Fig. 7). The size of bed materials appeared to be somewhat larger here, compared to survey site 1 downstream (Appendix 5); and the wetted area was greatly dominated by riffle/rapid conditions, less suitable for fry, in particular (Table 1).

Gravels appeared to be low in abundance at survey site 2, and tended to be smothered and/or highly compacted with fine materials (Appendix 5); accordingly, spawning potential was judged to be limited, despite the considerable size of the river (Table 1). Gravel abundance appeared to be higher closer to the reservoir, offering somewhat greater spawning potential (survey 1; Appendix 5). However, these gravels were also heavily impacted and compacted with fines, reducing their suitability and/or viability as spawning substrates (fair; Table 1).

Habitat survey 9 was located at the new bridge crossing, approximately 7 km upstream of the reservoir (Fig. 7), the location considered to represent the commencement of Reach 2. This section was characterized by a further increase in gradient (ca. 2.5%), and a substantial increase (apparently) in the size of bed materials (Appendix 5). This resulted in further dominance of turbulent riffle/rapid habitat, under the observed conditions (Table 1; Fig. 10).

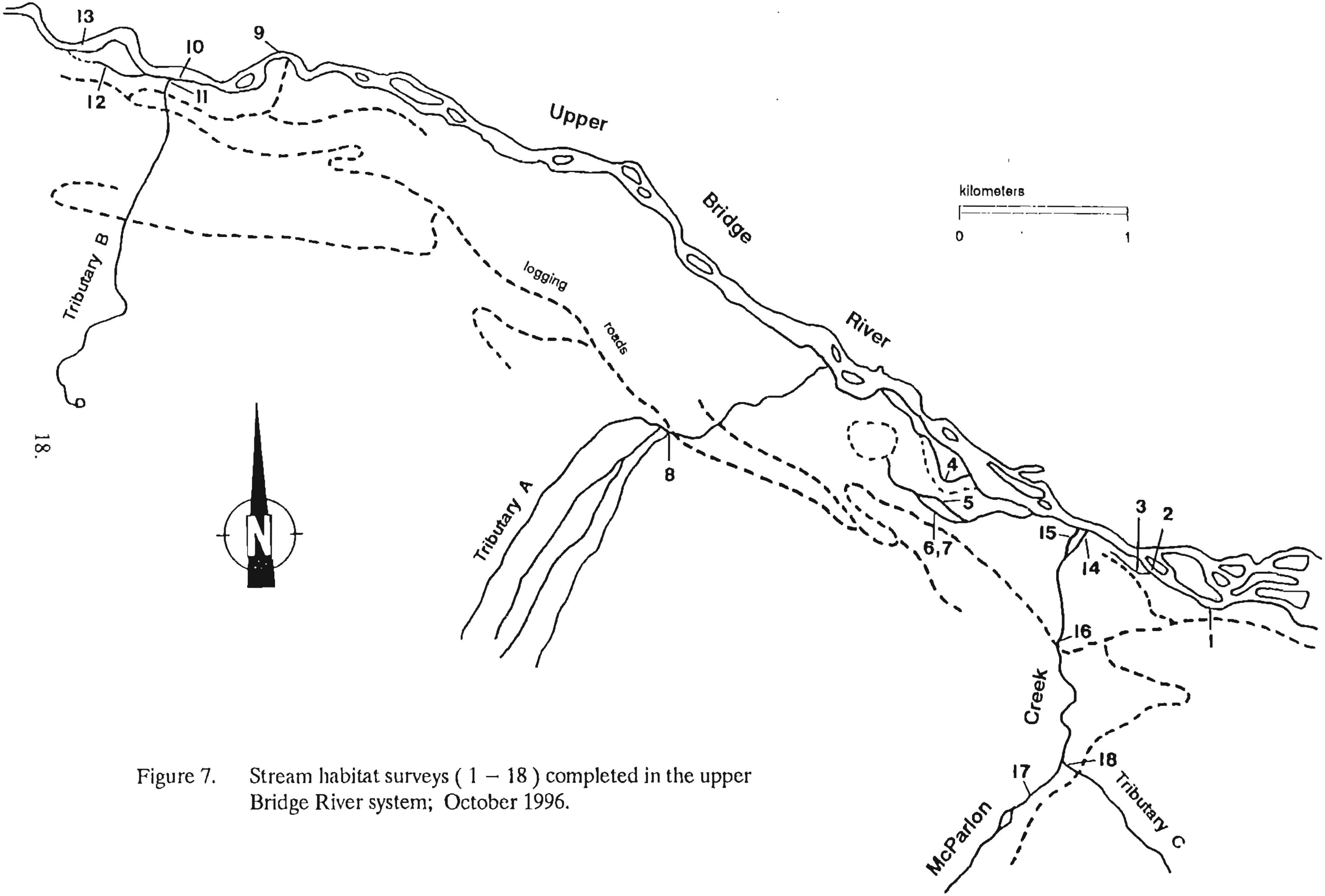

Figure 7. Stream habitat surveys (1 – 18) completed in the upper Bridge River system; October 1996.

Table 1. Summary of major habitat characteristics at survey sites in the upper Bridge River system, tributary to Downton Lake Reservoir, as observed in October 1996.

Site	Habitat Type	Reach No.	Length (km)	Gradient (%)	Hydraulic Habitat (% of area) [2] P	G/R	R/R	F/C	Total Cover (% of area) Fry	Parr [3]	Cover Type (% of total) Substrates [4]	Debris / Bank [5]	Spawning Potential [6]	Water Temperature °C	Date
Bridge River															
1.	mainstem	1.	7 [1]	1	5	45	50	–	30 *	40 *	40 *	60 ?	fair *	4.1	Oct 14
2.	mainstem braid	"	0.2	1.5	5	30	65	–	15 *	35 *	25 *	75 ?	very limited *	4.3	Oct 13
3.	small side channel	"	0.3	<0.5	99	1	–	–	25	10	0	100	none	5.9	Oct 13
4.	mainstem side channel	"	0.9	1	30	65	5	–	40 *	30 *	25 *	75 ?	limited *	3.6	Oct 14
5.	mainstem side channel	"	1	0.5	50	30	20	–	60	35	20	80	fair	6.7	Oct 13
6.	mainstem side channel	"	0.4	0.5	60	30	10	–	70	25	65	35	good	6.3	Oct 13
7.	mainstem side channel	"	0.2	0.5	15	75	10	–	60	20	15	85	very good	6.4	Oct 13
8.	Tributary A	3.	0.4 [1]	9	15	35	40	10	30	20	20	80	none	4.2	Oct 14
9.	mainstem	2.	11 [1]	2.5	5	10	85	–	10 *	35 *	>99 *	<1 ?	very limited *	3.6	Oct 12
10.	mainstem flood channel	"	0.2	1	25	35	40	–	60	20	>90	<10	doubtful	5.6	Oct 12
11.	Tributary B	1.	0.3 [1]	5	10	20	60	10	60	30	60	40	doubtful	5.9	Oct 12
12.	mainstem side channel	2.	above	0.5	90	5	5	–	15	10	75	25	doubtful	6.4	Oct 12
13.	mainstem	"	"	3	3	7	90	–	10 *	25 *	>99 *	<1 ?	doubtful *	3.6	Oct 12
McParlon Creek															
14.	mainstem braid	1.	1.4 [1]	3.5	5	35	60	–	20 *	50 *	95 *	5 ?	very limited *	5.1	Oct 13
15.	mainstem braid	"	0.2	2	10	50	40	–	65 *	40 *	35 *	65 ?	none *	5.1	Oct 14
16.	mainstem	"	above	3	15	20	65	–	25 *	40 *	100 *	0 ?	limited *	1.5	Oct 16
17.	mainstem	2.	5 [1]	3.5	10	15	75	–	30 *	50 *	60 *	40 ?	fair *	1.5	Oct 16
18.	Tributary C	1.	1 [1]	12	10	5	55	30	20	30	60	40	limited	1.2	Oct 16

1. reach length; other entries relate to the total available length of the specific habitat type described

2. P = pool
G / R = glide or run
R / R = riffle or rapids
F / C = falls or cascades

3. also applies to small resident adults
4. streambed materials suitable for parr
5. includes cutbanks, bank vegetation, etc.

6. based on general requirements of salmonids
* estimate only; evaluation hampered by high turbidity
? dependent on cover provided by bed materials

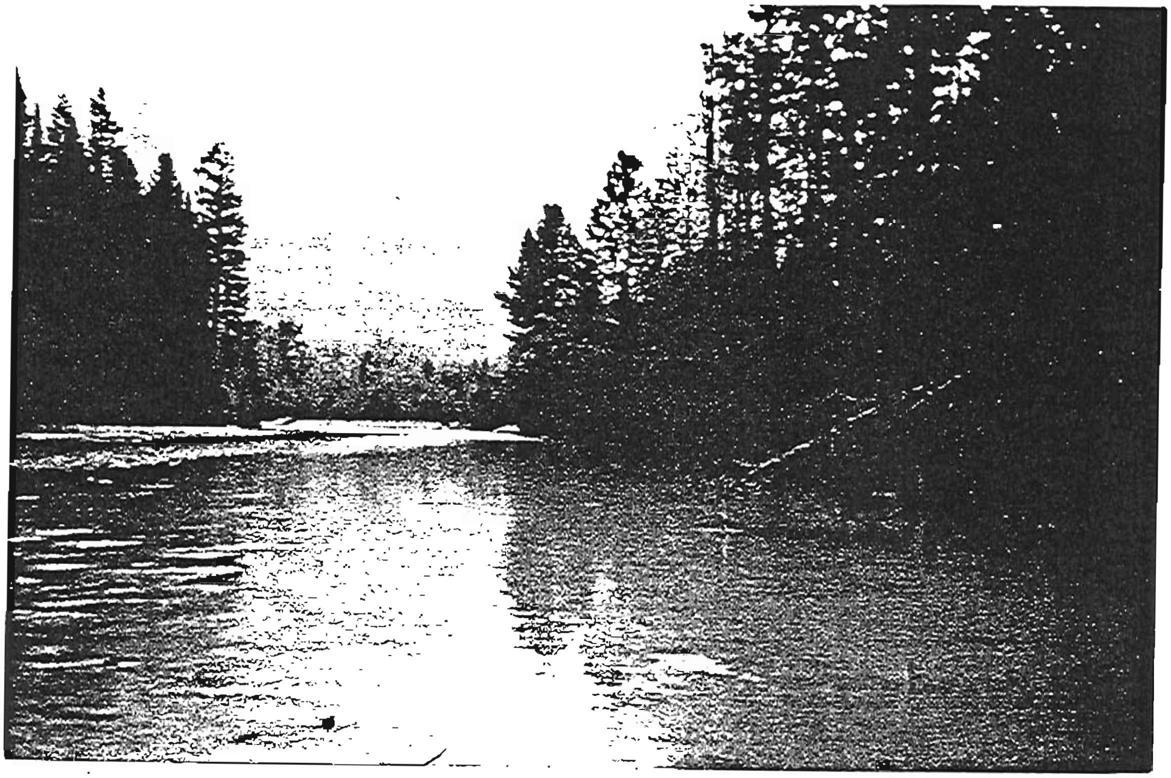

Figure 8. Habitat survey 1, in the upper Bridge River mainstem, 900m downstream of McParlon Creek.

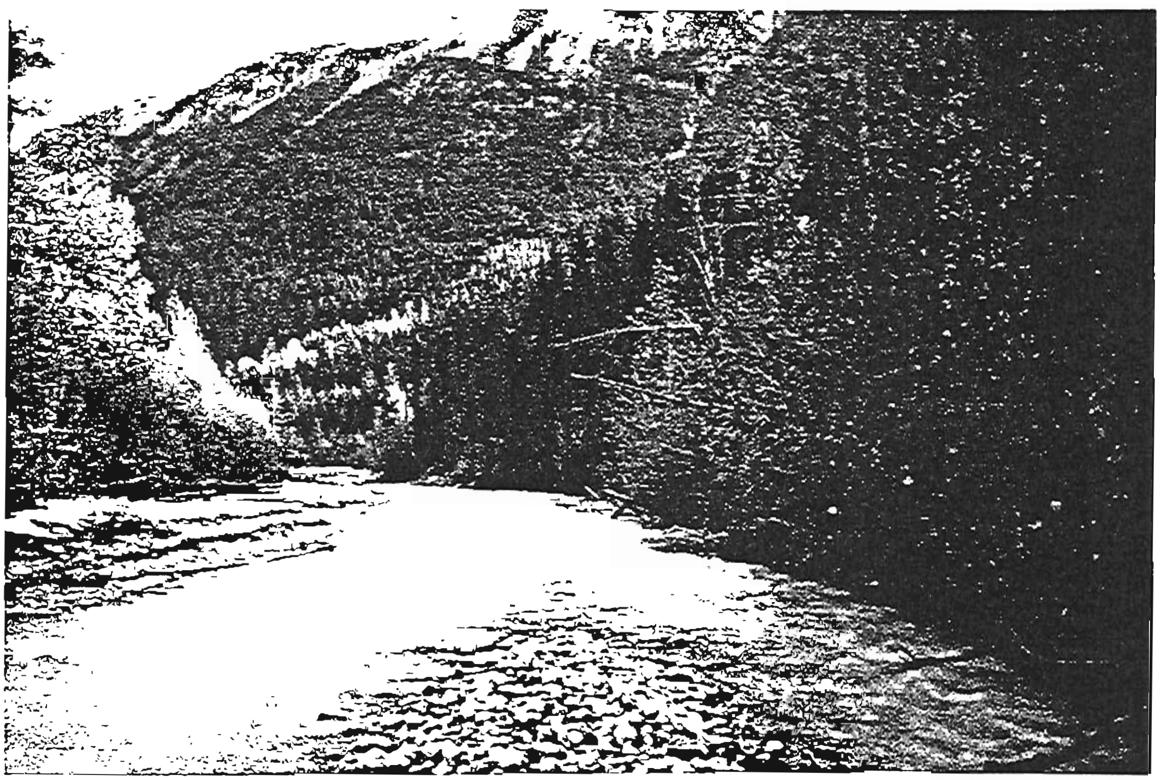

Figure 9. Habitat survey 2, in the upper Bridge River mainstem, 450m downstream of McParlon Creek.

Figure 10. Habitat survey 9, in the upper Bridge River mainstem, at new bridge crossing approximately 7 km upstream of the reservoir.

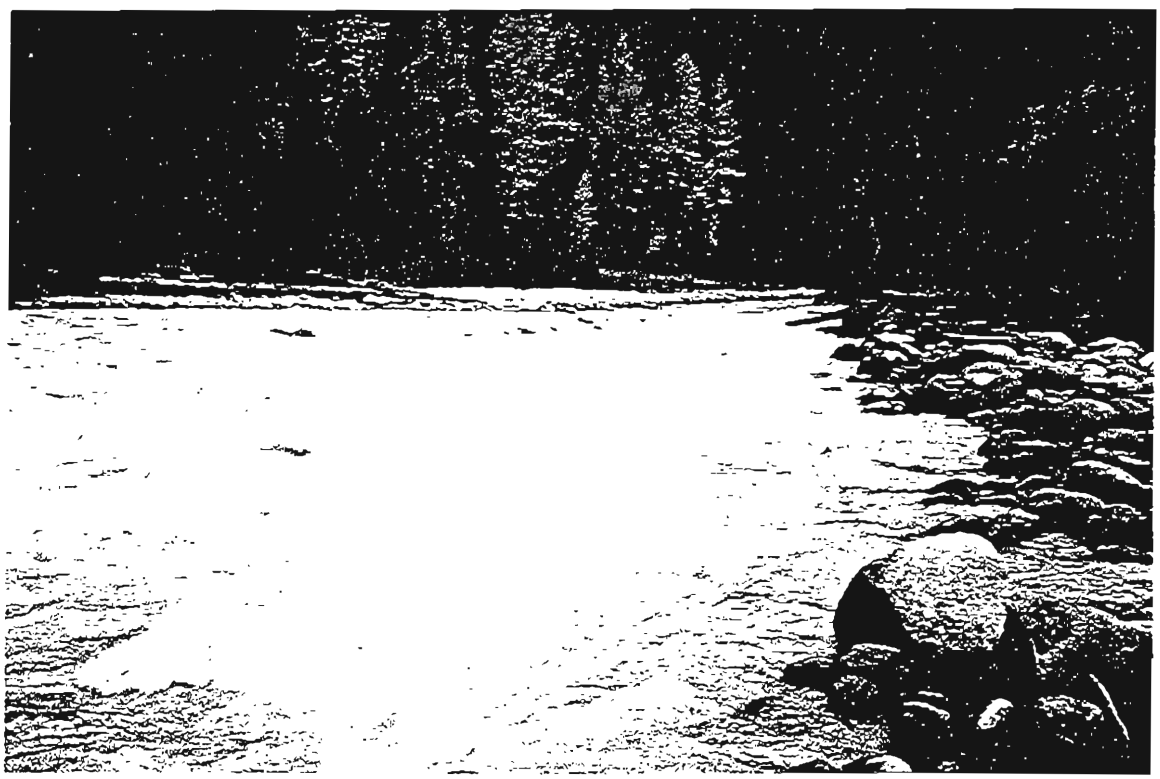

Figure 11. Habitat survey 13, in the upper Bridge River mainstem, 1.4 km upstream of the new bridge crossing.

The velocity and turbulence of water suggested further reduction in the general suitability of habitat for fry, compared to survey site 2, in Reach 1 (Table 1). For parr, however, this was likely offset by the increased size and complexity of bed materials, and presumed availability of pocket water. Nonetheless, the prevailingly laminar (though turbulent) hydraulic conditions did not suggest a great abundance of such refuge in total (Fig. 10).

Once again, spawning potential was judged to be limited (Table 1), due to low abundance of gravels and high impaction and compaction with fines (Appendix 5). A few small patches of cleaner/looser materials were observed behind boulders at the stream margins, but these tended to be blended with small cobbles, degrading viability as spawning habitat.

The uppermost survey site in the Bridge River mainstem was located 1.4 km further up Reach 2 (survey 13; Fig. 7). Once again, there was an increase in stream gradient, the size of bed materials, and the dominance (and turbulence) of riffle/rapid habitat, compared to areas downstream (Appendix 5; Fig. 11).

This was judged to further reduce the general suitability of habitat for both fry and parr (Table 1). In terms of spawning potential, gravels appeared to be particularly low in abundance at this location (Appendix 5). Conversely, fine materials (sands and clays) appeared to be more abundant, and were very highly compacted (*ibid.*). It seemed doubtful that viable spawning habitat was present anywhere within the 350 m of streamlength surveyed at this location.

In addition to the high turbidity and hydraulic inhospitality of the Bridge River mainstem, water temperatures were also very low. These varied between 3.6°C, at survey sites 9 and 13 on October 12, to 4.3°C at site 2 on October 14 (Table 1).

4.3.2 Bridge River side channels and associated tributaries

In addition to extensive braiding, Reach 1 of the Bridge River mainstem also contained numerous side channel areas. Some of these were directly connected with mainstem flows. One such channel was addressed by habitat survey 4, on the south side of the mainstem, 850 m upstream of McParlon Creek (Fig. 7).

As might be expected, the turbidity of the water in this channel was comparable to that in the mainstem (Fig. 12), and the temperature was equally low (Table 1). However, hydraulic conditions were far more conducive for fish (95% pool and glide), and the availability of suitable cover appeared to be greatly superior for fry, in particular (*ibid.*).

Gravels were also more abundant, compared to the mainstem (Appendix 5); but the same applied to fines, which appeared to constitute 50% of the bed materials, to the extent that this could be determined, given the high turbidity. Compaction was also high (*ibid.*), and all things considered, spawning potential was judged to be limited (Table 1).

Figure 12. Habitat survey 4, in a large side channel fed by the upper Bridge River mainstem, 850m upstream of McParlon Creek.

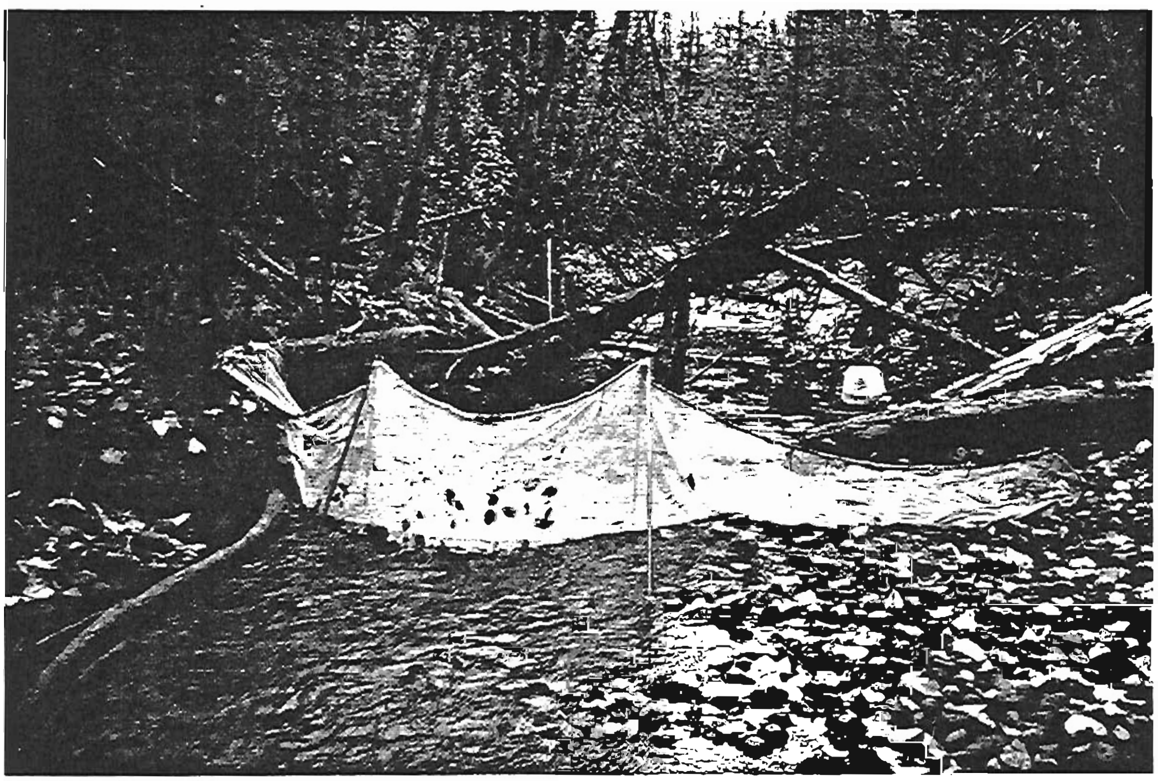

Figure 13. Habitat survey 5, in a clear-flowing side channel of the upper Bridge River, 850m upstream of McParlon Creek.

While the side channel investigated in survey 4 was directly linked with flows in the Bridge River mainstem, there was a network of other side channels in this area, that were not. In terms of fish habitat values, the presence of these channels, and conditions within them, was judged to be of utmost importance in the 1996 findings for the upper Bridge River system.

In dramatic contrast to the side channel linked with the mainstem (and the mainstem itself), the water was clear-flowing throughout this network of channels (Figs. 13 to 15). At 3 locations surveyed (surveys 5-7; Fig. 7), the abundance and quality of spawning habitat was judged to range from fair (survey 5) to very good (survey 7; Table 1).

This reflected diminishing size of the channels, and distance from the Bridge River mainstem. The channel addressed by survey 5 was largest, and closest to the mainstem. Those addressed by surveys 6 and 7 were smaller, and further away from the river.

Due to small size of bed materials, and the predominantly shallow water, parr habitat was again relatively limited within the above network of side channels (Appendix 5). Conversely, conditions were judged to be excellent for fry, throughout (Table 1).

Of further significance was the substantially higher temperature of water in all of these channels (6.3 °C to 6.7 °C), compared to the Bridge River mainstem (Table 1). This suggests the influence of groundwater, possibly upwelling within a marsh and series of ponds which feeds the network of channels in question (Fig. 16).

Another possible source of inflows to this area was an unnamed stream designated Tributary A, for the purposes of the 1996 investigations. This flowed from the south, and was surveyed at a location 900 m upstream of the Bridge River mainstem (survey 8; Fig. 7). The possible influence of this tributary was based on its proximity to the marsh/pond area, at the head of the side channel network.

Like the side channels, it was also clear-flowing at the time of investigation. Subsequent water analyses revealed 6.0 mg/L inert suspended solids in this stream, compared to 10.0 mg/L to 12.5 mg/L in the side channels themselves (Appendix 4). However, the water temperature (4.2 °C) was more consistent with that of the Bridge River mainstem.

In the surveyed section of Tributary A (Fig. 17), both spawning and rearing potential for fish were limited by the abundance of fines, the embeddedness of other materials, and extreme compaction (Appendix 5). No viable spawning substrates were observed. However, this was somewhat irrelevant with respect to fish in/from Downton Lake reservoir, since the surveyed section is inaccessible to upstreaming fish, due to very steep gradient (> 60%) within 500 m of the Bridge River.

This is shown in Figure 18, which also documents a matter of great concern regarding the exceptional side channel habitat described above. At the time of inspection in October 1996, this area of the watershed had been subjected to substantial and very recent clearcutting.

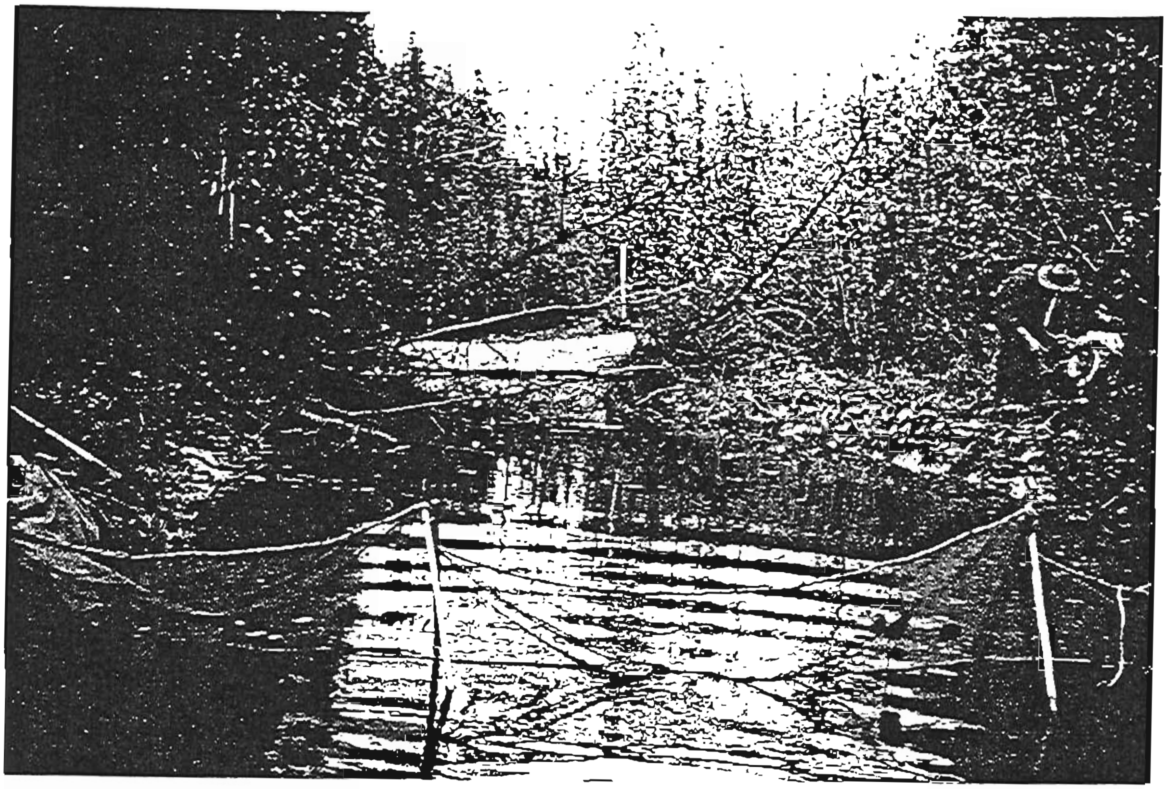

Figure 14. Habitat survey 6, in a clear-flowing side channel of the upper Bridge River, 850m upstream of McParlon Creek.

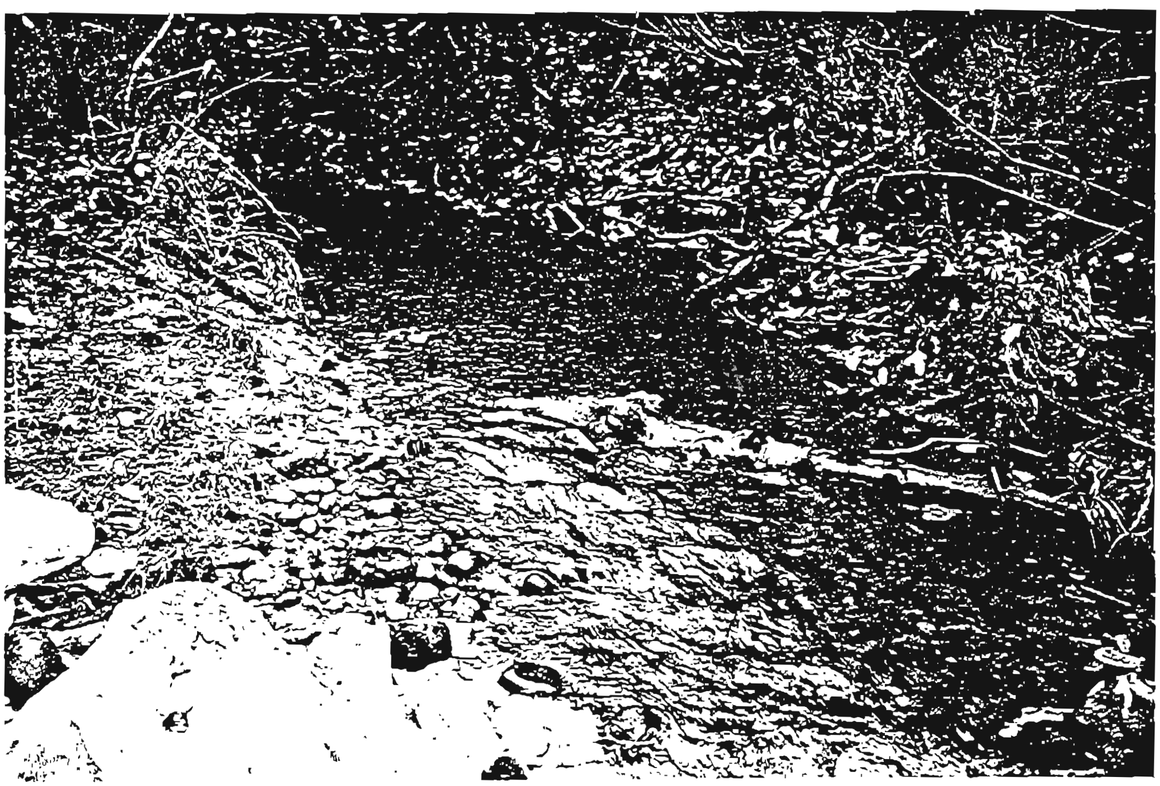

Figure 15. Habitat survey 7, in a clear-flowing side channel of the upper Bridge River, 850m upstream of McParlon Creek.

Figure 16. Marsh/pond area associated with clear-flowing side channels of the upper Bridge River, 850m upstream of McParlon Creek.

Figure 17. Habitat survey 8, in Tributary A, approximately 900m upstream of the Bridge River mainstem.

Figure 18. View of recent logging on lower Tributary A (note bridge, center left, and mainstem side channels, top right).

Figure 19. Closer view of logging encroachment on Bridge River side channels, 850m upstream of McParlon Creek.

As shown in Figure 18, this had totally overrun the steep section of Tributary A, downstream of survey section 8 (Fig. 7). More to the point, it had closely encroached upon the side channel area, as evidenced in both Figure 18 and Figure 19.

A further concern, at the time of investigation, was the presence of surveyors' flagging extending into the side channel area itself, possibly indicating intentions of further harvesting. In consultation with the B.C. Hydro project leader, the apparent importance of protecting and preserving this particular area was immediately brought to the attention of the forest harvesting licence holder[9].

Side channels of the Bridge River mainstem were also investigated at 2 other locations. The first (habitat survey 3) was a particularly small channel adjacent to mainstem survey section 2, just downstream of McParlon Creek (Fig. 7). This was also clear-flowing, and once again, the water temperature (5.9 °C) was significantly warmer than that of the Bridge River mainstem (Table 1). However, the volume of water and flow was very low (Fig. 20), and offered little habitat for fish, especially parr (Table 1). Bed materials were almost entirely fines (mud), which contributed to the poor rearing conditions, and eliminated any spawning potential (Appendix 5).

Fines (mostly sand) were also greatly abundant in a larger side channel (survey 12) associated with lower Reach 2 of the Bridge River mainstem, adjacent to survey section 13 (Fig. 7). Although this channel did contain some bouldery habitat (Appendix 5), there were also extensive accumulations of sand (Fig. 21). Flows were again clear, but were only a trickle (< 1L/s), offering little rearing potential, especially with the dominance of sand. Needless to say, the potential for viable spawning was also judged to be low (Table 1). On the positive side, the water temperature (6.4 °C) was again considerably warmer than in the Bridge River mainstem (*ibid.*).

Warmer temperatures (5.6 °C) were also encountered in a flood channel of the Bridge River (isolated from the base flow channel by a boulder/cobble bar), also in Reach 2, approximately 300 m downstream of the latter side channel (survey 10; Fig. 7). The source of the water in this flood channel was another small stream, designated Tributary B (survey 11; Fig.7).

The discharge in this stream was approximately 0.05 m^3/s, which resulted in shallow water depths within the mainstem flood channel, into which it flowed (survey 10; Appendix 5). This reduced the rearing potential for parr (Table 1); however, with a great dominance of cobble/ boulder bed materials (Appendix 5), habitat was highly suitable for fry (Table 1). Following the general pattern, possibilities of spawning were again judged to be poor (Table 1), due to low abundance of gravels, moderate abundance of fines, and compaction (Appendix 5).

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9. Ainsworth Lumber Company Ltd., Lillooet Division (Lillooet): concerns were also fueled by the results of electrofishing in the side channels, which was conducted simultaneous to the habitat surveys.

Figure 20. Habitat survey 3, in a small side channel of the upper Bridge River, 400m downstream of McParlon Creek.

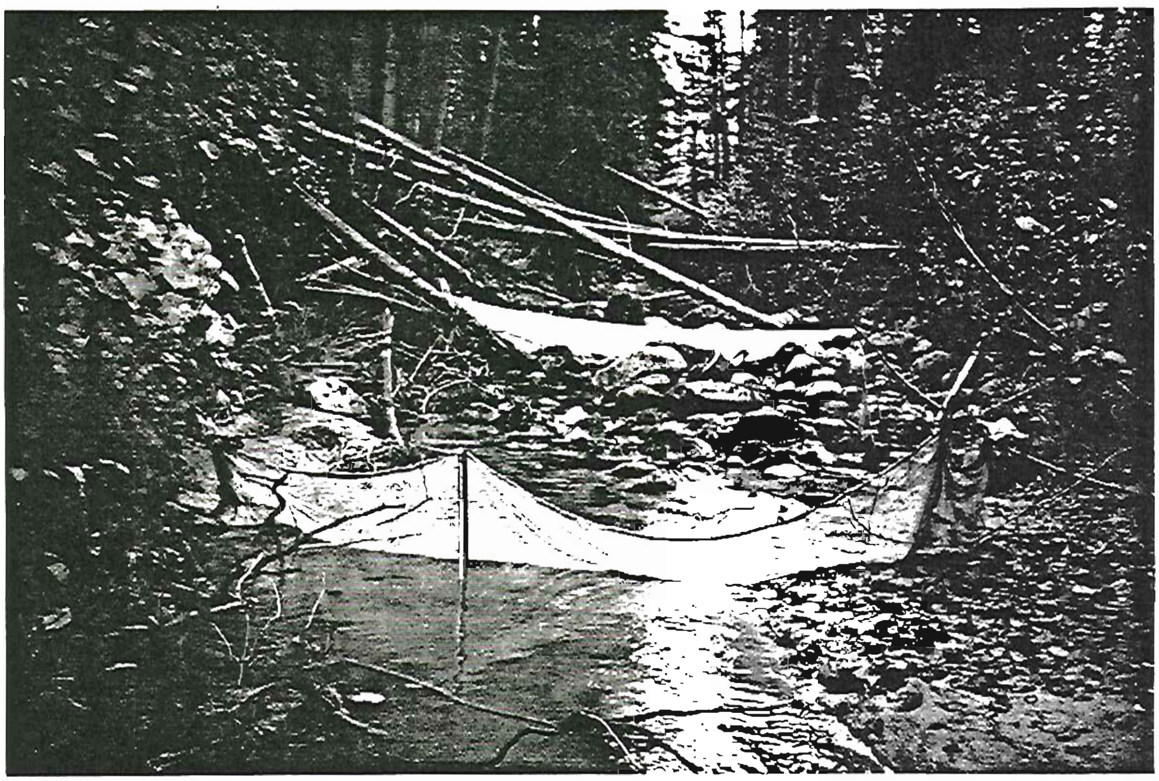

Figure 21. Habitat survey 12, in a large side channel of the upper Bridge River, 1.1 km upstream of the new bridge crossing.

Similar conditions also applied to the section of Tributary B that was surveyed, immediately above its mouth (survey 11; Fig. 22). Once again, spawning potential was deemed to be doubtful; but as in the case of Tributary A, this may be irrelevant with respect to migratory fish, by virtue of a 2 m barrier at the mouth of the stream (Fig. 23). Perhaps the most significant feature of Tributary B was its relatively warm water temperature of 5.6°C (Table 1).

4.3.3 McParlon Creek

As noted earlier, glacial turbidity was high in McParlon Creek, at the time of investigation in October 1996. This system is also similar to the Bridge River in the speed and turbulence of its flows. However, large bed materials, coupled with smaller stream size (Appendix 5), result in greater diversity of hydraulic habitat (Fig. 24), and associated rearing potential for both fry and parr, compared to the Bridge River (Table 1).

Braiding occurs within the lowermost 0.5 km of this stream, and other than the high turbidity, appears to provide some particularly good rearing habitat for fry (survey 15; Table 1; Fig. 25). Under the observed conditions, there appeared to be abundant pocket water for parr (Table 1), throughout the 2 km of this stream that was investigated (surveys 14-17; Fig. 7).

Again, to the extent that it could be determined, the main constraint of physical habitat in McParlon Creek appeared to be a lack of suitable spawning substrates (Table 1). Spawning potential appeared to be particularly limited in survey sections 14-16, all located downstream of barrier falls, situated 1.4 km upstream of the mouth (Fig. 7). Conditions appeared to be marginally better in survey section 17 (Table 1), but this was located in Reach 2, above the falls (Fig. 7), and inaccessible to migratory fish.

In a small stream tributary to Reach 2 of McParlon Creek, designated Tributary C (survey 18; Fig. 7), gravels were also quite abundant (Appendix 5). However, the proportion of very small gravels was high, reducing spawning potential (Table 1). These substrates were also highly compacted (Appendix 5).

A very interesting finding in the McParlon Creek investigations again related to water temperatures. In the lowermost 0.5 km of this stream, the temperature (5.1°C) was somewhat higher than it was in the Bridge River mainstem (surveys 14 and 15; Table 1). However, with the progressive deterioration of weather during October 12-15, the temperature had dropped to only 1.5°C, throughout this system, by October 16 (surveys 16-18; Table 1).

4.3.4 Smaller tributaries to the reservoir

A total of 17 habitat surveys were completed in the smaller tributaries along the north and south sides of Downton Lake Reservoir (surveys 19-35; Fig. 26). Once again, full details are provided in Appendix 5; key results are summarized in Table 2. As noted earlier, a total of 22

Figure 22. Habitat survey 11, in Tributary B, 30m upstream of the Bridge River mainstem.

Figure 23. Boulder/debris obstruction at the mouth of Tributary B.

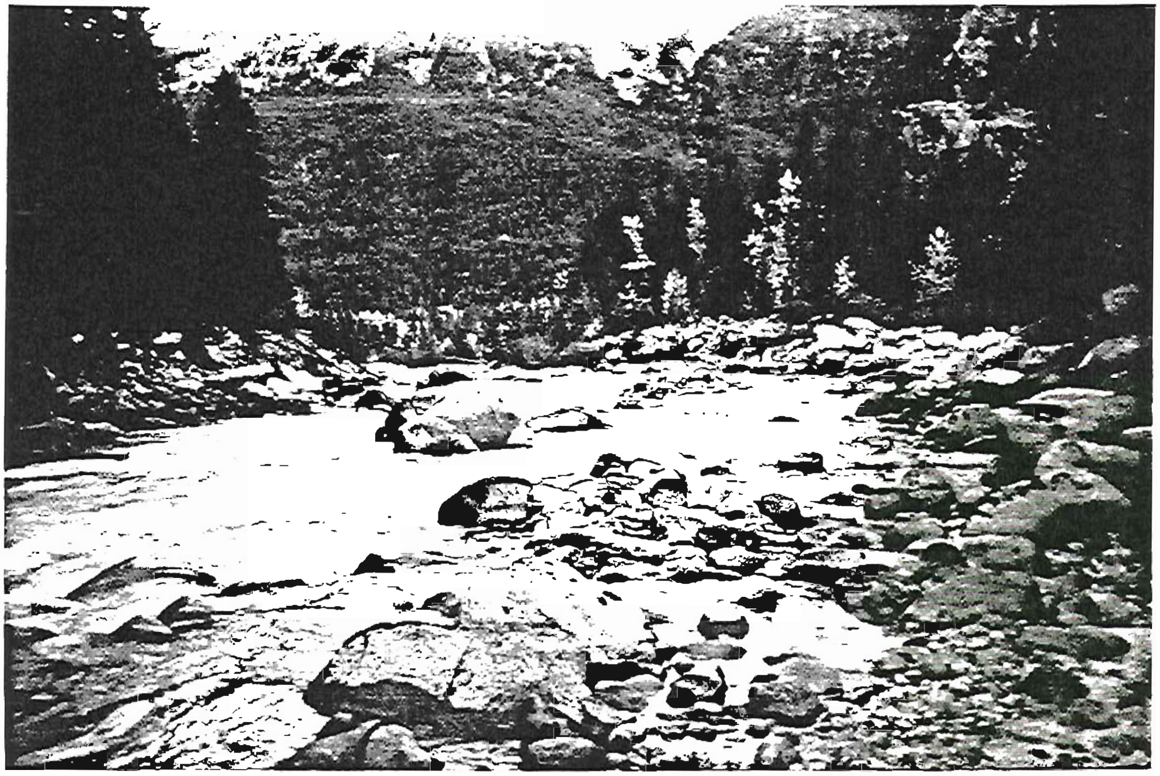

Figure 24. Habitat survey 16, in McParlon Creek, approximately 500m upstream of the Bridge River mainstem.

Figure 25. Habitat survey 15, in a small braid of McParlon Creek, 75m upstream of the Bridge River mainstem.

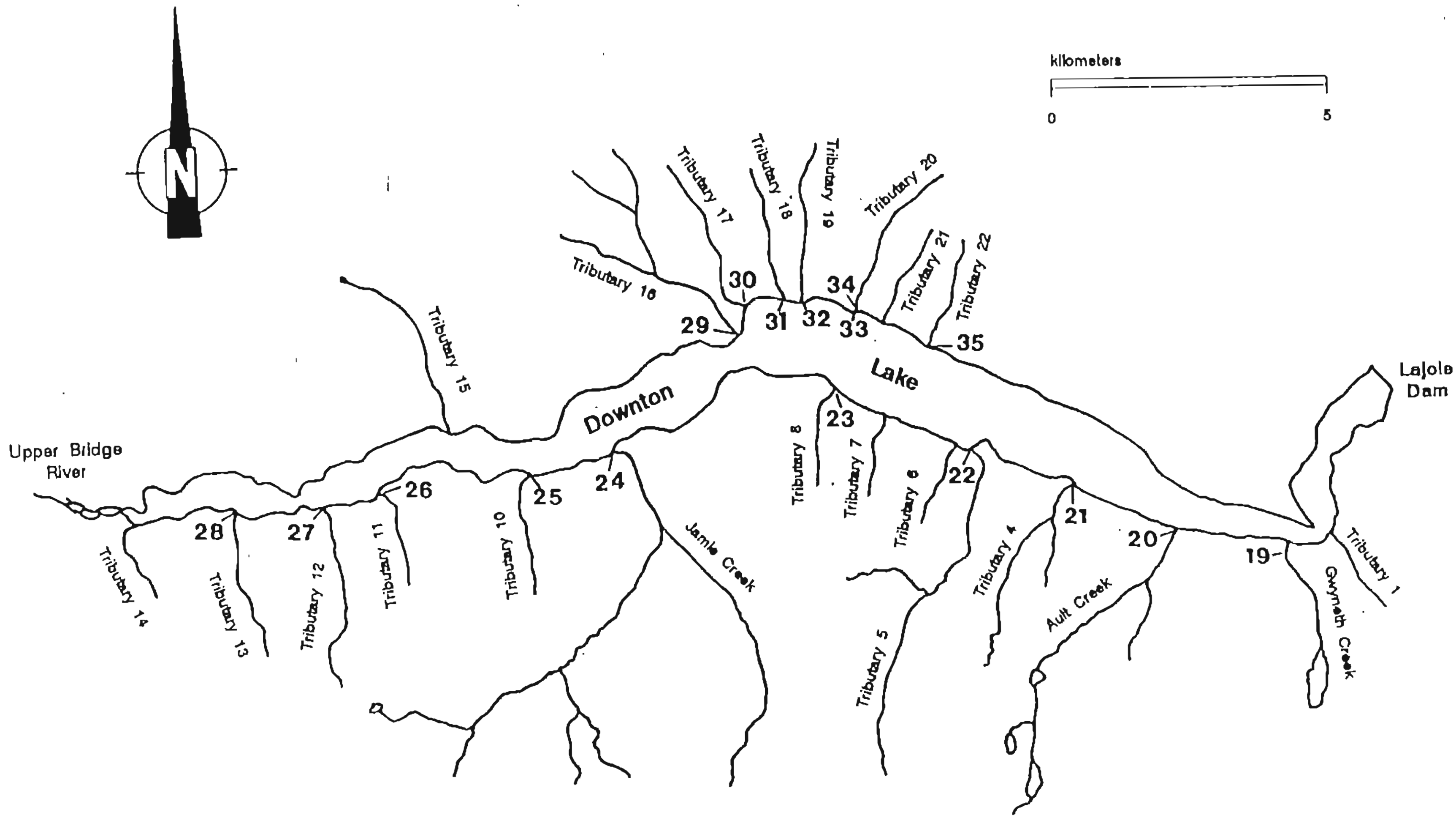

Figure 26. Stream habitat surveys (19–35) completed in the smaller tributaries to Downton Lake Reservoir; October 1996.

Table 2. Summary of major habitat characteristics at survey sites in smaller streams tributary to Downton Lake Reservoir, as observed in October 1996.

Site	Stream Identifier	Channel Width (m)	Gradient (%)	Hydraulic Habitat (% of area) [1]				Total Cover (% of area)		Cover Type (% of total)		Spawning Potential [5]	Temperature	
				P	G / R	R / R	F / C	Fry	Parr [2]	Substrates [3]	Debris / Bank [4]		°C	Date
Tributaries along the south shore of Downton Lake Reservoir														
19.	Tributary 2 (Gwyneth Cr.)	3.5	29	50	15	30	5	70	40	55	45	none	8.1	Oct 8
20.	Tributary 3 (Ault Cr.)	9	35	5	10	20	65	<5	10	60	40	none	7.2	Oct 8
21.	Tributary 4	11	22	5	15	30	50	15	25	70	30	marginal	6.9	Oct 8
22.	Tributary 5	9	17	5	35	60	–	50	65	65	35	none	7.2	Oct 8
23.	Tributary 8	0.6	37	5	35	50	10	50	<5	5	95	doubtful	6.9	Oct 9
24.	Tributary 9 (Jamie Cr.)	14	28	5	5	60	30	10	25	93	8	none	6.9	Oct 10
25.	Tributary 10	2.5	16	25	35	40	–	45	15	75	25	very limited	7.7	Oct 10
26.	Tributary 11	2.5	5	10	30	60	–	40	15	10	90	marginal	8.0	Oct 10
27.	Tributary 12	4	16	20	20	50	10	40	55	50	50	limited	1.4	Oct 17
28.	Tributary 13	3	12	10	35	55	–	25	20	25	75	none	8.2	Oct 10
Tributaries along the north shore of Downton Lake Reservoir														
29.	Tributary 16	3.5	10	15	20	60	5	70	50	55	45	good	8.1	Oct 11
30.	Tributary 17	3	16	15	5	55	25	40	30	50	50	none	2.0	Oct 16
31.	Tributary 18	–	15	5	20	75	–	60	<5	0	100	none	6.7	Oct 16
32.	Tributary 19	6	12	20	30	50	–	70	40	40	60	good	9.2	Oct 11
33.	Tributary 20	4.5	18	10	20	40	30	60	20	93	7	good	10.1	Oct 9
34.	"	4.5	25	15	15	40	30	15	20	98	2	doubtful	10.1	Oct 9
35.	Tributary 22	2.5	23	30	5	20	45	55	15	90	10	limited	8.8	Oct 9

1. P = pool
G / R = glide or run
R / R = riffle or rapids
F / C = falls or cascades

2. also applies to small resident adults
3. streambed materials suitable for parr
4. includes cutbanks, bank vegetation, etc.
5. based on general requirements of salmonids

such streams were scheduled for investigation, consistent with 1:50,000 topographic mapping (Fig. 26).

In October 1996, five of these were found to be totally dry (Fig. 27). Numerous other small dry channels (not shown on 1:50,000 mapping) were also noted in the field. In addition, discharges in some of the streams that *were* flowing were very low (Table 3).

Under the observed conditions, the 16 streams identified in Table 2 appeared to constitute the vast majority of flowing stream habitat associated with the reservoir, other than the Bridge River system. A possible exception was Tributary 15 (Fig. 26), which could not be investigated, due to constraints previously identified.

Since Downton Lake Reservoir now occupies what was once a portion of the Bridge River valley, these streams occur in series along both the north and south shores of the reservoir. The majority are located along the south shore (Fig. 26), where the terrain and valley walls tend to be particularly steep.

Above high water (full pool) all of these streams are similarly steep, and most of their length is inaccessible to upstreaming fish (Fig. 28). During the October 1996 investigations of these streams, the elevation of Downton Lake Reservoir remained very close to 747.5 m (Appendix 2), just 2.3 m below full pool. At this level, accessible streamlength was extremely limited, in all cases (Table 3).

This was particularly profound for all 3 of the largest tributaries along the south side of the reservoir. For Gwyneth Creek, exceedingly steep gradient (> 80%) immediately above the reservoir precludes any access of fish, above the full pool level (Table 3). The same applies to Ault Creek (Fig. 28), which consists of one barrier falls after another, extending below the full pool level (habitat survey 20; Table 3).

Under the observed conditions, a short section (est. 75 m; Table 3) of Jamie Creek may have been accessible to fish in October 1996, but even this was doubtful, due to a boulder constriction (and chute) just above the high water level (Fig. 29). This may be immaterial, since no suitable spawning substrates were observed in Jamie Creek, above the reservoir, during the October 1996 investigations (habitat survey 24; Appendix 5).

In fact, a lack of viable spawning habitat also seemed to apply to all other stream sections on the south side of the reservoir, inspected in October 1996 (Table 3). Implications of this are obvious for fall spawning species, such as bull trout.

On the other hand, rainbow trout traditionally spawn in the spring and/or early summer. Referring to Figure 4, a reservoir elevation in the order of 725 m might be expected at this time of year. Employing the detailed (1:2,500) bathymetric mapping completed for the reservoir by B.C. Hydro (footnote 3), length and gradient of additional streamlength exposed at this level were also estimated, and are provided in Table 3.

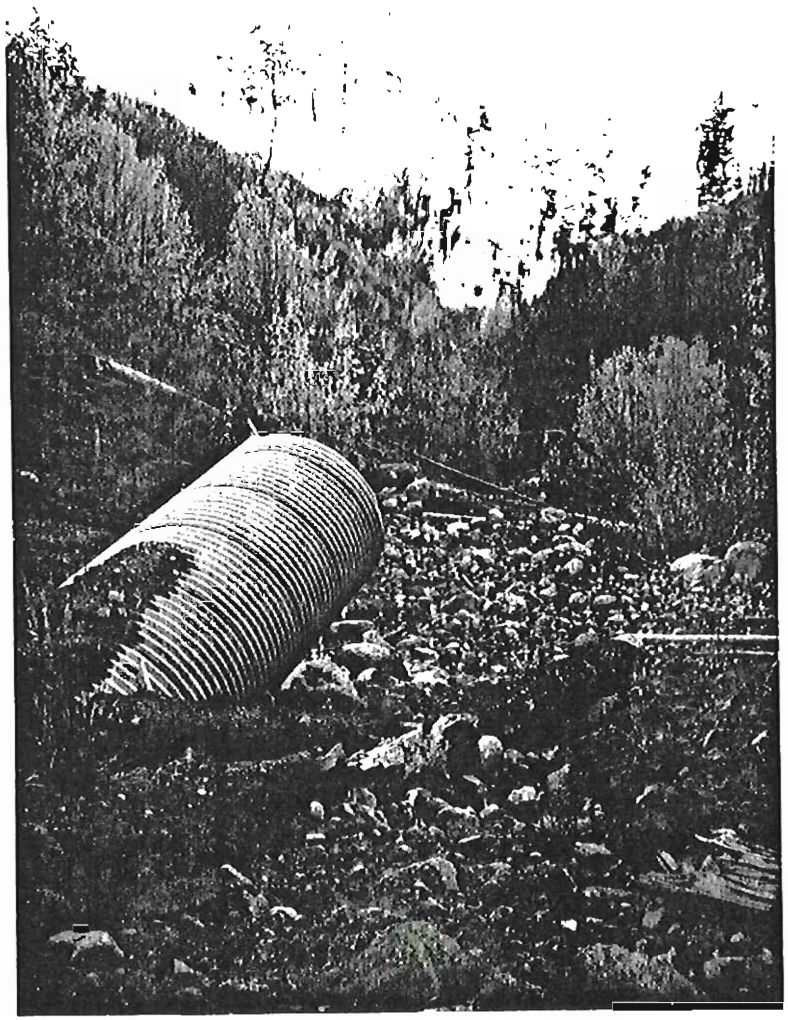

Figure 27. Steep gradient and dry channel in Tributary 1, at the the road crossing.

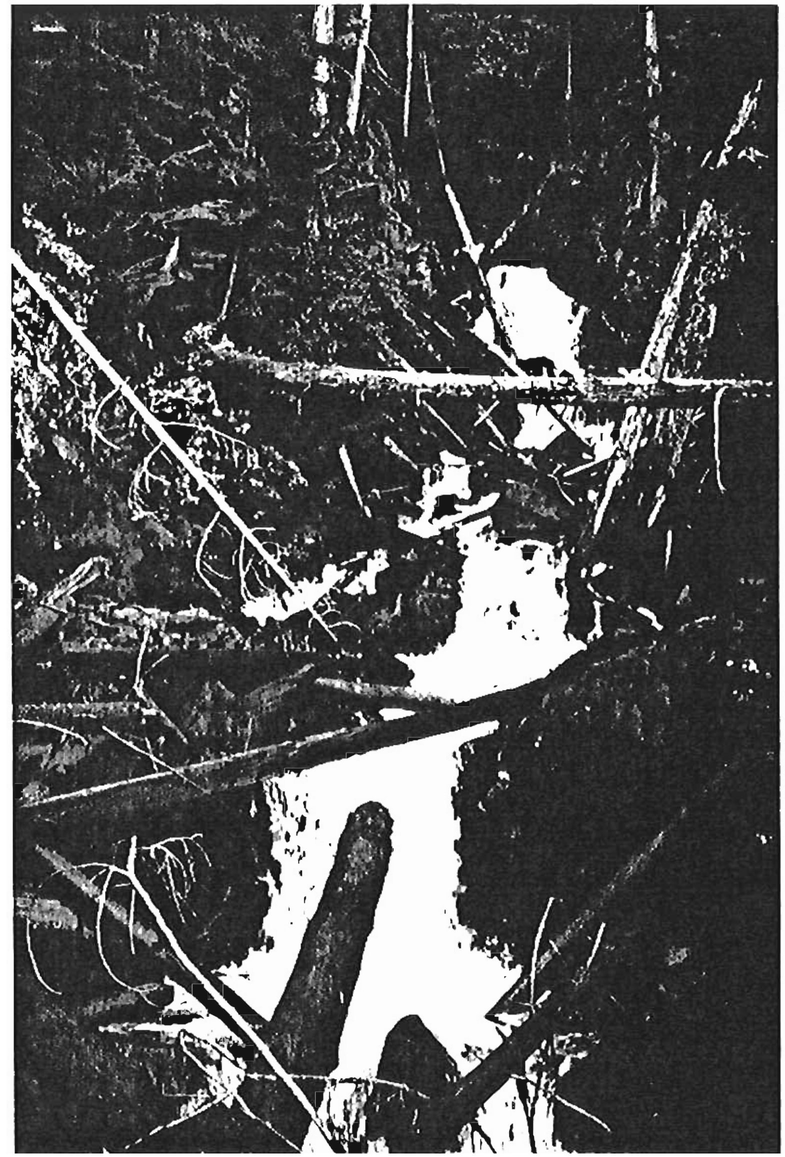

Figure 28. Habitat survey 20, in Ault Creek, downstream of the road crossing.

Table 3. Summary of stream gradients, accessibility for reservoir fish, and habitat potential of tributaries along the south shore of Downton Lake Reservoir.

Stream No.	Stream Name	Discharge (m^3/s)	Above Elev. 750m (full pool) Channel Gradient [1]	Above Elev. 750m (full pool) Length (m)	Elev. 725m – 750m (below full pool) Channel Gradient	Elev. 725m – 750m (below full pool) Length (m)	Rearing and Spawning Potential Above Full Pool (October 1996)
1.	–	0	ave. >40%	0	ave. 25%; max. >40%	90	totally dry in October 1996
2.	Gwyneth Creek	0.015	>80% immediately above elev. 750m	0	ave. >30%	70	stepped profile with complex rearing habitat for both fry and parr; barrier at reservoir no viable spawning substrates
3.	Ault Creek	0.71 E	series of barriers	0	740m – 750m; >100% 725m – 740m; ave. 15%	95	limited rearing potential due to swift flows; no viable spawning habitat
4.	–	0.048	mostly >25%	150	ave. 20%; max. >30%	135	limited rearing potential due to shallow depths, small bed materials, and swift flows; marginal spawning potential (high fines/compaction)
5.	–	0.339	numerous cascade obstructions (1.5m)	0	ave. 17%; max. >30%	150	highly complex rearing habitat, especially for parr; no viable spawning habitat
6.	–	0	ave. >50%	0	ave. >40%	60	totally dry in October 1996
7.	–	0	ave. >60%	0	ave. >40%	70	totally dry in October 1996
8.	–	0.005	ave. >60%	100	ave. >60%	35	shallow stepped habitat for fry; almost no potential for parr, due to shallow depths and small bed materials; spawning unlikely, due to small channel size and high abundance of fines
9.	Jamie Creek	1.14 E	numerous cacade barriers (>3m)	75	ave. 9%; max. 20%	200	great rearing complexity, but limited by high water vel– ocities and turbulence; no significant gravel accumulations
10.	–	0.005	ave. >30%	70	ave. 13%; max. 25%	175	limited depth and complexity of rearing habitat; little spawning potential, due to fines content and high compaction of gravels
11.	–	0.038	ave. >50%; barrier falls (11m)	35	ave. 11%; max. 25% *	175	complex debris habitat for fry; depths limited for parr; marginal spawning potential; high compaction
12.	–	0.221	ave. 30%; cascades to 2.2m	50	ave. 6%; max. 16% *	250	very complex rearing habitat for both fry and parr; some viable spawning habitat, despite moderate to high compaction of gravels
13.	–	0.168	ave. >50%; barrier falls (6m)	100	ave. 8%; max. 16% *	125	complex rearing habitat, but somewhat swift for fry; no viable spawning habitat
14.	–	0	<5 % for first 300m; then >40%	0	close to 0% *	0	totally dry in October 1996

1. First 500m upstream of full pool E. Estimated * Reservoir floor higher than Elev. 725m

Figure 29. Habitat survey 24, in Jamie Creek (Tributary 9) downstream of the road crossing.

Figure 30. Mouth of Tributary 5, during May 1996 investigations at drawdown (note intermittent surface flows at center).

A limited evaluation of some such sections was conducted during the May 1996 investigations, at drawdown (Griffith, 1996*b*), and will be addressed later in this document. However, an example of the conditions observed at that time is shown in Figure 30.

The terrain of the valley walls is also steep along the north side of the reservoir. Accordingly, the same applies to the gradient of associated tributaries, and once again accessible length was short, under the conditions observed in October 1996 (Table 4). These streams are less numerous than those on the south side of the reservoir (Fig. 26); and those that were flowing, tended to contain very low discharges (Table 4).

A notable exception was Tributary 16, which contained a discharge of 0.16 m^3/s, and appeared to be accessible for at least 170 m; ie. for the extent of the survey, commencing from the mouth (habitat survey 29; Fig. 26). In addition to complex rearing habitat for both fry and parr (Table 2; Fig. 31), the surveyed section of this stream was found to contain abundant gravels, and superior spawning substrates at some locations, despite widespread compaction (Appendix 5).

Two other streams on the north side of the reservoir were also found to contain viable spawning habitat; Tributary 19 (habitat survey 32) and Tributary 20 (habitat survey 33; Fig. 26). In addition to a substantial abundance of spawning substrates, Tributary 19 contained somewhat higher flows, and superior complexity of rearing habitat for both fry and parr (Table 4). Unfortunately, access to this stream appeared to be blocked by a complex debris jam near (and at) the full pool level (Fig. 32).

The mouth of Tributary 20 was only partially obstructed by debris (Fig. 33), but access for fish was limited to 65 m, by a 1.7 m debris/boulder plug caused by an apparently recent channel shift and bed erosion, within the alluvial fan above the full pool leve. This was followed by a series of boulder cascades, and then a culvert road crossing 115 m upstream of the reservoir, at the time of inspection (Appendix 5).

The culvert has been installed 0.9 m above the streambed, and was judged to constitute a likely barrier to fish passage (Fig. 34). However, this may not be overly significant, since in addition to the plug downstream, 2 m cascades constituted another barrier immediately upstream of the road crossing.

In terms of fish production, the potential value of Tributary 20 appeared to be concentrated within the first 50 m ($\pm$) above full pool, where gravels and associated spawning potential were also concentrated (Appendix 5). Upstream of the road crossing and cascades (habitat survey 34; Fig. 26), the gradient of Tributary 20 increases substantially (Fig. 35), and would offer little likelihood of successful ascent, spawning, and/or rearing of fish, even in the absence of the obstructions downstream (Table 2).

Although discharges were very low at the time of inspection (Table 4), there was considerable rearing habitat for fry in the first 50 m upstream of the reservoir (Table 2).

Table 4. Summary of stream gradients, accessibility for reservoir fish, and habitat potential of tributaries along the north shore of Downton Lake Reservoir.

Stream No.	Discharge (m^3/s)	Above Elev. 750m (full pool) Channel Gradient [1]	Above Elev. 750m (full pool) Length (m)	Elev. 725m – 750m (below full pool) Channel Gradient	Elev. 725m – 750m (below full pool) Length (m)	Rearing and Spawning Potential Above Full Pool (October 1996)
15.	?	ave. >30%	?	ave. 11%; max. >30% *	200	this stream could not be inspected (due to weather)
16.	0.161	ave. 15% for first 500m; then 15% – 20% for the next 500m	>170	ave. 10%; max. 15%	250	highly complex rearing habitat for both fry and parr; abundant gravels; some superior spawning substrates despite moderate to high compaction
17.	0.037	ave. >30%	<50	ave. 25%; max. >40%	100	fairly complex rearing habitat for both fry and parr (stepped); no spawning potential (few gravels; high compaction)
18.	0.004	ave. 15% for first 100m; then >40%	0	ave. 12%; max. 15%	225	tangle of debris and weeds at mouth; no definite channel; very shallow depths (suitable for fry only); no spawning potential (80% fines, no channel, etc.)
19.	0.091	<15% for first 200m; then ave. 20% – 25 %	0	ave. 13%; max. >50%	200	complex rearing habitat, especially for fry; substantial abundance of spawning substrates; debris plugs at mouth, and upstream
20.	0.032	ave. 15% – 20% for first 100m; then >25%	65	ave. 16%; max. 20%	150	complex rearing habitat, especially for fry; depths limited for parr; some viable spawning substrates, especially towards mouth; no debris plug at mouth; 1.7m plug at 65m; culvert/cadcades barrier at 115m
21.	0	ave. >40%	0	ave. >20%; max. >30%	120	totally dry In October 1996
22.	0.034	ave. >20% to barrier; >40% upstream	40	ave. >25%	90	highly complex rearing habitat for fry (stepped); depths limited for parr; spawning potential limited by fines and compaction; perhaps superior at higher flows; culvert/cascades barrier at 40m

1. First 500m upstream of full pool

* Reservoir floor higher than Elev. 725m

Figure 31. Habitat survey 29, in Tributary 16, approximately 150m upstream of Downton Lake Reservoir.

Figure 32. Large debris obstruction at the mouth of Tributary 19, near the full pool level (habitat survey 32).

Figure 33. Mouth of Tributary 20, showing debris and gravels (habitat survey 33).

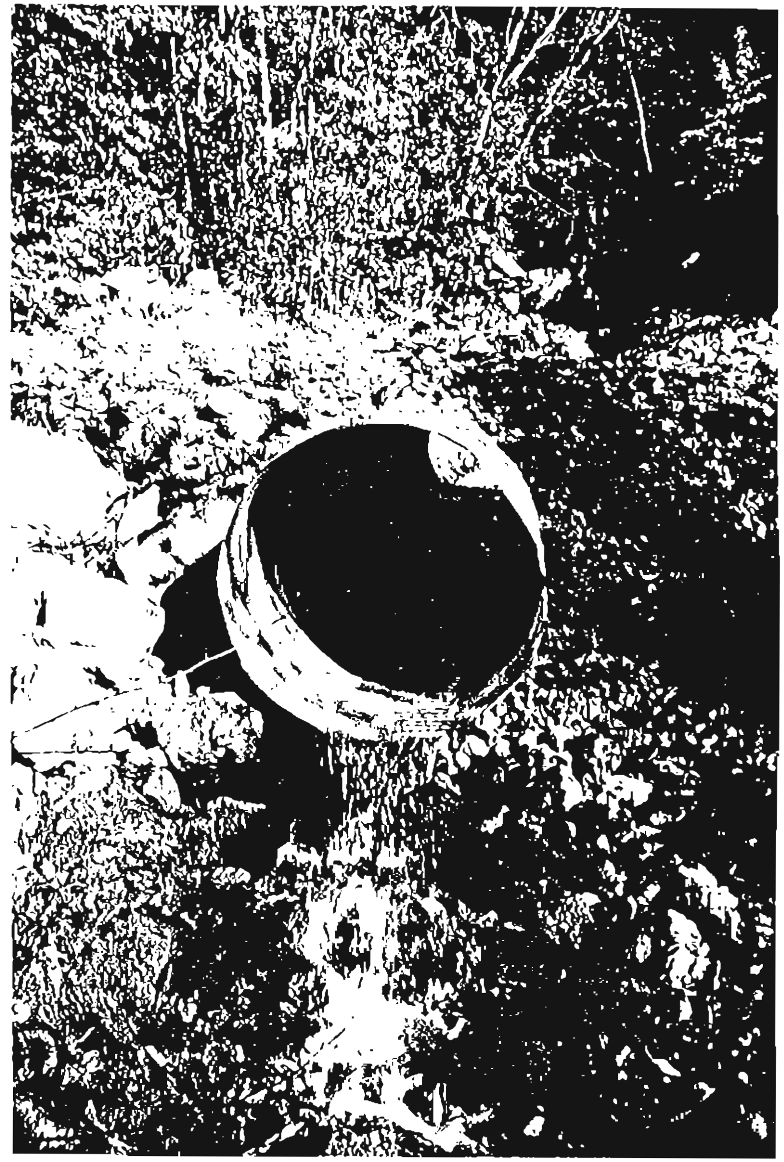

Figure 34. Recent culvert installation on Tributary 20, 115m upstream of Downton Lake.

Figure 35. Tributary 20, upstream of the road crossing (habitat survey 34).

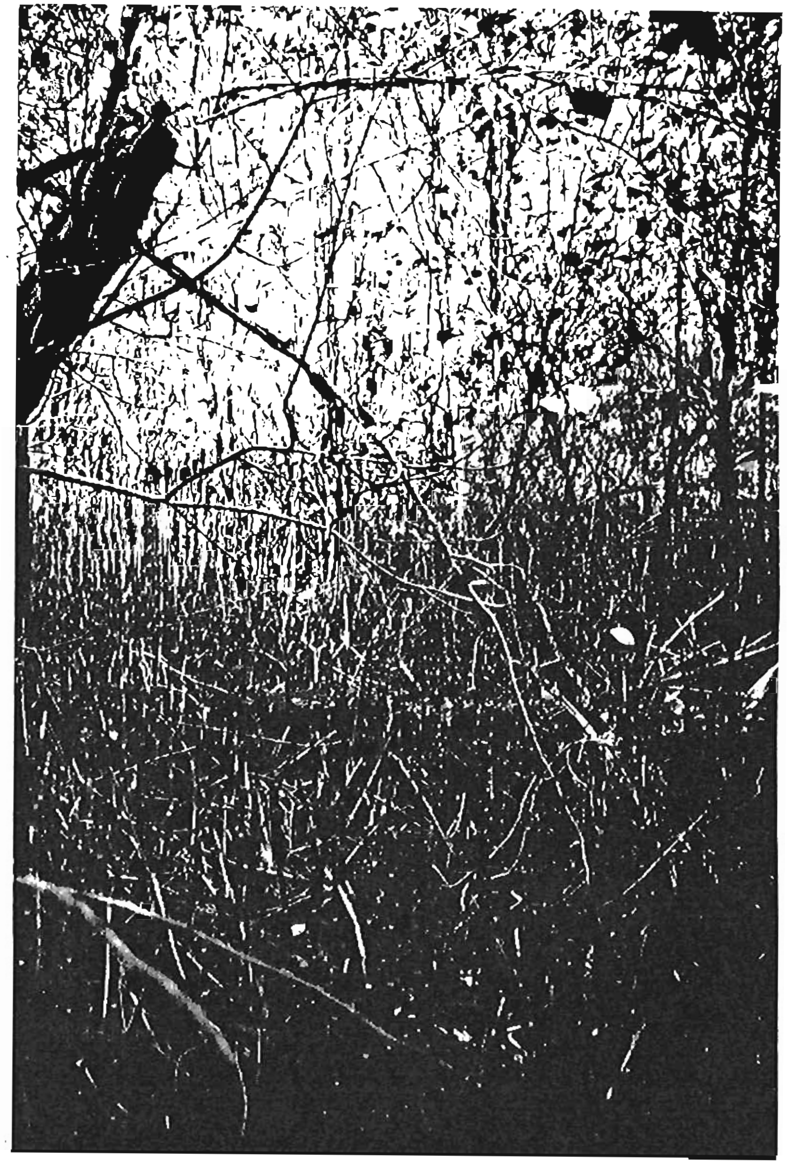

Figure 36. Tangle of weeds, shrubs and debris in lowermost Tributary 18 (habitat survey 31).

However, due to the lack of deeper water, conditions suitable for parr appeared to be very limited (*ibid.*; Appendix 5).

Another very notable finding for Tributary 20 was its higher water temperature (10.1 °C on October 9) compared to all other streams investigated (Tables 1 and 2). Furthermore, acknowledging minor differences in the dates of sampling, the temperatures in most of the smaller tributaries to Downton Lake Reservoir (Table 2) appear to have been warmer (considerably, in some cases) than those in the Bridge River system (Table 1).

In this regard, results for Tributary 18 were most profound. As noted earlier, with deteriorating weather conditions the water temperature in McParlon Creek dropped from 5.1 °C on October 13-14 to 1.5 °C on October 16 (Table 1). Similar temperatures were also encountered in some of the smaller tributaries to the reservoir that were also inspected on October 16-17; 1.4 °C in Tributary 12, and 2.0 °C in Tributary 17 (Table 2).

In comparison, the temperature in Tributary 18 was 6.7 °C on October 16 (Table 2). Unfortunately, aside from influences on the reservoir itself, this appeared to be of little significance (if any) in terms of fish production. For the first 75m of its length, above full pool, Tributary 18 lacked any distinct channel, as observed in October 1996. It consisted of unconfined and very shallow surface flow through a tangle of brush, weeds, and debris over predominately mud substrates (Fig. 36).

However, as was also evidenced for Tributaries 19 and 20, there was clear evidence of channel shifts and other instability of Tributary 18 (Appendix 5). The lowermost sections of all of these streams were essentially alluvial fans at the bottom of steep valleys, and are likely subject to constant change.

Similar to Tributary 18, no channel could be found in association with the valley designated Tributary 21 (Fig. 26); nor was there any evidence of inflows to the reservoir, at this location, and time of investigation. However, large gravel bars at the mouth of this valley suggest high flows on occasion (and associated instability), presumably on a seasonal basis.

In contrast to Tributary 21, well defined channel and active flow were exhibited by Tributary 22 (habitat survey 35; Fig. 26). In addition to size and discharge, this stream was quite similar to Tributary 20 in other respects as well. Firstly, an impassable culvert, immediately followed by cascades, reduces accessible length to just 40 m above full pool (Appendix 5). At the observed flows, rearing habitat was fairly abundant for fry within this section, but shallow water depths reduced potential for parr (Fig. 37).

Furthermore, the mouth was not obstructed in any way, and the abundance of gravels was comparable to that in lowermost Tributary 20 (Appendix 5). However, fines were more abundant, gradient was slightly steeper, and the compaction of gravels and other bed materials was high (*ibid.*). In addition, the water temperature was slightly cooler (Table 2).

Figure 37. Habitat survey 35, showing fines and compaction in Tributary 22.

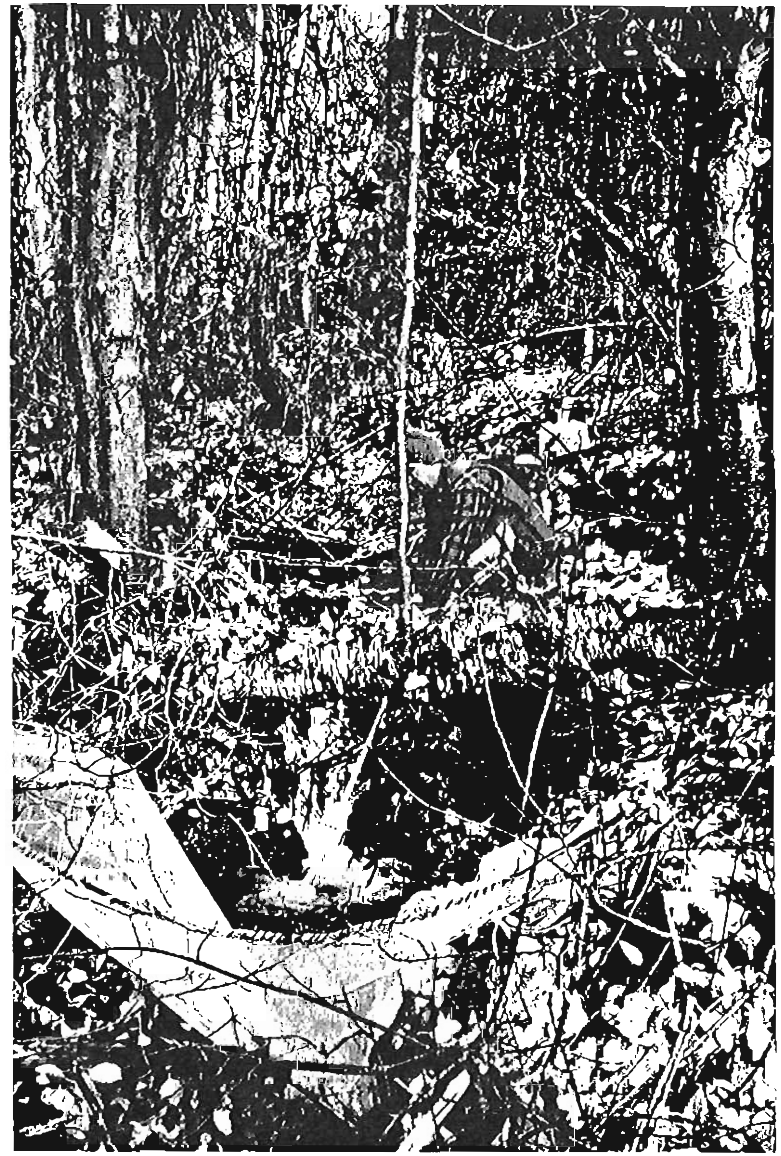

Figure 38. Habitat survey 30, and electrofishing site 34 in Tributary 17.

Tributary 17 (habitat survey 30; Fig. 26) appeared to be the most stable of the streams inspected on the north side of the reservoir. But once again, access for fish was likely restricted to < 50 m, due to numerous step falls and plugs, compounded by very narrow channel width (Fig. 38). In this case, however, no viable spawning habitat was observed whatsoever (Table 2).

4.4 Distribution and Abundance of Fish in Streams

The locations of the 40 electrofishing sites in streams tributary to Downton Lake Reservoir are shown in Figures 39 (Bridge River system) and 40 (smaller tributaries to the reservoir). Full data regarding fish captures at these sites are provided in Appendix 6. A summary of sampling locations, site types (as applicable), and the actual number of fish caught at each site is provided in Table 5. These results clearly indicate a variety of constraints. Firstly, rainbow trout was the only species captured at any site. Secondly, fish were only captured at 14 sites (35%) of the 40 that were completed, in all; and the number of captures was low overall, both within the upper Bridge River system and other tributaries to the reservoir.

4.4.1 Bridge River system

At first glance, the results for the upper Bridge River appear to be relatively impressive (Table 5); however, closer examination reveals that fish were greatly concentrated within the clear-flowing network of side channels just upstream of McParlon Creek (sites 4-7; Fig. 39). The only captures of fish in the Bridge River mainstem were low numbers of yearlings, downstream of these side channels (sites 1 and 2; *ibid.*).

Further upstream, no fish were captured in a clear-flowing flood channel of the mainstem (sites 10 and 11), nor a particularly quiet and complex braid (site 14). The same applies to a large clear-flowing side channel in the same area (site 13; Fig. 39).

The efficiency of sampling in the mainstem itself may well be suspect, due to high turbidity and low water temperatures (3.6 °C to 4.3 °C). However, the same does not apply to the flood channel and side channel addressed at sites 10, 11 and 13 (clear-flowing at 5.6 °C to 6.4 °C; Table 5). Turbidity was also high and temperature was low (3.6 °C) at site 4 in the mainstem-fed side channel associated with the clear-flowing network of channels referred to above (Fig. 39). Despite the sampling constraints, parr *were* captured at site 4 (Table 5), as they were at the 2 mainstem sites downstream (sites 1 and 2).

The absence of *fry* in captures at site 4 *may* have been attributable to sampling inefficiencies, with the same again applying to sites 1 and 2, as well as others in the Bridge River mainstem (Table 5). However, in the sampling procedure, the final downstream sweep is intensive (particularly when visibility is poor), and fry are generally trapped against the downstream net. This net is inspected for fish immediately following each capture attempt.

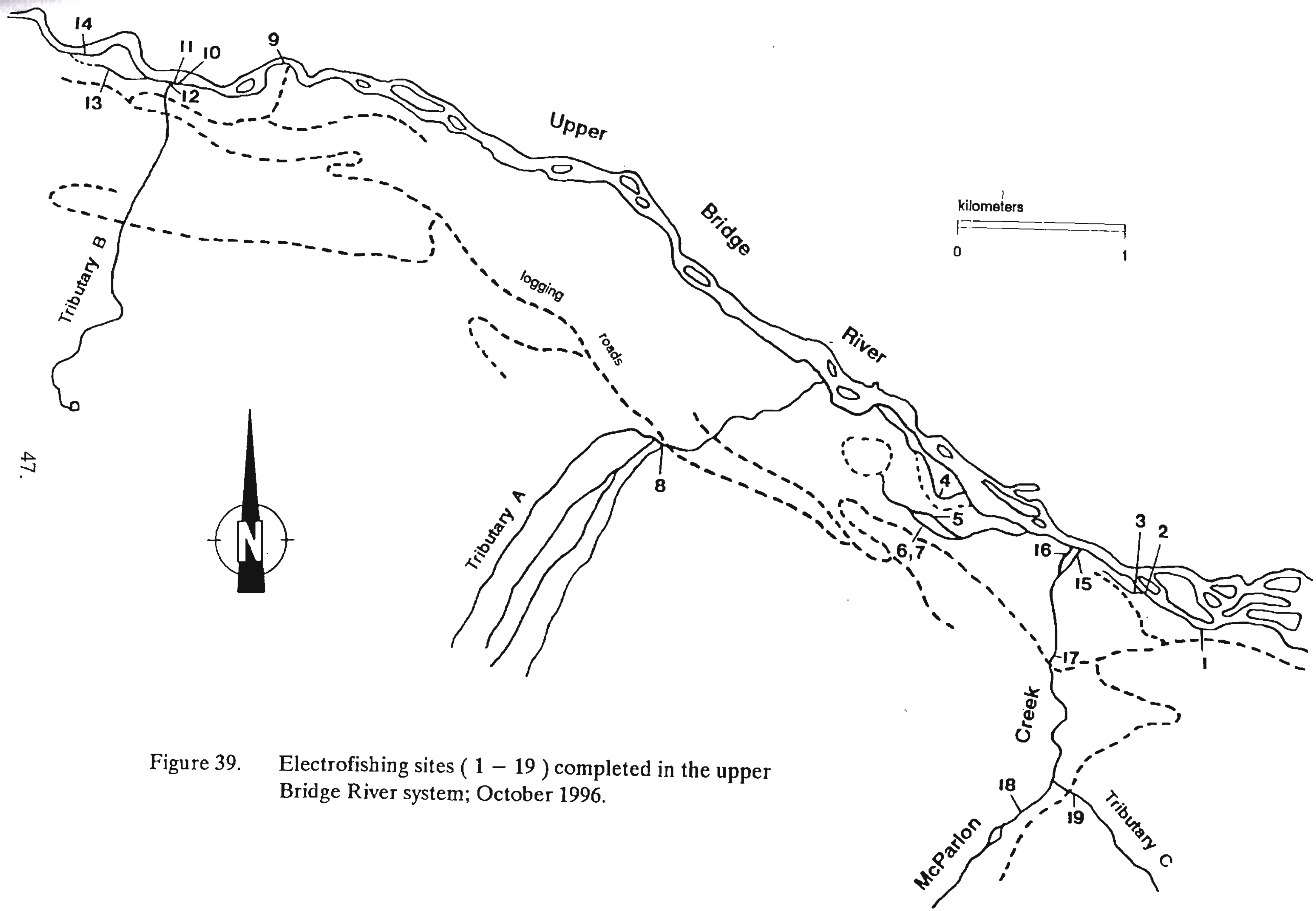

Figure 39. Electrofishing sites (1 – 19) completed in the upper Bridge River system; October 1996.

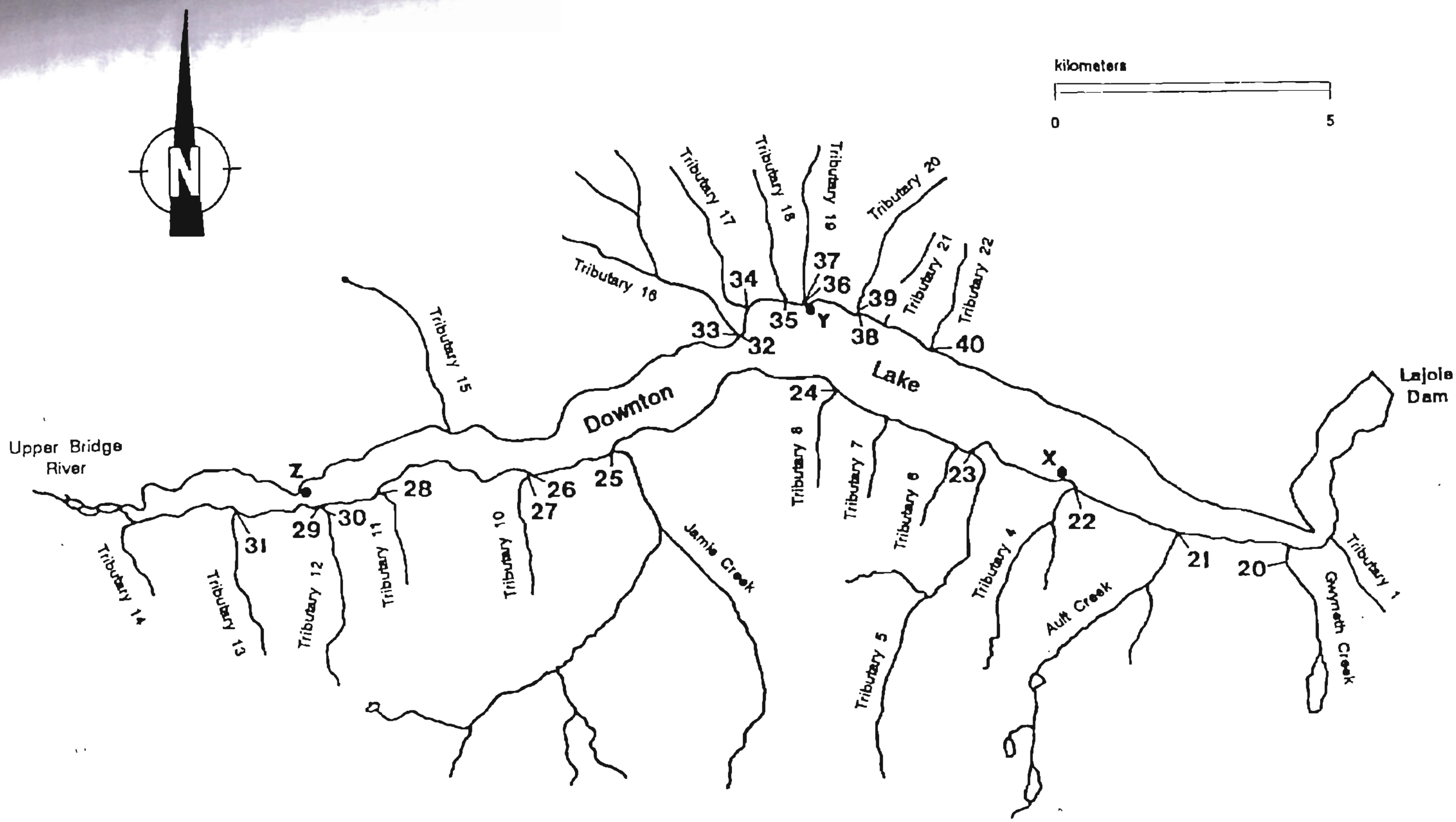

Figure 40. Electrofishing sites (20–40) completed in the smaller tributaries to Downton Lake Reservoir, and gill netting locations (X–Z) in the reservoir itself; October 1996.

Table 5. Summary of fish numbers caught at electrofishing sites in the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996.

Stream and Type of Site	Site No.	Area (m²)	Date (1996)	Temp. (°C)	Rainbow Trout Age 0+	Rainbow Trout Age 1+	Rainbow Trout Age 2+	Rainbow Trout Age 3+
Upper Bridge River								
mainstem – representative	1	50.4	Oct 14	4.0	–	5	–	–
mainstem braid – representative	2	42.1	Oct 13	4.3	–	2	–	–
small side channel	3	60.7	Oct 13	5.9	–	–	–	–
large glacial side channel	4	56.8	Oct 14	3.6	–	3	2	2
large clear side channel	5	47.7	Oct 13	6.7	16	9	2	–
smaller clear side channel	6	71.0	Oct 13	6.3	9	4	–	–
smallest clear side channel	7	22.6	Oct 13	6.4	10	2	–	–
Tributary A	8	75.5	Oct 14	4.2	–	–	–	–
mainstem – representative	9	51.9	Oct 12	3.8	–	–	–	–
mainstem flood channel – clear	10	40.3	Oct 12	5.6	–	–	–	–
mainstem flood channel – clear	11	98.6	Oct 12	5.6	–	–	–	–
Tributary B	12	41.2	Oct 12	5.9	–	–	–	–
large clear side channel	13	57.9	Oct 12	6.4	–	–	–	–
quiet complex mainstem braid	14	63.6	Oct 12	4.3	–	–	–	–
McParlon Creek								
mainstem – representative	15	55.5	Oct 13	5.1	–	1	–	–
small complex mainstem braid	16	94.5	Oct 14	5.1	–	2	2	–
mainstem – representative	17	41.6	Oct 16	1.5	–	–	2	1
	Falls							
mainstem – representative	18	33.5	Oct 16	1.5	–	–	–	–
Tributary C	19	64.5	Oct 16	1.2	–	–	–	–
Other tributaries to the reservoir								
	South shore							
Tributary 2 (Gwyneth Creek)	20	20.2	Oct 8	8.1	10	1	1	–
Tributary 3 (Ault Creek)	21	46.3	Oct 8	7.2	–	–	–	–
Tributary 4	22	52.4	Oct 8	6.9	–	–	–	–
Tributary 5	23	33.5	Oct 8	7.2	–	–	–	–
Tributary 8	24	18.3	Oct 9	6.9	–	–	–	–
Tributary 9 (Jamie Creek)	25	32.1	Oct 10	6.9	–	–	–	–
Tributary 10	26	16.9	Oct 10	7.7	–	1	–	–
"	27	24.1	Oct 10	7.7	–	–	–	–
Tributary 11	28	26.7	Oct 10	8.0	–	–	–	–
Tributary 12	29	28.8	Oct 17	1.4	–	–	–	1
"	30	56.1	"	"	–	–	–	–
Tributary 13	31	36.7	Oct 10	8.2	–	–	–	–
	North shore							
Tributary 16	32	62.6	Oct 11	8.1	2 ?	3	3	–
"	33	23.5	"	"	1 ?	1	3	–
Tributary 17	34	21.2	Oct 16	2.0	–	–	–	–
Tributary 18	35	104.1	Oct 16	6.7	–	–	–	–
Tributary 19	36	15.8	Oct 11	9.2	–	–	–	–
"	37	20.6	"	"	–	–	–	–
Tributary 20	38	39.4	Oct 9	10.1	25	–	–	–
"	39	61.9	"	"	–	–	–	–
Tributary 22	40	18.4	Oct 9	8.8	–	–	–	–

Using these procedures, rainbow fry *were* captured under similar conditions in both the Hurley River and the Bridge River mainstem, downstream of Downton Lake Reservoir, during earlier investigations (Griffith, 1996*a*; 1997*a*). While it might be assumed that mainstem habitat of the upper Bridge River would contain at least *some* fry, it seems that numbers were very low at the time of the October 1996 investigations. At this time, the only concentration of fry that was encountered in the upper Bridge River system was in the network of clear-flowing side channels, sampled at sites 5 to 7 (Table 5).

Particularly in view of the superior habitats sampled at sites 10, 11, 13 and 14 (Table 5), it appeared that fish numbers were low, upstream of these channels. Similar results were also obtained for the Hurley River, where much of the mainstem and associated tributaries appeared to lack fish, due to harsh glacial conditions (Griffith, 1997*a*).

It is quite conceivable that other side channel areas adjacent to the upper Bridge River might also be found to produce and support juvenile rainbow trout. However, this was *not* the case at sites 3 and 13, in such habitat, in the fall of 1996 (Table 5).

The concentration of rainbow trout fry in the network of side channels sampled at sites 5 to 7 was likely attributable to the far superior spawning habitat in these channels, compared to the very limited potential at all other sites investigated within the upper Bridge River system (Table 1). No doubt, the relatively clear water in these channels (at the time of inspection, at least) was another factor, both in terms of substrates quality (egg survival) and early rearing. In addition, the warmer water temperatures could only be of benefit to fish production (Griffith, 1980).

However, it is likely the quality and quantity of spawning substrates in these channels that was of *utmost* significance (Table 1). Again, no fish were captured in the clear-flowing and warmer habitat at sites 10, 11 and 13, further upstream, despite highly suitable habitat for fry, in each case (Appendix 6). The lack of associated spawning habitat seemed to provide the best explanation of the absence of fish at these sites.

Fish numbers in McParlon Creek appeared to be somewhat higher than those in the Bridge River mainstem (Table 5), possibly reflecting its somewhat superior diversity and complexity of rearing habitat (Table 1). However, once again, no fry were captured at any site, and numbers of yearlings were also low.

Internal examinations of the 4 Age 2+ fish (104 mm to 141 mm) that were captured in this stream, all revealed advanced development of reproductive organs. The largest individual (141 mm) was a maturing female, with granular ovaries. The single Age 3+ fish (199 mm) was a darkly coloured female kelt, with an eroded caudal fin.

On the collective strength of all results, stream resident production is likely predominant in McParlon Creek. Again, the size of the population is no doubt constrained by the harsh environmental conditions, including high glacial turbidity and low water temperatures.

However, in addition to more diverse and complex rearing habitat, McParlon Creek may offer other advantages to fish, compared to the Bridge River itself. As evidenced in October 1996, this included somewhat lower turbidity (Appendix 4), warmer temperatures (eg. prior to October 16 in 1996; Table 1), and marginally greater spawning potential (Table 1; Appendix 5).

On the strength of results at sites 18 and 19, it is possible that fish production in McParlon Creek is limited to the short streamlength below the barrier falls. Of course, these results are by no means conclusive; especially acknowledging the potential influence of very low temperature (1.5 °C), coupled with high turbidity, on the sampling efficiency at site 18, in the McParlon Creek mainstem, upstream of the falls (Appendix 6).

On the other hand, the absence of fish captures in Tributary A (site 8) and Tributary B (site 12) also suggested a limited distribution of fish within the upper Bridge River system. In both cases, water transparency was excellent, and temperature conditions were more conducive to efficient sampling at these sites (4.2 °C and 5.9 °C, respectively; Appendix 6).

4.4.2 Smaller tributaries to the reservoir

Fish (all rainbow trout) were only captured in 5 of the 16 smaller tributaries flowing into Downton Lake reservoir, at the time of inspection in October 1996[10]. Three of these streams were located on the south side of the reservoir: Gwyneth Creek (site 20), Tributary 10 (site 26), and Tributary 12 (site 29; Fig. 40).

The only one of these streams that was found to contain *fry* was Gwyneth Creek, and the number of these fish was relatively high (Table 5). However, there is no possibility that captures at this site reflected the spawning/recruitment of reservoir fish. As noted earlier, extremely high gradient (> 80%) in lower Gwyneth Creek precludes *any* access of reservoir fish to this stream, above the full pool-level (Table 3).

With respect to site 20, specifically, such access would certainly be precluded by 8 m bedrock falls located 30 m downstream of the sampling location (Appendix 5). Given the gradient of Gwyneth Creek (ave. > 30%; Table 3), and the apparent absence of viable spawning habitat (Table 2), it seems most probable that fish present at site 20 were related to the populations of rainbow trout reported (footnote 4) to exist in Gwyneth Lake, upstream (Fig. 40).

In contrast, it may be assumed that the Age 3+ individual captured at site 29, within the short (50 m) accessible length of Tributary 12 (Fig. 40), was an immigrant from Downton Lake reservoir. This individual (197 mm) was a fully mature male, and its presence in this stream may have been related to the limited amount of spawning habitat available here (Table 2).

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10. Again acknowledging the omission of Tributary 15, as another possible candidate.

The probability that the fish was an immigrant from the reservoir was supported by the lack of any captures above the barrier falls, located just 50 m upstream of the reservoir (site 30; Table 5). It was also supported by comparable findings in Tributary 10, discussed below.

It is acknowledged that the results at both sites in Tributary 12 are suspect, due to the very low water temperatures (1.4 °C) at time of sampling on October 17 (Table 5). However, the stream was clear-flowing, and other than possible temperature effects, capture efficiency was judged to be high. Furthermore, except for the presence of the Age 3+ individual, the results in Tributary 12 were entirely consistent with all other streams sampled on the south side of the reservoir, other than Gwyneth Creek (Table 5).

This includes Tributary 10, where a single yearling was captured at site 26 (Fig. 40), located 18 m upstream of the reservoir (Appendix 6). Although no distinct barriers were identified on this stream, there was an abrupt and substantial increase in stream gradient after the road crossing, 70 m upstream of the reservoir. Once again, sampling here (site 27; 106 m upstream of the reservoir) did not produce any fish (Table 5).

In this case, temperature was not a factor (7.7 °C; *ibid.*), and sampling efficiency was particularly high, due to very low discharge (0.005 m^3/s; Table 3), and narrow wetted width (1.3 m at site 27; Appendix 6). It is feasible that the single yearling captured at site 26 originated from the very limited spawning habitat in this stream (Table 2). However, it seems far more likely that this fish was also an immigrant from the reservoir, particularly in view of the small size and discharge of Tributary 10, and the associated possibility of total freeze-up during winter.

As far as it can be determined on the basis of the October 1996 sampling results, tributaries along the south side of Downton Lake Reservoir may have contributed very little to the recruitment of rainbow trout to the reservoir, for that brood year, at least. Despite the presence of some particularly large streams on this side of the reservoir (notably Ault Creek and Jamie Creek), fish production appeared to be constrained in these streams by limited accessibility, high gradient, and low abundance of viable spawning habitat (Tables 2 and 3).

In the one stream on the south side of the reservoir found to contain reasonable numbers of fish (Gwyneth Creek; Table 5), the only logical explanation was the presence of populations upstream. No doubt, the results at site 20 in lower Gwyneth Creek (ie. site 20; Fig. 40) indicate downstream displacment (or migration) of fish within this system. Ultimately, this may result in *some* level of indirect recruitment (ie. further displacement) to the reservoir, from Gwyneth Creek. Other than this, however, there was no direct evidence of any other recruitment from streams along the south side of the reservoir, as sampled in October 1996.

Implications were different for some streams along the north side of the reservoir. Site 38, near the mouth of Tributary 20 (Fig. 40), produced the single highest capture of rainbow fry, encountered anywhere within the Downton Lake drainage (Table 5). This was consistent with the superior spawning habitat concentrated within the lowermost 50 m of this stream, above the full pool level (Table 2; Appendix 5).

The absence of *parr* at this site was not surprising, given the limited depth of water, and lack of suitable cover, for such fish (*ibid.*); and once again, successful overwintering may well be precluded by total freeze-up of this small stream (flowing at just 0.03 m^3/s at time of inspection; Table 4).

It seems safe to conclude that fry in Tributary 20 were definitely progeny of immigrant reservoir fish. In addition to comments above (ie. questionable chances of overwinter survival), the absence of a stream resident population was supported by the total lack of captures at site 39 (Table 5), located upstream of barriers to fish passage, on this tributary (Appendix 5).

Given the similarity of conditions in Tributary 19 and Tributary 20 (including water temperatures; Tables 2 and 4), it is curious that no fish were caught in Tributary 19 (Table 5), despite efforts at 2 sites (sites 36 and 37; Fig. 40). No doubt, the explanation was provided by the complex debris accumulation at the mouth of this stream (Fig. 32), which was judged to constitute a barrier to fish passage, at the time of observation in October 1996 (Table 4; Appendix 5). The fish sampling results would appear to confirm this assessment.

Similarly, the apparent absence of fish in Tributary 18 (site 35; Fig. 40) was not surprising, in view of the lack of channel definition, the mud substrates, and the tangle of weeds, shrubs, and debris (Fig. 36). Due to the absence of viable spawning habitat, in particular (Table 4), the same may be said for the lack of fish captures at site 34, in Tributary 17 (Fig. 40).

In the case of Tributary 22, the most plausible explanation of the apparent absence of fish at site 40 (Fig. 40) was the higher abundance of fines, and related compaction of gravels, compared to Tributary 20 (Table 4). Otherwise, these two streams (and Tributary 19) appear to be quite similar (Table 2; Figs. 33 and 38).

Clearly, of all the smaller tributaries to Downton Lake Reservoir that were investigated in October 1996, Tributary 16 appears to constitute a special case. Firstly, it provided considerably greater accessible length, as noted earlier (Table 4). Secondly, it contained considerably higher discharge (0.161 m^3/s), and greater water depths (Appendix 5), compared to other streams on the north side of the reservoir, despite its relatively small channel (ave. 2 m; Table 2).

Consistent with this, parr appeared to be relatively abundant in this stream, at the time of sampling in October 1996 (sites 32 and 33; Table 5; Fig. 40). Rather surprisingly, however, fry numbers were low (Table 5), despite the presence of abundant gravels, and superior spawning potential (Table 4). Futhermore, access to this stream appeared to be totally unobstructed, at the time of inspection (Appendix 5).

In addition to this, there is a strong possibility that the few fry at sites 32 and 33 (Table 5) were actually yearlings. This is discussed in the following section. In any event (and despite efforts at 2 sites in Tributary 16), this stream certainly did not contain the concentrated fry populations encountered in Tributary 20 (Table 5).

A possible explanation of the results in Tributary 16 is that this stream is not used for spawning/recruitment of reservoir fish. Given higher flows, and greater water depths, year-round survival may be possible, and the fish captured in October 1996 may all have been stream resident. In support of this possibility, a 137 mm individual (Age 2+) captured at site 33 was also found to be a maturing female, with granular ovaries.

On the other hand, it seems extraordinary that reservoir fish would *not* utilize this stream, given its apparent accessibility and spawning potential; especially in view of the limited number of alternatives (Tables 1-4). Perhaps the results for Tributary 16 indicate that there was an emigration of fry, to the reservoir, prior to the October 1996 sampling. If this is the case, then the same might also apply to other tributaries investigated at this time (including the Upper Bridge River system), depending on the specific spawning potential in each stream, or stream section (Tables 1 to 4).

However, in the absence of time sequence sampling (or alternative methodologies), the latter may only be viewed as *hypothesis*. It should also be emphasized, that the October 1996 investigations occurred with the reservoir close to full pool, and accordingly, only addressed stream sections above this level. Obviously, stream sections exposed at lower reservoir levels (Tables 3 and 4) could not be assessed at this time.

4.5 Age and Size Characteristics of Fish in Streams

The length frequency distribution of all fish captured in streams during the October 1996 sampling in the Downton Lake Reservoir drainage is illustrated in Figure 41. Separate results are also provided for the upper Bridge River system, and (collectively) for the smaller tributaries to the reservoir, flowing at the time of investigation. Corresponding statistics are provided in Table 6.

The most profound finding, especially within the upper Bridge River system, was the exceptionally small size of rainbow fry, so late in the season. As shown in Figure 41, these fish ranged in size from 25 mm to 46 mm, and averaged only 36.3 mm (Table 6). Clearly, the smallest individuals were very newly emerged, with remnants of yolk-sacs still in evidence.

Similarly, yearlings in the upper Bridge River system were also very small (Fig. 41; Table 6). The identification of such fish was greatly hampered by the lack of a distinct first annulus on many scales, especially for the smallest individuals. This is not surprising, given the extremely small size of fry, in October. The same phenomenon has also been observed in the Kwoiek Creek drainage, 100 km southeast of Downton Lake Reservoir (Griffith, 1997*c*).

Under such circumstances, the focus of yearling scales is typically distorted and/or regenerated. Generally speaking, however, at least some scales within a sample will exhibit stronger evidence of an annulus, and in the final analysis, rainbow trout as small as 64 mm were identified as yearlings, in the 1996 captures from the upper Bridge River system (Table 6).

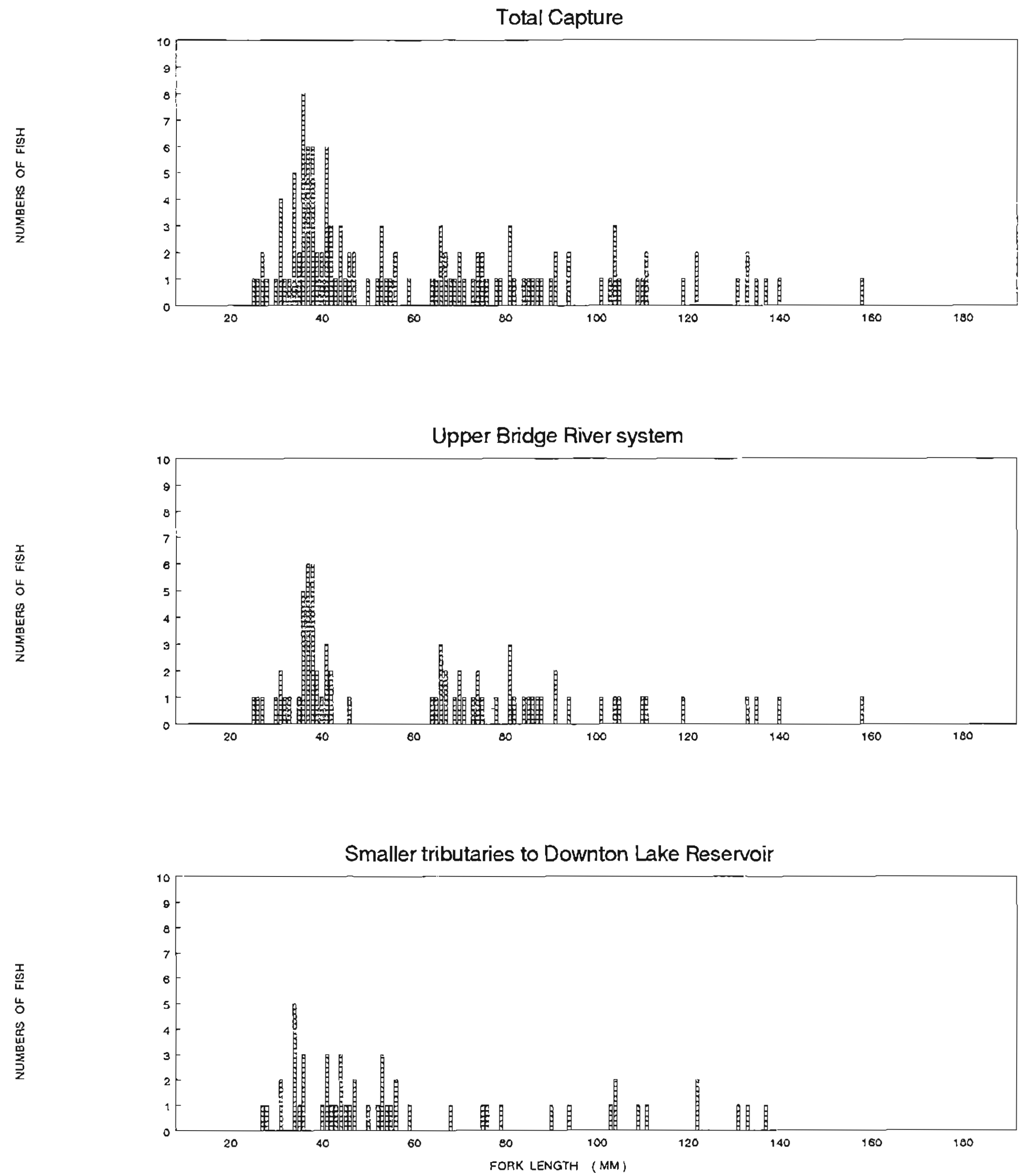

Figure 41. Length frequency distribution of rainbow trout captured at electrofishing sites in the Downton Lake Reservoir drainage; October 1996.

Table 6. Summary of size statistics for all rainbow trout captured at electrofishing sites in the Downton Lake Reservoir drainage; October 1996.

Cohort	Number	Fork Length (mm)			Weight (g)			Condition Factor[1] ($\times 10^{-5}$)		
	Captured	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Upper Bridge River system										
Age 0+	35	25	46	36.3	0.1	1.1	0.4	0.51	1.68	0.80
Age 1+	28	64	94	76.6	2.5	9.2	5.0	0.87	1.73	1.05
Age 2+	8	101	141	115.8	10.6	29.7	17.2	0.77	1.24	1.06
Age 3+	3	133	199	163.3	29.9	90.7	54.7	1.10	1.27	1.17
Other tributaries to the reservoir (excluding Tributary 16 for Age 0+)										
Age 0+	35	27	59	42.6	0.1	2.2	0.9	0.46	1.29	0.98
Age 1+	6	79	111	97.7	4.5	15.5	10.1	0.91	1.16	1.04
Age 2+	7	114	137	124.7	14.7	27.8	20.3	0.83	1.10	1.02
Age 3+	1	–	–	197	–	–	83.3	–	–	1.09
Tributary 16 only										
Age 0+	3	68	76	73.0	3.0	4.4	3.9	0.95	1.02	0.99
Tributary 16 only (68 mm to 76 mm fish included with Age 1+)										
Age 1+	7	68	109	85.7	3.0	12.8	6.8	0.91	1.04	0.99

1. *k*, in the equation $Weight_g = k\,(Fork\ Length_{mm}{}^3)$

This was supported by the very distinct length frequency results for this part of the Downton Lake Reservoir drainage (Fig. 41). It was also supported by fish as small as 104 mm exhibiting advanced reproductive development, clearly indicative of Age 2+ (a maturing male at site 17, in McParlon Creek; Appendix 6).

Results for other tributaries indicate somewhat larger sizes for all age groups (Fig. 41; Table 6). For the few streams in which fry were encountered (Table 5), the size range was 27 mm to 59 mm, with an average of 42.6 mm (Table 6). However, most of the larger individuals were captured at site 20, in Gwyneth Creek (40 mm to 59 mm; Appendix 6). As noted earlier, these fish can only be attributed to production associated with Gwyneth Lake, and consequently, have no relevance with respect to the spawning/recruitment of reservoir populations.

In Tributary 20, fry were most certainly attributable to the spawning of reservoir fish, and the size of these fry ranged from 27 mm to 56 mm, averaging 41.4 mm (Appendix 6). Once again, a large proportion (44%) were ≤ 35 mm in length (Fig. 41), and very newly emerged. On the other hand, nearly 28% were ≥ 50 mm in length (*ibid.*).

In Table 5, the 3 fish entered as fry for sites 32 and 33 in Tributary 16 ranged in size from 64 mm to 78 mm (Table 6). On the strength of all other findings, it seems very likely that these fish were actually yearlings. This includes the confident identification of a 79 mm individual, from the same stream, as a yearling (Appendix 6).

However, given the water temperature of this stream in October 1996 (8.1°C; Table 2), and the suggestion of a stream resident population (ie. perhaps able to spawn earlier), it is *possible* that the 3 individuals in question were in fact fry. Certainly, there was insufficient evidence in the scale samples for these particular fish to confidently identify them as yearlings.

Similar anomalies have been observed in other cold, glacial systems within the region. In the Kwoiek Creek system (noted above), fry as large as 74 mm were captured in warmer stream sections (7.5°C to 8.0°C) within the drainage, in October 1995. On the other hand, in the coldest stream (Chochiwa Creek; 5.0°C on October 23), fish of this size, and smaller (67 mm to 74 mm) were all yearlings (Griffith, 1997*c*).

In the Yalakom River, tributary to the Bridge River downstream of Carpenter Lake Reservoir (Fig. 1), rainbow fry were as large as 65 mm in warmer parts of the drainage (10°C) in September 1994. In colder areas (7°C) further up the system, yearlings were as small as 70 mm (Griffith, 1995).

In the Carpenter Lake Reservoir drainage, immediately downstream of Downton Lake Reservoir (Fig. 1), the length frequency of rainbow trout fry appeared to be extenuated, and at least bimodal. In September 1995, a large proportion of these fish were very small and newly emerged (20 mm to 30 mm), as observed in the Downton Lake Reservoir drainage in October 1996. However, in the Carpenter Lake Reservoir system there was also a substantial number of fry in the size range of 35 mm to 55 mm, and the maximum was 71 mm (Griffith, 1996*a*).

This was interpreted to reflect protracted spawning of rainbow trout in this system, related to temperature conditions in various streams, likely complexed with the effect of reservoir operations on the accessibility (or availability) of suitable spawning habitats (*ibid.*).

With respect to Downton Lake Reservoir, it is possible that the larger fry ($\geq$ 50 mm) in Tributary 20, and possibly Tributary 16 (if they *were* fry, in this stream), may indicate similar phenomena here as well. Alternatively, it might simply reflect warmer temperatures of these streams (Table 2). In any event, at the time of the October 1996 investigations, the vast majority of fry in stream habitats associated with Downton Lake Reservoir appeared to be recently emerged (ie. < 40 mm; Fig. 41).

In the upper Bridge River system, delayed emergence of fry might simply be attributable to the effect of cold temperatures on the period of incubation/development of eggs. However, the same conditions might possibly delay spawning activity itself. Certainly, with the considerably warmer temperatures encountered in Tributary 20 in October 1996 (Table 2), the very *small* fry captured here do suggest delayed spawning of adults in this stream, at least.

4.6 Standing Stock of Fish in Streams *vs.* Theoretical Habitat Capability

In the modelling procedure to estimate juvenile salmonid standing stock capability in B.C. streams (Ptolemy, 1992), all results are expressed in terms of fish per unit area. In Table 7, the electrofishing results for the Downton Lake Reservoir drainage in October 1996 are expressed in *fish/m²*, based on the numbers of captures and corresponding site areas provided in Table 5.

A further requirement of the modelling procedure is to restrict attention (logically) to the proportion of the sampled habitat that is actually suitable (usable) for any given age/size group of fish (*ibid.*). Accordingly, in Table 8 the results in Table 7 have been adjusted to express all fish densities (1996 standing stock) in terms of usable habitat only, as outlined in the presentation of methods.

For each site, specific water depth/velocity transect data (Appendix 6) were employed to derive corresponding species/size-specific probability-of-use estimates, following Bech *et al* (1994). The computer spreadsheet used in this procedure provides estimates for bull trout[11], coho salmon, and chinook salmon, in addition to rainbow trout (Appendix 6).

For rainbow trout, the estimates of usability are provided in Table 8, and represent the proportion of total site area where hydraulic conditions were actually suitable for a given age/size class of this species, at any given site.

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11. Incorporation of this species was undertaken by R.P. Griffith and Associates, employing preliminary data provided by the U.S. Fish and Wildlife Service (Anon., 1981; Pratt, 1984).

Table 7. Summary of fish densities ($fish/m^2$) at electrofishing sites in the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996.

Stream and Type of Site	Site No.	Date (1996)	Temp. (°C)	Rainbow Trout (fish / m²) Age 0+	Age 1+	Age 2+	Age 3+
Upper Bridge River							
mainstem – representative	1	Oct 14	4.0	–	0.11	–	–
mainstem braid – representative	2	Oct 13	4.3	–	0.05	–	–
small side channel	3	Oct 13	5.9	–	–	–	–
large glacial side channel	4	Oct 14	3.6	–	0.07	0.04	0.04
large clear side channel	5	Oct 13	6.7	0.42	0.21	0.04	–
smaller clear side channel	6	Oct 13	6.3	0.14	0.06	–	–
smallest clear side channel	7	Oct 13	6.4	0.80	0.09	–	–
Tributary A	8	Oct 14	4.2	–	–	–	–
mainstem – representative	9	Oct 12	3.8	–	–	–	–
mainstem flood channel – clear	10	Oct 12	5.6	–	–	–	–
mainstem flood channel – clear	11	Oct 12	5.6	–	–	–	–
Tributary B	12	Oct 12	5.9	–	–	–	–
large clear side channel	13	Oct 12	6.4	–	–	–	–
quiet complex mainstem braid	14	Oct 12	4.3	–	–	–	–
McParlon Creek							
mainstem – representative	15	Oct 13	5.1	–	0.02	–	–
small complex mainstem braid	16	Oct 14	5.1	–	0.02	0.02	–
mainstem – representative	17	Oct 16	1.5	–	–	0.05	0.02
	Falls						
mainstem – representative	18	Oct 16	1.5	–	–	–	–
Tributary C	19	Oct 16	1.2	–	–	–	–
Other tributaries to the reservoir							
	South shore						
Tributary 2 (Gwyneth Creek)	20	Oct 8	8.1	0.89	0.05	0.05	–
Tributary 3 (Ault Creek)	21	Oct 8	7.2	–	–	–	–
Tributary 4	22	Oct 8	6.9	–	–	–	–
Tributary 5	23	Oct 8	7.2	–	–	–	–
Tributary 8	24	Oct 9	6.9	–	–	–	–
Tributary 9 (Jamie Creek)	25	Oct 10	6.9	–	–	–	–
Tributary 10	26	Oct 10	7.7	–	0.06	–	–
"	27	Oct 10	7.7	–	–	–	–
Tributary 11	28	Oct 10	8.0	–	–	–	–
Tributary 12	29	Oct 17	1.4	–	–	–	0.03
"	30	"	"	–	–	–	–
Tributary 13	31	Oct 10	8.2	–	–	–	–
	North shore						
Tributary 16	32	Oct 11	8.1	0.03 ?	0.05	0.05	–
"	33	"	"	0.04 ?	0.04	0.13	–
Tributary 17	34	Oct 16	2.0	–	–	–	–
Tributary 18	35	Oct 16	6.7	–	–	–	–
Tributary 19	36	Oct 11	9.2	–	–	–	–
"	37	"	"	–	–	–	–
Tributary 20	38	Oct 9	10.1	0.66	–	–	–
"	39	"	"	–	–	–	–
Tributary 22	40	Oct 9	8.8	–	–	–	–

Table 8. Summary of fish densities (*fish / m* ^{2}) in *usable habitat* at electrofishing sites in the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996.

Stream and Type of Site	Site No.	Hydraulic Suitability RB Fry	Hydraulic Suitability RB Parr	Rainbow Trout / m ^{2} in Usable Habitat Age 0+	Age 1+	Age 2+	Age 3+
Upper Bridge River							
mainstem – representative	1	0.644	0.371	–	0.30	–	–
mainstem braid – representative	2	0.183	0.232	–	0.22	–	–
small side channel	3	0.965	0.150	–	–	–	–
large glacial side channel	4	0.710	0.457	–	0.15	0.09	0.09
large clear side channel	5	0.947	0.505	0.44	0.42	0.08	–
smaller clear side channel	6	0.596	0.903	0.23	0.07	–	–
smallest clear side channel	7	0.987	0.143	0.81	0.63	–	–
Tributary A	8	0.833	0.547	–	–	–	–
mainstem – representative	9	0.557	0.249	–	–	–	–
mainstem flood channel – clear	10	0.802	0.340	–	–	–	–
mainstem flood channel – clear	11	0.770	0.317	–	–	–	–
Tributary B	12	0.874	0.595	–	–	–	–
large clear side channel	13	0.998	0.476	–	–	–	–
quiet complex mainstem braid	14	0.894	0.274	–	–	–	–
McParlon Creek							
mainstem – representative	15	0.396	0.122	–	0.16	–	–
small complex mainstem braid	16	0.838	0.226	–	0.09	0.09	–
mainstem – representative	17	0.786	0.608	–	–	0.08	0.03
	Falls						
mainstem – representative	18	0.466	0.568	–	–	–	–
Tributary C	19	0.671	0.535	–	–	–	–
Other tributaries to the reservoir							
	South shore						
Tributary 2 (Gwyneth Creek)	20	1.000	0.223	0.89	0.22	0.22	–
Tributary 3 (Ault Creek)	21	0.641	0.295	–	–	–	–
Tributary 4	22	0.635	0.174	–	–	–	–
Tributary 5	23	0.233	0.167	–	–	–	–
Tributary 8	24	0.933	0.116	–	–	–	–
Tributary 9 (Jamie Creek)	25	0.561	0.296	–	–	–	–
Tributary 10	26	0.974	0.389	–	0.15	–	–
"	27	0.915	0.199	–	–	–	–
Tributary 11	28	0.997	0.338	–	–	–	–
Tributary 12	29	0.409	0.296	–	–	–	0.10
"	30	0.724	0.816	–	–	–	–
Tributary 13	31	0.034	0.074	–	–	–	–
	North shore						
Tributary 16	32	0.879	0.289	0.03 ?	0.17	0.17	–
"	33	0.570	0.437	0.07 ?	0.09	0.30	–
Tributary 17	34	0.773	0.428	–	–	–	–
Tributary 18	35	1.000	0.369	–	–	–	–
Tributary 19	36	0.720	0.140	–	–	–	–
"	37	0.510	0.073	–	–	–	–
Tributary 20	38	0.900	0.170	0.73	–	–	–
"	39	0.984	0.214	–	–	–	–
Tributary 22	40	0.715	0.141	–	–	–	–

Each value was weighted on the basis of the specific degree of usability (for depth and velocity combined) for each cell, between measurement stations, along the transect completed at the site. In the procedure, yearling and older fish were collectively addressed as *parr* (Bech *et al.*; *op. cit.*), and the fish densities in Table 8 provide the final expression of sampling results in terms of fish/m^2 of *usable habitat* only.

The next step in the modelling procedure was to generate corresponding capability estimates, employing relevant data, relating to fish size (mean weight; Table 6), total alkalinity (Appendix 4), and inert non-filterable residues (suspended solids; *ibid.*), following Ptolemy (1992). In the procedure, 2 mathematical models were employed for rainbow trout: 1) the standard model, for streams *not* subject to high glacial (and/or other) turbidity; and 2) a model specifically derived for streams that *are* subject to high turbidity (Appendix 3).

For each of the stream sampling sites found to contain fish in October 1996, the corresponding capability estimates, employing both models, are provided in Table 9. For each site and age group present at the site, separate estimates were made, employing relevant fish size data (Table 6) and water quality results (Appendix 4). Finally, in Table 10 the October 1996 standing stock estimates (Table 8) have been expressed as percentages of corresponding capability estimates (Table 9), using both models.

Ptolemy (*op. cit.*) cautions that the results employing the glacial model may be less reliable, since particularly wide variation is evidenced in the use of turbid habitats by fish. Consistent with this, the validity of results for the Downton Lake Reservoir data seems very questionable, when using this model.

Employing the glacial model, the standing stock of yearlings and Age 2+ fish captured in October 1996 theoretically exceeded corresponding capability estimates at nearly every sampling site where such fish were captured (Table 10). Even though the actual number of Age 1+ and 2+ captures was generally low (Table 5), on average they represented 198% and 355% of theoretical capabilities, respectively.

At first glance, these results may appear to be inconceivable (ie. densities exceeding 100% capability). However, small streams are often found to contain theoretically excessive (sometimes greatly) densities of rainbow parr, employing the Ptolemy (1992) methodology (eg. Griffith, 1997*a*; 1997*b*; 1997*c*). Assessment is geared to the period of low stream flows, when particular constraints may be exerted on larger fish in small streams.

As evidenced by the hydraulic suitability results in Table 8 (and as previously noted in habitat descriptions), shallow water depths greatly reduce habitat suitability for parr, at low flows (ave. 0.332, compared to 0.726 for fry; Table 8). With dwindling stream discharges and associated decline of deeper habitats, resultant densities of parr may greatly exceed theoretical capabilities, as a result of over-crowding of fish within the dwindling habitat that remains suitable for them.

Table 9. Theoretical standing stock capabilities (*fish / m²*) in *usable habitat* at electrofishing sites containing fish, in sampling of the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996 (following *Ptolemy, 1992*).

Stream and Type of Site	Site No.	Total Alkalinity (mg / L)	Inert NFR [1] (mg / L)	Rainbow Trout Capacities in Usable Habitat (fish / m^2)					
				Model for Glacial Streams			Standard Model		
				Age 0+	Age 1+	Age 2+	Age 0+	Age 1+	Age 2+
Upper Bridge River									
mainstem – representative	1	12.5	61.5	–	0.08	–	–	0.26	–
mainstem braid – representative	2	12.5	61.5	–	0.08	–	–	0.26	–
small side channel	3	16.0	16.0	–	–	–	–	–	–
large glacial side channel	4	12.5	61.5	–	0.08	0.02	–	0.26	0.07
large clear side channel	5	19.5	12.5	1.67	0.15	0.05	4.01	0.32	0.09
smaller clear side channel	6	19.5	10.0	1.77	0.16	–	4.01	0.32	–
smallest clear side channel	7	19.5	10.0	1.77	0.16	–	4.01	0.32	–
Tributary A	8	16.5	6.0	–	–	–	–	–	–
mainstem – representative	9	12.5	72.5	–	–	–	–	–	–
mainstem flood channel – clear	10	14.5	3.0	–	–	–	–	–	–
mainstem flood channel – clear	11	14.5	3.0	–	–	–	–	–	–
Tributary B	12	14.5	3.0	–	–	–	–	–	–
large clear side channel	13	25.0	12.0	–	–	–	–	–	–
quiet complex mainstem braid	14	12.5	72.5	–	–	–	–	–	–
McParlon Creek									
mainstem – representative	15	13.5	48.7	–	0.09	–	–	0.27	–
small complex mainstem braid	16	13.5	48.7	–	0.09	0.03	–	0.27	0.08
mainstem – representative	17	13.5	48.7	–	–	0.03	–	–	0.08
	Falls								
mainstem – representative	18	13.5	48.7	–	–	–	–	–	–
Tributary C	19	21.0	6.3	–	–	–	–	–	–
Other tributaries to the reservoir									
	South shore								
Tributary 2 (Gwyneth Creek)	20	39.0	10.5	1.11	0.11	0.06	2.52	0.22	0.11
Tributary 3 (Ault Creek)	21	16.5	0.7	–	–	–	–	–	–
Tributary 4	22	–	–	–	–	–	–	–	–
Tributary 5	23	18.5	0.0	–	–	–	–	–	–
Tributary 8	24	–	–	–	–	–	–	–	–
Tributary 9 (Jamie Creek)	25	58.0	31.3	–	–	–	–	–	–
Tributary 10	26	60.5	5.0	–	0.17	–	–	0.28	–
"	27	60.5	5.0	–	–	–	–	–	–
Tributary 11	28	–	–	–	–	–	–	–	–
Tributary 12	29	17.0	4.3	–	–	–	–	–	–
"	30	17.0	4.3	–	–	–	–	–	–
Tributary 13	31	–	–	–	–	–	–	–	–
	North shore								
Tributary 16	32	20.0	6.0	0.24 ?	0.10	0.05	0.71 ?	0.27	0.14
"	33	20.0	6.0	0.24 ?	0.10	0.05	0.71 ?	0.27	0.14
Tributary 17	34	38.0	11.0	–	–	–	–	–	–
Tributary 18	35	–	–	–	–	–	–	–	–
Tributary 19	36	–	–	–	–	–	–	–	–
"	37	–	–	–	–	–	–	–	–
Tributary 20	38	37.0	11.7	1.05	–	–	2.45	–	–
"	39	37.0	11.7	–	–	–	–	–	–
Tributary 22	40	52.3	10.5	–	–	–	–	–	–

1. Inert non–filterable residues (suspended solids)

Table 10. Comparison of standing stock estimates to theoretical capabilities at electrofishing sites in the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996 : employing two different capability models (Ptolemy, 1992).

Stream and Type of Site	Site No.	Total Alkalinity (mg/L)	Inert NFR [1] (mg/L)	1996 Standing Stock / Habitat Capability (%) — Model for Glacial Streams: Age 0+	Age 1+	Age 2+	Standard Model: Age 0+	Age 1+	Age 2+
Upper Bridge River									
mainstem – representative	1	12.5	61.5	–	375.0	–	–	115.4	–
mainstem braid – representative	2	12.5	61.5	–	275.0	–	–	84.6	–
small side channel	3	16.0	16.0	–	–	–	–	–	–
large glacial side channel	4	12.5	61.5	–	187.5	450.0	–	57.7	128.6
large clear side channel	5	19.5	12.5	26.3	280.0	160.0	11.0	131.3	88.9
smaller clear side channel	6	19.5	10.0	13.0	43.8	–	5.7	21.9	–
smallest clear side channel	7	19.5	10.0	45.8	393.8	–	20.2	196.9	–
Tributary A	8	16.5	6.0	–	–	–	–	–	–
mainstem – representative	9	12.5	72.5	–	–	–	–	–	–
mainstem flood channel – clear	10	14.5	3.0	–	–	–	–	–	–
mainstem flood channel – clear	11	14.5	3.0	–	–	–	–	–	–
Tributary B	12	14.5	3.0	–	–	–	–	–	–
large clear side channel	13	25.0	12.0	–	–	–	–	–	–
quiet complex mainstem braid	14	12.5	72.5	–	–	–	–	–	–
McParlon Creek									
mainstem – representative	15	13.5	48.7	–	177.8	–	–	59.3	–
small complex mainstem braid	16	13.5	48.7	–	100.0	300.0	–	33.3	112.5
mainstem – representative	17	13.5	48.7	–	–	266.7	–	–	100.0
	Falls								
mainstem – representative	18	13.5	48.7	–	–	–	–	–	–
Tributary C	19	21.0	6.3	–	–	–	–	–	–
Other tributaries to the reservoir									
	South shore								
Tributary 2 (Gwyneth Creek)	20	39.0	10.5	80.2	200.0	366.7	35.3	100.0	200.0
Tributary 3 (Ault Creek)	21	16.5	0.7	–	–	–	–	–	–
Tributary 4	22	–	–	–	–	–	–	–	–
Tributary 5	23	18.5	0.0	–	–	–	–	–	–
Tributary 8	24	–	–	–	–	–	–	–	–
Tributary 9 (Jamie Creek)	25	58.0	31.3	–	–	–	–	–	–
Tributary 10	26	60.5	5.0	–	88.2	–	–	53.6	–
"	27	60.5	5.0	–	–	–	–	–	–
Tributary 11	28	–	–	–	–	–	–	–	–
Tributary 12	29	17.0	4.3	–	–	–	–	–	–
"	30	17.0	4.3	–	–	–	–	–	–
Tributary 13	31	–	–	–	–	–	–	–	–
	North shore								
Tributary 16	32	20.0	6.0	12.5 ?	170.0	340.0	4.2 ?	63.0	121.4
"	33	20.0	6.0	29.2 ?	90.0	600.0	9.9 ?	33.3	214.3
Tributary 17	34	38.0	11.0	–	–	–	–	–	–
Tributary 18	35	–	–	–	–	–	–	–	–
Tributary 19	36	–	–	–	–	–	–	–	–
"	37	–	–	–	–	–	–	–	–
Tributary 20	38	37.0	11.7	69.5	–	–	29.8	–	–
"	39	37.0	11.7	–	–	–	–	–	–
Tributary 22	40	52.3	10.5	–	–	–	–	–	–

1. Inert non-filterable residues (suspended solids)

It should be noted that the far more conservative results employing the *standard* capability model in Table 10 still indicated theoretically excessive parr densities (Age 1+ and/or Age 2+) at most sites where such fish were encountered, within the Downton Lake Reservoir drainage in October 1996. It is most interesting that for sites associated with the Bridge River mainstem, and found to contain parr, the results for these age groups averaged 101% and 109% of theoretical capability, respectively, employing the standard model (Table 10).

The latter is interesting, but is not intended to infer a high level of accuracy or precision of the capability modelling, as applied to the Downton Lake Reservoir drainage. The Ptolemy (1992) procedure was derived from data addressing a broad variety of stream types and sizes, and is most accurate for *moderate* conditions, in all respects. Undoubtedly, the Downton Lake Reservoir system constitutes an extreme, for which the modelling exercise might be *least* accurate.

Accordingly, there is particular uncertainty in all of the modelling results presented here. However, those employing the standard model do appear to be more plausible than those of the glacial version (Table 10). While there is no hard and fast criterion separating the applicability of these models (Ptolemy, 1992), it is felt to be long-term occurrences of suspended solids concentrations in the order of 40 mg/L, or more (R. Ptolemy[12], *pers. comm.*).

On the basis of the October 1996 water analyses (Table 10), only the upper Bridge River mainstem and McParlon Creek could be placed in this category, with any confidence. Jamie Creek might also meet the criterion (*ibid.*), but this stream was not found to contain fish in 1996 (Table 9).

In view of this, and the extreme results when the glacial model was employed for both the Bridge River mainstem and McParlon Creek, use of the standard model (Table 10) may be most appropriate for the Downton Lake Reservoir drainage, as a whole.

Employing either model, the results were perhaps most surprising for fry. As observed in October 1996, the abundance and/or quality of spawning habitat in streams tributary to Downton Lake Reservoir seemed greatly limited, above the full pool level. Consequently, in streams (or stream sections) offering superior spawning potential, one might expect extensive (if not exhaustive) exploitation of such habitat by fry, in particular.

However, while numbers of fry *were* superior in such habitats (ie. sites 5-7, site 20, site 28; Table 5), the standing stock was well *below* theoretical capability, in every case (Table 10). But once again, it must be emphasized that this and *all* other results of the modelling exercise are surrounded by particular uncertainty, in the case of the Downton Lake Reservoir system.

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12. Senior Rivers Biologist, Stock Management Unit, B.C. Fisheries Branch, Victoria.

Futhermore, the results for fry may have been eceptionally distorted. In the Ptolemy (1992) methodology, theoretical habitat capabilities are directly proportional to fish size, especially in applications of the standard model (Appendix 3). The very small size of fry in the Downton Lake Reservoir drainage in October 1996 (Table 6) may have resulted in excessive capability estimates, at most sites (Table 9).

As it stands, it can only be ephasized that fry were found in very few streams (or stream sections) tributary to Downton Lake Reservoir, above the full pool level, in October 1996. While numbers/densities of fry *were* higher in streams (or stream sections) offering superior spawning opportunity, even here the standing stock of these fish *may* have been low, compared to corresponding habitat capability, as assessed in October 1996.

4.7 Hydraulic Suitability *vs.* Cover Availability at Electrofishing Sites in Streams

All adjustments of sampled fish densities (and subsequent comparisons to theoretical capabilities) were based directly on the mean weighted suitability of hydraulic conditions, at each site, for each size/age group of fish (Bech *et al.*, 1994). However, the capability estimates derived from the Ptolemy (1992) methodology specifically relate to *fully suitable* habitat, including the availability of adequate cover.

In order for the estimates based on hydraulic conditions to be valid (theoretically, at least), the type and abundance of cover must be equally suitable to the hydraulics, or capability estimates may be excessive. Particularly where the overall validity of the modelling results are suspect, as in the case of Downton Lake Reservoir, it is advisable to evaluate potential distortion(s) possibly related to cover.

In Table 11, the total availability of all cover for fish, at each electrofishing site, is compared to the corresponding hydraulic suitabilities. Separate cover estimates for fry and parr were based on the abundance (area) of suitably-sized bed materials for each, plus all other cover elements present (woody debris, cutbanks/roots, overhanging vegetation, etc.: Appendix 6). For ease of comparison, the hydraulic suitability estimates in Table 11 were expressed as percentages of total site area, consistent with those of cover.

Again, the objective of Table 11 is to evaluate the theoretical legitimacy of the comparisons in Table 10, based solely on hydraulic suitability, and the possibility that inadequacies of cover may have contributed to the rather strange results. The underlying rationale is that a given standing stock estimate (Table 9) is only valid if the hydraulic suitability value used to make this estimate was matched by at least equal availability of suitable cover.

In Table 11, all cases have been boxed where this did *not* apply. To allow for inaccuracies or lack of precision in either estimate (or both), a 10% margin of error has been allowed in all comparisons. Of the total 80 comparisons, cover availability was adequate in the great majority of cases (77.5%).

Table 11. Comparison of hydraulic suitability *vs.* total cover availability at electrofishing sites in the upper Bridge River and other tributaries to Downton Lake Reservoir; October 1996.

Stream and Type of Site	Site No.	Hydraulic Suitability		Total Cover	
		RB Fry	RB Parr	RB Fry	RB Parr
Upper Bridge River					
mainstem – representative	1	64.4	37.1	92	42 *
mainstem braid – representative	2	18.3	23.2	43	18 *
small side channel	3	96.5	15.0	17 [1]	17
large glacial side channel	4	71.0	45.7	33	23 *
large clear side channel	5	94.7	50.5	91 *	51 *
smaller clear side channel	6	59.6	90.3	78 *	33 *
smallest clear side channel	7	98.7	14.3	94 *	19 *
Tributary A	8	83.3	54.7	71	46
mainstem – representative	9	55.7	24.9	70 ?	50 ?
mainstem flood channel – clear	10	80.2	34.0	75	50
mainstem flood channel – clear	11	77.0	31.7	67	42
Tributary B	12	87.4	59.5	82	57
large clear side channel	13	99.8	47.6	35	25
quiet complex mainstem braid	14	89.4	27.4	92	82
	Mean	**76.9**	**39.7**	**67.1**	**39.6**
McParlon Creek					
mainstem – representative	15	39.6	12.2	65	45 *
small complex mainstem braid	16	83.8	22.6	59	44 *
mainstem – representative	17	78.6	60.8	60	50 *
	Falls				
mainstem – representative	18	46.6	56.8	50	50
Tributary C	19	67.1	53.5	75	55
	Mean	**63.1**	**41.2**	**61.8**	**48.8**
Other tributaries to the reservoir					
	South shore				
Tributary 2 (Gwyneth Creek)	20	100.0	22.3	95 *	75 *
Tributary 3 (Ault Creek)	21	64.1	29.5	70	40
Tributary 4	22	63.5	17.4	75	40
Tributary 5	23	23.3	16.7	70	50
Tributary 8	24	93.3	11.6	58	53
Tributary 9 (Jamie Creek)	25	56.1	29.6	82	66
Tributary 10	26	97.4	38.9	35	25 *
"	27	91.5	19.9	60	40
Tributary 11	28	99.7	33.8	100	100
Tributary 12	29	40.9	29.6	100	85 *
"	30	72.4	81.6	75	65
Tributary 13	31	3.4	7.4	51	41
	Mean	**67.1**	**28.2**	**72.6**	**56.7**
	North shore				
Tributary 16	32	87.9	28.9	88 *	63 *
"	33	57.0	43.7	100 *	85 *
Tributary 17	34	77.3	42.8	65	55
Tributary 18	35	100.0	36.9	100	100
Tributary 19	36	72.0	14.0	85	45
"	37	51.0	7.3	90	40
Tributary 20	38	90.0	17.0	73 *	43
"	39	98.4	21.4	80	55
Tributary 22	40	71.5	14.1	75	55
	Mean	**78.3**	**25.1**	**84.0**	**60.1**

1. Boxes indicate cases where cover is inferior to hydraulic suitability

* Fish of this category present at the site

Most of the exceptions applied to fry, for which cover availability was inferior to hydraulic suitability at 12 (30%) of the 40 different electrofishing sites. However, as shown in Table 11, rainbow fry were only present at 1 of these 12 sites (site 38, in Tributary 20).

Although the availability of cover for fry was actually good at this site (73% of total area), hydraulic conditions were even better (90%); and generally speaking, both hydraulic conditions and cover were well suited to fry, throughout the stream habitats tributary to Downton Lake Reservoir, at low flows, in October 1996 (Table 11).

The same did not apply to parr; both cover availability and hydraulic conditions were routinely less suitable for these fish, compared to fry (*ibid.*). However, the greatest constraint appears to have been hydraulic suitability (notably depth), as suggested earlier.

For parr, cover availability was inferior to hydraulic suitability at only 6 (15%) of the total 40 sites sampled. However, 4 of these sites *did* contain parr (Table 11), and the associated standing stock (Table 8) may have been under-estimated, in these instances. But needless to say, this would only serve to accentuate the extreme results for parr, when standing stock estimates are compared to theoretical habitat capability (ie. frequent super-saturation; Table 10).

In the final analysis, the issue of cover availability *vs.* hydraulic suitability had no real bearing on the capability modelling results, either for fry or for parr. The most useful value of Table 11 is simply to indicate the widespread superiority of stream habitat for fry (compared to parr), in terms of both hydraulic conditions and cover, at low flows.

4.8 Fish Captures in the Reservoir

The locations of the 3 sites where gill nets were installed in Downton Lake Reservoir during October 23-26, 1996 are shown in Figure 40 (sites X, Y and Z). As noted earlier, these are the same locations used for similar sampling of the reservoir by B.C. Hydro in October 1994 and August 1995 (B.C. Hydro, 1994*a*; 1995*b*).

As outlined in the presentation of methods, 2 gill nets (one floating; one sinking) were installed at each of these sites in the October 1996 sampling. The same also applies to the 2 previous sampling occasions, with one exception. In October 1994, there was no floating net at site Y (B.C. Hydro, *op. cit.*).

4.8.1 Species and numbers of fish captured in the reservoir

Full data for all fish captured during the October 1996 gill netting of Downton Lake Reservoir are provided in Appendix 7. A summary of sampling details and catch results is provided in Table 12.

Table 12. Summary of sampling details and catch rates of rainbow trout in gill netting of Downton Lake Reservoir; October 23 – 26, 1996.

Net	Water Depth (m)		Sampling Period		Sampling Duration (hours)	Total Capture of Fish	Catch Rate (fish / net hour)
	Shallow End	Deep End	Net Set	Net Retrieved			
Site X							
Floating	15.5	25.5	17:00 hrs Oct 23	10:30 hrs Oct 24	17.5	57	3.26
Sinking	1.6	15.5	16:30 hrs Oct 23	10:45 hrs Oct 24	18.25	10	0.55
Overall					35.75	67	1.87
Site Y							
Floating	9.9	15.2	14:45 hrs Oct 24	10:00 hrs Oct 25	19.25	23	1.19
Sinking	1.2	9.9	14:30 hrs Oct 24	10:15 hrs Oct 25	19.75	14	0.71
Overall					39.0	37	0.95
Site Z							
Floating	11.3	12.1	16:15 hrs Oct 25	09:30 hrs Oct 26	17.25	37	2.14
Sinking	1.4	11.3	16:00 hrs Oct 25	09:15 hrs Oct 26	17.25	8	0.46
Overall					34.5	45	0.95
Total							
Floating	–	–	–	–	54.0	117	2.17
Sinking	–	–	–	–	55.25	32	0.58
Overall					109.25	**149**	**1.36**

Since a major objective of the 1996 gill netting was to repeat the earlier sampling, catch results from 1994, 1995 and 1996 are compared in Table 13. However, in viewing any comparison of gill netting results, Hamley (1975) cautions that such sampling is subject to a variety of biases, and resultant data may not be reliable for assessing total population size and/or composition.

On the other hand, in evaluating gill net sampling for B.C. lakes specifically, Neuman (1992) suggests that with application of standard nets and methods, comparison of repeat captures from a given lake may at least enable tentative identification of major trends and/or dynamics. In view of this, the following assessment is presented for Downton Lake Reservoir, although reservations about the comparability of the data must be fully acknowledged.

Rainbow trout was the only fish species captured in Downton Lake Reservoir in the October 1996 sampling. This is consistent with the October 1994 results (Table 13). Readers are reminded that fish initially identified as kokanee salmon in both the 1994 and 1995 catches were later confirmed to have been rainbow trout.

For obvious reasons, there are only limited comparisons that can be made between the May 1996 gill net catch in the residual reservoir body at extreme drawdown, and the catches on all other occasions, with the reservoir at or near full pool (in August or October: Fig. 4). Nonetheless, it is worth noting that rainbow trout was the only species captured in the May 1996 sampling (Griffith, 1996*b*), consistent with the October results.

As noted earlier, Downton Lake Reservoir was drawn down to an abnormally low level in 1996, in order to enable inspection of dam control facilities. This raised particular concerns with respect to potential losses of fish, through entrainment and/or stranding within the drained reservoir bottom (*ibid.*).

In this regard, the comparison of catches in October 1994 and October 1996 is most interesting. Excluding results for the floating net at site Y in October 1996 (consistent with its absence in the October 1994 sampling), the total catch on this occasion (126 fish) exceeded that in 1994 (70 fish; Table 13) by 80%. The difference is elevated to 87% when results are compared on the basis of the catch rate, in *fish per net hour* (1.40 fish in 1996 *vs.* 0.75 fish in 1994; *ibid.*). This compensates for differences in the absolute duration of netting on the two occasions.

As shown in Table 13, the largest catch of fish overall was in the August 1995 sampling (180 fish; 1.58 fish/net hour), which included a floating net at site Y. Based on all six nets, the catch rate in October 1996 (1.36 fish/net hour; *ibid.*) was lower than that for the August 1995 sampling, but only by 14%.

Notwithstanding the generic constraints to gill netting data (noted above), logical evaluation of the three years of gill netting results for Downton Lake Reservoir do not indicate any extraordinary loss of fish to the extreme drawdown of the reservoir in May 1996. It might

Table 13. Comparison of October 1996 gill netting catch results for Downton Lake Reservoir to previous sampling by B.C. Hydro in October 1994 and August 1995.

Net	October 11–14, 1994			August 25–28, 1995			October 23–26, 1996		
	Duration (hours)	Total Capture of Fish	Ctach Rate (fish / net hour)	Duration (hours)	Total Capture of Fish	Ctach Rate (fish / net hour)	Duration (hours)	Total Capture of Fish	Ctach Rate (fish / net hour)
Site X									
Floating	16.8	13 RB	0.77	17.75	8 RB	0.45	17.5	57 RB	3.26
Sinking	20	18 RB	0.90	18	22 RB	1.22	18.25	10 RB	0.55
Site Y									
Floating	–	–	–	20.5	5 RB	0.24	19.25	23 RB	1.19
Sinking	17	12 RB	0.71	19.5	25 RB	1.28	19.75	14 RB	0.71
Site Z									
Floating	19	16 RB	0.84	18.5	55 RB, 2 BT	3.08	17.25	37 RB	2.14
Sinking	21	11 RB	0.52	19.5	57 RB, 6 BT	3.23	17.25	8 RB	0.46
Total Captures (including floating net at Site Y)									
Floating	–	–	–	56.75	70	1.23	54	117	2.17
Sinking	–	–	–	57	110	1.93	55.25	32	0.58
Overall	–	–	–	113.75	**180**	**1.58**	109.25	**149**	**1.36**
Total Captures (excluding floating net at Site Y)									
Floating	35.8	29	0.81	36.25	65	1.79	34.75	94	2.17
Sinking	58	41	0.71	57	110	1.93	55.25	32	0.58
Overall	93.8	**70**	**0.75**	93.25	**175**	**1.88**	90	**126**	**1.40**

RB = Rainbow Trout BT = Bull Trout

be argued that the 14% reduction in catch between August 1995 and October 1996 *could* reflect some such impact. On the other hand, comparison of the October catches for 1994 and 1996 suggest much greater differences in results, on the basis of background variability in fish numbers and/or sampling efficiency.

However, another aspect of the results may be of greater concern. The August 1995 catch included 8 bull trout (Table 13). No fish of this species were captured in May 1996 (*at* drawdown) or October 1996 (*following* drawdown). At the same time, no bull trout were captured in October 1994, either (Table 13).

Given the absence of bull trout in all sampling except that in August 1995, the capture of this species on the latter occasion could be attributable to seasonal influences on the distribution of the species, and its presence and/or distribution in the reservoir. The bull trout captured in August 1995 were all obtained at a single location, site Z, at the western end of the reservoir, near the inflow of the Bridge River (Fig. 40).

On this occasion, site Z also produced by far the greatest catch of fish overall (120 of the total 180 captured; Table 13). In addition, the 2 nets at this site produced very similar results, with the slightly larger catch occurring in the sinking net (55 rainbow and 2 bull trout in the floating net; 57 rainbow and 6 bull trout in the sinking net).

In October sampling of both 1994 and 1996, catches were more uniform between all three sites, X-Z (Table 13), and on both ocassions, nets at site Z produced only moderate captures of fish. Furthermore, the lowest capture was obtained with the sinking net at this location, in both October catches (11 fish and 8 fish, respectively; Tables 12 and 13).

Despite substantial disparity in the total number of fish captured, other consistencies between the two October catches seemed to support a seasonal influence in the more pronounced differences in results for the August 1995 sampling; possibly including the presence (or not) of bull trout. This and related issues are addressed further, later in this document.

With respect to the absolute size of fish populations in Downton Lake Reservoir, a further limitation of sampling by gill net is that it does not allow for any such estimation. Even if the catch data were unbiased and fully reliable, there is no area component to enable extrapolation of total population size.

On the other hand, with standardized sampling methodologies, catches in different lakes should *theoretically* allow for comparison of population densities, on a relative basis (*eg.* Krebs, 1972; Zar, 1974). Consistent with this, attempts were initially made to compare gill net sampling results for Downton Lake Reservoir to other lakes in British Columbia (Griffith, 1998).

Based on gill netting catch rates (fish/net hour), results for all sampling in Downton Lake Reservoir seemed to indicate surprisingly high densities of fish for a large cold glacially influenced hydroelectric reservoir.

Once again, however, the questionable reliability of gill netting data may compromise the absolute validity of the above comparisons. Furthermore, sampling methodologies were *not* entirely the same for all lakes compared; and in some cases, certain procedures were quite different (duration of netting; number of nets; time of year; etc.).

Recent consultations with authorities [13.] on the topic of gill netting in British Columbia lakes and reservoirs have not revealed any accepted standards by which population sizes in such water bodies can *confidently* be evaluated, on the basis of gill netting catch rates. Nor do there appear to be any data that are truly comparable to those for Downton Lake Reservoir, specifically (ie. same methods, similar timing, similar lake/reservoir size, similar turbidity, etc.).

Gill net catch data are available for Williston Lake Reservoir (B. Blackman [13.], *pers. comm.*) and the Kinbasket Reservoir (D. Sebastian [13.], *pers. comm.*), two other large hydroelectric reservoirs in British Columbia. In both cases, typical catch rates for rainbow trout are said to be considerably lower than those for Downton Lake Reservoir. However, both of the other reservoirs are vastly larger than Downton Lake Reservoir, and contain a variety of fish species.

While it has been shown that gill netting catch rates *can* be indicative of fish population densities in lakes (E. Parkinson [13.], *pers. comm.*), there are many influences that might effect these rates. Turbidity is one. In turbid water, high catch rates may result from the greater obscurity of the net, and possibly greater activity (and movement) of fish, in search of food (*ibid.*). Certainly, this factor could apply to the catch success in Downton Lake Reservoir.

4.8.2 Size and condition of fish captured in the reservoir

A summary of fish size and condition statistics for the October 1996 gill net capture from Downton Lake reservoir is provided in Table 14. The maximum length of fish (all rainbow trout) was 346 mm, and the average was 265 mm. This is highly consistent with the results of earlier sampling of this reservoir: ave. 262.1 mm in October 1994, and 268.9 mm in August 1995 (B.C. Hydro, 1994*a*; 1995*b*).

An interesting comparison of these results is to those of 6 small natural lakes within the Kwoiek Creek drainage, another glacially influenced system, 100 km southeast of Downton Lake Reservoir. These lakes were also sampled by gill netting in the month of October (Griffith, 1997*c*).

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13. Discussions were held with the following authorities in the B.C. Ministry of Environment, Lands and Parks: B. Blackman, Williston Fisheries Biologist, Prince George; B. Chan, Senior Fisheries Biologist, Kamloops; R. Lindsay, Fisheries Biologist, Nelson; E. Parkinson, Head, Biodiversity Unit, Fisheries Research Section, Vancouver; D. Sebastian, Large Lakes Biologist, Stock Management Unit, Victoria; and K. Tsumura, Biologist, Fish Culture Unit, Fisheries Research, Vancouver.

Table 14. Summary of size statistics for rainbow trout captured by gill netting in Downton Lake Reservoir; October 23–26, 1996.

Net	Number Captured	Fork Length (mm)			Weight (g)			Condition Factor[1] ($\times 10^{-5}$)		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Site X										
Floating	57	119	345	260.7	18.4	406	226.5	0.93	1.35	1.14
Sinking	10	217	334	289.1	114.3	412	284.1	1.03	1.24	1.11
Site Y										
Floating	23	166	328	259.8	51.9	368	214.0	0.99	1.38	1.16
Sinking	14	107	346	271.6	13.5	420	258.6	0.91	1.19	1.07
Site Z										
Floating	37	101	340	288.5	13.5	434	286.6	0.99	1.31	1.12
Sinking	8	110	282	160.6	14.2	268	78.7	0.94	1.32	1.11
Total	149	101	346	265.0	13.5	434	238.4	0.91	1.38	1.13

1. k, in the equation $Weight_g = k\,(Fork\ Length_{mm}{}^3)$

Nearly all of these lakes (5) produced substantially higher gill net capture rates for rainbow trout (2.15 to 6.14 fish/net hour; *ibid.*), compared to Downton Lake Reservoir (0.75 to 1.88 fish/net hour; Table 13). However, the mean length of fish in these 5 lakes was consistently shorter (145.5 to 198.7 mm) than for Downton Lake Reservoir.

The average condition factor (defined in Table 14) for the October 1996 capture of rainbow trout from Downton Lake Reservoir was 1.13 x 10^{-5} (Table 14). In the captures from October 1994 and August 1995 the averages were 1.16 x 10^{-5} and 1.17 x 10^{-5}, respectively (B. C. Hydro, *op. cit.*).

In comparison, the averages for the 5 lakes in the Kwoiek Creek drainage, referred to above, ranged from 1.03 x 10^{-5} to 1.14 x 10^{-5}, with an overall mean of 1.08 x 10^{-5} (Griffith, *op. cit.*). The best conditioned fish in the Kwoiek Creek drainage (ave. 1.18 x 10^{-5}) were those obtained from the sixth and coldest lake. This lake also produced the lowest gill net capture rate (0.92 fish/net hour; *ibid.*), which was also comparable to those of Downton Lake Reservoir (Table 13).

In Carpenter Lake reservoir, the mean length of rainbow trout from gill netting in October 1993 was 334.7 mm (B.C. Hydro, 1994*b*), considerably larger than for any sample from Downton Lake Reservoir. However, the mean condition factor of the Carpenter Lake Reservoir fish was just 0.89 x 10^{-5}, on this occasion (*ibid.*).

In September 1995 sampling of Carpenter Lake Reservoir (Griffith, 1996*a*), both the mean length (ave. 230.9 mm) and the condition of rainbow trout (ave. 1.12 x 10^{-5}) were far more similar to the results for Downton Lake Reservoir, especially those of October 1996 (Table 14). However, the catch rate in Carpenter Lake Reservoir was particularly poor in the September 1995 sampling (0.59 fish/net hour for trout and char combined; 0.20 fish/net hour for rainbow trout alone; *ibid.*).

Certainly, the average size of rainbow trout in Downton Lake Reservoir does not appear to be overly large. However, as the above comparisons illustrate, the populations in this reservoir appear to exhibit an excellent compromise between numbers, size, and condition, particularly given the harsh environmental conditions, natural and otherwise. In addition to comparisons presented here, this speculation is also supported (generally) by a variety of data from other lakes within the region, and in other parts of British Columbia (Griffith, 1994).

4.8.4 Age, growth and life history characteristics of fish captured in the reservoir

As noted in the presentation of methods, scale samples were obtained from all fish captured by gill netting in Downton Lake Reservoir in October 1996. Field level examinations of reproductive organs and gut contents were also completed (Appendix 7).

A breakdown of the total capture, by age group, is provided in Table 15. Once again, it is important to note that there was some doubt with respect to the age assigned to any given specimen, depending on whether the first year's growth could be accurately identified, or not.

Consistent with scales from juvenile fish captured in streams (previously discussed), some lake captures exhibited distorted and/or particularly small foci, complexed (variably) with a very limited number of circuli. Where this occurred, it was assumed to reflect the first year's growth, in a stream environment. Occasionally, another small tight annulus was present, and was interpreted as a second year of stream growth.

For other specimens, foci were more clear, and were followed by regular circuli, forming a distinct annulus. In such cases, this was accepted as the first annulus. Normally, this pattern also exhibited wider spacing of the initial circuli, and it was assumed to indicate reservoir entry at young Age 0+ (ie. shortly after emergence).

As was also experienced with scales from juveniles, there was a high incidence of regeneration, particularly affecting foci. As a result, indications were frequently inconsistent, even amongst scales from a single specimen. In addition, annuli formed within the reservoir were sometimes indistinct, and variably apparent on different scales within a given sample.

In some cases, interpretation was *aided* by patterns of regeneration (typically coinciding with the first and/or second annulus), as well as the status of reproductive development. Nonetheless, readers are cautioned that a variety of subjective evaluations were involved in the age interpretations provided in Appendix 7, and summarized in Table 15.

Notwithstanding the above, the reservoir capture in October 1996 appears to have consisted of Age 1+ to Age 5+ fish (Table 15). Due to the selective nature of gill netting, it is very doubtful that the relative catches of different age groups were accurately indicative of overall population sizes within the reservoir (Hamley, 1975).

This is particulary true for fish < 200 mm, which are likely to be captured by only 40% of the multi-mesh experimental nets employed for such sampling (Anon., 1995). For the catch from Downton Lake Reservoir, this may explain the relatively low numbers of Age 1+ and 2+ fish in the sample (Table 15).

In terms of older fish, it is interesting that Age 4+ was the maximum determined in the October 1994 sampling by B.C. Hydro; however, age was not determined for some of the largest fish on this occasion (B.C. Hydro, 1994*a*). For the August 1995 sample, numerous rainbow were identified as Age 6+ or 7+ (B.C. Hydro, 1995*b*).

The latter is interesting, and reassuring. Generally, it was felt that the criteria established for aging the October 1996 captures might have erred towards an additional year. On the other hand, there remains the possibility that the first year's growth may not have been identifiable (and accounted for), in any given case.

Table 15. Summary of size, condition, and life history results for rainbow trout captured by gill netting in Downton Lake Reservoir; October 23–26, 1996.

Age Group	Number Captured	Fork Length (mm)			Condition Factor[1] ($\times 10^{-5}$)			Age at Entry to the Reservoir		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean	Age 0+	Age 1+	Age 2+
Age 1+	7	101	132	114.4	1.00	1.31	1.11	7 (100 %)	–	–
Age 2+	28	121	287	193.6	0.91	1.32	1.14	16 (57 %)	9 (32 %)	3 (11 %)
Age 3+	58	209	338	265.7	0.99	1.38	1.17	24 (41 %)	26 (45 %)	8 (14 %)
Age 4+	39	267	346	317.1	0.93	1.29	1.09	22 (56 %)	12 (31 %)	5 (13 %)
Age 5+	17	310	340	323.0	0.95	1.13	1.06	5 (29 %)	8 (47 %)	4 (24 %)

1. *k*, in the equation $Weight_g = k\,(Fork\ Length_{mm}{}^3)$

Despite all of the above indications, the pattern of mean fork lengths by age group (Fig. 42) supported the overall aging of fish for the October 1996 sample. Aside from the lack of representation of Age 0+ (and perhaps Age 6+ and 7+), this pattern constitutes a typical growth slope for fish (Poole, 1974).

Assuming that this infers reasonable accuracy (overall) in the interpretation of ages for the October 1996 captures, the same should also apply to the corresponding interpretations of age at entry to the reservoir. Although this varied for different age group samples, it appeared that very close to half (49.7%) of the total capture had entered the reservoir as fry, perhaps shortly after emergence (Table 15).

Another 37% appear to have entered at Age 1+, and the remainder (13%) at Age 2+. The low proportion of Age 2+ recruits was not surprising, given the apparent constraints to parr habitat observed in streams, above full pool, throughout the Downton Lake Reservoir drainage, in October 1996 (Table 11).

However, given the greater suitability of habitat for fry (*ibid.*), the low proportion of Age 1+ recruits *did* seem somewhat surprising. On the other hand, it was consistent with the low numbers and very limited distribution of fry within stream habitats, as evidenced by the October 1996 sampling (eg. Table 10).

Again, the results here may indicate that an emigration of fry (to the reservoir) had occurred prior to the sampling of streams, and/or some major source of fry recruitment was not identified, during the 1996 investigations.

4.8.5 Condition and reproductive development of fish captured in the reservoir

Figure 42 also illustrates the mean age-specific condition factors for the October 1996 capture of fish from Downton Lake Reservoir. A progressive improvement in condition was suggested (on average) for Ages 1+ to 3+. A similar pattern also applied to most fish captured in streams (Table 6).

Again, this is a common phenomenon for fish, and likely reflects increasing efficiency at exploiting available resources, with increasing age and size (Lackey and Nielsen, 1980). However, the same did not hold for Age 4+ and 5+ individuals in the capture. These fish actually exhibited a progressive decline in mean condition (Table 15; Fig. 44).

Accepting the condition factor as an index of well-being for fish (King, 1995), this would seem to indicate some constraint (or stress) specific to the older age groups in Downton Lake Reservoir. Reproductive development and spawning may have been a major factor in this regard.

As outlined in Table 16, and documented in Figure 43, a large number of fish (62 in total) in the October 1996 capture were very close to mature, were fully mature, or were recently

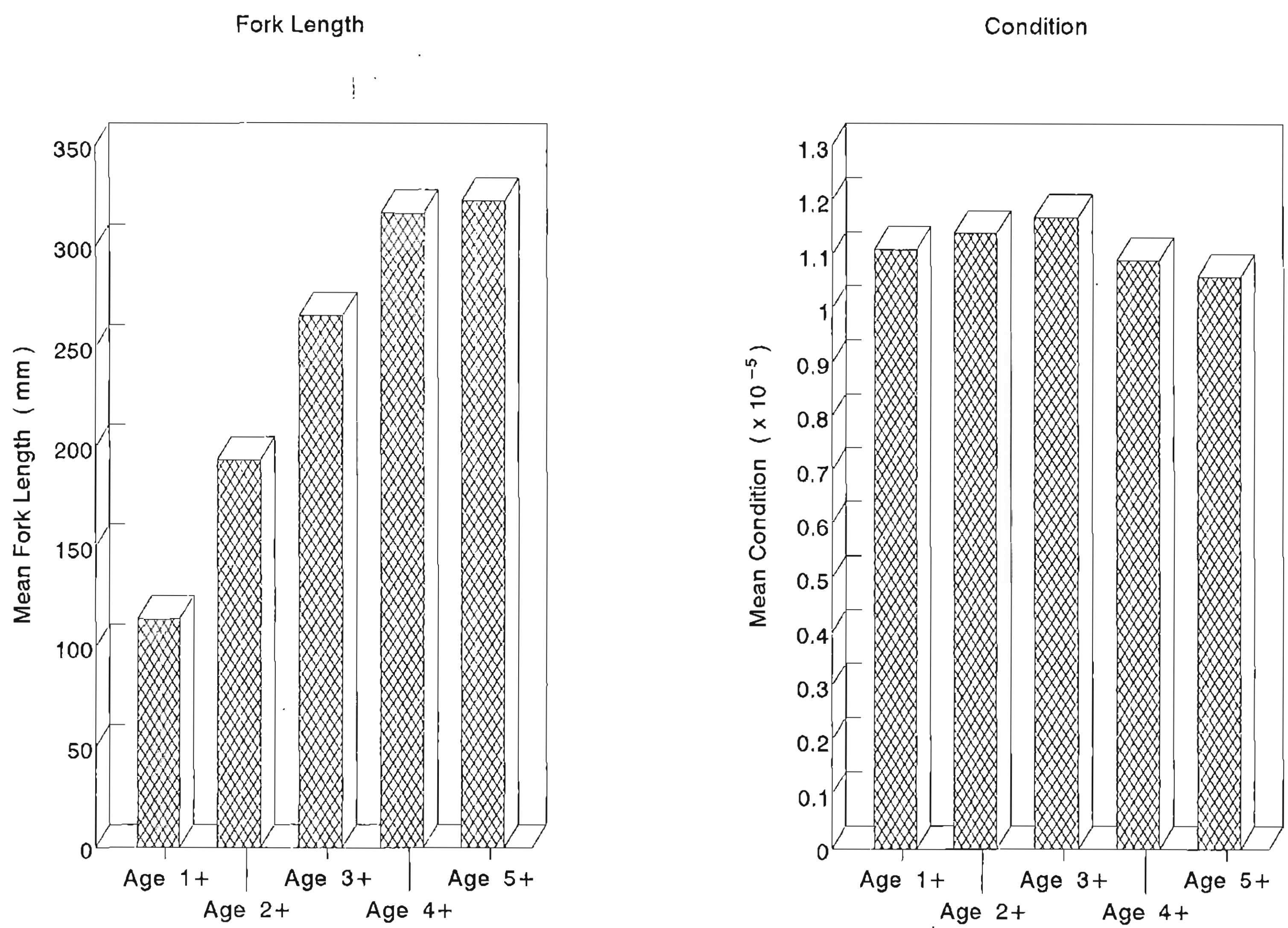

Figure 42. Mean fork length and condition, by age group, for rainbow trout captured by gill net in Downton Lake Reservoir; October 23–26, 1996.

Table 16. Numbers and condition of near mature and fully mature fish and kelts, by age group, in the capture of rainbow trout from Downton Lake reservoir; October 23–26, 1996.

Age Group	Total Number Captured	Near Mature, Mature, or Kelts	Condition Factor [1] (x 10 $^{-5}$)		
			Minimum	Maximum	Mean
Age 1+	Total capture	7	1.00	1.31	1.11
	Near mature / mature / kelts	0	–	–	–
Age 2+	Total capture	28	0.91	1.32	1.14
	Near mature / mature / kelts	3	1.23	1.32	1.27
Age 3+	Total capture	58	0.99	1.38	1.17
	Near mature / mature / kelts	29	1.09	1.38	1.20
Age 4+	Total capture	39	0.93	1.29	1.09
	Near mature / mature / kelts	20	0.93	1.21	1.05
Age 5+	Total capture	17	0.95	1.13	1.06
	Near mature / mature / kelts	10	0.95	1.10	1.04

1. *k*, in the equation $Weight_g = k\ (Fork\ Length_{mm}{}^3)$

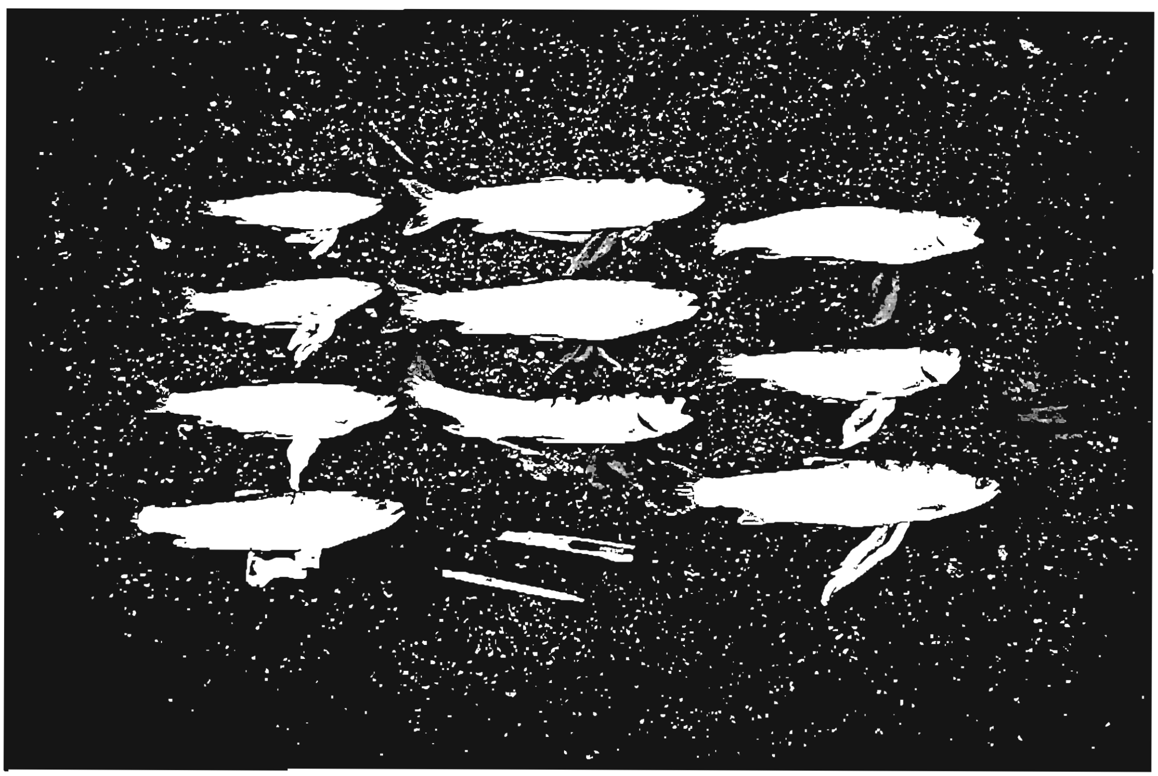

Figure 43. Selection of mature and near mature rainbow trout captured in Downton Lake reservoir; October 23–26, 1996 (note female with atrophying eggs, bottom centre).

spawned. Loose and atrophying eggs were found in the body cavities of 5 females. Two males were fully mature (releasing milt with handling), and many others (31) were close to it.

In fish of both sexes, the production of gametes always results in some depletion of body reserves and constituents (Love, 1970). Principal depletion is of lipids, but for salmonids in particular, depletion of protein (and even ash) may also be substantial, as the gametes develop, and spawning is carried out (*ibid.*). Futhermore, as evidenced by the gut contents (or lack of them) for many fish in the October 1996 sample from Downton Lake Reservoir (Appendix 7), feeding may be reduced in mature fish and/or kelts (Love, *op. cit.*).

As shown in Table 16, just over half (53.6%) of all Age 4+ and 5+ fish captured in Downton Lake Reservoir in October 1996 were nearly mature, fully mature, or recently spawned. In view of this, some decline in condition, relative to other age groups, might be expected. However, precisely half of the total capture of all Age 3+ fish also exhibited such development (Table 15), and yet this age group had the highest mean condition factor of the entire capture.

As noted above, the superior condition of this age group, relative to younger fish, was likely attributable to increasing efficiency of feeding with size. With respect to older fish (Ages 4+ and 5+), the superior condition of Age 3+ may have been due to the effects of repeat spawning (and associated depletion) in the older age groups.

Unfortunately, consistent with all that has been said thusfar about the difficulty in interpreting scales from Downton Lake Reservoir fish, there were added difficulties in attempts to identify spawning checks in the 1996 samples; and the doubtful results did nothing to illuminate considerations here.

Furthermore, the relationship between physical condition and state of reproductive development appeared to be complexed by various anomalies. For example, in the October 1996 catch of fish from Downton Lake Reservoir, the mean condition factor specific to Age 3+ fish showing advanced reproductive development was actually higher than that for the age group as a whole (1.20×10^{-5} *vs.* 1.17×10^{-5}; Table 15).

Similar anomalies were also observed in the capture of rainbow trout from Downton Lake Reservoir at drawdown, in May 1996, when many fish were also mature or near mature (Griffith, 1996*b*). However, the overall condition of the entire capture was suppressed at this time, presumably attributable to the immediately preceding winter and associated seasonal depletion (Love, 1970; Brett, 1979; Jobling, 1994).

Consequently, there was no clear explanation of the results in Figure 42 on the basis of reproductive development, although some major influence does seem logical. At the same time, it may also be possible that other factors serve (additionally, or independently) to progressively limit the growth and condition of older/larger fish in Downton Lake Reservoir.

Needless to say, there are multitudes of specific inter-relationships between environmental influences and biological responses, in the wild. Due to the extreme complexities of these inter-relationships, it may be impossible to accurately identify or evaluate any of them, individually (Love, 1970).

4.9 Limnological Monitoring

For the purposes of discussions here, the following is a summary of results for the limnological monitoring of the Downton Lake Reservoir system conducted by *Limnotek Research and Development Inc.* during 1996-97. For any and all specifics regarding the monitoring program, including detailed results, reviewers are again referred to the separate document addressing these studies, specifically (Kiffney and Perrin, 1998).

As an overview, findings to date suggest that the Downton Lake Reservoir drainage is a very harsh environment, with primary and secondary production apparently limited by low annual temperature, high turbidity, and low water detention times (C. Perrin[14.], *pers. comm.*). During 1996-97, the reservoir was a highly dynamic ecosystem exhibiting both riverine and lacustrine characteristics.

The following outline and consideration of the limnology of Downton Lake reservoir is based on monitoring over the 11 month period from November 1996 to September 1997 (Kiffney and Perrin, *op. cit.*). However, it should be noted that sampling was limited to just 4 occasions within this period (one per limnological season). In addition, the single year's monitoring program obviously did not (and could not) address annual variation of natural and/or operational factors affecting the reservoir's limnology in different years.

Once again, resultant indications (discussed here) should be viewed with corresponding reservations. The following is simply a summary of findings and indications, as they appeared to apply in 1996-97.

During the monitoring program, water chemistry of the reservoir was strongly influenced by discharge and temperatures of the upper Bridge River, and by hydroelectric operations (ie. changing water level/volume of the reservoir itself). During lower flows, and the drawdown phase (Figs. 3 and 4), the reservoir acted as a sink for dissolved materials (*ibid.*).

At higher flows, when storage was being built up, the reservoir then acted as a sink for particulate matter. A major source of such matter, at this time, was the drawdown zone of the reservoir basin itself. This was also an important source of particulate phosphorus for the reservoir in spring and early summer (*ibid.*).

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14. Senior Systems Ecologist, Limnotek Rsearch and Development Inc., Vancouver, B.C.

Water temperatures played a significant role in nutrient inputs and retention, within the reservoir. During periods of thermal stratification, most nutrients entering with the cold inflows of the upper Bridge River were carried along the bottom of the reservoir, and were then flushed through the low level outlets of LaJoie Dam. Accordingly, these inputs were not available to support biological productivity within the reservoir (Kiffney and Perrin, *op. cit.*).

In addition, there was a net loss of nutrients from the reservoir from fall to spring, when outflows through LaJoie Dam exceeded inflows from tributaries (ie. period of drawdown). In April 1997, most of the incoming nutrients were exported from the reservoir, due to the particularly short hydraulic residence time during peak power generation (*ibid.*).

During the period of re-filling, when inflows to the reservoir greatly exceeded outflows, most nutrient inputs were retained (*ibid.*). Presumably, this persisted until the development of thermal stratification, which then resulted in the entrainment (and loss) of nutrients, along the reservoir bottom, as outlined above.

Again, based on the 1996-97 monitoring program, nutrient flux within the Downton Lake Reservoir system appears to be highly dynamic. Data suggest that biological productivity in the upper Bridge River went from nitrogen-limitation in the fall, to phosphorus-limitation in the early summer. With respect to the reservoir itself, the pattern was from phosphorus-limitation upstream, to nitrogen-limitation downstream (*ibid.*).

In general, however, results suggest that Downton Lake Reservoir was principally nitrogen-limited during the 1996-97 monitoring program. An interesting phenomenon to support this conclusion was the presence of the blue-green alga *Microcystis sp.*. This species is common to eutrophic lakes, but has not been found in other B.C. reservoirs. It provides evidence that the biological productivity of Downton Lake Reservoir was primarily limited by nitrogen, during spring and summer (*ibid.*).

However, phytoplankton concentrations were low in 1996-97, consistent with those of other oligotrophic coastal lakes. The zooplankton community was dominated by cladocerans (especially *Daphnia pulex*) and copepods, but densities were at the *low end* of the range for *nutrient-deficient* lakes (*ibid.*).

Kiffney and Perrin (*op. cit.*) suggest 3 possible mechanisms that might explain the particularly low zooplankton densities: 1) high predation by fish; 2) physical factors within the reservoir itself; and 3) underestimation of zooplankton, due to limited sampling. The final hypothesis was that physical factors were the most likely cause, including displacement and entrainment of zooplankton in the bulk water moving through the reservoir (*ibid.*).

Ultimately, however, plankton densities may not be very important with respect to fish production in Downton Lake Reservoir (C. Perrin, *pers. comm.*). Based on investigations of other oligotrophic reservoirs, it is more likely that rainbow trout in Downton Lake Reservoir feed primarily on benthos and terrestrial insects (*ibid.*).

Unfortunately, the majority of stomach contents examined in association with the 1996 gill netting of the reservoir could only be described as *gray mush*, at the field level. However, in support of the above hypothesis, most items that *could* be identified were consistent with feeding on benthos (including stones and bits of wood), or insects (Appendix 7).

5.0 DISCUSSION

5.1 Methods Used and Reliability of Results

Fisheries investigations in the wild may be compared to the assembly of puzzles where only a limited number of pieces are available at any given time. Furthermore, due to the great host of biotic and abiotic variables that are involved (seasonally and otherwise), the few pieces that are available may also be expected to change configuration, at any given time.

Even for the most fundamental data, natural variation is generally substantial, and the fit is very rarely precise. Accordingly, even with very intensive collection of factual data, attempts to interpret associated dynamics *must* rely on *hypothesis*, to a large extent.

Obviously, there are particular limitations to any single point-in-time investigations. In the October 1996 study of the Downton Lake Reservoir drainage, the scope and depth of data collection were substantial. However, many estimates had to be made, and even though the data are numerous and diverse, they are no more than a collection of samples and observations from a broad continuum of time and conditions.

In addition, all methods of data collection and analysis are subject to their own constraints. None are perfect, or totally accurate. Furthermore, no matter how extensive the data base, there is always the risk that various considerations may be overlooked, under-estimated, or misinterpreted during either the collection or analysis of the data themselves.

However, the reality of resource management is that information is rarely (if ever) complete. Despite inevitable limitations, the investigator's responsibility is to provide the best possible interpretation and understanding of key issues and dynamics, in order to enable the most appropriate management decisions, based on what is known.

In terms of the information itself, the ideal is a balanced compromise between detail (full information on each issue) and scope (attention to as many attendant issues, as possible). By virtue of necessity, one is usually at the expense of the other. The objective is to establish the optimum balance between the two.

A standard component of the October 1996 Downton Lake Reservoir study was the application of a standing stock capability model for fish in stream habitats (Ptolemy, 1992). This model is based on thousands of data sets specific to B.C. streams. For rainbow trout, the only species captured in the Downton Lake Reservoir drainage in 1996, the same applies to the probability-of-use data used in association with the model (Bech *et al.*, 1994).

Both are based upon (and address) a wide range of stream sizes, and relate to habitat usability (as opposed to preferences) under an even greater range of conditions. They are based on actual fish densities sampled over this broad range, and thus provide the most useful measure of habitat capability, across a broad spectrum of streams, specific to British Columbia. At the same time, however, the fit of the model is best for streams closer to *average*, in all respects. For systems subject to extreme conditions, like the Downton Lake Reservoir drainage, the modelling process may be less accurate.

With respect to the field data, the degree to which they accurately reflect the true conditions and dynamics of a given system is largely reliant on the manner in which they are collected. In highly intensive investigations of salmonids and their habitat, the desire for results of maximum possible resolution may necessitate exhaustive and detailed sampling procedures, at any given site (eg. Bovee, 1994).

From a program perspective, such intensity directly limits the number of sites that may be addressed within the resources (time, budget) available for any given investigation. The trade-off between sampling intensity and *scope* (noted above) is particulary critical in the assessment of large drainages, such as that conducted for Downton Lake Reservoir in 1996.

The first objective must be a strategic inventory to identify as many of the important fish populations and habitat resources within the system, as possible. Hence, the scope of the investigation is of key importance. With the possible exception of one stream (Tributary 15; Fig. 40), all tributaries to Downton Lake Reservoir that were flowing with water in October 1996 were investigated at that time.

Although the investigations of the upper Bridge River system were limited to the lowermost 8 km (±), the results suggested little fish production in areas further upstream. On the other hand, not *all* tributary streams and side channels within the lowermost 8 km of the upper Bridge River system were investigated in 1996.

In terms of intensity (ie. in any given locale), a second trade-off must be made between diversification and replication of sampling. Given the limited distribution and abundance of fish in streams tributary to Downton Lake Reservoir in 1996, an emphasis was placed on superior habitats, to best establish presence *vs.* absence, as the first priority. Where fish were encountered, additional sampling was conducted, as warranted, to further delineate distribution, or more accurately quantify fish numbers.

A very critical issue in the collection of field data, particulary by electrofishing, is the care with which the sampling is actually conducted. For any site where reliable population estimates are to be derived, the most important factor is the efficient and *unobtrusive* installation of stopnets. This involves careful selection of the site to be sampled, ensuring the ability to successfully install and maintain net enclosures, throughout the sampling procedures. In all cases, electrofishing sites were selected with extreme care, to best reconcile all logistical constraints with investigative objectives. The only mishap was the loss of the downstream net, prior to its final inspection for fish, at one site in McParlon Creek.

Where sampling was limited to only part of the full wetted width, stopnets were always fed out from the downstream end of sites; were quietly extended from the shore, and then upstream; were sealed across the top end; and were pinned closely to the stream bottom with rocks, in addition to lead lines.

To favour speed and efficiency in this process (as well as capture efficiency), site areas were kept relatively small (mostly $< 100\ m^2$), as long as all requisite habitat features were adequately represented. This approach does not only ensure utmost confidence in the capture results at all sites, it also enables the greatest number of sites, and utmost confidence in the results overall.

In the Bridge River mainstem and McParlon Creek, the efficiency of electrofishing was hampered by high turbidity, accompanied by swift and turbulent flows at some locations. Furthermore, water temperatures were below the general criterion for efficient electrofishing (5 °C) at numerous sites in the upper Bridge River system, as well as some of the smaller tributaries to Downton Lake.

For cold systems, like the Downton Lake Reservoir drainage, it is unfortunate that the standard assessment of stream production (at low flows, and the end of the growing season) may coincide with the onset of water temperatures too cold for confidence in electrofishing results (ie. $< 5\,°C$). However, in the October 1996 investigations, this only applied to 11 of the total 40 electrofishing sites that were completed, in all (Table 5).

With respect to sampling in the reservoir itself, the October 1996 gill netting in Downton Lake was implemented as a repetition of earlier sampling completed by B.C. Hydro, in October 1994 and August 1995. However, there are a variety of limitations to the reliability of gill netting data in assessing fish populations (Hamley, 1975).

Accordingly, there is corresponding doubt in comparisons drawn between different sets of gill netting results. However, application of standard nets and methods (for all captures) may at least allow identification of major trends and/or dynamics (Neuman, 1992). Although there were various doubts and incongruities between all gill netting data sets for Downton Lake Reservoir, certain trends were also apparent.

For the fish themselves, various interpretations were based on age and life history characteristics, as indicated by scale samples. Due to the cold environment, and late emergence of at least *some* fry (based on October 1996 sampling), scales from any given specimen may not exhibit a distinct first annulus. This results in extra subjectivity (and potential error) in interpreting such scales.

For the October 1996 captures from the reservoir, samples from stream-caught juvenile fish were available for cross-reference, greatly aiding the interpretive process. Internal examinations with respect to the status of reproductive development were also employed. However, consistent with all of the foregoing, readers are again cautioned that all aspects and interpretations of the gill netting data are subject to particular uncertainty.

5.2 Fish Populations Within the Drainage

Based on all recorded data, rainbow trout is clearly the most abundant and most widely distributed fish species within the Downton Lake Reservoir drainage. As supported by re-examination of data from 1994 and 1995 gill net captures by B.C. Hydro (1994*a*; 1995*b*), previous reference to kokanee salmon (eg. Acres, 1990) was undoubtedly attributable to the extreme silvering of some rainbow trout in Downton Lake Reservoir (eg. Fig. 45). It may also have been influenced by the known stocking (and ongoing presence) of this species in Carpenter Lake Reservoir, immediately downstream (Griffith, 1996*a*).

It is *conceivable* that colloquial misidentification of highly silver rainbow trout may also account for anecdotal references to mountain whitefish in Downton Lake Reservoir (Triton, 1992). Once again, this species *is* present (and abundant) in Carpenter Lake Reservoir, and its presence in Downton Lake Reservoir may also have been assumed, on the same basis. If it was present historically, it should also be present now. Whitefish are known for their particular adaptability to hydroelectric reservoirs specifically (Nelson, 1965). As a highly relevant case in point, this is evidenced by Carpenter Lake Reservoir, the operation of which is highly similar to (and continuous with) that of Downton Lake Reservoir.

In terms of both geography and topography, the upper Bridge River system seems most comparable to the Hurley River drainage, located to the immediate south of Downton Lake Reservoir (Griffith, 1997*a*). Both rivers are cold glacial headwaters of the Bridge River system (Fig. 1). With notable exceptions in each case, tributaries are either cold and glacial themselves, or are otherwise limited in terms of fish production potential (eg. barriers and/or excessive stream gradients).

Similar to findings in the Downton Lake Reservoir drainage in October 1996, rainbow trout were the only fish captured in a comparable investigation of the Hurley River system in 1995[15.] (Griffith, *op. cit.*). Earlier captures of bull trout are also reported for the Hurley River drainage (Triton, 1992), but this species was not captured at any location during the 1995 investigations.

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15. The only exception to this was the lowermost 1.2 km of the Hurley River, below the first canyon, where other species of fish (associated with Carpenter Lake Reservoir) were also encountered.

5.3 Stream Production of Fish Within the Drainage

Based on the October 1996 fish and fish habitat investigations and the 1996-97 limnological monitoring program, environmental conditions within the Downton Lake Reservoir drainage appear to be very cold and harsh. Consistent with this, stream-dwelling fish are small, for age, especially in the upper Bridge River system (Table 6).

Harsh environmental conditions (notably temperature) undoubtedly explain the extremely small size of rainbow fry (for the month of October) in the upper Bridge River system, in particular. In addition to an extended period of incubation, this may be attributable to protracted spawning of the species, due to the cold thermal regime.

The usual spawning temperature for rainbow trout is between 10 °C and 15.5 °C (Scott and Crossman, 1973). During the limnological monitoring of the upper Bridge River from November 1996 to September 1997, water temperatures remained below 10 °C throughout the entire period (Kiffney and Perrin, 1998).

At the time of the October 1996 fish sampling, a concentration of rainbow fry was found within a network of clear-flowing side channels, to the south of the mainstem, 850 m upstream of McParlon Creek. In addition to relatively clear waters, these side channels appeared to offer some thermal advantage as well (Table 1).

They also offered a relative abundance of superior gravel substrates, and associated spawning potential (*ibid.*). All of these factors likely explain why these channels were the only habitat in which fry were captured within the portion of the upper Bridge River system that was sampled in October 1996 (Table 5).

Notwithstanding the possibility of fry emigrations from other habitats prior to the October 1996 sampling, it may be that spawning and recruitment in the upper Bridge River system is restricted to discrete areas offering superior conditions, like the above side channels. Such areas may not be greatly abundant within the system.

In the October 1996 investigations, sampling of other side channels adjacent to the Bridge River did not result in fish captures, despite warmer temperatures, and suitable habitat for fry (at least). In these and other cases, the lack of viable spawning habitat appeared to be the principal and most universal constraint (Table 1).

The same also applies to the majority of other tributaries to Downton Lake Reservoir, which flow down the north and south valley walls, along its length (Table 2). For most of these, spawning potential appears to be greatly limited, due to a lack (often absence) of suitable substrates, the presence of barriers, and/or excessive stream gradients, above the full pool level (Tables 3 and 4). This is most prevalent in the tributaries along the southern side of the reservoir (Table 3).

Along the north side, some tributaries offer superior spawning potential; however, as observed near full pool in October 1996, this was variably limited by the extent of accessible/usable streamlength (Table 4). In one case (Tributary 19), access appeared to be prohibited by a substantial debris accumulation, at the full pool level (Fig. 32).

In a neighbouring stream (Tributary 20), where debris did not preclude passage, there was 65 m of accessible/usable streamlength, which included viable spawning substrates (Table 4). In addition to the network of side channels adjacent to the Bridge River discussed above, this section of Tributary 20 was found to contain the only other concentration of fry, attributable to the spawning of reservoir fish (Table 5).

In another neighbouring tributary (Tributary 22), which offered 40 m of accessible streamlength, spawning potential was limited by the abundance of fines, and by high compaction (Table 4). No fish were captured in this stream (Table 5).

Other than differences in accessibility and/or the quality of spawning substrates, Tributaries 19, 20 and 22 were quite similar, as observed in October 1996 (Table 2). Collectively, they again illustrated the variety of limitations to spawning potential, within the various streams, at or close to full pool.

Unfortunately, efforts to evaluate the October 1996 standing stock of fish in streams, relative to theoretical habitat capability, were inconclusive. Due to extreme environmental conditions within the Downton Lake Reservoir drainage, it is felt that the modelling (Ptolemy, 1992) results may be unreliable here, despite adjustments for glacial influences (Table 10).

However, if the modelling exercise is accurate to *any* degree, it may indicate possibly widespread limitation in the availablity of stream habitat for parr, specifically, under low flow conditions at least (*ibid.*). Accordingly, streams tributary to Downton Lake Reservoir may offer only limited rearing potential for fish, beyond the fry stage.

On the other hand, stream habitat conditions (including cover) were consistently superior for fry, in most streams and stream sections sampled (Table 11); and again, if the habitat capability modelling is *at all* accurate, fry habitat may not have been fully exploited even where these fish were found to be most highly concentrated (Table 10)[16].

But the modelling results for fry are particularly questionable for Downton Lake Reservoir. Final capability estimates, expressed in numbers of fish, are inversely proportional to the mean weight of the age group in question (Appendix 3). Given the very small size of fry encountered in the October 1996 sampling of the drainage (ave. 0.4 g to 0.9 g; Table 6), the capability estimates may have been grossly inflated.

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16. Excluding Gwyneth Creek, where fish populations are not related to the spawning of reservoir fish.

Whether the modelling attempts are meaningful or not, all stream sampling results suggested a particularly narrow *distribution* of fry within stream habitats above full pool, at the time of inspection in October 1996.

5.4 Recruitment of Fish to the Reservoir

Acknowledging the questionable reliability of gill netting data for Downton Lake Reservoir (including the possible effect of turbidity on catch success), the impressive numbers of fish caught on all sampling occasions to date certainly do *not* seem to suggest low levels of recruitment. This seems to be at odds with indications of the October 1996 investigations, that juvenile fish (and fry, in particular) were narrowly distributed in streams tributary to the reservoir, and were low in number overall.

The gill net captures do not seem to suggest a lack of recruitment, although spawning habitat did seem to be limited, above the full pool level. A further anomaly was that one tributary which offered both superior accessible length and spawning opportunity (Tributary 16; Table 4), was found to contain very few fry, if any[17.] (Table 5).

In addition, there would seem to be doubt in the chances (or rates) of survival for the very small fry that were captured by electrofishing in October 1996 (Fig. 41); especially in view of the harsh environmental conditions of the Downton Lake Reservoir drainage. Nonetheless, scale analyses suggest that half of all fish captured by gill netting in October 1996 had entered the reservoir as fry (Table 15).

Collectively, all of the above would seem to suggest that the October 1996 investigations of stream habitats did not fully account for all sources (and/or levels) of recruitment to the reservoir. Firstly, there may well be other sites of concentrated fry production in the upper Bridge River system, that were not addressed in the 1996 undertakings (eg. other side channels and/or tributary streams).

In the case of Tributary 19, it is possible (if not likely) that changes in the debris accumulation near the full pool level might allow spawning/recruitment in this stream, in some years, at least. However, the 50 m of streamlength with spawning potential that would become available (Appendix 5) would hardly seem a major factor in overall recruitment to the reservoir.

As noted earlier, perhaps the best reconciliation of all of these anomalies is that for any and/or all streams offering viable and accessible spawning habitat, a substantial emigration of fry may have occurred prior to the October 1996 investigations. Certainly, this seems to be the most

17. Depending on the validity of scale analyses indicating Age 0+; the size of the fish was more consistent with Age 1+.

logical explanation for the near absence (or total absence) of fry in Tributary 16. In Tributary 20, the presence of a few larger fry (up to 56 mm) may also indicate an earlier emigration of such fish from the smaller tributaries to the reservoir, if not from the upper Bridge River system.

However, there is also the possibility that recruitment may occur within historic sections of tributaries inundated at full pool, but exposed at various stages of drawdown (Tables 3 and 4). During the May 1996 investigations of Downton Lake Reservoir at extreme drawdown, several tributaries along the southern shore of the reservoir were opportunistically inspected (Griffith, 1996*b*). Loose gravel substrates were frequently present within channel sections of these streams, exposed at the time.

In most cases, the ascent of fish would have been prevented by inadequate flows and complications due to alluvial deposits below the full pool level. However, some possibility of both ascent and spawning appeared to exist in the exposed section of Jamie Creek, at least. At the time, the chances of successful recruitment from such spawning (should it occur) were judged to be slim, due to the likelihood of re-inundation of the site (refilling of the reservoir) prior to the completion of egg incubation and fry emergence (*ibid.*).

However, monitoring of water chemistry within the reservoir during 1996-97 revealed that the water column was fully saturated with dissolved oxygen on all sampling dates (C. Perrin, *pers. comm.*). Accepting the possibility of intervening factors (eg. excessive pressure with depth; sedimentation with inundation), such conditions might be adequate for the incubation and hatching of fish eggs, subsequent to inundation (*ibid.*).

If this *is* the case, a substantial amount of spawning/recruitment potential may exist within the reservoir basin, at various levels of drawdown. A level in the order of 725 m (elev.) would seem to be an approximate norm for the traditional period of rainbow spawning, in mid to late June (Fig. 4). On this basis, the tributaries along the north and south sides of the reservoir would provide a total of very close to 3 km of additional streamlength, below the full pool level (Tables 3 and 4). While flows might be inadequate in many of these streams earlier in the spring (as observed in May 1996), higher discharges would be expected towards the end June (Table 3), so that possibilities of ascent by fish may be superior, at that time.

Tributaries towards the western end of the reservoir might offer the greatest potential. Firstly, they would be the last ones inundated. Based on large-scale bathymetric mapping, they also tend to offer the greatest length of additional channel and the most moderate gradients between 725 m (elev.) and the full pool level (Tables 3 and 4).

As a final note, the historic channel of the Bridge River flowing along the reservoir bottom also contains gravel substrates that could conceivably support spawning at drawdown, similar to that hypothesized for the smaller tributaries, above. However, based on limited investigations in May 1996, fine materials appear to be particularly abundant within this channel, and compaction tends to be very high. It seems doubtful that spawning potential would be any superior here, compared to sections of the river above full pool.

5.5 Spawning of Rainbow Trout Within the Drainage

Clearly, the condition of numerous fish captured in the May 1996 sampling of Downton Lake Reservoir indicated reproductive stress at extreme drawdown (Griffith, 1996*a*). Several females were found to be over-ripe, with atrophying eggs. While this was understandable for individuals stranded in pools (sampling coincident with maximum drawdown), the same also applied to some females within the residual reservoir body, continuous with the inflowing Bridge River.

In total, 13 (27%) of the 48 fish captured in isolated pools within the reservoir were near mature, fully mature, or spent (kelts), during the May 1996 sampling. For the catch from the residual reservoir body, the corresponding ratio was 21 (35%) of a 60 fish subsample.

It is mystifying that near mature or mature fish (including fully ripe and over-ripe individuals) would be present in the residual reservoir body, at the eastern extremity of the reservoir, where spawning opportunities seem least likely. If nothing else, the exposed section of Jamie Creek was available for spawning, as noted above. There were no apparent barriers in the historic channel of the Bridge River along the reservoir bottom, so that fish should have been able to ascend both Jamie Creek and the upper Bridge River system, itself.

However, temperature may have been a key factor in the May 1996 findings. Both in the isolated ponds, and the residual reservoir body, water temperatures ranged between 8.0°C and 9.5°C (Griffith, *op. cit.*), obviously sufficient to trigger reproductive development and spawning behaviour. Based on monitoring during May 1997, temperatures of the influent Bridge River flows likely ranged between 2 °C and 6 °C, at this time (C. Perrin, *pers. comm.*).

Such temperatures might dissuade any spawning-related migrations up the Bridge River channel within the reservoir basin. It may not be until the latter part of May, or early June that maximum daily temperatures reach 8°C, in the waters of the Bridge River (*ibid.*). Interestingly enough, this is coincident (approximately) with the commencement of reservoir refilling, and associated possibilities with respect to spawning in exposed sections of tributaries, within the reservoir basin.

If the spawning population of rainbow trout in Downton Lake Reservoir all reached maturity in early May, this could be disasterous to recruitment, and perpetuation of the stock. However, indications of protracted spawning of these fish was first evidenced in the October 1994 and August 1995 gill netting captures by B.C. Hydro (1994*a*; 1995*b*). On both occasions, catches included many mature rainbow trout, some of which were gravid (*ibid.*).

The latter findings were supported by the October 1996 gill netting results, in which 42% of the total capture (62 out of the 149 fish) were nearly mature, fully mature (some ripe), or recently spent (Table 16). It is very interesting that the corresponding proportion was 35% in the catch from the residual reservoir body in May 1996, a far more traditional timing for the spawning of rainbow trout (Scott and Crossman, 1973).

A possible explanation of this would be that some proportion of the spawning population had in fact migrated to spawning habitat in streams, by that time. Other than a general evaluation of streams, and the opportunistic inspection of some tributaries on the south side of the reservoir (noted above), an assessment of spawning was not part of the May 1996 investigations.

However, in streams that *were* inspected (including Jamie Creek), there was no evidence of spawning fish. On the other hand, the upper Bridge River was not investigated at this time, and would seem to have been the most likely destination of migrations, under the observed conditions.

Notwithstanding the above possibilities, it seems clearly evident that the maturation and spawning of rainbow trout is protracted within this system. Evidence includes the very small size of fry captured in October 1996 (Fig. 41), The same was evidenced in the 1995 investigations of Carpenter Lake Reservoir, downstream (Griffith, 1996*a*).

Such plasticity undoubtedly benefits the maintenance of stocks in reservoirs such as these, where drawdown coincides with the traditional spring spawning period for rainbow trout, and spawning opportunity may largely rely on the subsequent period of refilling. Obviously, both the rate and extent of this may vary from year to year (Fig. 4). In some years, full pool may not be achieved until the fall, if ever (*ibid.*).

To some extent, the protracted spawning evident for Downton Lake Reservoir and Carpenter Lake Reservoir may reflect specific adaptation to the reservoir environment. However, similar development and behaviour of rainbow trout has also been observed in totally natural systems within the region. In both the Nahatlatch River drainage and the neighbouring Kwoiek Creek drainage full maturity and imminence of spawning were also observed for raibow trout in mid to late October (Griffith, 1995*b*; 1997*c*).

This was particularly evident for rainbow populations in lakes associated with the Kwoiek Creek system; and in this case, substantial numbers of newly emerged fry (ie. 30 to 40 mm) were again encountered in electrofishing captures.

It is most interesting that atrophy of eggs was also observed in some rainbow trout within this system, during October investigations. This occurred under totally natural conditions, and with the *immediate* availability of excellent spawning habitat (*ibid.*).

Like the Bridge River system, both the Nahatlatch River and Kwoiek Creek drainages originate within the Coast Mountains to the west of the Fraser River, and are subject to similarly harsh (cold) seasonal conditions (*ibid.*). Presumably, the protracted spawning period of rainbow trout in this region is a natural adaptation to cold water temperatures, in particular. It would also appear to be fortuitous for the maintenance of trout production in a reservoir environment, specifically.

5.6 Implications Specific to Bull Trout

Although bull trout are a dominant species in Carpenter Lake Reservoir (Griffith, 1996*a*), this clearly does not apply to either the Hurley River or Downton Lake Reservoir drainages. In these systems, it is suspected that populations (if they still exist) are small, and are likely isolated, as is common for this species (Rieman and McIntyre, 1993).

As noted earlier, such populations may be particularly sensitive to habitat perturbations. Widespread declines in bull trout stocks, throughout its range, have been attributed to a variety of habitat disturbances (McPhail and Baxter, 1992; Rieman and McIntyre, *op. cit.*).

Prior to the development of all dams on the Bridge River (Fig. 1), it is possible that bull trout in this drainage were associated with those in the Fraser River, linked by extensive migrations of fish, within and between these systems (*ibid.*). Depending on the nature and size of the natural falls that preceded LaJoie Dam, the construction of this dam may have terminated previous migrations to what is now the Downton Lake drainage. Unfortunately, however, there are no historic records to assess this issue.

In any event, the capture of bull trout in the Downton Lake Reservoir drainage in 1995 certainly documents survival of populations for nearly 50 years, following the construction of LaJoie Dam, and operation of the reservoir. However, presuming a particular sensitivity of these populations, their absence in sampling following the extreme drawdown in 1996 has raised concerns about specific impacts of this event, on this species (Griffith, 1996*b*).

Not to belittle this possibility in any way, it would be premature to draw any such conclusion on the strength of findings to date. Once again, the absence of bull trout in the October 1996 gill netting was consistent with the results in October 1994 (Table 13).

The *only* capture of bull trout in Downton Lake Reservoir was at a single site, on a single occasion (site Z, in August 1995; Table 13). In addition to the 8 bull trout, the capture at this site also produced 112 of the total 172 rainbow trout that were captured in the reservoir, on that occasion (*ibid.*). Consistent with the absence of bull trout, there was no evident concentration of rainbow at site Z in the October results of either 1994 or 1996 (*ibid.*).

Based on monitoring of the upper Bridge River during 1996-97, a concentration of fish at site Z in August seems best explained by feeding advantages at the western end of the reservoir (Fig. 40), at that time of year (C. Perrin, *pers. comm.*). It is most probable that production of fish food organisms in the upper Bridge River system (and resultant organic drift to the reservoir) reaches a maximum during the month of August (*ibid.*).

It is also interesting to note that August is the month when Downton Lake Reservoir generally reaches full pool, following the commencement of the filling process in May or June (Fig. 4). It is conceivable that some factor in the re-inundation of the exposed reservoir bottom may also provide some sort of feeding advantage in the advancing reservoir interface.

This could be related to the reactivation of invertebrate species sustained in a resting stage, during the period of exposure (*ibid.*). It might also be due to the release of concentrated invertebrate production (including *Gammarus*) in isolated pools within the drained reservoir bottom (Griffith, 1996*b*).

It is possible that spawning or pre-spawning migrations or congregations might also explain, or contribute to, a concentration of fish at the western end of the reservoir in August. However, for rainbow trout the percentage of mature or nearly mature fish in the August 1995 catch (35%; B.C. Hydro, 1995*b*) was certainly *no higher* than those for the October catches in either 1994 (51%; B.C. Hydro, 1994*a*) or 1996 (42%; Table 16). With respect to bull trout, exactly half of the capture (4 fish) were mature, in the August 1995 catch.

With so few data for the species, it is obviously impossible to conclude whether the capture of bull trout in the reservoir on a single occasion indicates the presence of a lacustrine-adfluvial population, or not. However, the *absence* of any captures other than those at site Z in August 1995 would seem to suggest otherwise.

In lakes where bull trout are the only fish species present, they may subsist entirely on benthic invertebrates and plankton (McPhail and Baxter, 1992). However, in the presence of rainbow trout, and with an absence of forage fish species, bull trout may be restricted to cold waters, upstream of those inhabited by rainbow (Pratt, 1985). This seems more consistent with findings and non-findings for this species in Downton Lake Reservoir, to date.

It would suggest that the species may be principally fluvial-adfluvial, within the upper Bridge River system. It is characteristically tolerant of both cold temperatures and turbidity (McPhail and Baxter, *op. cit.*; Rieman and McIntyre, 1993); however, such conditions would also be expected to limit production and population size, consistent with all findings (or lack of them) thusfar.

With drawdown of the reservoir, it is possible that these fish would descend into the fluvial habitat of the historic Bridge River channel, flowing through the drained reservoir basin. The occupation of such habitat by bull trout was very evident in Carpenter Lake Reservoir, at drawdown in 1996 (Griffith, 1996*a*). Such behaviour of fish from the upper Bridge River, would be consistent with their capture *only* at the western end of the reservoir, coincident with the latter stages of refilling, in the month of August (Fig. 4).

In the absence of forage fish species, and with competition from apparently much larger numbers of rainbow trout (Table 13), a concentration of food in the vicinity of site Z, during August, might be important to bull trout within the system (thus explaining their presence and capture at this location, in the August 1995 gill netting).

Needless to say, all of this is further *hypothesis*, in the absence of more complete information. However, it is offered as what seems to be the most logical explanation of *all* sampling results to date (including *absences* in both 1994 and 1996). This includes the isolated pools within the drained reservoir bottom, that were sampled at extreme drawdown in May 1996, and were found to contain rainbow trout only (Griffith, 1996*b*). In similar investigations of Carpenter Lake Reservoir, at drawdown, bull trout were the *only* salmonids found in such pools (Griffith, 1996*c*).

Again, fluvial-adfluvial behaviour within the upper Bridge River system, and seasonal presence at the western end of the reservoir, does appear to provide the most plausible *hypothesis* for all findings to date, relating to bull trout within the Downton Lake Reservoir drainage. However, in the final analysis, the *only* thing that can be said with any confidence is that their numbers are apparently very low, based on *all* years of sampling, including 1995.

5.7 Implications of Hydroelectric Operations Relative to Fish Production

Given the substantial fluctuations in the volume of Downton Lake Reservoir, due to hydroelectric operations (Figures 5 and 6), one might anticipate equally profound effects on fish. However, accurate identification and quantification of such effects could only be achieved with specialized, diverse, and sufficiently extended (time sequence) investigations.

It must be re-emphasized that all interpretation of fish production and dynamics presented in this document is based on a limited amount of instantaneous data, and a single year of limnological monitoring, which was limited in scope. Following discussions are believed to provide most logical consideration of all data presently available for fish and fish habitat in the Downton Lake Reservoir drainage, but some level of uncertainty is duly acknowledged in all regards.

5.7.1 Impacts of hydroelectric operations on the limnology of the reservoir as related to fish production

As noted earlier, the 1996-97 limnological monitoring of the Downton Lake Reservoir system indicated that the draining and filling of the reservoir appeared to have great influence on its limnology (Kiffney and Perrin, 1998). It was also suspected that the relatively fast movement of bulk water through the reservoir may have contributed to low zooplankton densities, through displacement and entrainment (*ibid.*).

However, Perrin (*pers. comm.*) suggests that benthic production may be the most important source of aquatic food for trout in Downton Lake Reservoir. If this hypothesis is correct, it is ultimately the dynamics of (and within) benthic habitat that may be of greatest importance to fish, potentially including bull trout.

Needless to say, reservoir operations would be expected to exert major influences on benthic production, especially in areas drained and exposed during drawdown. Unfortunately, however, an investigation of benthic production was beyond the scope of the 1996-97 monitoring program.

Perrin (*ibid.*) suspects that there would be great variability in benthic production, both within different areas of the reservoir, and at different water levels. The high turbidity of water within the reservoir would directly (and variably) limit the extent of littoral habitat, especially in steeper parts of the basin.

Possibly, shallower habitats at the western end of the reservoir are of key importance. At the same time, this might also apply to fan areas (where they are present) at mouths of tributary streams throughout the length of the reservoir. The direct input of food items (organic drift) from these streams may also be important, as it is suspected to be for the upper Bridge River.

Again, it must be emphasized that none of these issues were within the scope of the 1996-97 undertakings, and accordingly, the related *hypotheses* can only be viewed as *hypotheses*. However, on the strength of the 1996-97 limnological monitoring program, it would seem that food is the most critical factor in the production of fish within Downton Lake Reservoir, from an *ecological* perspective.

If the *net* result of limnological factors associated with the operations of Downton Lake Reservoir is detrimental to fish feeding and production, this does not seem evident in the information obtained to date; except, perhaps, for the vague possibility that food may be specifically limited in some way, for older/larger fish (Fig. 42).

While acknowledging the multitude of limitations in the extent and type of information collected thusfar, nonetheless it would be hard to conclude, on the basis of findings to date, that fish production in Downton Lake Reservoir is *abnormally* constrained, in any way. In fact, the reverse seems to apply, despite the attendance of reservoir operations.

In 1996-97, limnological monitoring indicated that Downton Lake Reservoir was consistently well oxygenated to the bottom, and also served as a heat sink, with water temperatures increasing during retention (Kiffney and Perrin, 1998). As a result, the reservoir may offer superior advantage for fish survival and production, relative to associated stream habitats; notably, the upper Bridge River system.

It was earlier noted that evaluation of streams within the Downton Lake Reservoir drainage indicated generally inferior habitat conditions for parr, compared to fry (Table 11). This was offered as one explanation of an apparently high rate of reservoir recruitment at the fry stage (*ca.* 50%), evidenced on scales from reservoir fish. Again acknowledging the particular uncertainty in analyzing these scales, the relative advantages of the reservoir environment (noted above) might also explain (or contribute to) a high rate of fry recruitment, and (ostensibly) survival.

In the final analysis, and in the absence of more detailed and specific assessment, the condition and numbers (apparent) of fish in Dowton Lake Reservoir are offered as the best indicators, at present, to evaluate fish production in this reservoir, including the effects of hydroelectric operations.

Since the condition of fish captured from the reservoir has been good on all sampling occasions, including 1996 (Table 13), it would seem that food production was at least adequate for the population levels present on those occasions. Although the indications of population size from gill net catches may be inflated (notably, by potential influences of turbidity on catch), it can at least be said that sampling of Downton Lake Reservoir, at or near full pool, has consistently produced impressive numbers of well conditioned fish.

5.7.2 Impacts of hydroelectric operations on the spawning/recruitment of fish

Needless to say, creation of Downton Lake Reservoir constituted major alteration of historic habitat. Based on inspection of tributary stream sections now exposed only at drawdown, it can likely be assumed that this included losses of spawning habitat for fish. In addition, field investigations in October 1996 revealed that spawning potential was generally limited in tributaries to Downton Lake Reservoir, above the full pool level.

However, there is no evidence thusfar to suggest that present spawning habitat is *limiting to fish production*, even though it may be *limited* in terms of *absolute abundance*. Firstly, in the 1996 fish sampling in streams, fry were not always encountered where spawning habitat was more abundant and/or suitable in tributaries to the reservoir, above full pool.

Unfortunately, in the case of the Downton Lake Reservoir drainage, with its harsh environment, there is considerable uncertainty in the application of the standard habitat capability model employed for B.C. streams (Ptolemy, 1992). Furthermore, there may be particular distortion of results for fry, due to their very small size in the October 1996 sampling (Fig. 41).

Notwithstanding the latter, it *may* be significant (and should be noted here) that the modelling procedure indicated that fry densities were well below theoretical capacity, even where spawning potential seemed best, and/or where fry were most numerous in habitat above the full pool level (Table 10).

If the modelling procedure is *at all* accurate, a greater constraint to stream production of fish may be the availability of suitable habitat for parr, at low flows, as previously noted. This may result in (ie. force) substantial recruitment of fish to the reservoir, at the fry stage. As hypothesized earlier, some proportion of overall 1996 fry production may have emigrated to Downton Lake Reservoir, prior to the October sampling in 1996. For most streams within the system, such emigration would offer the benefit of warmer water temperatures, at least (Kiffney and Perrin, 1998).

Again, this is only hypothesis, and largely hinges on the indications of adult scales, about which there is *particular* uncertainty for the Downton Lake Reservoir system. However, major lakeward emigrations of rainbow trout fry are known to occur in tributaries to Loon Lake (Tautz and Land, 1976), located just 115 km east of Downton Lake Reservoir. These migrations principally occur during August and September, with fish at a length between 25 and 45 mm (*ibid.*).

As outlined earlier, it may be conceivable that some degree of spawning might occur in sections of tributaries to Downton Lake Reservoir that are inundated at or near full pool, but are exposed during drawdown. For obvious reasons, this possibility could not be addressed in the October 1996 investigations, near full pool.

It is also *possible* that low numbers of fry in 1996 may have been due, in part, to specific effects of the extreme drawdown in the spring of 1996. As noted earlier, there was certainly evidence of reproductive stress in mature and near-mature rainbow trout sampled at the height of drawdown in May 1996. It was also observed that access was precluded to many of the tributaries along the south side of the reservoir, due to insufficient stream flows, at this time. This was aggravated by the substantial alluvium in the lowermost sections of tribuaries, exposed at this level of drawdown.

However, as was also emphasized earlier, there was no apparent barrier to migrations of fish to spawning habitat in the upper Bridge River; and the proportion of mature and near-mature fish in the gill netting results may have indicated that some part of the spawning poulation of rainbow trout was already in streams, at that time. While water temperatures may have been too cold for spawning in the Bridge River itself, discrete sites within the system may have offered more acceptable conditions (eg. as evidenced by the network of side channels found to contain fry in October 1996).

Depending on various factors (eg. stream discharges, water temperatures, etc.), spawning in some of the smaller tributaries to the reservoir *may* have been more greatly affected. However, the narrow distribution of rainbow fry in these streams is not necessarily indicative of this. In most cases, parr were also absent or low in number.

Obviously, the latter may be related to the widespread constraints to stream habitat for parr, discussed earlier; and if nowhere else, the absence of fry in Tributary 16 in the October 1996 sampling did seem very strange, given the number of parr (Table 5). But once again, this may have been due to an earlier emigration of fry from this warmer stream (*ibid.*).

In the absence of specific assessment of rainbow spawning within the system, including comparisons between years, it is not possible to assess the effects of reservoir operations in 1996, or any other year. As it stands, this is just another issue left to various hypotheses, at this point in time.

5.7.3 Entrainment of fish through the dam during drawdown

At the outset of this discussion, it must be emphasized that *direct* assessment of fish losses to entrainment was *not* an objective of the 1996 investigations of Downton Lake Reservoir. To be workable and reliable, such studies constitute very specialized undertakings of their own (eg. Skarr *et al.*, 1995).

The main objective of the May 1996 investigations at extreme drawdown, was to assess the *stranding* of fish in isolated pools within the drained reservoir bottom, following the successful completion of similar activities in Carpenter Lake Reservoir, downstream (Griffith, 1996*c*). Results of the Downton Lake Reservoir investigations (including gill netting within the residual main water body) only addressed fish that *remained* within the reservoir, and were not intended to *actively* evaluate fish losses through the dam, in any way.

In the reporting for the May 1996 investigations (Griffith, 1996*b*) the results were employed to *hypothesize* about the entrainment of fish, in the absence of direct evaluation. In the October 1996 investigations, the repetition of 1994 and 1995 gill net sampling was an attempt, in part, to investigate for any *extraordinary* decline in fish numbers, following the extreme drawdown in 1996.

There is no doubt that the draining of reservoirs constitutes a very dramatic environmental change (Figs. 5 and 6). Under such circumstances, the presumption of equally dramatic impacts on attendant fish populations may be understandable. Certainly, entrainment of fish through hydroelectric facilities is known to occur, but most work to date has focused on juvenile salmon, actively downstreaming in accordance with their life history (eg. Mathur, *et al.*, 1996).

Far less is known about the extent of entrainment (ie. displacement) of fish populations that are resident within reservoirs (Skarr *et al.*, *op. cit.*). Work conducted thusfar suggests great variation in levels of vulnerability, on a species-specific basis. In a study of the Libby Reservoir from 1990 to 1994, rates of entrainment appeared to be very high for kokanee salmon. In contrast, the rates appeared to be very low ($<< 1\%$ of total) for bull trout, rainbow trout, and cutthroat trout (*ibid.*).

The particular vulnerability of kokanee to entrainment is attributable to this species' *extreme* reliance upon pelagic habitat (Skarr *et al.*, 1995). In contrast, both trout and char exhibit much greater flexibility in the types of habitat they can successfully utilize (eg. Nilsson and Northcote, 1981). As evidenced in Carpenter Lake Reservoir, this may include the fluvial habitat in reservoir basins, at drawdown (Griffith, 1996*c*).

If there was any *extraordinary* (ie. greater than usual) loss of rainbow trout from Downton Lake Reservoir in 1996, this was certainly not evidenced in the October gill netting results. In fact, higher numbers of fish were captured on this occasion, compared to sampling in the same month in 1994 (Table 13).

Furthermore, the October 1996 catch was even close to the largest catch to date, which occurred in August 1995; and the latter appears to have been influenced by a concentration of fish (presumably seasonal), not evident in the October results of either 1994 or 1996.

This is *not* meant to suggest that there were *no fish losses* to entrainment during the drawdown of Downton Lake in 1996, or *any other year*, for that matter. No doubt, some level of such losses may be expected to occur regularly, if only on the basis of chance (Skarr *et al.*, *op. cit.*). However, in the 1996 investigations of Downton Lake Reservoir, there was *no evidence* to suggest any *unusual* loss of fish to entrainment; or in fact, any loss at all.

An earlier section addressed the possibility of specific effects of the 1996 drawdown on bull trout. Again, on the strength of all available information to date, it would be premature to suggest any such effects. The suggestion hinges on the fact that no bull trout were encountered in the 1996 investigations; however, the same applied to sampling in 1994.

If the hypothesis that these fish are principally fluvial-adfluvial in the upper Bridge River is correct, as seems quite likely (Reiman and McIntyre, 1993), they may be less vulnerable to entrainment than the rainbow trout in Downton Lake Reservoir. Obviously, proximity to the dam forebay is a very key factor in the vulnerability of fish to entrainment (Skarr *et al.*, 1995).

Assuming that their behaviour is similar to that of Dolly Varden, bull trout might be disinclined to venture far into the dwindling pelagic habitat of the reservoir during drawdown, due to the concentrated numbers of rainbow trout (Nilsson and Northcote, 1981) that were evidenced by the May 1996 sampling (Griffith, 1996*b*). As observed in the Carpenter Lake Reservoir drainage (Griffith, 1996*a*), bull trout may tend to remain within the fluvial habitat along the drained reservoir bottom, thus reducing their specific vulnerability to entrainment.

Again, this does not belittle concerns about the status of this species, within the drainage. Based on all indications to date, the population is undoubtedly small, and may be particularly vulnerable to habitat disturbances, as noted earlier. But if there is a scenario which would make Downton Lake Reservoir bull trout *more* vulnerable to entrainment than rainbow, it is unknown to the author of this document; and to reiterate, there is no evidence to suggest any unusual losses of rainbow trout to entrainment in 1996.

5.7.4 Stranding of fish during drawdown

As evidenced by Figure 6, the occurrence of isolated waters was extensive within drained portions of Downton Lake Reservoir, at extreme drawdown in May 1996. This may again prompt speculation about proportionately large losses of fish to stranding, and subsequent mortality.

Certainly, the May 1996 investigation of such waters conclusively demonstrated the occurrence of such stranding, and indicated that it was widespread (Griffith, 1996*b*). In addition, there was *indirect* evidence of associated losses to predators (ie. tracks in and/or around many pools).

However, there was no *direct* evidence of fish losses in the way of dead carcasses, remains, or even observed predation. In fact, the consistent capture of fish in all pools where gill netting was employed only attested to survival of fish, on an equally widespread basis.

A number of totally dewatered depressions were observed in the drained reservoir bottom, leading to speculation that fish may have become isolated in such areas, and with further draining (seepage), succumbed to some form of mortality.

Obviously, this is possible (if not probable). But once again, no *evidence* of such losses was observed in the field. As in the case of entrainment, this issue can only be confirmed (and quantified) with specialized investigations, beyond those conducted to date.

In terms of the physiological well-being of fish in Downton Lake Reservoir under drawdown conditions in 1996, comparison to data for other lakes in British Columbia again suggests that these fish were in remarkably good condition (eg. Griffith, 1994); especially allowing for natural physiological depletion of the entire population during the preceding winter, in addition to the reproductive maturation of many individuals in the May sample (eg. Jobling, 1994).

As previously noted, there was evidence of reproductive stress in stranded fish, and mature and maturing fish captured in isolated waters constituted the most poorly conditioned component. However, even for these fish, the mean condition factor (1.01×10^{-5}) was within the range of averages for natural unregulated lakes, sampled under superior seasonal conditions (Griffith, *op. cit.*).

Based on the condition of immature fish only (ie. reducing the bias of physiological depletion specifically related to reproductive maturation), fish captured in isolated pools in May 1996 appeared to be at least as well conditioned as those in the residual reservoir body (Griffith, 1996*b*). This was likely related to lower population densities, and accordingly lower competition for space and food.

In the absence of monitoring, it cannot be said how many of the stranded fish subsequently died (or were predated upon), and how many survived until re-inundation (and release). With filling of the reservoir in progress at the time of the investigations, and temperatures remaining cool within the isolated pools (*ibid.*), the chances of ultimate survival for stranded fish appeared to be reasonable, at the time; and once again, if losses were severe, this was not evident in the October 1996 results.

With specific reference to bull trout, no fish of this species were found in any of the isolated pools sampled in May 1996. The only fish encountered were rainbow trout. However, this does not mean to say that there was *no* stranding of bull trout: this is unknown.

As noted earlier, bull trout were the *only* salmonids encountered in isolated pools inspected within the drained portion of Carpenter Lake Reservoir in 1996 (Griffith, 1996*c*). Individuals of this species *may* have been present in the many isolated waters that were *not* sampled during the May investigations of Downton Lake Reservoir. Their absence from pools that *were* sampled is simply mentioned to note that there was no evidence to indicate that stranding *was* a major issue with respect to bull trout, in the Downton Lake Reservoir system.

5.8 Mitigation and/or Enhancement Recommendations

In determining what mitigation (and/or compensation) is warranted for any type of development, it is obviously essential to know what the losses have been. As noted earlier, the creation of Downton Lake Reservoir has clearly (and greatly) modified what used to be 25 ± km of the upper Bridge River valley. If mitigation or compensation is awarded simply on the basis of such change, this must be addressed by the appropriate authorities, with the requisite expertise in this type of reconciliation.

The focus of the present document is the relationship between the hydroelectric developments and *fish production* within the drainage. In terms of historic conditions *versus* those following the development of Downton Lake Reservoir, it is *not possible* to determine what mitigation (if any) is required for fish. There are no *reliable* historic data to go by. This includes the issue of bull trout production, notwithstanding the possible concerns with respect to this particular species.

Another issue is the requirement (or not) for mitigation of present and ongoing losses to fish production, through hydroelectric operations of the reservoir (eg. entrainment and/or stranding during drawdown). As emphasized earlier, there may be a variety of *hypotheses* regarding such losses, but certainly no *quantification* of them, assuming that they do occur.

Any attempt to mitigate for *presumed* (but unquantified) losses could be *detrimental* to fish production within the system. If regular losses do occur, they may play a significant role in the maintainance of size and condition of present fish populations, which seem remarkably good for a large glacially influenced reservoir.

Any augmentation of fish numbers, to compensate for presumed losses, could result in over-population and excessive competition. The relationship between population size and fish size in reservoirs has been shown for kokanee salmon, with the conclusion that some level of entrainment may actually be beneficial to fisheries values (Skarr *et al.*, 1995).

By the same token, and for precisely the same reasons, it would be premature to recommend any *enhancement* activities for the Downton Lake Reservoir system, at the present time. Certainly, viable/accessible spawning habitat appears to be limited in abundance in stream habitats, above the full pool level. However, findings to date do *not* suggest that spawning and subsequent recruitment are limiting to *fish production* within the system.

Existing spawning habitat, above the full pool level, may be adequate even if it is limited in total abundance. Certainly, as a matter of course, it would be advisable to safeguard the habitat that currently exists in tributary streams, above full pool. This should include monitoring and removal of debris obstructions like that on Tributary 19, in October 1996 (Fig. 32).

It may be very important to monitor and maintain access to *all* spawning habitat that is currently accessible to reservoir fish. However, this does not necessarily mean that development of *additional* habitat would be beneficial. Without further assessment to determine the need, any such undertaking might represent an unnecessary expenditure of effort and funds. It could also lead to over-recruitment of the reservoir.

The same applies to consideration of any other form of enhancement, at this time. Findings to date do *not* indicate *any* enhancement needs, either general or specific. This even applies to bull trout, even though numbers of these fish may be very low within the Downton Lake Reservoir system. For any fish population, it must first be determined that enhancement measures *are* required, and *what* the appropriate measures actually are, before they can be legitimately prescribed and implemented.

It is the conclusion of both the 1996 assessment of fish and fish habitat (reported in this document) and the 1996-97 limnological monitoring program (Kiffney and Perrin, 1998) that the acquisition of further information is the most immediate and identifiable need for Downton Lake Reservoir, at the present time. This is essential, in order to identify *all* appropriate action for the future, including the possibility of future mitigation and/or enhancement initiatives.

For bull trout, the most vital requirement is to conduct focused inventories, specifically for these fish, to identify the present status, distribution, and behaviour of populations within the drainage. Beyond this (as the top priority), *any* additional expenditure of effort and funds should be directed towards further investigations of rainbow trout production within the system.

From the standpoint of fish production, the Downton Lake Reservoir drainage is a complex system, abounding with anomalies. With the information currently available, attempts to interpret both the status and dynamics of rainbow production in the drainage rely greatly on *hypothesis*, as emphasized throughout preceding discussions.

For rainbow trout, specific investigation of spawning behaviour and associated fry production would provide better evaluation of effects and influences associated with reservoir operations. It might also reveal opportunities to specifically regulate reservoir levels, in order to optimize spawning and recruitment potential. Equally, it might identify any need or desirability for spawning habitat enhancement, that may actually exist.

With respect to reservoir populations, it would be most beneficial to conduct a detailed study of benthic invertebrate production, and its role as food for fish. This should include an evaluation of drawdown effects, associated implications, and opportunities to *optimize* operations from this standpoint as well.

Needless to say, it would also be extremely beneficial to conduct monitoring programs to confirm and quantify fish losses through entrainment and stranding (including predation), during drawdown. This information would be most useful, not only for Downton Lake Reservoir, but for the sake of adding to the understanding of such impacts on resident fish populations, in general.

6.0 SUMMARY AND CONCLUSIONS

1. In 1996, undertakings were initiated to investigate fish production associated with Downton Lake Reservoir, the impacts of hydroelectric operations on fish production within the system, and related mitigation or enhancement needs and opportunities.

2. The study consisted of two components: 1) an investigation of fish and fish habitat within the drainage at low flows, and the reservoir near full pool, in October 1996; and 2) limnological monitoring of the reservoir and the upper Bridge River, from November 1996 to September 1997.

3. The main component of the October 1996 investigations was habitat evaluation and fish sampling by electrofishing in accessible parts of the upper Bridge River system, and all other streams flowing into the reservoir at the time of investigation.

4. Fish sampling by gill netting was conducted within the reservoir itself, repeating earlier sampling by B.C. Hydro, in 1994 and 1995.

5. Consistent with gill netting results in October 1994, rainbow trout were the only fish captured in the Downton Lake Reservoir drainage in October 1996.

6. Although low numbers of bull trout were caught in gill netting of the reservoir in August 1995, this species was not encountered in any of the 1996 sampling.

7. With respect to stream habitat, the abundance of accessible and/or viable spawning habitat tended to be limited, above the full pool level.

8. For many streams, this was due to excessive gradient and/or barriers to fish passage; in other cases it was simply due to lack of gravels and/or compaction with fine materials.

9. Streams entering along the south side of the reservoir appear to offer the least potential for spawning/recruitment of fish, above full pool.

10. Some streams entering along the north side of the reservoir do offer greater spawning potential, and a concentration of rainbow trout fry was found in one of these streams in October 1996 (Tributary 20).

11. Access to comparable habitat in an adjacent stream (Tributary 19) was precluded by a large debris accumulation near the full pool level.

12. In the final analysis, however, the potential of these and other streams is limited by the lack of accessible/usable streamlength (< 50m in most cases): again, due to rapidly increasing gradient and/or barriers.

13. Investigations in 1996 included the lowermost 8km of the Bridge River mainstem, and several associated side shannels and tributaries, including McParlon Creek; in most of these areas habitat assessment was complicated by high glacial turbidity, at the time of investigation; however, viable spawning habitat appeared to be generally limited, as well.

14. A notable exception was a series of clear-flowing side channels on the south side of the Bridge River mainstem, 850m upstream of McParlon Creek; these channels contained substantial amounts of viable spawning substrates, and were warmer than the cold waters of the Bridge River mainstem, at the time of investigation.

15. These channels were also found to contain concentrations of very small (ave. 36.3mm) rainbow fry; these were the only captures of fry within the portion of the upper Bridge system that was sampled in 1996.

16. No fish, of any kind, were caught at sampling locations in the upper Bridge River system upstream of the network of side channels noted above.

17. Only rainbow parr (ie. no fry) were captured in McParlon Creek, and a predominance of stream resident production was evidenced by the reproductive development of these fish.

18. It seems likely that spawning/recruitment potential in the upper Bridge River system is concentrated within (and perhaps restricted to) discrete and limited areas offering superior conditions, like the aforementioned side channels.

19. Results of standard habitat capability modelling may not be reliable for the Downton Lake Reservoir drainage, due to its extreme conditions (cold, turbid); however, it may be significant that the modelling results indicated that fry habitat was not heavily exploited in October 1996, even where fry densities were highest.

20. In contrast to the low numbers and narrow distribution of fry in streams above full pool, gill netting of the reservoir in October 1996 produced impressive numbers of fish; analysis of scale samples suggests that half of the capture on this occasion had entered the reservoir as fry; however, it should be noted that scale interpretations for the Downton Lake Reservoir system are subject to particular doubt, due to the effects of harsh environmental conditions on early growth and scale development.

21. In view of all indications to date, it is *possible* that some emigration of fry from stream sections above full pool may have occurred in 1996, prior to the October sampling program.

22. It is also *conceivable* that some level of spawning and recuitment of rainbow trout may occur within sections of Downton Lake Reservoir tributaries that are inundated at full pool, but exposed (variably) during drawdown.

23. It is further *possible* that the apparently low numbers of fry in some of the smaller tributaries to Downton Lake Reservoir may have been related to the extreme drawdown of the reservoir in 1996, in some way; however, this would not seem to apply to the upper Bridge River system, at least.

24. Based on internal examinations of fish caught by gill netting, some proportion of the Downton Lake Reservoir rainbow population is in spawning condition (or close to it) from spring (May) through to fall (October); very small fry in one of the warmer tributaries to the reservoir (Tributary 20) suggests protracted spawning here, at least; the same may also apply to the even smaller fry encountered in the upper Bridge River system.

25. Protracted spawning has also been observed in unregulated drainages nearby, and would appear to be natural adaptation to the harsh environmental conditions of the region; it may also fortuitously provide plasticity for survival in a reservoir environment, specifically.

26. In addition to impressive numbers of fish, all gill netting catches in Downton Lake Reservoir (1994-1996) have also consistently indicated remarkably good condition of fish, especially for a large cold hydroelectric reservoir.

27. It may be possible, however, that food resources are limited in some way, for older/larger individuals specifically (ie. Age 4+ and 5+).

28. The 1996-97 limnological monitoring program indicated that the Downton Lake Reservoir drainage is a harsh and dynamic system, with primary and secondary production limited by cold temperatures, high turbidity, and low water retention times.

29. The water chemistry of the system is extraordinary in some ways (occurrence of nitrogen limitation), but primary production appears to be low, consistent with other large oligotrophic reservoirs.

30. During the monitoring program, zooplankton densities appear to have been low within the range for nutrient-deficient lakes; this may be largely due to physical factors, including displacement and entrainment in the bulk water transport through the reservoir.

31. However, this may not be important to fish; it is likely that benthic production is the major aquatic source of food for trout in the reservoir, and may also be the most critical factor in the production of fish within the system, overall; unfortunately, assessment of such production was beyond the scope of the 1996-97 monitoring program.

32. Notwithstanding the constraints and uncertainty relating to all gill netting data (and maintaining particular reservations with respect to bull trout), comparison of October 1996 netting results to earlier catches does not suggest any *unusual* fish losses, following the exceptionally low drawdown of Downton Lake Reservoir in the spring of 1996.

33. However, the absence of bull trout in the October 1996 reservoir catch may be a specific concern, given the capture of the species (in low numbers) in August 1995.

34. On the other hand, the presence and catch of the species in the month of August may have been due to seasonal influences, and an associated concentration of fish not evident in the October sampling of either 1994 or 1996.

35. This does not belittle concerns for the species within this drainage, particularly in view of the lack of any captures at electrofishing sites in October 1996.

36. No doubt, development of the reservoir resulted in losses of historic spawning habitat for fish; for rainbow trout, ongoing hydroelectric operations may variably impede passage to remaining spawning habitat in tributaries, above the full pool level.

37. In addition, the effects of drawdown may result in reproductive stress of some individuals, due to overcrowding and/or stranding.

38. However, despite these impacts, and the limited abundance of spawning habitat in streams above the full pool level, there are no indications to date that spawning and recruitment is limiting to the production of rainbow trout within the system.

39. In the final analysis, Downton Lake Reservoir appears to support impressive numbers of remarkably well conditioned fish; if there are any needs for mitigation or enhancement of fish production within the system, they are not evident on the strength of information to date.

40. Unfortunately, there are no data to document historic fish populations in the upper Bridge River, prior to development of Downton Lake Reservoir; accordingly, it is not possible to identify or even confirm losses of fish production due to associated hydroelectric developments; by the same token, it is not possible to identify related needs for mitigation, if any.

41. The greatest need for the Downton Lake Reservoir drainage is for further information, in order to eliminate the current reliance on hypothesis in the interpretation of its complex dynamics, its remarkable production of fish, and the effects of hydroelectric operations.

42. Future studies to determine the present status and direction of bull trout production should be the top priority for *any* future activities related to fish production within the Downton Lake Reservoir drainage.

43. In addition, detailed studies of benthic production within the reservoir, and relevance to fish, should be viewed as another high priority, in order to assess related effects of drawdown, and possibilities of optimizing reservoir operations for the benefit of fish.

44. For rainbow trout, it is essential that other investigations be undertaken to identify actual spawning behaviour within the system, in order to adequately understand and assess the effects of reservoir operations on the recruitment of this species.

45. Lastly, it would obviously be extremely beneficial to actually confirm and quantify losses of fish to entrainment and stranding, during drawdown of the reservoir; in addition to enabling assessment of impacts and implications specific to Downton Lake Reservoir itself, this would also add to the general understanding of this key issue with respect to resident fish in hydroelectric reservoirs, in general.

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Appendix 1.

1996 stream discharge records for Sta. 06MB028 in the Bridge River mainstem, upstream of Downton Lake (Water Survey of Canada)

Courtesy of :

Environmental Services and Applications
Pacific and Yukon Region
Environment Canada, Vancouver, B.C.

WATER SURVEY OF CANADA BRIDGE RIVER ABOVE DOWNTON LAKE STATION NO. 08MBC
MAR 12 1997 PAGE 1 READQQ D08 SEP/S
OTTAWA, ONT. 12:16

DAILY DISCHARGE IN CUBIC METRES PER SECOND FOR 1996

DEC 31, 5.30 B

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	5.70 B	3.20 B	3.70 B	4.87	9.84	52.4	95.2	103	79.2	35.4	7.92	5.02
2	6.40 B	3.40 B	3.90 B	4.76	9.45	55.0	103	102	69.3	29.7	7.58	4.73
3	6.70 B	3.80 B	4.05 B	4.70	9.12	74.8	128	94.2	69.2	36.5	7.34	4.59
4	6.45 B	4.50 B	4.00 B	4.77	8.86	92.9	123	91.9	61.5	100 E	6.73	4.60 B
5	6.05 B	5.40 B	3.90 B	5.69	9.07	86.7	95.4	90.6	49.6	78.0 E	6.55	4.60
6	6.30 B	6.80 B	3.85 B	8.87	9.44	83.5	87.2	83.4	44.1	50.0 E	6.42	4.53
7	6.70 B	6.70 B	4.40 B	11.1	9.22	83.9	92.3	85.7	43.5	37.0 E	5.27	4.35
8	6.90 B	6.50 B	4.90 B	15.3	8.85	80.5	114	89.6	55.5	35.0 E	7.78	4.26
9	6.60 B	6.70 B	5.50 B	17.4	8.42	69.0	136	103	56.3	36.0 E	12.0	4.27
10	6.20 B	6.10 B	6.00 B	17.3	8.24	59.7	124	104	53.1	39.0 E	11.4	4.24
11	6.60 B	5.30 B	6.60 E	16.9	8.13	53.5	114	99.6	52.9	42.0 E	10.5	4.17
12	6.80 B	6.00 B	6.10 E	15.6	8.40	51.1	120	95.5	60.3	34.0 E	14.2	4.06
13	6.20 B	6.00 B	5.30 E	14.4	11.9	52.8	137	90.1	66.5	34.0 E	14.8	4.02
14	5.90 B	5.90 B	5.50 E	13.4	17.6	55.8	145	92.7	62.3	32.0 E	11.7	3.98
15	5.61 B	5.85 B	6.20 E	14.9	18.8	55.1	154	96.2	50.2	27.0 E	9.63	3.81
16	5.50 B	5.90 B	6.00 E	17.9	18.2	49.9	145	104	42.2	24.0 E	8.26	3.65
17	5.35 B	6.00 B	5.70 E	18.2	17.6	47.1	114	88.6	36.1	23.0 E	8.25	3.55 B
18	5.25 B	6.20 B	5.70 E	16.5	17.8	46.5	92.1	75.6	33.1	22.0 E	7.58	3.70 B
19	5.18 B	6.30 B	5.80 E	15.1	19.2	48.7	78.9	74.4	33.6	21.0 E	7.25	3.73
20	5.10 B	5.90 B	5.76 A	14.3	19.5	55.9	77.5	70.9	31.6	20.0 E	6.77	3.77
21	4.95 B	5.40 B	5.76	14.3	18.5	64.9	83.5	59.8	27.5	19.5 E	6.98	3.68
22	4.70 B	5.05 B	5.64	14.5	19.5	72.5	93.4	59.8	23.8	18.8 E	7.32	3.60 B
23	4.60 B	4.80 B	5.40	15.0	23.2	79.7	110	77.2	21.2	18.3 E	8.27	3.50 B
24	4.75 B	4.50 B	5.30	15.2	30.8	100	126	86.9	19.6	17.8 E	8.57	3.40 B
25	4.70 B	4.25 B	5.36	13.7	39.6	103	135	85.8	18.8	17.3 E	8.29	3.38 B
26	4.60 B	3.90 B	5.23	12.5	46.0	98.1	138	85.5	26.8	16.7 E	9.28	3.40 B
27	4.35 B	3.59 B	5.10	11.6	43.3	88.4	140	96.1	32.5	15.9 E	7.12	3.48 B
28	4.00 B	3.60 B	5.04	10.8	40.9	90.4	142	99.8	38.0	15.5	5.67	3.55 B
29	3.70 B	3.70 B	4.97	10.4	40.1	86.4	149	101	47.4	17.6	5.04	3.65 B
30	3.50 B		4.88	10.1	40.9	84.1	148	128	44.0	17.1	5.10	3.72 B
31	3.20 B		4.88		48.3		122	108		8.37		3.75 B
TOTAL	168.54	151.84	160.42	380.06	638.74	2122.3	3662.5	2822.9	1349.7	936.47	249.57	122.74
MEAN	5.44	5.24	5.17	12.7	20.6	70.7	118	91.1	45.0	30.2	8.32	3.96
DAM3	14600	13100	13900	32800	55200	[illegible]	316000	244000	117000	80900	21600	10600
MAX	6.90	6.80	6.60	18.2	48.3	103	154	128	79.2	100	14.8	5.02
MIN	3.20	3.20	3.70	4.70	8.13	46.5	77.5	59.8	18.8	8.37	5.04	3.38

SUMMARY FOR THE YEAR 1996 -
MEAN DISCHARGE, 34.9 M3/S
TOTAL DISCHARGE, 1100000 DAM3
MAXIMUM DAILY DISCHARGE, 154 M3/S ON JUL 15
MINIMUM DAILY DISCHARGE, 3.20 M3/S ON JAN 31
TABLE No 2 USED JAN 1, TO DEC 31,
MAX INST DISCHARGE 185 m3/s JUL 15 (1.929m)
@ 21:35 PST

A-MANUAL GAUGE
B-ICE CONDITIO
E-ESTIMATED

PREPARED BY/DATE: B Henly Mar 12 1997
CHECKED BY/DATE: B Henly Mar 12/97
APPROVED BY/DATE [signature] Mar. 19,

Appendix 2.

Records of Downton Lake elevations during October 1996 and 1997 (B.C. Hydro Operations, Edmonds)

Downton Lake elevations at hour ending 24

	m		m
961001	747.29	971001	749.94
961002	747.27	971002	749.94
961003	747.27	971003	749.86
961004	747.50	971004	749.71
961005	747.61	971005	749.54
961006	747.65	971006	749.34
961007	747.67	971007	749.17
961008	747.50	971008	749.10
961009	747.50	971009	749.04
961010	747.53	971010	748.97
961011	747.59	971011	748.90
961012	747.59	971012	748.83
961013	747.57	971013	748.77
961014	747.53	971014	748.70
961015	747.48	971015	748.66
961016	747.40	971016	748.80
961017	747.34	971017	748.99
961018	747.27	971018	749.07
961019	747.17	971019	749.14
961020	747.10	971020	749.17
961021	747.05	971021	749.19
961022	746.92	971022	749.20
961023	746.83	971023	749.20
961024	746.73	971024	749.17
961025	746.62	971025	749.17
961026	746.52	971026	749.16
961027	746.41	971027	749.13
961028	746.33	971028	749.10
961029	746.22	971029	749.09
961030	746.12	971030	749.09
961031	746.01	971031	749.05

Appendix 3.

Standing stock capability model for juvenile salmonids in streams (Ptolemy, 1992).

Equations for standing stock capability estimates used in this study (Ptolemy, 1982):

Standard Model

$$FPU = 36.3\ (Alk^{0.5})\ (Size^{-1})$$

Model for Glacial Streams

$$\log_{10}(FPU) = 1.57 - 0.95 \log_{10}(Size) + 0.45 \log_{10}(Alk) - 0.28 \log_{10}(NFR)$$

Where:

FPU = numbers of fish/100m², at capacity
Alk = total alkalinity (mg/L) for late summer/fall base flow period
Size = mean fish size (g) for cohort
NFR = non–filterable residues (inert suspended solids) at time of sampling

Appendix 4.

Results of laboratory analyses for water samples obtained from streams in the Downton Lake drainage; October 1996.

Note :

Samples from Jamie Creek and Tributary 16 are believed to have been confused during the analyses.

Jamie Creek contained high glacial turbidity at the time of sampling; Tributary 16 was clear (Appendix 6).

The sample from Jamie Creek was collected on October 17. However, the sample from Tributary 16 was collected at the time of electrofishing, on October 11 (*ibid.*)

R.F. Griffith & Associates
1237 Munro Road
Sidney, BC
V8L 3R9

TEL: 656-2181
FAX: 656-2181

Source unknown
Type of Sample water
No. of Samples 20

Comments Arrival temp.: -3.0C

Sample: Downton Lake October 1996

SAMPLE	DATE	TIME	Alkalinity (mg/L)	TDS (mg/L)	Inert Suspended solids (mg/L)
Up.Bridge main gauging	13Oct96		12.5	34.0	61.5
Up.Bridge main @ bridge	12Oct96		12.5	27.0	72.5
Up.Bridge sidech gaug.	13Oct96		16.0	40.0	16.0
Up.Bridte side ch A	13Oct96		19.5	37.0	12.5
Up.Bridge side ch C	13Oct96		19.5	39.0	10.0
Up.Bridge up side ch	12Oct96		25.0	55.0	12.0
Up.Bridge trib up.brdg	12Oct96		14.5	34.0	3.00
Bridge trib up McPln Ck	14Oct96		16.5	31.0	6.00
McPalon Crk near mouth	13Oct96		13.5	35.0	46.7
Tribtry McParlon Ck	16Oct96		21.0	37.0	6.00
Tribtry McParlon Ck	DUP		n/a	33.0	6.50
Gwyneth Creek	16Oct96		39.0	29.0	10.5
Ault Creek	17Oct96		16.5	29.0	0.700
Downton Lk tribtry 5	17Oct96		16.5	36.0	ND
Jamie Creek	17Oct96		20.0	35.0	6.00
Downton Lk tribtry10	17Oct96		60.5	73.0	5.00
Downton Lk tribtry12	17Oct96		17.0	27.0	4.33
Downton Lk stream 16	17Oct97		58.0	65.0	31.3
Downton Lk stream 17	16Oct96		38.0	52.0	11.0
Downton Lk stream 20	16Oct96		37.0	69.0	11.7
Downton Lk stream 22	16Oct96		52.0	84.0	10.5
Downton Lk stream 22	DUP		52.5	87.0	10.5
Lab Blank			0.200	0.050	ND
S_o			0.100	0.700	0.400
REF. VALUE			20.0	200	5.00
STD ± 2SD			20.0 ± 1.10	200 ± 10.0	4.99 ± 0.480
REF. VALUE					210
STD ± 2SD					209 ± 14.2

SD = standard deviation
STD = secondary standard calibrated to primary standard reference material
S_o = standard deviation at zero analyte concentration; method detection limit is generally considered to be 3x S_o value
ND = none detected n/a = not applicable

H. Hartmann

R. Jones
Supervisor

H. Hartmann
Analytical Chemist

MB RESEARCH
ANALYTICAL &TESTING SERVICES P.O.BOX 2103, SIDNEY, B.C. V8L 3S6 TEL: (250) 656-1334 FAX: 656-0443

Appendix 5.

Habitat survey data for streams in the Downton Lake drainage; October 1996.

Site 1	Stream Survey Data	Bridge River mainstem

Location: 900 m downstream of McParlon Creek confluence (electrofishing site 1)
Access: new logging road up the Bridge River
Surveyed Length (m): 200 **Stream Temperature (°C):** 4.1 **Date:** October 14, 1996

Ave. Chan. width (m):	55
Ave. Wet. Width (m):	23
Ave. Max. Riffle Depth (cm):	25
Ave. Max. Pool Depth (cm):	45

% Pool:	5
% Riffle/Rapid:	45
% Glide/Run:	50
% other:	

Gradient (%):	1.0
Side Channel (%):	braided
Debris: % area	< 1
% stable	65

Bed Materials:	
clay, silt, sand (<2mm)	20
small gravel (2–16mm)	15
large gravel (16–64mm)	15
small cobble (64–128mm)	20
large cobble (128–256mm)	15
boulder (>256mm)	15
bedrock	
D_{90} (cm):	30
Bars (%):	20
Compaction:	moderate – high

Banks:	
height (m)	1.4
% stable	75
texture	fines, larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	2
Braided ?:	yes
Crown Closure (%):	5
Aspect:	east

Cover (total %):	
salmonid fry	30 ?
parr and adults	40 ?
Components (% of total cover):	
large organic debris	10 ?
small organic debris	15 ?
instream vegetation	
overstream vegetation	10 ?
cutbanks	25 ?
bed substrates	40 ?
bed substrates (fry)	60 ?

Obstructions:	—none observed or suspected
Riparian Zone	—maturing mixed forest; largely deciduous
Spawning:	—hard to evaluate due to high glacial turbidity; suspect fair (marginal) potential for spawning —gravels abundant, but heavily impacted and compacted with fines
Rearing:	—hard to evaluate due to high turbidity; suspect restricted use for rearing (primarily along the margins) —bed materials principally small; bank cover moderately diverse, but not highly complex

Photo : Figure 8 in text

Site 2	Stream Survey Data	Bridge River mainstem

Location: mainstem braid, 450 m downstream of McParlon Creek confluence (electrofishing site 2)
Access: access road to discharge gauging station
Surveyed Length (m): 125 **Stream Temperature (°C):** 4.3 **Date:** October 13, 1996

Ave. Chan. width (m):	25
Ave. Wet. Width (m):	10
Ave. Max. Riffle Depth (cm):	35
Ave. Max. Pool Depth (cm):	20

% Pool:	5
% Riffle/Rapid:	65
% Glide/Run:	30
% other:	

Gradient (%):	1.5
Side Channel (%):	braided
Debris: % area	< 1
% stable	60

Bed Materials:	
clay, silt, sand (<2mm)	20
small gravel (2–16mm)	5
large gravel (16–64mm)	5
small cobble (64–128mm)	30
large cobble (128–256mm)	25
boulder (>256mm)	15
bedrock	
D_{90} (cm):	30
Bars (%):	40
Compaction:	high

Banks:	
height (m)	0.6
% stable	60
texture	fines, larges
Confinement:	unconined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	east by south

Cover (total %):	
salmonid fry	15 ?
parr and adults	35 ?
Components (% of total cover):	
large organic debris	25 ?
small organic debris	
instream vegetation	
overstream vegetation	10 ?
cutbanks	40 ?
bed substrates	25 ?
bed substrates (fry)	60 ?

Obstructions:	–none observed or suspected
Riparian Zone	–mature but stunted mixed forest; some clearcutting to within approximately 25 m of channel along the south side of the river
Spawning:	–hard to evaluate due to high glacial turbidity; but suspect very limited spawning potential –gravels low in abundance; fines content and compaction high
Rearing:	–hard to evaluate due to high glacial turbidity; but suspect limited rearing potential (primarily along margins) –turbulent and swift flows; bed materials limited in size and complexity

Photo : Figure 9 in text.

Site 3	**Stream Survey Data**	Bridge River side channel 1

Location: small side channel adjacent to mainstem, 400 m downstream of McParlon Creek (electrofishing site 3)
Access: access road to discharge gauging station
Surveyed Length (m): 65 **Stream Temperature (°C):** 5.9 **Date:** October 13, 1996

Ave. Chan. width (m):	2
Ave. Wet. Width (m):	1
Ave. Max. Riffle Depth (cm):	–
Ave. Max. Pool Depth (cm):	15

% Pool:	99
% Riffle/Rapid:	
% Glide/Run:	1
% other:	

Gradient (%):	< 0.5
Side Channel (%):	100
Debris: % area	10
% stable	75

Bed Materials:	
clay, silt, sand (<2mm)	100
small gravel (2–16mm)	
large gravel (16–64mm)	
small cobble (64–128mm)	
large cobble (128–256mm)	
boulder (>256mm)	
bedrock	
D_{90} (cm):	< 0.1
Bars (%):	50 (mud)
Compaction:	low (muddy)

Banks:	
height (m)	0.25
% stable	75
texture	fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.5
Braided ?:	no
Crown Closure (%):	60
Aspect:	east

Cover (total %):	
salmonid fry	25
parr and adults	10
Components (% of total cover):	
large organic debris	
small organic debris	70
instream vegetation	5
overstream vegetation	10
cutbanks	15
bed substrates	
bed substrates (fry)	

Obstructions:	–lack of surface flows at numerous locations
Riparian Zone	–tangle of deciduous shrubs and small trees –bodered by clearcut to south
Spawning:	–no spawning habitat observed
Rearing:	–shallow; periodically isloated; lacking in cover –rearing potential low

Photo : Figure 20 in text.

Site 4	Stream Survey Data	Bridge River side channel 2

Location: large glacial side channel, 850 m upstream of McParlon Creek confluence (electrofishing site 4)
Access: hike down from main logging road up the Bridge River
Surveyed Length (m): 150 **Stream Temperature (°C):** 3.6 **Date:** October 14, 1996

Ave. Chan. width (m):	10
Ave. Wet. Width (m):	9.5
Ave. Max. Riffle Depth (cm):	20
Ave. Max. Pool Depth (cm):	80

% Pool:	30
% Riffle/Rapid:	5
% Glide/Run:	65
% other:	

Gradient (%):	1.0
Side Channel (%):	100
Debris: % area	2
% stable	70

Bed Materials:	
clay, silt, sand (<2mm)	50
small gravel (2–16mm)	20
large gravel (16–64mm)	10
small cobble (64–128mm)	5
large cobble (128–256mm)	10
boulder (>256mm)	5
bedrock	
D_{90} (cm):	15
Bars (%):	5
Compaction:	high

Banks:	
height (m)	0.4
% stable	70
texture	fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1
Braided ?:	no
Crown Closure (%):	20
Aspect:	southeast

Cover (total %):	
salmonid fry	40 ?
parr and adults	30 ?
Components (% of total cover):	
large organic debris	5 ?
small organic debris	5 ?
instream vegetation	40 ?
overstream vegetation	15 ?
cutbanks	10 ?
bed substrates	25 ?
bed substrates (fry)	40 ?

Obstructions:	–none observed or suspected –channel linked directly to mainstem at both ends
Riparian Zone	–sparse mature forest with large trees to south; stunted scrubby bush dominated by deciduous species to north
Spawning:	–hard to evaluate due to high glacial turbidity; suspect limited (marginal) potential for spawning –fines abundance and compaction high; however, gravels also abundant
Rearing:	–hard to evaluate due to high glacial turbidity; suspect moderate potential for rearing –bed materials rather small, and lacking complexity; reasonable abundance and complexity of bank cover

Photo : Figure 12 in text.

Site 5	Stream Survey Data	Bridge River side channel 3

Location: large clear–flowing side channel 850 m upstream of McParlon Creek confluence (electrofishing site 5)
Access: hike down from main logging road up the Bridge River
Surveyed Length (m): 100 **Stream Temperature (°C):** 6.7 **Date:** October 13, 1996

Ave. Chan. width (m):	7
Ave. Wet. Width (m):	5.5
Ave. Max. Riffle Depth (cm):	5
Ave. Max. Pool Depth (cm):	40

% Pool:	50
% Riffle/Rapid:	20
% Glide/Run:	30
% other:	

Gradient (%):	0.5
Side Channel (%):	100
Debris: % area	15
% stable	40

Bed Materials:	
clay, silt, sand (<2mm)	20
small gravel (2–16mm)	10
large gravel (16–64mm)	10
small cobble (64–128mm)	30
large cobble (128–256mm)	25
boulder (>256mm)	5
bedrock	
D_{90} (cm):	15
Bars (%):	15
Compaction:	moderate

Banks:	
height (m)	0.25
% stable	90
texture	fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	> 1.0
Braided ?:	no
Crown Closure (%):	10
Aspect:	southeast

Cover (total %):	
salmonid fry	60
parr and adults	35
Components (% of total cover):	
large organic debris	30
small organic debris	10
instream vegetation	35
overstream vegetation	5
cutbanks	10
bed substrates	20
bed substrates (fry)	75

Obstructions:	–occasional small debris plugs; loose, and passable
Riparian Zone	–mature but sparse forest of large deciduous and coniferous trees on south side –stunted scrubby deciduous growth on north side
Spawning:	–occasional patches of gravels (large and small); fair potential for spawning –most gravels impacted and moderately compacted, due to high abundance of fines
Rearing:	–complex rearing habitat for fry; largely reliant on cobble bed materials –depths somewhat limiting for parr

Photo : Figure 13 in text.

Site 6	Stream Survey Data	Bridge River side channel 4

Location: smaller clear–flowing side channel 850 m upstream of McParlon Creek confluence (electrofishing site 6)
Access: hike down from main logging road up the bridge river
Surveyed Length (m): 75 **Stream Temperature (°C):** 6.3 **Date:** October 13, 1996

Ave. Chan. width (m):	5
Ave. Wet. Width (m):	4.5
Ave. Max. Riffle Depth (cm):	2
Ave. Max. Pool Depth (cm):	40

% Pool:	60
% Riffle/Rapid:	10
% Glide/Run:	30
% other:	

Gradient (%):	0.5
Side Channel (%):	100
Debris: % area	< 1
% stable	50

Bed Materials:	
clay, silt, sand (<2mm)	20
small gravel (2–16mm)	15
large gravel (16–64mm)	10
small cobble (64–128mm)	20
large cobble (128–256mm)	30
boulder (>256mm)	5
bedrock	
D_{90} (cm):	20
Bars (%):	10
Compaction:	moderate

Banks:	
height (m)	0.35
% stable	60
texture	fines (sand)
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.9
Braided ?:	no
Crown Closure (%):	10
Aspect:	southeast

Cover (total %):	
salmonid fry	70
parr and adults	25
Components (% of total cover):	
large organic debris	2
small organic debris	3
instream vegetation	15
overstream vegetation	10
cutbanks	5
bed substrates	65
bed substrates (fry)	75

Obstructions:	–none observed or suspected
Riparian Zone	–dense mature forest (conifers dominant) on the south side; sparse mature mature forest on the north side –large clearcuts in adjacent areas to the south
Spawning:	–some excellent accumulations of small and large gravels, despite substantial abundance of fines –occasional concentrations in pool tail–out areas
Rearing:	–moderately complex cover for rearing; particularly suitable for fry –potential for parr limited by relatively small size of bed materials

Photo : Figure 14 in text.

Site 7	Stream Survey Data	Bridge River side channel 5

Location: small secondary side channel 850 m upstream of McParlon Creek confluence (electrofishing site 7)
Access: hike down from main logging road up the Bridge River
Surveyed Length (m): 150 **Stream Temperature (°C):** 6.4 **Date:** October 13, 1996

Ave. Chan. width (m):	2
Ave. Wet. Width (m):	2
Ave. Max. Riffle Depth (cm):	4
Ave. Max. Pool Depth (cm):	20

% Pool:	15
% Riffle/Rapid:	10
% Glide/Run:	75
% other:	

Gradient (%):	0.5
Side Channel (%):	100
Debris: % area	3
% stable	70

Bed Materials:	
clay, silt, sand (<2mm)	> 24
small gravel (2–16mm)	30
large gravel (16–64mm)	20
small cobble (64–128mm)	22
large cobble (128–256mm)	3
boulder (>256mm)	< 1
bedrock	
D_{90} (cm):	10
Bars (%):	0
Compaction:	moderate – high

Banks:	
height (m)	0.3
% stable	90
texture	fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.9
Braided ?:	no
Crown Closure (%):	25
Aspect:	southeast

Cover (total %):	
salmonid fry	60
parr and adults	20
Components (% of total cover):	
large organic debris	5
small organic debris	10
instream vegetation	50
overstream vegetation	10
cutbanks	10
bed substrates	15
bed substrates (fry)	60

Obstructions:	–none
Riparian Zone	–entirely contained within sparse stunted forest, with little understory except along stream margins
Spawning:	–frequent patches of large and small gravels suitable for spwaning –best substrates observed anywhere in association with the Bridge River
Rearing:	–excellent habitat for fry –complexity limited for parr, due to small size of bed materials; depths also limited for parr

Photo : Figure 15 in text.

Site 8	Stream Survey Data	Bridge River Tributary A

Location: 900 m upstream of the Bridge River mainstem (electrofishing site 8)
Access: bridge crossing of main logging road up the Bridge River
Surveyed Length (m): 150 **Stream Temperature (°C):** 4.2 **Date:** October 14, 1996

Ave. Chan. width (m):	3.5
Ave. Wet. Width (m):	2
Ave. Max. Riffle Depth (cm):	10
Ave. Max. Pool Depth (cm):	30

% Pool:	15
% Riffle/Rapid:	40
% Glide/Run:	35
% other: (cascades)	10

Gradient (%):	9
Side Channel (%):	0
Debris: % area	20
% stable	30

Bed Materials:	
clay, silt, sand (<2mm)	40
small gravel (2–16mm)	5
large gravel (16–64mm)	5
small cobble (64–128mm)	10
large cobble (128–256mm)	15
boulder (>256mm)	25
bedrock	
D_{90} (cm):	50
Bars (%):	15
Compaction:	extremely high

Banks:	
height (m)	0.7
% stable	80
texture	larges, fines
Confinement:	occasionally confined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.2
Braided ?:	no
Crown Closure (%):	5
Aspect:	northeast

Cover (total %):	
salmonid fry	30
parr and adults	20
Components (% of total cover):	
large organic debris	20
small organic debris	35
instream vegetation	20
overstream vegetation	
cutbanks	5
bed substrates	20
bed substrates (fry)	20

Obstructions:	–continuous series of boulder/debris plugs and cascades; gradients > 50% downstream
Riparian Zone	–mature mixed forest giving way to swamp and meadow upstream –clearcut entirely overrunning channel downstream of survey section
Spawning:	–no spawning potential observed –bed materials extremely consolidated and compacted with fines (like cement)
Rearing:	–cover from bed materials reduced by fines abundance and consolidation –velocities and turbulence predominantly excessive

Photo : Figure 17 in text.

Site 9	Stream Survey Data	Bridge River mainstem

Location: mainstem habitat, immediately upstream of new bridge crossing (electrofishing site 9)
Access: hike in from access road to new bridge crossing
Surveyed Length (m): 300 **Stream Temperature (°C):** 3.6 **Date:** October 12, 1996

Ave. Chan. width (m):	35	**% Pool:**	5	**Gradient (%):**	2.5
Ave. Wet. Width (m):	25	**% Riffle/Rapid:**	85	**Side Channel (%):**	20 (flood channel)
Ave. Max. Riffle Depth (cm):	?	**% Glide/Run:**	10	**Debris: % area**	< 1
Ave. Max. Pool Depth (cm):	?	**% other:**		% stable	

Bed Materials: (based on exposed bars)		**Banks:**		**Cover (total %):**	
clay, silt, sand (<2mm)	20	height (m)	1.5	salmonid fry	10 ?
small gravel (2–16mm)	10	% stable	70	parr and adults	35 ?
large gravel (16–64mm)	5	texture	larges, bedrock, fines	**Components (% of total cover):**	
small cobble (64–128mm)	10	**Confinement:**	occasionally confined	large organic debris	< 1 ?
large cobble (128–256mm)	15	**Valley:Chan. Ratio:**	> 10	small organic debris	< 1 ?
boulder (>256mm)	45	**Stage:**	low	instream vegetation	
bedrock		**Flood Signs Ht. (m):**	2.5	overstream vegetation	
D_{90} (cm):	80	**Braided ?:**	yes	cutbanks	< 1 ?
Bars (%):	25	**Crown Closure (%):**	< 5	bed substrates	> 99 ?
Compaction:	high	**Aspect:**	northeast	bed substrates (fry)	> 99 ?

Obstructions:	—none observed or suspected
Riparian Zone	—mature mixed forest along both banks
Spawning:	—a few small patches of gravels, but generally blended with cobbles; doubtful spawning potential —gravels limited in abundance, and heavily impacted and compacted with fines
Rearing:	—hard to evaluate due to glacial turbidity, but suspect principal limitation to bed materials as cover —mid channel velocities and turbulence likely limit use to margins, flood channels, etc.

Photo : Figure 10 in text.

Site 10	Stream Survey Data	Bridge River mainstem

Location: flood channel (high water braid) 800 m upstream of new bridge crossing (electrofishing sites 10 and 11)
Access: hike in from road along south side of mainstem, upstream of the new bridge crossing
Surveyed Length (m): 200 **Stream Temperature (°C):** 5.6 **Date:** October 12, 1996

Ave. Chan. width (m):	(braid)
Ave. Wet. Width (m):	5
Ave. Max. Riffle Depth (cm):	3
Ave. Max. Pool Depth (cm):	20

% Pool:	25
% Riffle/Rapid:	40
% Glide/Run:	35
% other:	

Gradient (%):	1.0
Side Channel (%):	100% braid
Debris: % area	4
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	15
small gravel (2–16mm)	5
large gravel (16–64mm)	5
small cobble (64–128mm)	10
large cobble (128–256mm)	25
boulder (>256mm)	40
bedrock	
D_{90} (cm):	80
Bars (%):	60
Compaction:	moderate

Banks:	
height (m)	0.8
% stable	50
texture	larges, fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.5
Braided ?:	not applicable
Crown Closure (%):	< 5
Aspect:	east

Cover (total %):	
salmonid fry	60
parr and adults	20
Components (% of total cover):	
large organic debris	< 1
small organic debris	< 1
instream vegetation	
overstream vegetation	5
cutbanks	
bed substrates	> 90
bed substrates (fry)	> 90

Obstructions:	–no flowing connection to mainstem at top end (active only during higher water) –fed by small tributary stream during low water
Riparian Zone	–mature mixed forest along south side; mainstem boulder/cobble bar on north side
Spawning:	–occasional small accumulations of gravels, but doubtful spawning potential –most gravels blended with cobbles and fines
Rearing:	–good cobble boulder habitat for fry –depths limiting for parr

Photo not available.

Site 11	Stream Survey Data	Bridge River Tributary B

Location: immediately upstream of mouth in flood channel of Bridge River mainstem (electrofishing site 12)
Access: hike in from road along south side of mainstem, upstream of new bridge crossing
Surveyed Length (m): 60 **Stream Temperature (°C):** 5.9 **Date:** October 12, 1996

Ave. Chan. width (m):	2.4
Ave. Wet. Width (m):	2.2
Ave. Max. Riffle Depth (cm):	15
Ave. Max. Pool Depth (cm):	30

% Pool:	10
% Riffle/Rapid:	60
% Glide/Run:	20
% other: (cascade)	10

Gradient (%):	5
Side Channel (%):	0
Debris: % area	8
% stable	60

Bed Materials:	
clay, silt, sand (<2mm)-	20
small gravel (2–16mm)	10
large gravel (16–64mm)	15
small cobble (64–128mm)	23
large cobble (128–256mm)	10
boulder (>256mm)	20
bedrock	2
D_{90} (cm):	60
Bars (%):	< 1
Compaction:	moderate – high

Banks:	
height (m)	1.8
% stable	90
texture	larges, fines
Confinement:	frequently confined
Valley:Chan. Ratio:	5–10
Stage:	low
Flood Signs Ht. (m):	1.4
Braided ?:	no
Crown Closure (%):	60
Aspect:	north

Cover (total %):	
salmonid fry	60
parr and adults	30
Components (% of total cover):	
large organic debris	15
small organic debris	5
instream vegetation	
overstream vegetation	10
cutbanks	10
bed substrates	60
bed substrates (fry)	80

Obstructions:	–2 m boulder/debris plug at mouth; backfilled with fines
Riparian Zone	–entirely contained within mature mixed forest –sparse understory, including stream banks
Spawning:	–gravels mostly impacted and compacted with fines –little (if any) spawning potential
Rearing:	–some embeddedness of cobbles and boulders, but still substantial complexity for fry, in particular –limited amount of deeper pool habitat for parr

Photos : Figures 22 and 23 in text.

Site 12	**Stream Survey Data**	Bridge River side channel 6

Location: side channel, 1.1 km upstream of new bridge crossing (electrofishing site 13)
Access: hike in from road along south side of mainstem, upstream of the new bridge crossing
Surveyed Length (m): 150 **Stream Temperature (°C):** 6.4 **Date:** October 12, 1996

Ave. Chan. width (m):	9
Ave. Wet. Width (m):	3.5
Ave. Max. Riffle Depth (cm):	< 1
Ave. Max. Pool Depth (cm):	25

% Pool:	90
% Riffle/Rapid:	5
% Glide/Run:	5
% other:	

Gradient (%):	0.5
Side Channel (%):	100
Debris: % area	7
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	60
small gravel (2–16mm)	5
large gravel (16–64mm)	1
small cobble (64–128mm)	4
large cobble (128–256mm)	10
boulder (>256mm)	20
bedrock	
D_{90} (cm):	70
Bars (%):	60 (sand)
Compaction:	high

Banks:	
height (m)	1.4
% stable	50
texture	larges, fines
Confinement:	unconfined
Valley:Chan. Ratio:	>10
Stage:	low
Flood Signs Ht. (m):	2
Braided ?:	no
Crown Closure (%):	20
Aspect:	east by south

Cover (total %):	
salmonid fry	15
parr and adults	10
Components (% of total cover):	
large organic debris	10
small organic debris	15
instream vegetation	
overstream vegetation	<1
cutbanks	<1
bed substrates	75
bed substrates (fry)	50

Obstructions:	–periodic near dry trickles over sand accumulations
Riparian Zone	–large mature mixed forest, with minimal understory, on south side of channel; adjacent clearcutting with buffer strip –stunted scrubby forest (mixed) on north side, with more dense understory
Spawning:	–suspect little if any spawning potential –gravels scarce, and fines greatly abundant; compaction also high
Rearing:	–some complexity of rearing habitat in sections with boulders –almost no complexity in sections dominated by sands

Photo : Figure 21 in text.

Site 13	Stream Survey Data	Bridge River mainstem

Location: 1.4 km upstream of new bridge crossing (electrofishing site 14)
Access: hike in from road along south side of mainstem, upstream of of the new bridge crossing
Surveyed Length (m): 350 **Stream Temperature (°C):** 4.3 **Date:** October 12, 1996

Ave. Chan. width (m):	45	**% Pool:**	3	**Gradient (%):**	3.0
Ave. Wet. Width (m):	20	**% Riffle/Rapid:**	90	**Side Channel (%):**	10
Ave. Max. Riffle Depth (cm):	?	**% Glide/Run:**	7	**Debris: % area**	< 1
Ave. Max. Pool Depth (cm):	?	**% other:**		% stable	0

Bed Materials: (based on exposed bars)		**Banks:**		**Cover (total %):**	
clay, silt, sand (<2mm)	30	height (m)	0.8	salmonid fry	10 ?
small gravel (2–16mm)	5	% stable	75	parr and adults	25 ?
large gravel (16–64mm)	5	texture	larges, fines, bedrock	**Components (% of total cover):**	
small cobble (64–128mm)	5	**Confinement:**	occasionally confined	large organic debris	< 1 ?
large cobble (128–256mm)	10	**Valley:Chan. Ratio:**	> 10	small organic debris	< 1 ?
boulder (>256mm)	45	**Stage:**	low	instream vegetation	
bedrock	< 1	**Flood Signs Ht. (m):**	2	overstream vegetation	
D_{90} (cm):	90	**Braided ?:**	yes	cutbanks	
Bars (%):	40	**Crown Closure (%):**	< 5	bed substrates	> 99 ?
Compaction:	very high	**Aspect:**	east	bed substrates (fry)	> 99 ?

Obstructions:	–none observed or suspected
Riparian Zone	–continuous mature mixed forest along both banks –frequent snags along the stream banks
Spawning:	–occasional small gravel accumulations behind boulders; heavily impacted and compacted with sand –suspect little (if any) spawning potential
Rearing:	–hard to evaluate, due to high glacial turbidity –suspect limited usability of mid channel ares, due to water velocities and turbulence

Photo : Figure 11 in text.

Site 14	Stream Survey Data	McParlon Creek

Location: eastern braid immediately upstream of confluence with Bridge River mainstem (electrofishing site 15)
Access: hike up Bridge River mainstem from discharge gauging station
Surveyed Length (m): 150 **Stream Temperature (°C):** 5.1 **Date:** October 13, 1996

Ave. Chan. width (m):	15
Ave. Wet. Width (m):	9
Ave. Max. Riffle Depth (cm):	50 ?
Ave. Max. Pool Depth (cm):	30

% Pool:	5
% Riffle/Rapid:	60
% Glide/Run:	35
% other:	

Gradient (%):	3.5
Side Channel (%):	0
Debris: % area	< 1
% stable	70

Bed Materials: (based on exposed bars)	
clay, silt, sand (<2mm)	5
small gravel (2–16mm)	5
large gravel (16–64mm)	10
small cobble (64–128mm)	10
large cobble (128–256mm)	10
boulder (>256mm)	60
bedrock	
D_{90} (cm):	80
Bars (%):	30
Compaction:	moderate – high

Banks:	
height (m)	1.2
% stable	95
texture	larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low – moderate
Flood Signs Ht. (m):	1.5
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	north by east

Cover (total %):	
salmonid fry	20 ?
parr and adults	50 ?
Components (% of total cover):	
large organic debris	5 ?
small organic debris	
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	95 ?
bed substrates (fry)	> 95 ?

Obstructions:	–none
Riparian Zone	–mature mixed forest along both banks
Spawning:	–very limited –gravels blended with cobbles and boulders
Rearing:	–hard to evaluate, due to high glacial turbidity; however, considerable complexity of bed materials indicated –water velocity and turbulence likely limiting in mid channel areas

Site 15	Stream Survey Data	McParlon Creek

Location: small braid of main western braid, 75 m upstream of the Bridge River mainstem (electrofishing site 16)
Access: hike up Bridge River mainstem from discharge guaging station
Surveyed Length (m): 130 **Stream Temperature (°C):** 5.1 **Date:** October 14, 1996

Ave. Chan. width (m):	6
Ave. Wet. Width (m):	4
Ave. Max. Riffle Depth (cm):	15
Ave. Max. Pool Depth (cm):	30

% Pool:	10
% Riffle/Rapid:	40
% Glide/Run:	50
% other:	

Gradient (%):	2.0
Side Channel (%):	0
Debris: % area	8
% stable	60

Bed Materials: (based on exposed bars)	
clay, silt, sand (<2mm)	30
small gravel (2–16mm)	5
large gravel (16–64mm)	5
small cobble (64–128mm)	10
large cobble (128–256mm)	20
boulder (>256mm)	30
bedrock	
D_{90} (cm):	55
Bars (%):	20
Compaction:	high

Banks:	
height (m)	0.5
% stable	60
texture	larges, fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low – moderate
Flood Signs Ht. (m):	1.2
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	north

Cover (total %):	
salmonid fry	65 ?
parr and adults	40 ?
Components (% of total cover):	
large organic debris	25 ?
small organic debris	15 ?
instream vegetation	
overstream vegetation	5 ?
cutbanks	20 ?
bed substrates	35 ?
bed substrates (fry)	60 ?

Obstructions:	–none
Riparian Zone	–small mixed forest along western bank; boulder/cobble bar on eastern side
Spawning:	–no viable spawning habitat observed –almost no gravels; fines abundance and compaction high
Rearing:	–good diversity and complexity of cover for both fry and parr –some embeddedness of cobbles and boulders

Photo : Figure 25 in text.

Site 16	Stream Survey Data	McParlon Creek

Location: immediately downstream of first bridge crossing, 550 m upstream of Bridge River (electrofishing site 17)
Access: main logging road up the Bridge River (bridge crossing)
Surveyed Length (m): 200 **Stream Temperature (°C):** 1.5 **Date:** October 16, 1996

Ave. Chan. width (m):	25
Ave. Wet. Width (m):	12
Ave. Max. Riffle Depth (cm):	50 ?
Ave. Max. Pool Depth (cm):	40 ?

% Pool:	15
% Riffle/Rapid:	65
% Glide/Run:	20
% other:	

Gradient (%):	3.0
Side Channel (%):	0
Debris: % area	< 1
% stable	60

Bed Materials: (based on exposed bars)	
clay, silt, sand (<2mm)	10
small gravel (2–16mm)	8
large gravel (16–64mm)	8
small cobble (64–128mm)	10
large cobble (128–256mm)	15
boulder (>256mm)	49
bedrock	
D_{90} (cm):	150
Bars (%):	35
Compaction:	moderate

Banks:	
height (m)	2.5
% stable	70
texture	larges, fines
Confinement:	occasionally confined
Valley:Chan. Ratio:	> 10
Stage:	low – moderate
Flood Signs Ht. (m):	3
Braided ?:	no
Crown Closure (%):	< 5
Aspect:	north by east

Cover (total %):	
salmonid fry	25 ?
parr and adults	40 ?
Components (% of total cover):	
large organic debris	
small organic debris	
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	100 ?
bed substrates (fry)	100 ?

Obstructions:	–none observed
Riparian Zone	–mature mixed forest along both banks –sparse understory
Spawning:	–glacial turbidity too high to properly evaluate potential –some patches of gravels behind boulders at stream margins
Rearing:	–hard to evaluate due to high glacial turbidity; however, large complex bed materials; little other cover –rearing potential likely limited by high water velocities and turbulence

Photo : Figure 24 in text.

Site 17	Stream Survey Data	McParlon Creek

Location: 1.2 km upstream of first bridge crossing; 400 m upstream of barrier falls (electrofishing site 18)
Access: main logging road up McParlon Creek
Surveyed Length (m): 150 **Stream Temperature (°C):** 1.5 **Date:** October 16, 1996

Ave. Chan. width (m):	35
Ave. Wet. Width (m):	10
Ave. Max. Riffle Depth (cm):	60 ?
Ave. Max. Pool Depth (cm):	60 ?

% Pool:	10
% Riffle/Rapid:	75
% Glide/Run:	15
% other:	

Gradient (%):	3.5
Side Channel (%):	0
Debris: % area	4
% stable	25

Bed Materials: (based on exposed bars)	
clay, silt, sand (<2mm)	10
small gravel (2–16mm)	10
large gravel (16–64mm)	12
small cobble (64–128mm)	15
large cobble (128–256mm)	10
boulder (>256mm)	43
bedrock	
D_{90} (cm):	100
Bars (%):	60
Compaction:	low – moderate

Banks:	
height (m)	1.2
% stable	60
texture	larges, fines
Confinement:	occasionally confined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	2.5
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	northeast

Cover (total %):	
salmonid fry	30 ?
parr and adults	50 ?
Components (% of total cover):	
large organic debris	25 ?
small organic debris	10 ?
instream vegetation	
overstream vegetation	
cutbanks	5 ?
bed substrates	60 ?
bed substrates (fry)	80 ?

Obstructions:	–none within survey section –major bedrock falls located 400 m downstream
Riparian Zone	–mature mixed forest with moderately thick understory
Spawning:	–proper evaluation precluded by high glacial turbidity –some clean loose gravel accumulations at stream margins
Rearing:	–proper evaluation precluded by high glacial turbidity; however, complexity of bed materials likely high –some limitation from high water velocities and turbulence in mid channel

Site 18	**Stream Survey Data**	McParlon Creek Tributary C

Location: immediately upstream of confluence with McParlon Creek mainstem (electrofishing site 19)
Access: bridge crossing by main logging road up McParlon Creek
Surveyed Length (m): 175 **Stream Temperature (°C):** 1.2 **Date:** October 16, 1996

Ave. Chan. width (m):	5
Ave. Wet. Width (m):	4.8
Ave. Max. Riffle Depth (cm):	30
Ave. Max. Pool Depth (cm):	45

% Pool:	10
% Riffle/Rapid:	55
% Glide/Run:	5
% other: (cascades)	30

Gradient (%):	12
Side Channel (%):	0
Debris: % area	12
% stable	50

Bed Materials:	
clay, silt, sand (<2mm)	4
small gravel (2–16mm)	16
large gravel (16–64mm)	10
small cobble (64–128mm)	10
large cobble (128–256mm)	15
boulder (>256mm)	45
bedrock	
D_{90} (cm):	90
Bars (%):	0
Compaction:	high

Banks:	
height (m)	1.5
% stable	90
texture	larges
Confinement:	occasionally confined
Valley:Chan. Ratio:	> 10
Stage:	low – moderate
Flood Signs Ht. (m):	1.8
Braided ?:	no
Crown Closure (%):	40
Aspect:	northwest

Cover (total %):	
salmonid fry	20
parr and adults	30
Components (% of total cover):	
large organic debris	15
small organic debris	10
instream vegetation	
overstream vegetation	5
cutbanks	10
bed substrates	60
bed substrates (fry)	75

Obstructions:	–numerous cascades to approx. 1 m
Riparian Zone	–stunted mixed forest along both banks
Spawning:	–some pockets of gravels in pools –fines not greatly abundant, but consolidation high, due to small gravels
Rearing:	–highly complex bed materials, plus frequent woody debris –some limitation due to turbulence

Site 19	Stream Survey Data	Gwyneth Creek (Downton Tributary 2)

Location: immediately downstream of road crossing (elctrofishing site 20)
Access: main road along south side of Downton Lake reservoir
Surveyed Length (m): 150 **Stream Temperature (°C):** 8.1 **Date:** October 8, 1996

Ave. Chan. width (m):	3.5
Ave. Wet. Width (m):	2
Ave. Max. Riffle Depth (cm):	15
Ave. Max. Pool Depth (cm):	30

% Pool:	50
% Riffle/Rapid:	30
% Glide/Run:	15
% other: (cascades)	5

Gradient (%):	29
Side Channel (%):	0
Debris: % area	10
% stable	20

Bed Materials:	
clay, silt, sand (<2mm)	5
small gravel (2–16mm)	3
large gravel (16–64mm)	2
small cobble (64–128mm)	5
large cobble (128–256mm)	15
boulder (>256mm)	45
bedrock	25
D_{90} (cm):	80
Bars (%):	20
Compaction:	high

Banks:	
height (m)	0.6
% stable	80
texture	larges
Confinement:	confined
Valley:Chan. Ratio:	5–10
Stage:	low
Flood Signs Ht. (m):	1
Braided ?:	no
Crown Closure (%):	60
Aspect:	north

Cover (total %):	
salmonid fry	70
parr and adults	40
Components (% of total cover):	
large organic debris	20
small organic debris	10
instream vegetation	
overstream vegetation	13
cutbanks	2
bed substrates	55
bed substrates (fry)	80

Obstructions:	–steep 8 m bedrock chute 70 m downstream of road crossing; culvert with 1.5 m vertical drop at the road crossing –major gradient barrier, and falls at mouth (observable from road)
Riparian Zone	–contained with logging clearcut –narrow buffer strip left; but many trees have blown down into channel
Spawning:	–very few gravels –no reasonable spawning potential
Rearing:	–extremely complex cover for both fry and parr –depths somewhat limiting to parr

Site 20	**Stream Survey Data**	Ault Creek (Downton Tributary 3)

Location: lowermost 50 m, between the road crossing and the reservoir (electrofishing site 21)
Access: main road along south side of Downton Lake reservoir
Surveyed Length (m): 35 **Stream Temperature (°C):** 7.2 **Date:** October 8, 1996

Ave. Chan. width (m):	9
Ave. Wet. Width (m):	4
Ave. Max. Riffle Depth (cm):	20
Ave. Max. Pool Depth (cm):	40

% Pool:	5
% Riffle/Rapid:	20
% Glide/Run:	10
% other: (cascades)	65

Gradient (%):	35
Side Channel (%):	0
Debris: % area	15
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	10
small gravel (2–16mm)	8
large gravel (16–64mm)	2
small cobble (64–128mm)	5
large cobble (128–256mm)	5
boulder (>256mm)	50
bedrock	20
D_{90} (cm):	150
Bars (%):	0
Compaction:	high

Banks:	
height (m)	> 2
% stable	70
texture	bedrock, fines
Confinement:	entrenched
Valley:Chan. Ratio:	0–2
Stage:	low
Flood Signs Ht. (m):	3
Braided ?:	no
Crown Closure (%):	< 5
Aspect:	north by east

Cover (total %):	
salmonid fry	< 5
parr and adults	10
Components (% of total cover):	
large organic debris	5
small organic debris	35
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	60
bed substrates (fry)	80

Obstructions:	–one falls after another; first is right at the mouth (2.5m high) –major falls (>20m high) immediately upstream of survey section
Riparian Zone	–very little riparian vegetation within survey section –mature forest dominated by conifers commences at major falls, immediately upstream of survey section
Spawning:	–no spawning potential whatsoever
Rearing:	–very limited rearing potential due to high water velocities and turbulence –this stream section is basically a series of cascades with no significant fisheries value of any sort

Photo : Figure 28 in text.

Site 21	Stream Survey Data	Downton Tributary 4

Location: between the road crossing and the reservoir (electrofishing site 22)
Access: main road along the south side of Downton Lake reservoir
Surveyed Length (m): 155 **Stream Temperature (°C):** 6.9 **Date:** October 8, 1996

Ave. Chan. width (m):	11
Ave. Wet. Width (m):	4.5
Ave. Max. Riffle Depth (cm):	8
Ave. Max. Pool Depth (cm):	25

% Pool:	5
% Riffle/Rapid:	30
% Glide/Run:	15
% other: (cascades)	50

Gradient (%):	22
Side Channel (%):	0
Debris: % area	7
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	15
small gravel (2–16mm)	10
large gravel (16–64mm)	15
small cobble (64–128mm)	15
large cobble (128–256mm)	20
boulder (>256mm)	25
bedrock	
D_{90} (cm):	50
Bars (%):	40
Compaction:	very high

Banks:	
height (m)	1.4
% stable	75
texture	larges, gravel
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	> 1
Braided ?:	yes
Crown Closure (%):	0
Aspect:	northeast

Cover (total %):	
salmonid fry	15
parr and adults	25
Components (% of total cover):	
large organic debris	20
small organic debris	10
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	70
bed substrates (fry)	80

Obstructions:	—steep section (25%) at point of entry to reservoir; 20 m in length —other steep sections and cascades upstream
Riparian Zone	—riparian vegetation limited to small shrubs below road crossing; mature mixed forest upstream
Spawning:	—gravels quite abundant; however, most are angular, and heavily impacted/compacted with fines (very solid) —marginal spawning habitat, at best
Rearing:	—bed materials provide diverse and complex habitat for fry; however, water velocities and turbulence generally high —habitat limited for parr, due to predominantly small bed materials, and shallow depths

Site 22	Stream Survey Data	Downton Tributary 5

Location: between the road crossing and the reservoir (electrofishing site 23)
Access: main road along south side of Downton Lake reservoir
Surveyed Length (m): 183 **Stream Temperature (°C):** 7.2 **Date:** October 8, 1996

Ave. Chan. width (m):	9
Ave. Wet. Width (m):	4.5
Ave. Max. Riffle Depth (cm):	30
Ave. Max. Pool Depth (cm):	60

% Pool:	5
% Riffle/Rapid:	60
% Glide/Run:	35
% other:	

Gradient (%):	17
Side Channel (%):	5
Debris: % area	15
% stable	25

Bed Materials:	
clay, silt, sand (<2mm)	10
small gravel (2–16mm)	3
large gravel (16–64mm)	2
small cobble (64–128mm)	5
large cobble (128–256mm)	10
boulder (>256mm)	70
bedrock	
D_{90} (cm):	70
Bars (%):	20
Compaction:	high

Banks:	
height (m)	0.7
% stable	40
texture	fines, larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.3
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	northwest

Cover (total %):	
salmonid fry	50
parr and adults	65
Components (% of total cover):	
large organic debris	20
small organic debris	15
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	65
bed substrates (fry)	75

Obstructions:	–numerous cascades to 1.5 m high; frequently complexed with woody debris –perhaps preclude access collectively
Riparian Zone	–sparse and immature forest below road –narrow leave strip of larger trees has resulted in substantial blowdown
Spawning:	–no viable spawning habitat observed –very few gravels, and highly compacted
Rearing:	–complex rearing habitat, especially for parr –velocities and turbulence largely excessive for fry

Site 23	Stream Survey Data	Downton Tributary 8

Location: immediately upstream of reservoir (electrofishing site 24)
Access: main road along south side of Downton Lake reservoir
Surveyed Length (m): 75 **Stream Temperature (°C):** 6.9 **Date:** October 9, 1996

Ave. Chan. width (m):	0.6
Ave. Wet. Width (m):	0.4
Ave. Max. Riffle Depth (cm):	< 1
Ave. Max. Pool Depth (cm):	5

% Pool:	5
% Riffle/Rapid:	50
% Glide/Run:	35
% other: (cascades)	10

Gradient (%):	37
Side Channel (%):	0
Debris: % area	30
% stable	80

Bed Materials:	
clay, silt, sand (<2mm)	40
small gravel (2–16mm)	20
large gravel (16–64mm)	20
small cobble (64–128mm)	2
large cobble (128–256mm)	3
boulder (>256mm)	15
bedrock	
D_{90} (cm):	30
Bars (%):	0
Compaction:	low

Banks:	
height (m)	0.4
% stable	90
texture	fines, larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.8
Braided ?:	no
Crown Closure (%):	0
Aspect:	northeast

Cover (total %):	
salmonid fry	50
parr and adults	< 5
Components (% of total cover):	
large organic debris	10
small organic debris	45
instream vegetation	10
overstream vegetation	25
cutbanks	5
bed substrates	5
bed substrates (fry)	30

Obstructions:	–steep gradient compounded with small debris accumulations –passage possible, but difficult
Riparian Zone	–surrounded by clearcut –riparian vegetation dominated by weeds and shrubs
Spawning:	–frequent small patches of gravel, but fines content high –spawning might be feasible, but is unlikely, due to stream size, gradient, fines, lack of holding pools, etc.
Rearing:	–despite steep gradient, reasonably good rearing potential for fry –depths extremely limiting for parr

Site 24	Stream Survey Data	Jamie Creek (Downton Tributary 9)

Location: immediately upstream of reservoir (electrofishing site 25)
Access: main road alonf south side of Downton Lake reservoir
Surveyed Length (m): 200 **Stream Temperature (°C):** 6.9 **Date:** October 10, 1996

Ave. Chan. width (m):	14
Ave. Wet. Width (m):	8
Ave. Max. Riffle Depth (cm):	> 100
Ave. Max. Pool Depth (cm):	> 100

% Pool:	5
% Riffle/Rapid:	60
% Glide/Run:	5
% other: (cascades)	30

Gradient (%):	28
Side Channel (%):	0
Debris: % area	2
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	2
small gravel (2–16mm)	1
large gravel (16–64mm)	1
small cobble (64–128mm)	3
large cobble (128–256mm)	3
boulder (>256mm)	70
bedrock	20
D_{90} (cm):	> 150
Bars (%):	5
Compaction:	high

Banks:	
height (m)	1.2
% stable	95
texture	larges, bedrock
Confinement:	confined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.5
Braided ?:	yes
Crown Closure (%):	10
Aspect:	west

Cover (total %):	
salmonid fry	10
parr and adults	25
Components (% of total cover):	
large organic debris	2
small organic debris	
instream vegetation	
overstream vegetation	
cutbanks	5
bed substrates	93
bed substrates (fry)	> 95

Obstructions:	–numerous cascade barriers > 3 m in height towards top of survey section; one series of cascades totalling 12 m in height –boulder constriction just above full pool level
Riparian Zone	–moderately dense forest dominated by small conifers; considerable blowdown, but very little of it stable within the channel
Spawning:	–no significant accumulations of gravels observed
Rearing:	–great complexity from large bed materials; however, highly excessive water velocities and turbulence

Photo : Figure 29 in text.

Site 25	Stream Survey Data	Downton Tributary 10

Location: between the road crossing and the reservoir (electrofishing sites 26 and 27)
Access: main road along the south side of Downton Lake reservoir
Surveyed Length (m): 86 **Stream Temperature (°C):** 7.7 **Date:** October 10, 1996

Ave. Chan. width (m):	2.5
Ave. Wet. Width (m):	2
Ave. Max. Riffle Depth (cm):	5
Ave. Max. Pool Depth (cm):	15

% Pool:	25
% Riffle/Rapid:	40
% Glide/Run:	35
% other:	

Gradient (%):	16
Side Channel (%):	0
Debris: % area	10
% stable	10

Bed Materials:	
clay, silt, sand (<2mm)	25
small gravel (2–16mm)	10
large gravel (16–64mm)	10
small cobble (64–128mm)	15
large cobble (128–256mm)	25
boulder (>256mm)	15
bedrock	
D_{90} (cm):	65
Bars (%):	10
Compaction:	high

Banks:	
height (m)	0.6
% stable	50
texture	fines, larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.8
Braided ?:	no
Crown Closure (%):	0
Aspect:	northeast

Cover (total %):	
salmonid fry	45
parr and adults	15
Components (% of total cover):	
large organic debris	25
small organic debris	
instream vegetation	
overstream vegetation	
cutbanks	
bed substrates	75
bed substrates (fry)	80

Obstructions:	—rapid increase in gradient above the road crossing
Riparian Zone	—clearcut; mostly weeds and small deciduous shrubs and trees
Spawning:	—gravels heavily impacted and compacted with fines —very little spawning potential, if any
Rearing:	—cover complexity for fry greatly reduced by embeddedness of substrates in fines —in addition, limited depths for parr

Site 26	Stream Survey Data	Downton Tributary 11

Location: between the road crossing and the reservoir (electrofishing site 28)
Access: main road along the south side of Downton Lake reservoir
Surveyed Length (m): 35 **Stream Temperature (°C):** 8.0 **Date:** October 10, 1996

Ave. Chan. width (m):	2.5	**% Pool:**	10	**Gradient (%):**	5
Ave. Wet. Width (m):	2.2	**% Riffle/Rapid:**	60	**Side Channel (%):**	0
Ave. Max. Riffle Depth (cm):	5	**% Glide/Run:**	30	**Debris: % area**	35
Ave. Max. Pool Depth (cm):	15	**% other:**		% stable	40

Bed Materials:		**Banks:**		**Cover (total %):**	
clay, silt, sand (<2mm)	45	height (m)	0.3	salmonid fry	40
small gravel (2–16mm)	15	% stable	75	parr and adults	15
large gravel (16–64mm)	15	texture	fines, larges	**Components (% of total cover):**	
small cobble (64–128mm)	20	**Confinement:**	unconfined	large organic debris	30
large cobble (128–256mm)	3	**Valley:Chan. Ratio:**	> 10	small organic debris	40
boulder (>256mm)	2	**Stage:**	low	instream vegetation	
bedrock		**Flood Signs Ht. (m):**	0.7	overstream vegetation	15
D_{90} (cm):	10	**Braided ?:**	no	cutbanks	5
Bars (%):	0	**Crown Closure (%):**	70	bed substrates	10
Compaction:	high	**Aspect:**	northwest	bed substrates (fry)	30

Obstructions:	–mouth choked with woody debris (possible obstruction); also, major falls (11 m) at top of survey section, immediately below the road crossing
Riparian Zone	–relatively dense mature and maturing deciduous forest
Spawning:	–gravels heavily impacted and compacted with fines; very few loose gravel accumulations –spawning potential marginal at best, and greatly limited in terms of area
Rearing:	–very complex cover from debris, but length extremely short (20 m) –larger substrates highly embedded in fines; extremely solid

Site 27	Stream Survey Data	Downton Tributary 12

Location: immediately upstream of reservoir (electrofishing site 29 and 30)
Access: main road along south side of Downton Lake reservoir
Surveyed Length (m): 100 **Stream Temperature (°C):** 1.4 **Date:** October 17, 1996

Ave. Chan. width (m):	4	**% Pool:**	20	**Gradient (%):**	16
Ave. Wet. Width (m):	4	**% Riffle/Rapid:**	50	**Side Channel (%):**	0
Ave. Max. Riffle Depth (cm):	25	**% Glide/Run:**	20	**Debris: % area**	15
Ave. Max. Pool Depth (cm):	40	**% other:** (cascades)	10	% stable	50

Bed Materials:		**Banks:**		**Cover (total %):**	
clay, silt, sand (<2mm)	10	height (m)	> 3	salmonid fry	35
small gravel (2–16mm)	10	% stable	90	parr and adults	55
large gravel (16–64mm)	12	texture	larges	**Components (% of total cover):**	
small cobble (64–128mm)	8	**Confinement:**	confined	large organic debris	10
large cobble (128–256mm)	20	**Valley:Chan. Ratio:**	> 10	small organic debris	25
boulder (>256mm)	40	**Stage:**	low ?	instream vegetation	
bedrock		**Flood Signs Ht. (m):**	2	overstream vegetation	5
D_{90} (cm):	90	**Braided ?:**	no	cutbanks	10
Bars (%):	0	**Crown Closure (%):**	10	bed substrates	50
Compaction:	moderate – high	**Aspect:**	north	bed substrates (fry)	60

Obstructions:	–series of 1–2.2 m cascades 50 m upstream of reservoir; probable barrier to reservoir fish
Riparian Zone	–relatively dense deciduous shrubs and small trees
Spawning:	–majority of gravels moderately to highly compacted with fines –some viable accumulations in glides, and behind large boulders
Rearing:	–very complex cover –superior water depth, and proportion of pool habitat

Site 28	Stream Survey Data	Downton Tributary 13

Location: between the road crossing and the reservoir (electrofishing site 31)
Access: main road along the south side of Downton Lake reservoir
Surveyed Length (m): 105 **Stream Temperature (°C):** 8.2 **Date:** October 10, 1996

Ave. Chan. width (m):	3
Ave. Wet. Width (m):	3
Ave. Max. Riffle Depth (cm):	20
Ave. Max. Pool Depth (cm):	30

% Pool:	10
% Riffle/Rapid:	55
% Glide/Run:	35
% other:	

Gradient (%):	12
Side Channel (%):	0
Debris: % area	10
% stable	60

Bed Materials:	
clay, silt, sand (<2mm)	60
small gravel (2–16mm)	5
large gravel (16–64mm)	5
small cobble (64–128mm)	5
large cobble (128–256mm)	5
boulder (>256mm)	20
bedrock	
D_{90} (cm):	40
Bars (%):	0
Compaction:	high

Banks:	
height (m)	0.4
% stable	95
texture	fines (including clay)
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low ?
Flood Signs Ht. (m):	0.7
Braided ?:	no
Crown Closure (%):	70
Aspect:	north by east

Cover (total %):	
salmonid fry	25
parr and adults	20
Components (% of total cover):	
large organic debris	40
small organic debris	15
instream vegetation	
overstream vegetation	10
cutbanks	10
bed substrates	25
bed substrates (fry)	40

Obstructions:	–6 m falls at road crossing (top of survey section) –very spectacular falls (> 100 m ?) visible approximately 500 m upstream
Riparian Zone	–dense but small deciduous forest with occasional young conifers –evidence of past inundation of this section by landslides
Spawning:	–very few gravels; compaction of bed materials very high –no viable spawning habitat observed
Rearing:	–complex cover and reasonable depths for parr –high water velocities and compacted/embedded substrates reduce suitability for fry

Site 29	Stream Survey Data	Downton Tributary 16

Location: immediately upstream of the reservoir (electrofishing sites 32 and 33)
Access: boat, via Downton Lake reservoir
Surveyed Length (m): 170 **Stream Temperature (°C):** 8.1 **Date:** October 11, 1996

Ave. Chan. width (m):	3.5
Ave. Wet. Width (m):	1.5
Ave. Max. Riffle Depth (cm):	10
Ave. Max. Pool Depth (cm):	30

% Pool:	15
% Riffle/Rapid:	60
% Glide/Run:	20
% other: (cascades)	5

Gradient (%):	10
Side Channel (%):	0
Debris: % area	15
% stable	60

Bed Materials:	
clay, silt, sand (<2mm)	5
small gravel (2–16mm)	10
large gravel (16–64mm)	25
small cobble (64–128mm)	30
large cobble (128–256mm)	20
boulder (>256mm)	10
bedrock	
D_{90} (cm):	25
Bars (%):	0
Compaction:	moderate – high

Banks:	
height (m)	0.8
% stable	95
texture	larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1
Braided ?:	no
Crown Closure (%):	75
Aspect:	southwest

Cover (total %):	
salmonid fry	70
parr and adults	50
Components (% of total cover):	
large organic debris	10
small organic debris	15
instream vegetation	
overstream vegetation	5
cutbanks	15
bed substrates	55
bed substrates (fry)	75

Obstructions:	–none within the survey section; occasional small cascades to 0.5 m (all with excellent plunge pools)
Riparian Zone	–old growth coniferous forest with fairly sparse deciduous understory
Spawning:	–abundant gravels, with good access from the reservoir –moderately to highly compacted, but some superior substrates in pools and glides
Rearing:	–great complexity for both fry and parr

Photo : Figure 31 in text.

Site 30	Stream Survey Data	Downton Tributary 17

Location: immediately upstream of the reservoir (electrofishing site 34)
Access: boat, via Downton Lake reservoir
Surveyed Length (m): 70 **Stream Temperature (°C):** 2.0 **Date:** October 16, 1996

Ave. Chan. width (m):	3
Ave. Wet. Width (m):	1.5
Ave. Max. Riffle Depth (cm):	8
Ave. Max. Pool Depth (cm):	25

% Pool:	15
% Riffle/Rapid:	55
% Glide/Run:	5
% other: (cascades)	25

Gradient (%):	16
Side Channel (%):	0
Debris: % area	20
% stable	40

Bed Materials:	
clay, silt, sand (<2mm)	8
small gravel (2–16mm)	5
large gravel (16–64mm)	2
small cobble (64–128mm)	5
large cobble (128–256mm)	10
boulder (>256mm)	70
bedrock	
D_{90} (cm):	40
Bars (%):	10
Compaction:	very high

Banks:	
height (m)	0.8
% stable	60
texture	larges, fines
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.5
Braided ?:	no
Crown Closure (%):	60
Aspect:	southeast

Cover (total %):	
salmonid fry	40
parr and adults	30
Components (% of total cover):	
large organic debris	30
small organic debris	10
instream vegetation	
overstream vegetation	
cutbanks	10
bed substrates	50
bed substrates (fry)	30

Obstructions:	–debris accumulation at mouth; possible obstruction at low flows –frequent debris/boulder cascades upstream; maximum height of 0.7 m within survey section
Riparian Zone	–moderately dense forest of small to medium size deciduous trees
Spawning:	–no spawning habitat observed –very few gravels, and extremely high compaction of other materials
Rearing:	–fairly complex habitat for both fry and parr –however, limited by steep gradient

Photo : Figure 38 in text.

Site 31	Stream Survey Data	Downton Tributary 18

Location: immediately upstream of the reservoir (electrofishing site 35)
Access: boat, via Downton Lake reservoir
Surveyed Length (m): 75 **Stream Temperature (°C):** 6.7 **Date:** October 16, 1996

Ave. Chan. width (m):	?
Ave. Wet. Width (m):	6
Ave. Max. Riffle Depth (cm):	2
Ave. Max. Pool Depth (cm):	4

% Pool:	5
% Riffle/Rapid:	75
% Glide/Run:	20
% other:	

Gradient (%):	15
Side Channel (%):	?
Debris: % area	70
% stable	30

Bed Materials:	
clay, silt, sand (<2mm)	80
small gravel (2–16mm)	20
large gravel (16–64mm)	
small cobble (64–128mm)	
large cobble (128–256mm)	
boulder (>256mm)	
bedrock	
D_{90} (cm):	0.5
Bars (%):	0
Compaction:	muddy

Banks:	
height (m)	not applicable
% stable	not applicable
texture	not applicable
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	0.6
Braided ?:	yes
Crown Closure (%):	< 5
Aspect:	south by east

Cover (total %):	
salmonid fry	60
parr and adults	< 5
Components (% of total cover):	
large organic debris	30
small organic debris	45
instream vegetation	25
overstream vegetation	
cutbanks	
bed substrates	
bed substrates (fry)	

Obstructions:	—tangle of debris and weeds at mouth, persisting for > 40 m —no definite channel; basically, water just flowing over the surface, through the debris and weeds, to 20 m wide
Riparian Zone	—a tangle of weeds, shrubs, and small deciduous trees —increasing blowdown and other signs of instability upstream
Spawning:	—no spawning habitat observed —primarily mud; transition to boulders with increasing gradient, upstream
Rearing:	—potentiall good for fry, but no depth for parr —but clearly unstable; evidence of shits

Photo : Figure 36 in text.

Site 32	Stream Survey Data	Downton Tributary 19

Location: immediately upstream of the reservoir (electrofishing sites 36 and 37)
Access: boat, via Downton Lake reservoir
Surveyed Length (m): 180 **Stream Temperature (°C):** 9.2 **Date:** October 11, 1996

Ave. Chan. width (m):	6
Ave. Wet. Width (m):	1.5
Ave. Max. Riffle Depth (cm):	7
Ave. Max. Pool Depth (cm):	30

% Pool:	20
% Riffle/Rapid:	50
% Glide/Run:	30
% other:	

Gradient (%):	12
Side Channel (%):	0
Debris: % area	10
% stable	60

Bed Materials:	
clay, silt, sand (<2mm)	5
small gravel (2–16mm)	20
large gravel (16–64mm)	10
small cobble (64–128mm)	45
large cobble (128–256mm)	10
boulder (>256mm)	10
bedrock	
D_{90} (cm):	25
Bars (%):	40
Compaction:	moderate

Banks:	
height (m)	1.2
% stable	90
texture	larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.5
Braided ?:	yes
Crown Closure (%):	40
Aspect:	south

Cover (total %):	
salmonid fry	70
parr and adults	40
Components (% of total cover):	
large organic debris	25
small organic debris	20
instream vegetation	
overstream vegetation	10
cutbanks	5
bed substrates	40
bed substrates (fry)	70

Obstructions:	–major debris accumulation at mouth (near full pool level) –debris plug (0.7 m high) located 31 m upstream of reservoir; possible barrier at low flows
Riparian Zone	–mixed mature forest; indications of diruptions from landslides
Spawning:	–substantial abundance of viable spawning substrates within the first 50 m above the reservoir –declining potential upstream
Rearing:	–complex rearing habitat, especially for fry

Photo : Figure 32 in text.

Site 33	Stream Survey Data	Downton Tributary 20

Location: from reservoir to a new road crossing (electrofishing site 38)
Access: boat, via Downton Lake reservoir *or* new road along the north side of the reservoir
Surveyed Length (m): 115 **Stream Temperature (°C):** 10.1 **Date:** October 9, 1996

Ave. Chan. width (m):	4.5
Ave. Wet. Width (m):	2
Ave. Max. Riffle Depth (cm):	5
Ave. Max. Pool Depth (cm):	15

% Pool:	10
% Riffle/Rapid:	40
% Glide/Run:	20
% other: (cascades)	30

Gradient (%):	18
Side Channel (%):	0
Debris: % area	4
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	15
small gravel (2–16mm)	15
large gravel (16–64mm)	10
small cobble (64–128mm)	15
large cobble (128–256mm)	15
boulder (>256mm)	30
bedrock	
D_{90} (cm):	40
Bars (%):	40
Compaction:	moderate–high

Banks:	
height (m)	1.4
% stable	25
texture	fines, larges, gravels
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	> 1.5
Braided ?:	no
Crown Closure (%):	40
Aspect:	south

Cover (total %):	
salmonid fry	60
parr and adults	20
Components (% of total cover):	
large organic debris	2
small organic debris	3
instream vegetation	
overstream vegetation	
cutbanks	2
bed substrates	93
bed substrates (fry)	98

Obstructions:	–1.7 m debris/boulder plug, 67 m upstream of reservoir; due to channel shift and bed erosion –followed by a series of small cascades, and finally a culvert with a 0.9 m drop, under the new road crossing
Riparian Zone	–sparse forest of small to moderate mixed deciduous and coniferous; essentially no understory –evidence of widespread flooding and instability; eposed boulders and cobbles throughout treed areas, etc.
Spawning:	–concentration of gravels near mouth; small accumulations throughout sections upstream –compaction occasionally high, but some viable substrates present (especially near mouth)
Rearing:	–complex cover for fry, in particluar –depths somewhat limiting for parr

Photos : Figures 33 and 34 in text.

Site 34	Stream Survey Data	Downton Tributary 20

Location: immediately upstream of new road crossing, 115 m above the reservoir (electrofishing site 39)
Access: boat, via Downton Lake reservoir *or* new road along the north side of the reservoir
Surveyed Length (m): 150 **Stream Temperature (°C):** 10.1 **Date:** October 9, 1996

Ave. Chan. width (m):	4.5
Ave. Wet. Width (m):	1.5
Ave. Max. Riffle Depth (cm):	8
Ave. Max. Pool Depth (cm):	25

% Pool:	15
% Riffle/Rapid:	40
% Glide/Run:	15
% other: (cascades)	30

Gradient (%):	25
Side Channel (%):	0
Debris: % area	< 1
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	15
small gravel (2–16mm)	5
large gravel (16–64mm)	1
small cobble (64–128mm)	4
large cobble (128–256mm)	20
boulder (>256mm)	55
bedrock	
D_{90} (cm):	60
Bars (%):	30
Compaction:	very high

Banks:	
height (m)	0.9
% stable	60
texture	larges, gravels, fines
Confinement:	frequently confined
Valley:Chan. Ratio:	2 – 5
Stage:	low
Flood Signs Ht. (m):	> 1.5
Braided ?:	no
Crown Closure (%):	80
Aspect:	south

Cover (total %):	
salmonid fry	15
parr and adults	20
Components (% of total cover):	
large organic debris	< 1
small organic debris	< 1
instream vegetation	
overstream vegetation	< 1
cutbanks	< 1
bed substrates	98
bed substrates (fry)	98

Obstructions:	–2 m cascade immediately above road crossing; one small cascade after another, further upstream
Riparian Zone	–moderately dense forest dominated by small to moderate deciduous trees and shrubs
Spawning:	–occasional small patches of gravels in pools; however, compaction generally very high –very doubtful spawning potential
Rearing:	–some complex step pools, but otherwise excessively fast flowing and turbulent

Photo : Figure 35 in text.

Site 35	Stream Survey Data	Downton Tributary 22

Location: immediately upstream of the reservoir (electrofishing site 40)
Access: boat, via Downton Lake reservoir *or* new road along the north side of the reservoir
Surveyed Length (m): 100 **Stream Temperature (°C):** 8.8 **Date:** October 9, 1996

Ave. Chan. width (m):	2.5
Ave. Wet. Width (m):	0.75
Ave. Max. Riffle Depth (cm):	3
Ave. Max. Pool Depth (cm):	15

% Pool:	30
% Riffle/Rapid:	20
% Glide/Run:	5
% other:	45

Gradient (%):	23
Side Channel (%):	0
Debris: % area	< 1
% stable	0

Bed Materials:	
clay, silt, sand (<2mm)	20
small gravel (2–16mm)	15
large gravel (16–64mm)	10
small cobble (64–128mm)	15
large cobble (128–256mm)	15
boulder (>256mm)	25
bedrock	
D_{90} (cm):	30
Bars (%):	60
Compaction:	high

Banks:	
height (m)	0.8
% stable	60
texture	fines, gravels, larges
Confinement:	unconfined
Valley:Chan. Ratio:	> 10
Stage:	low
Flood Signs Ht. (m):	1.4
Braided ?:	no
Crown Closure (%):	75
Aspect:	south by west

Cover (total %):	
salmonid fry	55
parr and adults	15
Components (% of total cover):	
large organic debris	
small organic debris	5
instream vegetation	
overstream vegetation	5
cutbanks	
bed substrates	90
bed substrates (fry)	80

Obstructions:	—culvert under new road, 40 m upstream of the reservoir; 1.1 m drop from culvert to stream bed —2.2 m cascade immediately upstream of road, followed by a rapid increase in gradient (> 40%)
Riparian Zone	—forest of small to moderate mixed deciduous and coniferous; sparse understory —cobble boulder fan conditions throughout the riparian zone, downstream of the road
Spawning:	—some gravels present, but generally impacted and compacted with fines —superior gravels at higher levels within channel (ie. higher flows)
Rearing:	—highly complex shallow step pools, excellent for fry —very little depth for parr

Photo : Figure 37 in text.

Appendix 6.

Fish captures, habitat descriptions, and water depth/velocity transects at electrofishing sites in the Downton Lake drainage; October 1996.

Note :

RB = rainbow trout

BT = bull trout

Electrofishing Population Estimates and Site Data

Site No.: 1 **Length (m):** 9.5 October 14, 1996
Stream: Bridge River mainstem **Area (m^2):** 50.4
Location: 900 m downstream of McParlon Creek confluence

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m
RB 1+	66	88	78.4	5.8	4	1	5.3	0.11	0.62	0.56

Habitat Type (%) : 5 **riffle** 15 **pool** 80 **glide**

Substrates (%) :

fines	15
small gravel	10
large gravel	25
cobble	40
boulders	10
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	2
cutbanks / roots	5
substrates (fry)	80
substrates (parr)	30
D_{90} (cm)	25

Turbidity high **Compaction** high **Water Temp. (°C)** 4.0

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use: RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.15	0.14	0.90	0.66	0.68	0.15	0.76	0.13
0.5	0.22	0.30	0.35	0.76	0.56	0.20	0.29	0.03
1.0	0.19	0.33	0.18	0.63	0.56	0.12	0.12	0.02
1.5	0.12	0.30	0.35	0.35	0.56	0.00	0.10	0.01
2.0	0.08	0.20	1.00	0.17	0.80	0.00	0.21	0.02
2.5	0.09	0.26	0.75	0.25	0.68	0.00	0.11	0.01
3.0	0.04	0.14	1.00	0.03	0.90	0.00	0.06	0.01
3.4	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.12	0.28	0.644	0.371	0.693	0.057	0.187	0.022

Electrofishing Population Estimates and Site Data

Site No.: 2 **Length (m):** 9.8 October 13, 1996

Stream: Bridge River mainstem **Area (m²):** 42.1

Location: braid 450 m downstream of McParlon Creek confluence

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 1+	81	86	83.5	6.1	2	0	2.0	0.05	0.29	0.20

Habitat Type (%) : 15 **riffle** 5 **pool** 80 **glide**

Substrates (%) :

fines	25
small gravel	5
large gravel	5
cobble	55
boulders	15
bedrock	

Cover Components (%) :

canopy / vegetation	2
woody debris	1
cutbanks / roots	
substrates (fry)	40
substrates (parr)	15
D_{90} (cm)	35

Turbidity high **Compaction** high **Water Temp. (°C)** 4.3

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.26	0.78	0.00	0.13	0.13	0.15	0.00	0.00
0.5	0.29	0.36	0.13	0.86	0.44	0.30	0.11	0.00
1.0	0.21	0.72	0.00	0.00	0.05	0.03	0.00	0.00
1.5	0.16	0.73	0.00	0.00	0.05	0.02	0.00	0.00
2.0	0.12	0.68	0.00	0.01	0.05	0.00	0.00	0.00
2.5	0.16	0.65	0.00	0.02	0.05	0.04	0.00	0.00
3.0	0.25	0.33	0.18	0.82	0.56	0.24	0.15	0.03
3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.0	0.09	0.19	1.00	0.25	0.80	0.00	0.21	0.02
4.4	0.00	0.00	1.00	0.10	1.00	0.00	0.06	0.02
Weighted Means	0.16	0.52	0.183	0.232	0.271	0.080	0.053	0.007

Electrofishing Population Estimates and Site Data

Site No.: 3 **Length (m):** 26.4 October 13, 1996
Stream: Bridge River mainstem **Area (m^2):** 60.7
Location: small side channel on the south side of the mainstem, 400 m downstream of McParlon Creek

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 0 **riffle** 100 **pool** 0 **glide**

Substrates (%) :		**Cover Components (%) :**	
fines	100	canopy / vegetation	5
small gravel		woody debris	11
large gravel		cutbanks / roots	
cobble		substrates (fry)	0
boulders		substrates (parr)	0
bedrock		D_{90} (cm)	< 0.1

Turbidity clear **Compaction** muddy **Water Temp. (°C)** 5.9

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.00	0.00	1.00	0.17	1.00	0.00	0.10	0.04
0.25	0.13	0.00	1.00	0.35	1.00	0.10	0.41	0.20
0.50	0.10	0.00	1.00	0.25	1.00	0.00	0.19	0.04
0.75	0.05	0.00	1.00	0.10	1.00	0.00	0.05	0.02
1.00	0.05	0.00	1.00	0.10	1.00	0.00	0.05	0.02
1.25	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
1.50	0.06	0.00	1.00	0.10	1.00	0.00	0.10	0.04
1.75	0.04	0.00	1.00	0.03	1.00	0.00	0.05	0.02
2.00	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.07	0.00	0.965	0.150	0.919	0.012	0.127	0.045

Electrofishing Population Estimates and Site Data

Site No.: 4 **Length (m):** 11.6 October 14, 1996
Stream: Bridge River mainstem **Area (m²):** 56.8
Location: glacial side channel on the south side of the mainstem 850 m upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 1+	66	94	83.7	6.2	2	1	4.0	0.07	0.43	0.34
RB 2+	111	119	115.0	13.4	2	0	2.0	0.04	0.47	0.17
RB 3+	133	158	145.5	36.7	2	0	2.0	0.04	1.29	0.17

Habitat Type (%) : 0 **riffle** 25 **pool** 75 **glide**

Substrates (%) :

fines	60
small gravel	20
large gravel	5
cobble	13
boulders	2
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	17
cutbanks / roots	1
substrates (fry)	10
substrates (parr)	0
D_{90} (cm)	10

Turbidity high **Compaction** high **Water Temp. (°C)** 3.6

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.04	0.00	1.00	0.17	1.00	0.00	0.10	0.04
0.5	0.10	0.00	1.00	0.25	1.00	0.00	0.19	0.04
1.0	0.11	0.00	1.00	0.25	1.00	0.00	0.31	0.14
1.5	0.15	0.02	1.00	0.45	1.00	0.10	0.41	0.20
2.0	0.12	0.04	1.00	0.35	1.00	0.00	0.31	0.14
2.5	0.17	0.32	0.25	0.54	0.56	0.12	0.14	0.02
3.0	0.19	0.42	0.04	0.46	0.32	0.10	0.04	0.00
3.5	0.19	0.37	0.08	0.57	0.44	0.12	0.09	0.00
4.0	0.18	0.21	0.90	0.66	0.80	0.15	0.76	0.13
4.5	0.21	0.00	1.00	0.77	1.00	0.30	0.88	0.43
4.7	0.16	0.00	1.00	0.66	1.00	0.20	0.75	0.34
Weighted Means	0.15	0.18	0.710	0.457	0.800	0.089	0.325	0.111

Electrofishing Population Estimates and Site Data

Site No.:	5	**Length (m):**	12.9	October 13, 1996
Stream:	Bridge River mainstem	**Area (m^2):**	47.7	
Location:	larger clear sidechannel south of the mainstem 850 m upstream of McParlon Creek			

Species/	Length (mm)			Mean	Capture		**Population Estimates**			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m
RB 0+	27	46	36.2	0.4	11	5	20.2	0.42	0.18	1.56
RB 1+	64	84	72.1	4.1	7	2	9.8	0.21	0.85	0.76
RB 2+	101	105	103.0	11.2	2	0	2.0	0.04	0.47	0.16

Habitat Type (%) : 10 **riffle** 40 **pool** 50 **glide**

Substrates (%) :		**Cover Components (%) :**	
fines	10	canopy / vegetation	2.5
small gravel	5	woody debris	7
large gravel	10	cutbanks / roots	1
cobble	60	substrates (fry)	80
boulders	15	substrates (parr)	40
bedrock		D_{90} (cm)	30

Turbidity clear **Compaction** moderate **Water Temp. (°C)** 6.7

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
0.5	0.05	0.00	1.00	0.10	1.00	0.00	0.05	0.02
1.0	0.26	0.05	0.98	0.86	1.00	0.50	0.90	0.62
1.5	0.34	0.12	0.85	0.98	0.90	0.70	1.00	0.90
2.0	0.27	0.14	0.98	0.93	0.90	0.45	1.00	0.54
2.5	0.18	0.04	1.00	0.66	1.00	0.20	0.75	0.34
3.0	0.07	0.00	1.00	0.17	1.00	0.00	0.10	0.04
3.5	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.16	0.08	0.947	0.505	0.899	0.250	0.514	0.331

Electrofishing Population Estimates and Site Data

Site No.: 6 **Length (m):** 15.1 October 13, 1996
Stream: Bridge River mainstem **Area (m^2):** 71.0
Location: smaller side channel on the south side of the mainstem 850 m upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.n	n/m^2	g/m^2	n/m
RB 0+	25	41	35.6	0.4	7	2	9.8	0.14	0.05	0.65
RB 1+	69	78	72.8	4.2	3	1	4.5	0.06	0.26	0.30

Habitat Type (%) : 10 **riffle** 60 **pool** 30 **glide**

Substrates (%) :

fines	24
small gravel	15
large gravel	10
cobble	50
boulders	1
bedrock	

Cover Components (%) :

canopy / vegetation	11
woody debris	6
cutbanks / roots	1
substrates (fry)	60
substrates (parr)	15
D_{90} (cm)	20

Turbidity slightly tannic **Compaction** moderate **Water Temp. (°C)** 6.3

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.45	1.00	0.10	0.41	0.20
0.5	0.30	0.00	0.98	0.93	1.00	0.60	0.90	0.70
1.0	0.56	0.00	0.21	1.00	0.70	1.00	0.90	0.80
1.5	0.60	0.00	0.21	1.00	0.70	1.00	0.90	0.80
2.0	0.51	0.00	0.29	1.00	0.80	1.00	0.90	0.80
2.5	0.45	0.01	0.50	1.00	0.90	1.00	0.90	0.80
3.0	0.45	0.01	0.50	1.00	0.90	1.00	0.90	0.80
3.5	0.39	0.01	0.66	1.00	0.90	0.80	0.90	0.80
4.0	0.31	0.00	0.85	0.98	1.00	0.60	0.90	0.75
4.5	0.14	0.00	1.00	0.45	1.00	0.10	0.41	0.20
4.7	0.00	0.00	1.00	0.17	1.00	0.00	0.10	0.04
Weighted Means	0.40	0.00	0.596	0.903	0.883	0.757	0.820	0.691

Electrofishing Population Estimates and Site Data

Site No.: 7 **Length (m):** 11.3 October 13, 1996

Stream: Bridge River mainstem **Area (m^2):** 22.6

Location: small secondary side channel on the south side of the mainstem 850 m upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 0+	30	42	37.2	0.4	6	4	18.0	0.80	0.33	1.59
RB 1+	67	75	71.0	3.6	2	0	2.0	0.09	0.32	0.18

Habitat Type (%) : 15 **riffle** 15 **pool** 70 **glide**

Substrates (%) :

fines	15
small gravel	35
large gravel	30
cobble	15
boulders	5
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	3
cutbanks / roots	6
substrates (fry)	80
substrates (parr)	5
D_{90} (cm)	8

Turbidity clear **Compaction** moderate **Water Temp. (°C)** 6.4

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
0.25	0.02	0.02	1.00	0.03	1.00	0.00	0.00	0.00
0.50	0.04	0.02	1.00	0.03	1.00	0.00	0.05	0.02
0.75	0.09	0.05	1.00	0.25	1.00	0.00	0.19	0.04
1.00	0.11	0.11	1.00	0.25	0.90	0.00	0.34	0.15
1.25	0.10	0.14	1.00	0.25	0.90	0.00	0.21	0.04
1.50	0.08	0.21	0.90	0.17	0.80	0.00	0.19	0.02
1.75	0.05	0.09	1.00	0.10	1.00	0.00	0.06	0.02
1.90	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.06	0.11	0.987	0.143	0.914	0.000	0.136	0.036

Electrofishing Population Estimates and Site Data

Site No.: 8 **Length (m):** 22.2 October 14, 1996

Stream: Bridge River Tributary A **Area (m²):** 75.5

Location: 900 m up a clear–flowing tributary located 1.8 km upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 45 **riffle** 10 **pool** 40 **glide** 5 **cascades**

Substrates (%) :

fines	20
small gravel	20
large gravel	5
cobble	35
boulders	20
bedrock	

Cover Components (%) :

canopy / vegetation	7
woody debris	6
cutbanks / roots	3
substrates (fry)	55
substrates (parr)	30
D_{90} (cm)	40

Turbidity clear **Compaction** high **Water Temp. (°C)** 4.2

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.25	1.00	0.00	0.19	0.04
0.5	0.18	0.08	1.00	0.66	1.00	0.20	0.79	0.42
1.0	0.20	0.03	1.00	0.66	1.00	0.30	0.75	0.34
1.5	0.32	0.21	0.77	0.98	0.80	0.45	0.92	0.28
2.0	0.10	0.35	0.13	0.23	0.44	0.00	0.03	0.00
2.5	0.12	0.06	1.00	0.35	1.00	0.00	0.32	0.14
3.0	0.18	0.02	1.00	0.66	1.00	0.20	0.75	0.34
3.3	0.01	0.00	1.00	0.25	1.00	0.00	0.19	0.04
Weighted Means	0.17	0.12	0.833	0.547	0.885	0.168	0.539	0.223

Electrofishing Population Estimates and Site Data

Site No.: 9 **Length (m):** 17.3 October 12, 1996
Stream: Bridge River mainstem **Area (m^2):** 51.9
Location: 26 m upstream of new bridge crossing of mainstem, 5.7 km upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 40 **riffle** 10 **pool** 35 **glide** 15 **rapids**

Substrates (%) :		**Cover Components (%) :**	
fines	15	canopy / vegetation	
small gravel	10	woody debris	
large gravel	10	cutbanks / roots	
cobble	35	substrates (fry)	> 70 ?
boulders	30	substrates (parr)	> 50 ?
bedrock		D_{90} (cm)	90

Turbidity high **Compaction** low–moderate **Water Temp. (°C)** 3.8

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
0.5	0.04	0.10	1.00	0.03	1.00	0.00	0.06	0.02
1.0	0.10	0.12	1.00	0.25	0.90	0.00	0.21	0.05
1.5	0.14	0.13	1.00	0.45	0.90	0.10	0.45	0.20
2.0	0.09	0.24	0.90	0.25	0.68	0.00	0.16	0.01
2.5	0.15	0.33	0.18	0.43	0.56	0.06	0.07	0.01
3.0	0.09	0.33	0.18	0.24	0.56	0.00	0.03	0.00
3.5	0.12	0.31	0.25	0.34	0.56	0.00	0.08	0.01
4.0	0.15	0.51	0.00	0.10	0.20	0.04	0.00	0.00
4.5	0.17	0.38	0.01	0.28	0.32	0.10	0.03	0.00
Weighted Means	0.11	0.29	0.557	0.249	0.669	0.028	0.118	0.033

Electrofishing Population Estimates and Site Data

Site No.: 10 **Length (m):** 16.1 October 12, 1996
Stream: Bridge River mainstem **Area (m^2):** 40.3
Location: mainstem flood channel, 800 m upstream of new bridge; 6.5 km upstream of McParlon Creek

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 50 **riffle** 20 **pool** 30 **glide**

Substrates (%) :

fines	10
small gravel	2
large gravel	8
cobble	20
boulders	60
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	
cutbanks / roots	
substrates (fry)	75
substrates (parr)	50
D_{90} (cm)	90

Turbidity clear **Compaction** low–moderate **Water Temp. (°C)** 5.6

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.00	0.00	1.00	0.17	1.00	0.00	0.19	0.04
0.50	0.16	0.01	1.00	0.55	1.00	0.20	0.54	0.26
0.75	0.19	0.33	0.18	0.63	0.56	0.12	0.12	0.02
1.00	0.19	0.02	1.00	0.66	1.00	0.20	0.75	0.34
1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.50	0.16	0.01	1.00	0.55	1.00	0.20	0.54	0.26
1.75	0.08	0.01	1.00	0.17	1.00	0.00	0.19	0.04
2.00	0.06	0.00	1.00	0.10	1.00	0.00	0.10	0.04
2.30	0.00	0.00	1.00	0.03	1.00	0.00	0.05	0.02
Weighted Means	0.11	0.07	0.802	0.340	0.843	0.089	0.298	0.125

Note : additional 75 m^2 sampled – no fish captured

Electrofishing Population Estimates and Site Data

Site No.: 11 **Length (m):** 17.6 October 12, 1996
Stream: Bridge River mainstem **Area (m^2):** 98.6
Location: 12 m downstream of Tributary B; top of mainstem flood channel, 850 m upstream of new bridge

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 10 **riffle** 55 **pool** 35 **glide**

Substrates (%) :

fines	10
small gravel	8
large gravel	10
cobble	25
boulders	32
bedrock	15

Cover Components (%) :

canopy / vegetation	2
woody debris	< 1
cutbanks / roots	
substrates (fry)	65
substrates (parr)	40
D_{90} (cm)	70

Turbidity clear **Compaction** moderate **Water Temp. (°C)** 5.6

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.17	0.80	0.00	0.21	0.02
0.3	0.16	0.35	0.13	0.51	0.44	0.12	0.09	0.00
0.5	0.22	0.06	1.00	0.77	1.00	0.30	0.93	0.43
1.0	0.15	0.05	1.00	0.45	1.00	0.10	0.41	0.20
1.5	0.14	0.01	1.00	0.45	1.00	0.10	0.41	0.20
2.0	0.09	0.04	1.00	0.25	1.00	0.00	0.19	0.04
2.5	0.12	0.00	1.00	0.35	1.00	0.00	0.31	0.14
3.0	0.15	0.00	1.00	0.45	1.00	0.10	0.41	0.20
3.5	0.14	0.02	1.00	0.45	1.00	0.10	0.41	0.20
4.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.0	0.06	0.00	1.00	0.10	1.00	0.00	0.10	0.04
5.3	0.00	0.00	1.00	0.03	1.00	0.00	0.05	0.02
Weighted Means	0.10	0.05	0.770	0.317	0.780	0.065	0.284	0.127

Electrofishing Population Estimates and Site Data

Site No.: 12 **Length (m):** 21.7 October 12, 1996
Stream: Bridge River Tributary B **Area (m^2):** 41.2
Location: 28 m upstream of recipient flood channel of the Bridge River mainstem

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 60 **riffle** 20 **pool** 20 **glide**

Substrates (%) :

fines	20
small gravel	10
large gravel	15
cobble	35
boulders	20
bedrock	

Cover Components (%) :

canopy / vegetation	10
woody debris	7
cutbanks / roots	10
substrates (fry)	55
substrates (parr)	30
D_{90} (cm)	50

Turbidity clear **Compaction** moderate–high **Water Temp. (°C)** 5.9

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.25	1.00	0.00	0.19	0.04
0.5	0.20	0.01	1.00	0.66	1.00	0.30	0.75	0.34
0.8	0.22	0.41	0.04	0.54	0.32	0.15	0.05	0.00
1.0	0.21	0.04	1.00	0.77	1.00	0.30	0.88	0.43
1.5	0.21	0.00	1.00	0.77	1.00	0.30	0.88	0.43
1.9	0.00	0.00	1.00	0.25	1.00	0.00	0.31	0.14
Weighted Means	0.18	0.08	0.874	0.595	0.911	0.209	0.594	0.273

Electrofishing Population Estimates and Site Data

Site No.: 13 **Length (m):** 18.1 October 12, 1996
Stream: Bridge River mainstem **Area (m²):** 57.9
Location: side channel on south side of mainstem, 1.1 km upstream of new bridge crossing

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 1 **riffle** 99 **pool** 0 **glide**

Substrates (%) :

fines	40
small gravel	1
large gravel	1
cobble	18
boulders	40
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	5
cutbanks / roots	
substrates (fry)	30
substrates (parr)	20
D_{90} (cm)	70

Turbidity near clear **Compaction** high **Water Temp. (°C)** 6.4

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.25	1.00	0.00	0.19	0.04
0.5	0.20	0.00	1.00	0.66	1.00	0.30	0.75	0.34
1.0	0.15	0.00	1.00	0.45	1.00	0.10	0.41	0.20
1.5	0.29	0.00	0.98	0.93	1.00	0.50	0.90	0.70
2.0	0.19	0.00	1.00	0.66	1.00	0.20	0.75	0.34
2.5	0.08	0.00	1.00	0.17	1.00	0.00	0.19	0.04
3.0	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
3.5	0.16	0.00	1.00	0.55	1.00	0.20	0.54	0.26
4.0	0.17	0.00	1.00	0.55	1.00	0.20	0.54	0.26
4.3	0.00	0.00	1.00	0.25	1.00	0.00	0.19	0.04
Weighted Means	0.15	0.00	0.998	0.476	1.000	0.170	0.484	0.248

Electrofishing Population Estimates and Site Data

Site No.: 14 **Length (m):** 10.1 October 12, 1996
Stream: Bridge River mainstem **Area (m^2):** 63.6
Location: quiet mainstem braid 1.4 km upstream of new bridge; 7.1 km upstream of McParlon Creek

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 25 **riffle** 45 **pool** 30 **glide**

Substrates (%) :

fines	20
small gravel	1
large gravel	1
cobble	10
boulders	68
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	12
cutbanks / roots	
substrates (fry)	80
substrates (parr)	70
D_{90} (cm)	80

Turbidity high **Compaction** high **Water Temp. (°C)** 3.6

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use: RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.17	0.00	1.00	0.45	1.00	0.10	0.41	0.20
0.5	0.11	0.00	1.00	0.25	1.00	0.00	0.31	0.14
1.0	0.02	0.00	1.00	0.03	1.00	0.00	0.00	0.00
1.5	0.08	0.00	1.00	0.17	1.00	0.00	0.19	0.04
2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.19	0.02	1.00	0.66	1.00	0.20	0.75	0.34
3.0	0.14	0.01	1.00	0.45	1.00	0.10	0.41	0.20
3.5	0.11	0.01	1.00	0.25	1.00	0.00	0.31	0.14
4.0	0.12	0.02	1.00	0.35	1.00	0.00	0.31	0.14
4.5	0.11	0.00	1.00	0.25	1.00	0.00	0.31	0.14
4.7	0.00	0.00	1.00	0.10	1.00	0.00	0.10	0.04
Weighted Means	0.10	0.01	0.894	0.274	0.894	0.037	0.287	0.126

Electrofishing Population Estimates and Site Data

Site No.: 15 **Length (m):** 14.6 October 13, 1996
Stream: McParlon Creek **Area (m^2):** 55.5
Location: 59 m upstream of the confluence with the Bridge River

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m
RB 1+	81	81	81.0	6.0	1	0	1.0	0.02	0.11	0.07

Habitat Type (%) : 25 **riffle** 15 **pool** 60 **glide**

Substrates (%) :

fines	10
small gravel	5
large gravel	5
cobble	30
boulders	50
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	
cutbanks / roots	
substrates (fry)	65
substrates (parr)	45
D_{90} (cm)	80

Turbidity high **Compaction** moderate–high **Water Temp. (°C)** 5.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.42	0.58	0.00	0.00	0.00	0.05	0.00	0.00
0.5	0.50	0.95	0.00	0.00	0.00	0.00	0.00	0.00
1.0	0.42	0.87	0.00	0.00	0.00	0.05	0.00	0.00
1.5	0.52	0.63	0.00	0.04	0.04	0.20	0.00	0.00
2.0	0.30	0.49	0.01	0.31	0.20	0.24	0.02	0.00
2.5	0.10	0.07	1.00	0.25	1.00	0.00	0.20	0.04
3.0	0.06	0.24	0.90	0.10	0.68	0.00	0.08	0.01
3.5	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
3.8	0.00	0.00	1.00	0.10	1.00	0.00	0.05	0.02
Weighted Means	0.29	0.68	0.396	0.122	0.397	0.067	0.062	0.011

Electrofishing Population Estimates and Site Data

Site No.: 16 **Length (m):** 22.5 October 14, 1996
Stream: McParlon Creek **Area (m²):** 94.5
Location: small braid 75 m upstream of the confluence with the Bridge River

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m
RB 1+	82	91	86.5	6.9	2	0	2.0	0.02	0.15	0.09
RB 2+	135	141	138.0	28.9	2	0	2.0	0.02	0.61	0.09

Habitat Type (%) : 25 **riffle** 15 **pool** 60 **glide**

Substrates (%) :

fines	55
small gravel	1
large gravel	4
cobble	15
boulders	25
bedrock	

Cover Components (%) :

canopy / vegetation	2
woody debris	15
cutbanks / roots	7
substrates (fry)	35
substrates (parr)	20
D_{90} (cm)	75

Turbidity high **Compaction** low **Water Temp. (°C)** 5.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use: RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	0.90	0.00	0.06	0.02
0.5	0.07	0.24	0.90	0.17	0.68	0.00	0.08	0.01
1.0	0.10	0.23	0.90	0.25	0.68	0.00	0.16	0.01
1.5	0.17	0.19	1.00	0.55	0.80	0.16	0.59	0.13
2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.10	0.20	1.00	0.25	0.80	0.00	0.21	0.02
3.0	0.08	0.17	1.00	0.17	0.80	0.00	0.21	0.03
3.5	0.12	0.22	0.90	0.35	0.68	0.00	0.31	0.05
4.0	0.00	0.00	1.00	0.10	0.90	0.00	0.11	0.05
Weighted Means	0.09	0.20	0.838	0.226	0.668	0.020	0.205	0.034

Electrofishing Population Estimates and Site Data

Site No.: 17 **Length (m):** 12.6 October 16, 1996
Stream: McParlon Creek **Area (m^2):** 41.6
Location: 74 m downstream of lowermost bridge crossing; 550 m upstream of the Bridge River

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m
RB 2+	104	110	107.0	15.2	2	0	2.0	0.05	0.73	0.16
RB 3+	199	199	199.0	90.7	1	0	1.0	0.02	2.18	0.08

Habitat Type (%) : 20 **riffle** 25 **pool** 55 **glide**

Substrates (%) :

fines	15
small gravel	10
large gravel	15
cobble	20
boulders	40
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	
cutbanks / roots	
substrates (fry)	60
substrates (parr)	50
D_{90} (cm)	> 150

Turbidity high **Compaction** moderate **Water Temp. (°C)** 1.5

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.35	0.29	0.23	0.99	0.56	0.52	0.30	0.05
0.5	0.39	0.31	0.17	0.98	0.50	0.48	0.23	0.05
1.0	0.25	0.05	1.00	0.86	1.00	0.40	0.90	0.51
1.5	0.32	0.18	0.85	0.98	0.80	0.48	0.98	0.38
2.0	0.15	0:16	1.00	0.45	0.80	0.08	0.45	0.13
2.5	0.06	0.09	1.00	0.10	1.00	0.00	0.10	0.05
3.0	0.04	0.01	1.00	0.03	1.00	0.00	0.05	0.02
3.2	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.22	0.20	0.786	0.608	0.826	0.266	0.446	0.180

Electrofishing Population Estimates and Site Data

Site No.:	18	**Length (m):**	19.7	October 16, 1996
Stream:	McParlon Creek	**Area (m^2):**	33.5	
Location:	1.2 km upstream of lowermost bridge crossing; 400 m upstream of falls			

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 15 **riffle** 35 **pool** 40 **glide** 10 **rapdis**

Substrates (%) :		**Cover Components (%) :**	
fines	10	canopy / vegetation	
small gravel	15	woody debris	
large gravel	15	cutbanks / roots	
cobble	15	substrates (fry)	50
boulders	45	substrates (parr)	50
bedrock		D_{90} (cm)	110

Turbidity high **Compaction** low–moderate **Water Temp. (°C)** 1.5

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.00	0.00	1.00	0.25	1.00	0.00	0.31	0.14
0.25	0.22	0.08	1.00	0.77	1.00	0.30	0.93	0.54
0.50	0.31	0.14	0.85	0.98	0.90	0.54	1.00	0.66
0.75	0.33	0.21	0.77	0.98	0.80	0.53	0.92	0.30
1.00	0.35	0.40	0.05	0.78	0.32	0.35	0.08	0.00
1.25	0.36	0.53	0.00	0.23	0.20	0.32	0.00	0.00
1.50	0.40	0.82	0.00	0.00	0.00	0.05	0.00	0.00
1.70	0.39	1.10	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.32	0.42	0.466	0.568	0.547	0.305	0.454	0.230

Note : additional 70 m^2 sampled – no fish captured

Electrofishing Population Estimates and Site Data

Site No.: 19 **Length (m):** 12.4 October 16, 1996
Stream: McParlon Creek Tibutary C **Area (m^2):** 64.5
Location: 24 m above bridge crossing; 150 m upstream of mouth (McParlon Creek)

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 45 **riffle** 20 **pool** 20 **glide** 15 **cascades**

Substrates (%) :

fines	5
small gravel	5
large gravel	15
cobble	40
boulders	35
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	
cutbanks / roots	
substrates (fry)	75
substrates (parr)	55
D_{90} (cm)	45

Turbidity clear **Compaction** high **Water Temp. (°C)** 1.2

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
0.5	0.05	0.00	1.00	0.10	1.00	0.00	0.05	0.02
1.0	0.15	0.06	1.00	0.45	1.00	0.10	0.43	0.20
1.5	0.24	0.27	0.55	0.86	0.68	0.26	0.51	0.06
2.0	0.34	0.41	0.03	0.69	0.32	0.35	0.05	0.00
2.5	0.41	1.47	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.41	0.16	0.50	1.00	0.72	0.72	1.00	0.50
3.5	0.39	0.10	0.66	1.00	0.90	0.80	0.95	1.00
4.0	0.24	0.24	0.90	0.86	0.68	0.28	0.74	0.13
4.5	0.13	0.10	1.00	0.35	1.00	0.10	0.43	0.25
4.9	0.09	0.09	1.00	0.25	1.00	0.00	0.20	0.05
5.1	0.00	0.00	1.00	0.10	1.00	0.00	0.05	0.02
Weighted Means	0.24	0.41	0.671	0.535	0.735	0.255	0.416	0.212

Note : nets blew out prior to being inspected for fish

Electrofishing Population Estimates and Site Data

Site No.: 20 **Length (m):** 8.4 Octber 8, 1996

Stream: Gwyneth Creek (Tributary 2) **Area (m^2):** 20.2

Location: 40 m downstream of road crossing; 230 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 0+	40	59	45.8	1.1	6	4	18.0	0.89	1.00	2.14
RB 1+	94	94	94.0	9.6	1	0	1.0	0.05	0.48	0.12
RB 2+	131	131	131.0	24.7	1	0	1.0	0.05	1.23	0.12

Habitat Type (%) : 40 **riffle** 40 **pool** 10 **glide** 10 **cascades**

Substrates (%) :		**Cover Components (%) :**	
fines	2	canopy / vegetation	10
small gravel	1	woody debris	
large gravel	2	cutbanks / roots	
cobble	20	substrates (fry)	85
boulders	60	substrates (parr)	65
bedrock	15	D_{90} (cm)	90

Turbidity clear **Compaction** high **Water Temp. (°C)** 8.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
0.5	0.05	0.00	1.00	0.10	1.00	0.00	0.05	0.02
0.7	0.17	0.08	1.00	0.55	1.00	0.20	0.57	0.33
1.0	0.10	0.06	1.00	0.25	1.00	0.00	0.20	0.04
1.5	0.17	0.07	1.00	0.55	1.00	0.20	0.57	0.26
2.0	0.03	0.05	1.00	0.03	1.00	0.00	0.05	0.02
2.5	0.04	0.19	1.00	0.03	0.80	0.00	0.06	0.01
2.6	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.08	0.07	1.000	0.223	0.977	0.058	0.220	0.095

Electrofishing Population Estimates and Site Data

Site No.: 21 **Length (m):** 11.3 October 8, 1996

Stream: Ault Creek (Tribitary 3) **Area (m^2):** 46.3

Location: 40 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		**Population Estimates**			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 5 **riffle** 10 **pool** 15 **glide** 70 **rapids**

Substrates (%) :

fines	8
small gravel	22
large gravel	10
cobble	20
boulders	35
bedrock	5

Cover Components (%) :

canopy / vegetation	
woody debris	< 1
cutbanks / roots	
substrates (fry)	70
substrates (parr)	40
D_{90} (cm)	75

Turbidity slight **Compaction** high **Water Temp. (°C)** 7.2

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.10	1.00	0.00	0.10	0.05
0.5	0.11	0.18	1.00	0.25	0.80	0.00	0.33	0.07
1.0	0.29	0.14	0.98	0.93	0.90	0.45	1.00	0.61
1.5	0.41	0.85	0.00	0.00	0.00	0.05	0.00	0.00
2.0	0.34	1.05	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.35	0.47	0.01	0.39	0.20	0.28	0.02	0.00
3.0	0.19	0.06	1.00	0.66	1.00	0.20	0.79	0.34
3.5	0.08	0.03	1.00	0.17	1.00	0.00	0.19	0.04
4.0	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
4.2	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
Weighted Means	0.22	0.52	0.641	0.295	0.619	0.116	0.288	0.130

Electrofishing Population Estimates and Site Data

Site No.: 22 **Length (m):** 16.9 October 8, 1996
Stream: Downton Tributary 4 **Area (m^2):** 52.4
Location: 21 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 35 **riffle** 15 **pool** 20 **glide** 30 **rapids**

Substrates (%) :

fines	15
small gravel	10
large gravel	15
cobble	35
boulders	25
bedrock	

Cover Components (%) :

canopy / vegetation	< 1
woody debris	< 1
cutbanks / roots	
substrates (fry)	75
substrates (parr)	40
D_{90} (cm)	50

Turbidity near clear **Compaction** very high **Water Temp. (°C)** 6.9

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5	0.01	0.02	1.00	0.03	0.50	0.00	0.00	0.00
1.0	0.03	0.16	1.00	0.03	0.80	0.00	0.06	0.01
1.5	0.17	0.00	1.00	0.55	1.00	0.20	0.54	0.26
2.0	0.18	0.13	1.00	0.66	0.90	0.20	0.83	0.34
2.5	0.12	0.83	0.00	0.00	0.00	0.00	0.00	0.00
3.0	0.09	0.87	0.00	0.00	0.00	0.00	0.00	0.00
3.5	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
3.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.08	0.34	0.635	0.174	0.480	0.054	0.193	0.082

Electrofishing Population Estimates and Site Data

Site No.: 23 **Length (m):** 8.6 October 8, 1996
Stream: Downton Tributary 5 **Area (m^2):** 33.5
Location: 140 m below bridge crosiing; 40 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 65 **riffle** 5 **pool** 20 **glide** 10 **rapids**

Substrates (%) :

fines	1
small gravel	2
large gravel	7
cobble	30
boulders	60
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	
cutbanks / roots	
substrates (fry)	70
substrates (parr)	50
D_{90} (cm)	40

Turbidity clear **Compaction** high **Water Temp. (°C)** 7.2

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.13	0.03	0.44	0.00	0.01	0.00
0.5	0.07	0.70	0.00	0.01	0.05	0.00	0.00	0.00
1.0	0.13	0.28	0.55	0.35	0.56	0.07	0.14	0.03
1.5	0.16	0.35	0.13	0.51	0.44	0.12	0.09	0.00
2.0	0.30	1.21	0.00	0.00	0.00	0.00	0.00	0.00
2.5	0.20	0.86	0.00	0.00	0.00	0.02	0.00	0.00
3.0	0.11	0.11	1.00	0.25	0.90	0.00	0.34	0.15
3.1	0.00	0.00	1.00	0.10	1.00	0.00	0.10	0.04
Weighted Means	0.15	0.73	0.233	0.167	0.308	0.032	0.072	0.019

Electrofishing Population Estimates and Site Data

Site No.: 24 **Length (m):** 14.1 October 9, 1996
Stream: Downton Tributary 8 **Area (m^2):** 18.3
Location: 40 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 40 **riffle** 15 **pool** 40 **glide** 5 **cascades**

Substrates (%) :

fines	75
small gravel	15
large gravel	5
cobble	4
boulders	1
bedrock	

Cover Components (%) :

canopy / vegetation	6
woody debris	45
cutbanks / roots	2
substrates (fry)	5
substrates (parr)	
D_{90} (cm)	5

Turbidity clear **Compaction** low **Water Temp. (°C)** 6.9

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use: RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.05	0.02
0.5	0.06	0.06	1.00	0.10	1.00	0.00	0.10	0.04
0.7	0.10	0.16	1.00	0.25	0.80	0.00	0.21	0.03
0.9	0.12	0.03	1.00	0.35	1.00	0.00	0.31	0.14
1.1	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
1.3	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
1.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.05	0.07	0.933	0.116	0.773	0.000	0.102	0.033

Electrofishing Population Estimates and Site Data

Site No.: 25 **Length (m):** 9.3 October 10, 1996
Stream: Jamie Creek (Tributary 9) **Area (m^2):** 28.8
Location: 130 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 55 **riffle** 10 **pool** 15 **glide** 10 **rapids**

Substrates (%) :

fines	2
small gravel	3
large gravel	5
cobble	32
boulders	50
bedrock	8

Cover Components (%) :

canopy / vegetation	2
woody debris	< 1
cutbanks / roots	
substrates (fry)	80
substrates (parr)	65
D_{90} (cm)	110

Turbidity high **Compaction** high **Water Temp. (°C)** 6.9

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
0.5	0.03	0.14	1.00	0.03	0.90	0.00	0.06	0.01
1.0	0.06	0.06	1.00	0.10	1.00	0.00	0.10	0.04
1.5	0.11	0.61	0.00	0.01	0.05	0.00	0.00	0.00
2.0	0.17	0.34	0.18	0.52	0.44	0.12	0.09	0.02
2.5	0.21	0.43	0.01	0.46	0.32	0.15	0.05	0.00
3.0	0.24	0.18	1.00	0.86	0.80	0.32	0.98	0.26
3.2	0.22	0.21	1.00	0.77	0.80	0.30	0.98	0.19
Weighted Means	0.13	0.33	0.561	0.296	0.575	0.087	0.185	0.045

Electrofishing Population Estimates and Site Data

Site No.: 26 **Length (m):** 18.8 October 10, 1996
Stream: Downton Tributary 10 **Area (m^2):** 16.9
Location: 70 m downstream of road crossing; 18 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 1+	111	111	111.0	15.1	1	0	1.0	0.06	0.89	0.05

Habitat Type (%) : 73 **riffle** 20 **pool** 7 **glide**

Substrates (%) :

fines	15
small gravel	5
large gravel	10
cobble	65
boulders	5
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	10
cutbanks / roots	
substrates (fry)	25
substrates (parr)	15
D_{90} (cm)	20

Turbidity clear **Compaction** moderate **Water Temp. (°C)** 7.7

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.17	1.00	0.00	0.10	0.04
0.1	0.13	0.00	1.00	0.35	1.00	0.10	0.41	0.20
0.2	0.14	0.07	1.00	0.45	1.00	0.10	0.43	0.20
0.3	0.15	0.05	1.00	0.45	1.00	0.10	0.41	0.20
0.4	0.17	0.00	1.00	0.55	1.00	0.20	0.54	0.26
0.5	0.17	0.07	1.00	0.55	1.00	0.20	0.57	0.26
0.6	0.19	0.08	1.00	0.66	1.00	0.20	0.79	0.42
0.7	0.16	0.01	1.00	0.55	1.00	0.20	0.54	0.26
0.8	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
0.9	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Weighted Means	0.12	0.04	0.974	0.389	0.934	0.116	0.398	0.195

Electrofishing Population Estimates and Site Data

Site No.: 27 **Length (m):** 18.5 October 10, 1996
Stream: Downton Tributary 10 **Area (m^2):** 24.1
Location: 18 m upstream of road crossing; 106 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 15 **riffle** 10 **pool** 25 **glide** 50 **cascades**

Substrates (%) :		**Cover Components (%) :**	
fines	30	canopy / vegetation	< 1
small gravel	3	woody debris	
large gravel	1	cutbanks / roots	
cobble	11	substrates (fry)	60
boulders	55	substrates (parr)	40
bedrock		D_{90} (cm)	70

Turbidity clear **Compaction** very high **Water Temp. (°C)** 7.7

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
0.2	0.04	0.04	1.00	0.03	1.00	0.00	0.05	0.02
0.4	0.07	0.21	0.90	0.17	0.80	0.00	0.10	0.02
0.6	0.13	0.27	0.55	0.35	0.68	0.07	0.23	0.03
0.8	0.15	0.09	1.00	0.45	1.00	0.10	0.43	0.25
1.0	0.11	0.03	1.00	0.25	1.00	0.00	0.31	0.14
1.2	0.03	0.01	1.00	0.03	1.00	0.00	0.05	0.02
1.3	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
Weighted Means	0.08	0.13	0.915	0.199	0.901	0.025	0.178	0.070

Electrofishing Population Estimates and Site Data

Site No.:	28	**Length (m):**	11.6	October 10, 1996
Stream:	Downton Tributary 11	**Area (m^2):**	26.7	
Location:	15 m upstream of the reservoir			

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 35 **riffle** 15 **pool** 40 **glide**

Substrates (%) :		**Cover Components (%) :**	
fines	50	canopy / vegetation	70
small gravel	5	woody debris	20
large gravel	5	cutbanks / roots	5
cobble	10	substrates (fry)	40
boulders	30	substrates (parr)	25
bedrock		D_{90} (cm)	60

Turbidity clear **Compaction** high **Water Temp. (°C)** 8.0

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.03	0.06	1.00	0.10	1.00	0.00	0.10	0.05
0.5	0.09	0.10	1.00	0.25	1.00	0.00	0.20	0.05
1.0	0.14	0.04	1.00	0.45	1.00	0.10	0.41	0.20
1.5	0.26	0.18	0.98	0.86	0.80	0.40	0.98	0.31
2.0	0.14	0.01	1.00	0.45	1.00	0.10	0.41	0.20
2.5	0.04	0.03	1.00	0.03	1.00	0.00	0.05	0.02
3.0	0.06	0.15	1.00	0.10	0.90	0.00	0.11	0.03
3.2	0.00	0.00	1.00	0.03	1.00	0.00	0.06	0.02
Weighted Means	0.12	0.10	0.997	0.338	0.958	0.094	0.341	0.129

Electrofishing Population Estimates and Site Data

Site No.: 29 **Length (m):** 9.6 October 17, 1996

Stream: Downton Tributary 12 **Area (m^2):** 28.8

Location: 22 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m
RB 3+	197	197	197.0	83.3	1	0	1.0	0.03	2.89	0.10

Habitat Type (%) : 25 **riffle** 35 **pool** 40 **glide**

Substrates (%) :

fines	8
small gravel	12
large gravel	10
cobble	25
boulders	45
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	10
cutbanks / roots	10
substrates (fry)	75
substrates (parr)	60
D_{90} (cm)	40

Turbidity clear **Compaction** high **Water Temp. (°C)** 1.4

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.18	0.10	0.56	0.00	0.01	0.00
0.5	0.10	0.67	0.00	0.01	0.05	0.00	0.00	0.00
1.0	0.15	0.84	0.00	0.00	0.00	0.01	0.00	0.00
1.5	0.15	0.11	1.00	0.45	0.90	0.10	0.45	0.23
2.0	0.26	0.67	0.00	0.03	0.05	0.08	0.00	0.00
2.5	0.34	0.18	0.85	0.98	0.80	0.56	0.98	0.40
2.9	0.20	0.05	1.00	0.66	1.00	0.30	0.75	0.34
3.0	0.00	0.00	1.00	0.25	1.00	0.00	0.19	0.04
Weighted Means	0.18	0.41	0.409	0.296	0.433	0.139	0.288	0.126

Electrofishing Population Estimates and Site Data

Site No.: 30 **Length (m):** 16.5 October 17, 1996
Stream: Downton Tributary 12 **Area (m^2):** 56.1
Location: 86 m upstream of reservoir; 35 m upstream of cascades

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 30 **riffle** 60 **pool** 10 **glide**

Substrates (%) :

fines	20
small gravel	10
large gravel	5
cobble	15
boulders	50
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	8
cutbanks / roots	2
substrates (fry)	60
substrates (parr)	50
D_{90} (cm)	50

Turbidity clear **Compaction** moderate **Water Temp. (°C)** 1.4

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.17	1.00	0.00	0.10	0.04
0.5	0.13	0.00	1.00	0.35	1.00	0.10	0.41	0.20
1.0	0.32	0.00	0.85	0.98	1.00	0.60	0.90	0.75
1.5	0.41	0.11	0.50	1.00	0.81	0.90	1.00	0.90
2.0	0.40	0.30	0.23	0.99	0.50	0.59	0.30	0.05
2.5	0.33	0.09	0.85	0.98	1.00	0.70	0.95	1.00
3.0	0.40	0.00	0.66	1.00	0.90	0.90	0.90	0.80
3.4	0.00	0.00	1.00	0.66	1.00	0.30	0.75	0.34
Weighted Means	0.30	0.09	0.724	0.816	0.886	0.561	0.693	0.555

Electrofishing Population Estimates and Site Data

Site No.:	31	**Length (m):**	16.7	October 10, 1996
Stream:	Downton Tributary 13	**Area (m^2):**	36.7	
Location:	50 m upstream of reservoir			

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 80 **riffle** 5 **pool** 15 **glide**

Substrates (%) :

fines	60
small gravel	10
large gravel	5
cobble	10
boulders	15
bedrock	

Cover Components (%) :

canopy / vegetation	25
woody debris	6
cutbanks / roots	
substrates (fry)	20
substrates (parr)	10
D_{90} (cm)	30

Turbidity clear **Compaction** high **Water Temp. (°C)** 8.2

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.25	0.25	0.56	0.00	0.08	0.01
0.5	0.22	0.63	0.00	0.03	0.05	0.06	0.00	0.00
1.0	0.17	0.67	0.00	0.02	0.05	0.03	0.00	0.00
1.5	0.13	0.54	0.00	0.08	0.13	0.03	0.00	0.00
1.9	0.00	0.38	0.01	0.09	0.20	0.00	0.00	0.00
Weighted Means	0.15	0.59	0.034	0.074	0.151	0.031	0.011	0.001

Electrofishing Population Estimates and Site Data

Site No.: 32 **Length (m):** 11.6 October 11, 1996
Stream: Downton Tributary 16 **Area (m²):** 62.6
Location: 15 m upstream of the reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m
RB 0+	68	76	72.0	3.7	2	0	2.0	0.03	0.12	0.17
RB 1+	79	103	90.7	7.8	3	0	3.0	0.05	0.37	0.26
RB 2+	114	133	123.0	19.8	3	0	3.0	0.05	0.95	0.26

Habitat Type (%) : 25 **riffle** 25 **pool** 50 **glide**

Substrates (%) :

fines	25
small gravel	40
large gravel	20
cobble	10
boulders	5
bedrock	

Cover Components (%) :

canopy / vegetation	3
woody debris	50
cutbanks / roots	5
substrates (fry)	30
substrates (parr)	5
D_{90} (cm)	10

Turbidity clear **Compaction** moderate – high **Water Temp. (°C)** 8.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
0.5	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
1.0	0.07	0.00	1.00	0.17	1.00	0.00	0.10	0.04
1.5	0.14	0.15	1.00	0.45	0.90	0.09	0.45	0.15
2.0	0.13	0.23	0.90	0.35	0.68	0.07	0.33	0.05
2.5	0.12	0.42	0.04	0.25	0.32	0.00	0.02	0.00
3.0	0.09	0.26	0.75	0.25	0.68	0.00	0.11	0.01
3.5	0.17	0.11	1.00	0.55	0.90	0.20	0.60	0.30
4.0	0.21	0.14	1.00	0.77	0.90	0.27	0.98	0.38
4.5	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
5.0	0.04	0.00	1.00	0.03	1.00	0.00	0.05	0.02
5.4	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.10	0.16	0.879	0.289	0.827	0.058	0.266	0.092

Electrofishing Population Estimates and Site Data

Site No.: 33 **Length (m):** 11.2 October 11, 1996
Stream: Downton Tributary 16 **Area (m^2):** 23.5
Location: 35 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m
RB 0+	75	75	75.0	4.3	1	0	1.0	0.04	0.18	0.09
RB 1+	109	109	109.0	12.8	1	0	1.0	0.04	0.54	0.09
RB 2+	114	137	124.3	19.2	3	0	3.0	0.13	2.45	0.27

Habitat Type (%) : 40 **riffle** 15 **pool** 20 **glide** 25 **rapids**

Substrates (%) :

fines	3
small gravel	5
large gravel	15
cobble	50
boulders	27
bedrock	

Cover Components (%) :

canopy / vegetation	5
woody debris	8
cutbanks / roots	12
substrates (fry)	80
substrates (parr)	60
D_{90} (cm)	35

Turbidity clear **Compaction** moderate – high **Water Temp. (°C)** 8.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.17	0.00	1.00	0.55	1.00	0.20	0.54	0.26
0.25	0.15	0.02	1.00	0.45	1.00	0.10	0.41	0.20
0.50	0.10	0.23	0.90	0.25	0.68	0.00	0.16	0.01
0.75	0.13	0.19	1.00	0.35	0.80	0.08	0.44	0.10
1.00	0.15	0.24	0.90	0.45	0.68	0.07	0.33	0.05
1.25	0.19	0.46	0.01	0.33	0.20	0.08	0.02	0.00
1.50	0.17	0.63	0.00	0.02	0.05	0.04	0.00	0.00
1.75	0.90	0.37	0.00	0.87	0.18	0.48	0.11	0.00
2.00	0.00	0.00	0.50	1.00	0.72	0.80	0.98	0.40
Weighted Means	0.26	0.31	0.570	0.437	0.556	0.169	0.278	0.087

Electrofishing Population Estimates and Site Data

Site No.: 34 **Length (m):** 16.3 October 16, 1996
Stream: Downton Tributary 17 **Area (m^2):** 21.2
Location: 15 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 20 **riffle** 30 **pool** 30 **glide** 20 **cascades**

Substrates (%) :

fines	40
small gravel	39
large gravel	1
cobble	10
boulders	10
bedrock	

Cover Components (%) :

canopy / vegetation	30
woody debris	5
cutbanks / roots	15
substrates (fry)	15
substrates (parr)	5
D_{90} (cm)	25

Turbidity clear **Compaction** high **Water Temp. (°C)** 2.0

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.03	0.00	1.00	0.10	1.00	0.00	0.05	0.02
0.25	0.07	0.00	1.00	0.17	1.00	0.00	0.10	0.04
0.50	0.14	0.09	1.00	0.45	1.00	0.10	0.43	0.25
0.75	0.21	0.27	0.55	0.77	0.68	0.20	0.50	0.05
1.00	0.17	0.34	0.18	0.52	0.44	0.12	0.09	0.02
1.25	0.14	0.12	1.00	0.45	0.90	0.10	0.45	0.23
1.40	0.08	0.04	1.00	0.25	1.00	0.00	0.32	0.17
Weighted Means	0.14	0.19	0.773	0.428	0.829	0.088	0.286	0.107

Electrofishing Population Estimates and Site Data

Site No.: 35 **Length (m):** 13.7 October 16, 1996

Stream: Downton Tributary 18 **Area (m^2):** 104.1

Location: first 15 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 10 **riffle** 50 **pool** 40 **glide**

Substrates (%) :

fines	100
small gravel	
large gravel	
cobble	
boulders	
bedrock	

Cover Components (%) :

canopy / vegetation	55
woody debris	60
cutbanks / roots	
substrates (fry)	0
substrates (parr)	0
D_{90} (cm)	< 0.1

Turbidity clear **Compaction** muddy **Water Temp. (°C)** 6.7

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m / s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.10	1.00	0.00	0.05	0.02
1.0	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
1.5	0.15	0.01	1.00	0.45	1.00	0.10	0.41	0.20
2.0	0.14	0.02	1.00	0.45	1.00	0.10	0.41	0.20
2.5	0.08	0.00	1.00	0.17	1.00	0.00	0.19	0.04
3.0	0.17	0.00	1.00	0.55	1.00	0.20	0.54	0.26
4.0	0.21	0.01	1.00	0.77	1.00	0.30	0.88	0.43
4.5	0.11	0.00	1.00	0.25	1.00	0.00	0.31	0.14
5.0	0.14	0.00	1.00	0.45	1.00	0.10	0.41	0.20
6.0	0.08	0.01	1.00	0.17	1.00	0.00	0.19	0.04
6.5	0.18	0.02	1.00	0.66	1.00	0.20	0.75	0.34
6.9	0.07	0.00	1.00	0.17	1.00	0.00	0.10	0.04
7.4	0.00	0.00	1.00	0.03	1.00	0.00	0.05	0.02
Weighted Means	0.12	0.01	1.000	0.369	1.000	0.086	0.369	0.162

Electrofishing Population Estimates and Site Data

Site No.: 36 **Length (m):** 19.7 October 11, 1996

Stream: Downton Tributary 19 **Area (m^2):** 15.8

Location: 23 m upstream of the reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 40 **riffle** 15 **pool** 45 **glide**

Substrates (%) :		**Cover Components (%) :**	
fines	5	canopy / vegetation	
small gravel	50	woody debris	45
large gravel	40	cutbanks / roots	
cobble	5	substrates (fry)	40
boulders		substrates (parr)	0
bedrock		D_{90} (cm)	5

Turbidity clear **Compaction** moderate – high **Water Temp. (°C)** 9.2

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0	0.01	0.17	1.00	0.03	0.40	0.00	0.00	0.00
2.0	0.04	0.21	0.90	0.03	0.80	0.00	0.06	0.01
3.0	0.03	0.14	1.00	0.03	0.90	0.00	0.06	0.01
4.0	0.07	0.09	1.00	0.17	1.00	0.00	0.10	0.05
5.0	0.11	0.36	0.13	0.23	0.44	0.00	0.04	0.00
6.0	0.14	0.44	0.01	0.27	0.32	0.05	0.02	0.00
7.0	0.09	0.19	1.00	0.25	0.80	0.00	0.21	0.02
8.0	0.11	0.27	0.55	0.25	0.68	0.00	0.17	0.02
9.0	0.07	0.03	1.00	0.17	1.00	0.00	0.10	0.04
10.0	0.03	0.09	1.00	0.03	1.00	0.00	0.06	0.02
10.4	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
Weighted Means	0.07	0.25	0.720	0.140	0.687	0.005	0.077	0.015

Electrofishing Population Estimates and Site Data

Site No.: 37 **Length (m):** 14.7 October 11, 1996

Stream: Downton Tributary 19 **Area (m²):** 20.6

Location: 43 m upstream of the reservoir

Species/ Cohort	Length (mm)			Mean	Capture		Population Estimates			
	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 45 **riffle** 15 **pool** 40 **glide**

Substrates (%) :

fines	5
small gravel	20
large gravel	10
cobble	50
boulders	15
bedrock	

Cover Components (%) :

canopy / vegetation	2
woody debris	17
cutbanks / roots	1
substrates (fry)	70
substrates (parr)	20
D_{90} (cm)	35

Turbidity clear **Compaction** moderate – high **Water Temp. (°C)** 9.2

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use					
			RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0	0.01	0.00	1.00	0.03	0.50	0.00	0.00	0.00
2.0	0.02	0.22	0.90	0.03	0.68	0.00	0.00	0.00
3.0	0.05	0.12	1.00	0.10	0.90	0.00	0.06	0.02
4.0	0.06	0.10	1.00	0.10	1.00	0.00	0.10	0.05
5.0	0.08	0.27	0.55	0.17	0.68	0.00	0.11	0.01
6.0	0.09	0.67	0.00	0.01	0.05	0.00	0.00	0.00
7.0	0.10	0.54	0.00	0.06	0.13	0.00	0.00	0.00
8.0	0.08	0.34	0.18	0.16	0.44	0.00	0.03	0.00
9.0	0.06	0.29	0.35	0.10	0.56	0.00	0.03	0.00
10.0	0.04	0.36	0.13	0.03	0.44	0.00	0.01	0.00
11.0	0.00	0.00	1.00	0.03	0.80	0.00	0.00	0.00
Weighted Means	0.05	0.35	0.510	0.073	0.525	0.000	0.031	0.007

Electrofishing Population Estimates and Site Data

Site No.: 38 **Length (m):** 14.6 October 9, 1996
Stream: Downton Tributary 20 **Area (m^2):** 39.4
Location: 7 m upstream of reservoir

Species/	Length (mm)			Mean	Capture		Population Estimates			
Cohort	Min.	Max.	Mean	Wt(g)	1	2	Pop.*n*	n/m^2	g/m^2	n/m
RB 0+	27	56	41.4	0.8	21	4	25.9	0.66	0.54	1.78

Habitat Type (%) : 40 **riffle** 10 **pool** 20 **glide** 30 **cascades**

Substrates (%) :		**Cover Components (%) :**	
fines	15	canopy / vegetation	
small gravel	15	woody debris	3
large gravel	10	cutbanks / roots	< 1
cobble	25	substrates (fry)	70
boulders	35	substrates (parr)	40
bedrock		D_{90} (cm)	40

Turbidity clear **Compaction** high **Water Temp. (°C)** 10.1

Transect and Associated Hydraulic Suitability Data

Length	Depth	Velocity	Probability of Use					
(m)	(m)	(m/s)	RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.00	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
0.25	0.04	0.03	1.00	0.03	1.00	0.00	0.05	0.02
0.50	0.09	0.21	0.90	0.25	0.80	0.00	0.19	0.02
0.75	0.06	0.00	1.00	0.10	1.00	0.00	0.10	0.04
1.00	0.01	0.10	1.00	0.03	0.50	0.00	0.00	0.00
1.25	0.08	0.18	1.00	0.17	0.80	0.00	0.21	0.02
1.50	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
1.75	0.13	0.21	0.90	0.35	0.80	0.08	0.41	0.08
2.00	0.17	0.17	1.00	0.55	0.80	0.16	0.60	0.17
2.25	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75	0.03	0.00	1.00	0.03	1.00	0.00	0.05	0.02
3.00	0.00	0.00	1.00	0.03	0.50	0.00	0.00	0.00
Weighted Means	0.07	0.11	0.900	0.170	0.788	0.020	0.169	0.036

Electrofishing Population Estimates and Site Data

Site No.: 39 **Length (m):** 18.2 October 9, 1996
Stream: Downton Tributary 20 **Area (m²):** 61.9
Location: immediately above cascade located 17 m upstream of road

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m²	g/m²	n/m

NO FISH CAPTURED

Habitat Type (%) : 15 **riffle** 5 **pool** 15 **glide** 60 **cascades**

Substrates (%) :		**Cover Components (%) :**	
fines	enter	canopy / vegetation	
small gravel		woody debris	
large gravel		cutbanks / roots	< 1
cobble		substrates (fry)	80
boulders		substrates (parr)	55
bedrock		D_{90} (cm)	70

Turbidity clear **Compaction** very high **Water Temp. (°C)** 10.1

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.00	0.00	1.00	0.10	1.00	0.00	0.05	0.02
0.5	0.09	0.00	1.00	0.25	1.00	0.00	0.19	0.04
1.0	0.14	0.02	1.00	0.45	1.00	0.10	0.41	0.20
1.5	0.08	0.07	1.00	0.17	1.00	0.00	0.20	0.04
2.0	0.10	0.14	1.00	0.25	0.90	0.00	0.21	0.04
2.5	0.08	0.21	0.90	0.17	0.80	0.00	0.19	0.02
3.0	0.04	0.00	1.00	0.03	1.00	0.00	0.05	0.02
3.2	0.00	0.00	1.00	0.03	1.00	0.00	0.00	0.00
Weighted Means	0.09	0.07	0.984	0.214	0.953	0.016	0.197	0.055

Electrofishing Population Estimates and Site Data

Site No.: 40 | **Length (m):** 24.5 | October 9, 1996
Stream: Downton Tributary 22 | **Area (m^2):** 18.4
Location: 10.5 m upstream of reservoir

Species/ Cohort	Length (mm) Min.	Max.	Mean	Mean Wt(g)	Capture 1	2	Population Estimates Pop.*n*	n/m^2	g/m^2	n/m

NO FISH CAPTURED

Habitat Type (%) : 35 **riffle** 20 **pool** 45 **glide**

Substrates (%) :

fines	20
small gravel	15
large gravel	10
cobble	35
boulders	20
bedrock	

Cover Components (%) :

canopy / vegetation	
woody debris	15
cutbanks / roots	
substrates (fry)	60
substrates (parr)	40
D_{90} (cm)	40

Turbidity clear **Compaction** high **Water Temp. (°C)** 8.8

Transect and Associated Hydraulic Suitability Data

Length (m)	Depth (m)	Velocity (m/s)	Probability of Use RB fry	RB parr	BT fry	BT parr	Chinook	Coho
0.0	0.08	0.01	1.00	0.25	1.00	0.00	0.19	0.04
1.0	0.09	0.01	1.00	0.25	1.00	0.00	0.19	0.04
2.0	0.05	0.06	1.00	0.10	1.00	0.00	0.06	0.02
3.0	0.04	0.25	0.75	0.03	0.68	0.00	0.04	0.00
4.0	0.10	0.11	1.00	0.25	0.90	0.00	0.21	0.05
5.0	0.03	0.35	0.13	0.03	0.44	0.00	0.01	0.00
6.0	0.14	0.01	1.00	0.45	1.00	0.10	0.41	0.20
7.0	0.07	0.09	1.00	0.17	1.00	0.00	0.10	0.05
8.0	0.02	0.40	0.06	0.02	0.32	0.00	0.00	0.00
9.0	0.03	0.30	0.35	0.03	0.56	0.00	0.02	0.00
10.0	0.06	0.15	1.00	0.10	0.90	0.00	0.11	0.03
11.0	0.08	0.10	1.00	0.17	1.00	0.00	0.20	0.05
12.0	0.02	0.40	0.06	0.02	0.32	0.00	0.00	0.00
13.0	0.13	0.02	0.90	0.17	0.80	0.00	0.10	0.02
Weighted Means	0.06	0.12	0.715	0.141	0.771	0.008	0.115	0.036

Appendix 7.

Fish captures and sampling specifics for gill netting of Downton Lake; October 23–26, 1996.

Note :

RB = rainbow trout

Gill Netting Fish Capture Data

Floating Net **Downton Lake – Site X**

Set:	17:00 hrs. October 23, 1996	Shallow End:	15.5 m
Retrieved:	10:30 hrs. October 24, 1996	Deep End:	25.5 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	119	18.4	1 +	M	imm	gut empty	0	2
RB	132	25.0	1 +	?	imm	gray mush in gut / full	0	23
RB	158	48.7	2 +	M	near mat	gray mush in gut / part full	2	21
RB	160	49.8	2 +	M	mg	gray mush in gut / full	1	22
RB	167	50.1	2 +	F	imm	gut empty	0	16
RB	169	47.8	2 +	M	imm	insect parts and gray mush in gut	2	20
RB	171	58.9	2 +	M	mg	gray mush in gut / half full	1	14
RB	178	74.2	2 +	M	mat	gray mush in gut / full	0	1
RB	180	73.2	2 +	M	mg	gray mush in gut / full	0	17
RB	199	91.6	2 +	F	imm	gray mush in gut / full	0	15
RB	217	124.8	3 +	F	imm	tiny ovaries / gray mush in gut	1	7
RB	221	127.1	2 +	F	imm	tiny ovaries / gut empty	0	44
RB	221	130.3	2 +	F	imm	tiny ovaries / gray stuff (full)	0	54
RB	229	129	2 +	F	imm	gray–green mush / half full	1	11
RB	231	136.5	2 +	F	imm	tiny ovaries / gray mush (half full)	0	45
RB	231	147.1	2 +	F	imm	tiny ovaries / gut near empty	0	43
RB	232	143.8	3 +	M	mat (kelt ?)	gray mush in gut / half full	0	6
RB	235	150.2	3 +	M	imm	gut empty	1	19
RB	236	159.9	3 +	M	near mat	gut empty	0	18
RB	241	158	2 +	F	imm	gray mush in gut / full	0	13
RB	241	170.8	2 +	F	mg	2 mm eggs / gray mush (full)	0	41
RB	243	156.6	2 +	F	imm	tiny ovaries / gut empty	0	47
RB	246	191.9	2 +	F	imm	tiny ovaries / gray mush (part full)	0	37
RB	249	208	3 +	M	mat	gray mush in gut / half full	2	4
RB	259	199.4	3 +	M	imm	gut empty	1	5
RB	264	204	3 +	M	mat	gut empty	0	42
RB	266	232	3 +	M	mat	gray mush in gut / half full	2	10
RB	268	212	3 +	F	imm	tiny ovaries / gray mush (full)	2	29
RB	271	250	3 +	F	mg	2 mm eggs / gut empty	1	51
RB	272	236	3 +	M	mat	gut empty	2	8
RB	274	258	3 +	M	mat	green–gray mush in gut / full	1	26
RB	280	274	3 +	M	kelt	stones, fly, and gray mush in gut	1	28
RB	285	256	3 +	F	mg	3 mm eggs / gray mush (part full)	1	30
RB	287	244	2 +	F	imm	granular ovaries / gray mush (half)	0	12
RB	292	278	3 +	M	near mat	gray mush in gut / full	0	33
RB	292	282	3 +	F	mg	2 mm eggs / gut empty	0	38
RB	295	270	4 +	M	kelt	green–gray mush in gut / full	0	24

(cont'd)

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mg = maturing; fish likely to spawn within 12 months
mat = mature; fully developed, but not in spawning condition
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning

Gill Netting Fish Capture Data

Floating Net (cont'd) **Downton Lake – Site X**

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	296	312	3 +	F	mg	2 mm eggs / gut empty	1	50
RB	297	328	3 +	F	mg	1.5 mm eggs / gut empty	1	3
RB	300	328	4 +	M	kelt ?	tiny testes / gut empty	1	46
RB	305	318	4 +	F	mg	1.5 mm eggs / gray mush (full)	1	25
RB	306	296	3 +	F	mg	2 mm eggs / gut empty	2	52
RB	306	310	4 +	F	imm	granular ovaries / gut empty	0	40
RB	310	338	4 +	M	kelt	gray mush in gut / full	1	55
RB	312	324	5 +	M	kelt	gut empty	2	9
RB	313	346	4 +	F	mg	2.5 mm eggs / gray mush (part full)	2	31
RB	315	402	4 +	F	mg	3 mm eggs / gray mush (gut full)	0	49
RB	316	322	4 +	F	kelt	granular ovaries	1	56
RB	317	346	3 +	F	mat	atrophied eggs, plus developing eggs	0	53
RB	323	344	4 +	M	mat	gray mush in gut / half full	0	34
RB	324	374	5 +	F	mg	3 mm eggs / gray mush (part full)	0	36
RB	325	394	4 +	F	mg	3 mm eggs / green–gray mush (half)	1	57
RB	330	386	5 +	F	mg	2.5 mm eggs / gut near empty	2	39
RB	331	392	5 +	M	near mat	4 mm eggs / gut empty	0	35
RB	338	406	3 +	F	mg	2 mm eggs / gray stuff (full)	0	48
RB	341	394	4 +	F	kelt	eroded fins / gray mush (part full)	1	27
RB	345	382	4 +	F	mat	atrophied eggs, plus developing eggs	0	32

Sinking Net **Downton Lake – Site X**

Set: 16:30 hrs. October 23, 1996 Shallow End: 1.6 m
Retrieved: 10:45 hrs. October 24, 1996 Deep End: 15.5 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	217	114.3	3 +	F	imm	granular ovaries / gray mush in gut	1	60
RB	231	142.4	3 +	F	imm	granular ovaries / gut empty	1	59
RB	233	129.9	3 +	F	imm	tiny ovaries / gut empty	1	58
RB	303	346	3 +	F	mg	3 mm eggs / gut near empty	0	62
RB	305	322	3 +	F	imm	granular ovaries / gut empty	0	61
RB	307	300	4 +	M	mg	stones and green eggs in gut	2	65
RB	312	336	4 +	M	mg	gray mush and benthos in gut	1	66
RB	319	368	4 +	F	mg	3 mm eggs / grat mush in gut	0	67
RB	330	370	4 +	M	kelt ?	gut empty	2	63
RB	334	412	4 +	F	mg	3 mm eggs / gut near empty	2	64

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mg = maturing; fish likely to spawn within 12 months
mat = mature; fully developed, but not in spawning condition
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning

Gill Netting Fish Capture Data

Floating Net **Downton Lake – Site Y**

Set: 14:45 hrs. October 24, 1996 Shallow End: 9.9 m
Retrieved: 10:00 hrs. October 25, 1996 Deep End: 15.2 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	166	51.9	2 +	F	mg	tiny ovaries / gray mush in gut (full)	1	1
RB	198	96.7	2 +	M	mat	gray mush in gut / full	0	3
RB	210	127.5	3 +	M	mat	gray mush in gut / full	0	5
RB	217	114.4	2 +	M	imm	gut empty	0	4
RB	224	127.9	3 +	F	mg	tiny ovaries / gray mush in gut (half)	1	2
RB	226	148.3	3 +	M	mat	gut empty	1	8
RB	234	144.2	3 +	M	mat	spawning colours / gut empty	0	7
RB	236	163.4	3 +	M	mat	gray mush in gut / half full	1	6
RB	247	175.9	3 +	M	imm	gray mush in gut / part full	1	12
RB	254	202	3 +	M	mat	gray mush in gut / part full	1	9
RB	258	194	3 +	M	kelt	eroded caudal / gut empty	0	22
RB	258	204	3 +	M	imm	gray mush in gut	1	10
RB	267	242	4 +	F	mg	2 mm eggs / gray mush in gut (full)	2	14
RB	271	238	3 +	F	kelt ?	granular ovaries / gut empty	0	21
RB	273	240	3 +	M	mat	gut empty	0	23
RB	285	266	3 +	M	mat	gut empty	0	20
RB	291	244	3 +	M	imm	green–gray mush in gut	1	15
RB	293	280	4 +	F	kelt ?	granular ovaries / gut empty	1	18
RB	296	286	3 +	M	kelt	gut empty	0	17
RB	310	318	5 +	F	kelt ?	granular ovaries / gut empty	0	19
RB	311	324	4 +	F	kelt	eroded caudal / gray mush in gut (full)	1	13
RB	323	366	4 +	F	near ripe	4 mm eggs / gray mush and stones	0	11
RB	328	368	4 +	F	kelt	next eggs developing (2 mm)	0	16

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mg = maturing; fish likely to spawn within 12 months
mat = mature; fully developed, but not in spawning condition
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning

Gill Netting Fish Capture Data

Sinking Net | **Downton Lake – Site Y**

Set: 14:30 hrs. October 24, 1996 | Shallow End: 1.2 m
Retrieved: 10:15 hrs. October 25, 1996 | Deep End: 9.9 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suspected Age at Lake Entry	Scale Sample No.
RB	107	13.5	1 +	?	imm	faint parr marks / very silvery	0	24
RB	138	24.0	2 +	?	imm	gray mush in gut / part full	1	25
RB	170	52.2	2 +	F	imm	tiny ovaries / gray mush (part full)	1	26
RB	251	178.2	3 +	M	mg	gut empty	0	27
RB	269	228	3 +	M	mat	gut empty	0	28
RB	279	258	3 +	F	kelt	granular ovaries / gut empty	0	37
RB	302	306	4 +	F	kelt ?	1 mm eggs / wood, stones in gut	0	35
RB	313	354	4 +	F	mg	2.5 mm eggs / gut empty	0	34
RB	315	326	5 +	F	mg	3.5 mm eggs / gut empty	1	30
RB	318	306	5 +	F	mat	full of atrophied eggs / gut empty	1	29
RB	322	368	4 +	F	mg	3 mm eggs / gray mush in gut (half)	0	32
RB	336	396	5 +	M	mat	wood, gray mush, stones in gut	0	31
RB	337	420	5 +	M	mat	stones and wood in gut	1	33
RB	346	390	4 +	M	mat	spawning colours / gut near empty	0	36

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mg = maturing; fish likely to spawn within 12 months
mat = mature; fully developed, but not in spawning condition
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning

Gill Netting Fish Capture Data

Floating Net

Downton Lake – Site Z

Set: 14:15 hrs. October 25, 1996
Retrieved: 09:30 hrs. October 26, 1996

Shallow End: 11.3 m
Deep End: 12.1 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	101	13.5	1 +	?	imm	parr marks	0	1
RB	178	66.1	2 +	M	mg	parr marks / gray mush (half full)	1	2
RB	192	76.6	2 +	?	imm	gray mush in gut / full	0	3
RB	209	104.9	3 +	M	ripe	gut empty	1	6
RB	231	142.2	3 +	F	mg	granular ovaries / gut empty	0	5
RB	244	168.3	3 +	F	mg	granular ovaries / gray mush (full)	1	7
RB	252	191.9	3 +	M	imm	gray mush, red oligochaete / full	1	10
RB	260	210	3 +	F	mg	granular ovaries / gray mush (near full)	0	4
RB	262	220	3 +	F	kelt	atrophied eggs / gray mush (full)	1	29
RB	267	240	3 +	M	mat	spawning colours / gray mush, worm	1	30
RB	282	280	3 +	M	mat	gray mush in gut / part full	2	14
RB	283	248	3 +	M	ripe	gut empty	1	11
RB	285	266	3 +	F	mg	4 mm eggs / gray–green mush, insects	2	33
RB	291	284	3 +	F	imm	0.5 mm eggs / gray–geen mush, stones	2	34
RB	296	300	3 +	F	mg	2 mm eggs / gray–green mush in gut	0	20
RB	297	302	3 +	M	imm	very silvery / gray mush (full)	1	21
RB	303	320	4 +	M	ripe	partially spawned, coloured / gut empty	0	17
RB	310	316	5 +	F	mg	2.5 mm eggs / gut empty	2	12
RB	311	350	4 +	F	mg	3 mm eggs / gut empty	1	18
RB	312	382	4 +	F	mg	2.5 mm eggs / gray mush, stones (full)	1	13
RB	313	328	5 +	M	kelt	gray–green mush in gut / half full	2	35
RB	315	334	4 +	M	mat	gray mush in gut / full	0	27
RB	316	322	5 +	M	mat	wood. gray matter in gut / near empty	1	23
RB	317	338	4 +	F	mg	3.5 mm eggs / gray–green mush in gut	0	26
RB	318	326	4 +	F	imm	1.5 mm eggs / gray–green mush in gut	0	37
RB	319	338	5 +	M	mat	gray–green mush in gut / full	1	32
RB	319	350	4 +	F	mg	2.5 mm eggs / gray–green mush (full)	0	24
RB	320	358	5 +	F	mg	granular ovaries / gray mush, worms	0	19
RB	322	332	4 +	F	kelt ?	granular ovaries / gray mush (part full)	0	9
RB	323	362	5 +	F	mg	3 mm eggs / gray mush (half full)	1	15
RB	324	344	4 +	M	kelt	gray–green mush in gut / full	1	36
RB	325	378	4 +	F	mg	4 mm eggs / gray mush (full)	0	25
RB	330	392	4 +	F	mg	3 mm eggs / gut empty	0	16
RB	335	372	4 +	F	over ripe	atrophying eggs / gray mush (full)	0	28
RB	336	420	4 +	F	near ripe	loose 4 mm eggs / spawning colours	0	8
RB	337	434	5 +	F	mg	3.5 mm eggs / gray mush in gut (full)	1	22
RB	340	394	5 +	M	kelt	gut empty	1	31

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mg = maturing; fish likely to spawn within 12 months
mat = mature; fully developed, but not in spawning condition
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning

Gill Netting Fish Capture Data

Sinking Net **Downton Lake – Site Z**

Set:	14:00 hrs. October 25, 1996	Shallow End:	1.4 m
Retrieved:	09:15 hrs. October 26, 1996	Deep End:	11.3 m

Species	Fork Length (mm)	Weight (g)	Age	Sex	Status of Reproductive Development	Stomach Contents and Other Observations	Suggested Age at Lake Entry	Scale Sample No.
RB	110	14.2	1 +	?	imm	parr marks √	0	38
RB	110	15.3	1 +	?	imm	parr marks √	0	39
RB	121	20.8	2 +	?	imm	faint parr marks √	1	41
RB	122	18.1	1 +	?	imm	faint parr marks √	0	40
RB	127	23.6	2 +	?	imm	parr marks	2	43
RB	140	25.9	2 +	?	imm	faint parr marks	1	42
RB	273	268	3 +	M	near mat	gut empty √	0	45
RB	282	244	3 +	M	near mat	gut empty √	0	44

Key: Status of Reproductive Development

imm = immature; no significant development of organs
mat = mature; fully developed, but not in spawning condition
mg = maturing; fish likely to spawn within 12 months
ripe = fully developed, and in spawning condition
kelt = recovering from recent spawning