Habitat Inventory and Enhancement Needs for the Endangered Salish Sucker (*Catostomus Sp.*) and Nooksack Dace (*Rhinichthys Sp.*)

by

Mike Pearson

British Columbia Conservation Foundation

Fisheries Project Report No.76
1998

BRITISH COLUMBIA

Province of British Columbia
Ministry of Fisheries

ACKNOWLEDGMENTS

A number of people contributed greatly to this work. In particular I wish to thank Jordan Rosenfeld for many ideas gleaned from hours of discussion, and Tyese Patton for her able field assistance. The Langley Environmental Partners Society, the Bertrand Creek Enhancement Committee, and GVRD Parks, quickly seized the opportunity to complete some restoration work on key reaches of Cave and Pepin Creeks. Kim Anderson of LEPS and Gordon Smith of the GVRD and the BCEC were especially helpful. Kathleen Fry of Ducks Unlimited Canada facilitated their ongoing feasibility study on the Cave Creek headwater wetland restoration. Gordon Haas and Krista Payette of MoELP, Dr. J.D. McPhail of UBC, and Marina Stjepobic of LEPS provided technical assistance or valuable resources at various stages. Numerous landowners, in particular Fred and Maureen Pepin, George Feddes, Don and Ila Burke, and John and Pat Lawrence contributed invaluable historical information about the creeks (in addition to the odd glass of lemonade). This research was funded by the Habitat Conservation Trust Fund.

TABLE OF CONTENTS

INTRODUCTION

Salish sucker (*Catostomus sp.*) and Nooksack dace (*Rhinichthys sp.*) are undescribed members of the Chehalis fauna, a unique assemblage of freshwater fish that survived continental glaciation in an ice-free refuge in Washington state. They are designated endangered both provincially and nationally (Campbell 1990; Cannings 1992; McPhail 1997) and both species are in rapid decline within Canada (McPhail 1987, 1997; Inglis et al. 1992, 1994; Pearson 1998). The Canadian distribution of both species is extremely limited. Dace currently inhabit only Bertrand, Cave, Pepin and Fishtrap Creeks (Inglis et al. 1994). All are tributaries of the Nooksack River in Washington State. Sucker are found in these streams and in the Salmon River, a tributary of the Fraser (Inglis et al. 1992). Small populations may also persist in the Salwein River near Chilliwack (J.D. McPhail, UBC, pers. comm.), although their present status is unknown.

The Salish sucker is considered extirpated from the Little Campbell River (circa 1976; McPhail 1987) and from Semiault Creek (a Fraser River tributary near Chilliwack; Inglis et al. 1992). Both it and the Nooksack dace have also disappeared from Howes Creek, a tributary of Bertrand (Inglis et al. 1992, 1994). Dace remain abundant only in Bertrand Creek south of 16th Avenue (Inglis et al. 1994; Pearson, unpublished data) and only lower Pepin Creek contains healthy numbers of Salish sucker (Inglis et al. 1992; McAdam 1995 MS).

In keeping with its increased commitment to biodiversity (Anon. 1996), the B.C. Ministry of Environment, Lands and Parks has supported several research projects since 1990 aimed at increasing our understanding of these species to the point that management is possible. Building on earlier studies by McPhail (1967, 1987), Inglis and coworkers (1992, 1994) studied broad scale distribution patterns and adult habitat requirements during summer. They found that Nooksack dace, like their close relatives the longnose dace (*Rhinichthys cataractae),* are bottom dwelling riffle specialists as adults, preferring water depths of 10 to 19 cm at velocities of 25-30cm/s over gravel, cobble or small boulders. They spawn at night, usually at the head of riffles and the young inhabit slow moving backwater pools and marginal habitat over sand and mud substrates (McPhail 1997). Adults appear to overwinter in interstitial spaces in cobble riffles (Pearson 1998). Salish suckers inhabit a relatively broad range of habitats within streams and are found in a variety of water velocities, depths, and hydraulic types but are most often captured in slow currents over sand or silt substrate in areas with in-stream vegetation and over-stream cover (Inglis et al. 1992). Winter habitat is unknown, but it seems likely that they require off-channel refuge during periods of high flow. Suckers also require gravel riffles for spawning. Both species appear to be benthic insectivores (McPhail 1987, 1997). Life history information and distribution patterns were recently reviewed in detail by Pearson (1998).

Although our understanding of Salish sucker and Nooksack dace habitat requirements is incomplete, it is clear that action to restore and stabilize populations is needed immediately given the grave and declining status of these species in Canada. The purpose of this study is to inventory the extent and condition of habitat in the Canadian streams in which Salish sucker and Nooksack dace occur, and to identify and prioritize restoration needs based on available life history information for both species.

CONTEXT

The conundrum constantly facing people engaged in habitat restoration is "Restoration to what?" The Fraser Valley, in which these fish have evolved for the past several thousand years, has been completely transformed in just the past 200 (see Healey 1997 for overview). Prior to European colonization the landscape was dominated by temperate rainforest and wetlands (M. North, University of British Columbia pers. comm.) - two of the most biologically productive habitats on the planet. These have been almost completely replaced by pasture land, row-crop agriculture, aggregate mining, and urban landscapes.

A recent study of the plant community of the Fraser Valley found that 25% of native species were rare, that fully 43% of species outside cultivation were non-native, and that over 175 of these non-natives had arrived since 1980 (Healey 1997). While many invading species are quite benign in effect and serve only to increase diversity (Lodge 1993) some, like purple loosestrife (*Lythrum salicaria*), are dramatically altering riparian and wetland habitats.

To speak of restoring such systems to their pristine state is clearly unrealistic. Our society, with its cleared farmland, imported species, expanding urban centres and appetite for wood fibre and aggregates is not about to disappear and allow native forests and wetlands to reestablish themselves. That said, the question becomes one of restoring a self-sustaining (although much reduced), ecosystem with as full a complement of native species as possible. This will only be accomplished through the restoration and maintenance of basic ecosystem.

For fish habitat the list of important parameters will include the creek's flow regime, water temperature, water quality, and the physical structure of the channel and riparian zones. All of these are profoundly affected by watershed scale factors, particularly land use. Successful long term restoration and management of fish populations, including those of the Salish sucker and Nooksack dace, must be conceived and implemented at the watershed scale and consider all life history stages. Excellent adult and rearing habitat will be of no use without a nearby spawning area, and restoration of all three will be of little help to the fish if upstream conditions produce lethal summer temperatures, or if the reach drys up in August due to storm-sewer interception of groundwater recharge during the rainy season.

THE STUDY AREA

The Canadian range of Salish sucker and Nooksack dace is restricted to the central Fraser Valley to the south of the Fraser River in the municipalities of Langley and Abbotsford (figure 1). The Salmon River flows north and west into the Fraser, while Cave, Bertrand, Pepin and Fishtrap Creek flow south over the international border to the Nooksack River system of Washington State.

Climatically, the area is characterized by warm rainy winters and relatively cool, dry summers. Annual rainfall averages 1310 mm at Abbotsford Airport (elevation 58 m) and is typically highest in November and lowest in July (figure 2). Most groundwater recharge occurs during the winter months when precipitation is heaviest and evaporation and evapotranspiration are minimized. Between June and September the climate is relatively dry and during drought periods evapotranspiration may exceed the average seasonal precipitation (Halstead, 1986).

Surface soils of the study area are regionally divided into two main types. Those to the west and north underlying the Cave, Bertrand, and upper Fishtrap Creek catchments and the upper Salmon River are predominantly stony clays of glaciomarine origin and low permeability. In places they are overlain by a patchwork of thin gravel and sand glacial outwash deposits. Consequently flows in these streams vary greatly and track precipitation patterns closely. The southeast portion of the study area, which includes Pepin Creek, lower Fishtrap and part of Howes Creek is underlain by thick glacial outwash deposits consisting of gravel and sand with scattered till lenses over stony clays. This highly permeable layer houses a large aquifer which contributes substantially to the flow of lower Fishtrap Creek (Johanson 1988). The aquifer has also provided an abundant source of clean water for domestic and agricultural use historically, although it is now badly contaminated with nitrates (Liebscher et al. 1992). Localized areas throughout the study area are underlain by surface deposits of peat (Johanson 1988).

Virtually all of the study area is privately owned and land use is predominantly agricultural and urban. The expanding urban centres of Aldergrove and Clearbrook/Abbotsford occupy the headwaters of Bertrand and Fishtrap Creeks respectively. The agricultural lands around Bertrand and Cave Creeks and the upper Salmon River are primarily used for livestock farming, while the lower Fishtrap Creek watershed is mostly berry farms. Lower Pepin flows through Aldergrove Lake Regional Park while its upper reaches are flanked by a series of gravel pits. Extensive gravel extraction activity is also planned for the lower Fishtrap Creek watershed around Echo Road. Most of the lands outside the urban centres lie within the Agricultural Land Reserve although there is increasing pressure to remove parcels from it to permit urban expansion.

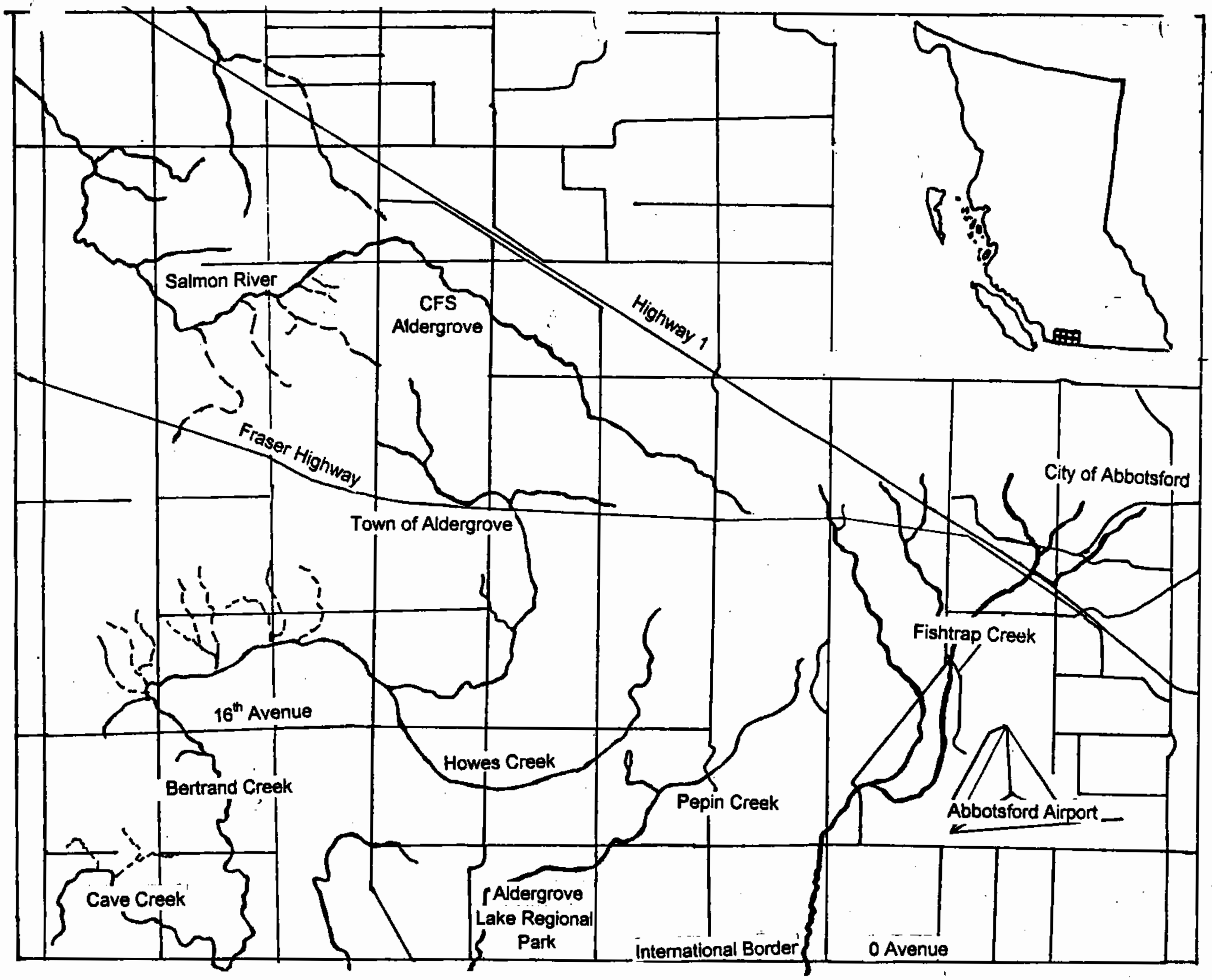

Figure 1: Study area: current known range of Salish sucker and Nooksack dace in Canada

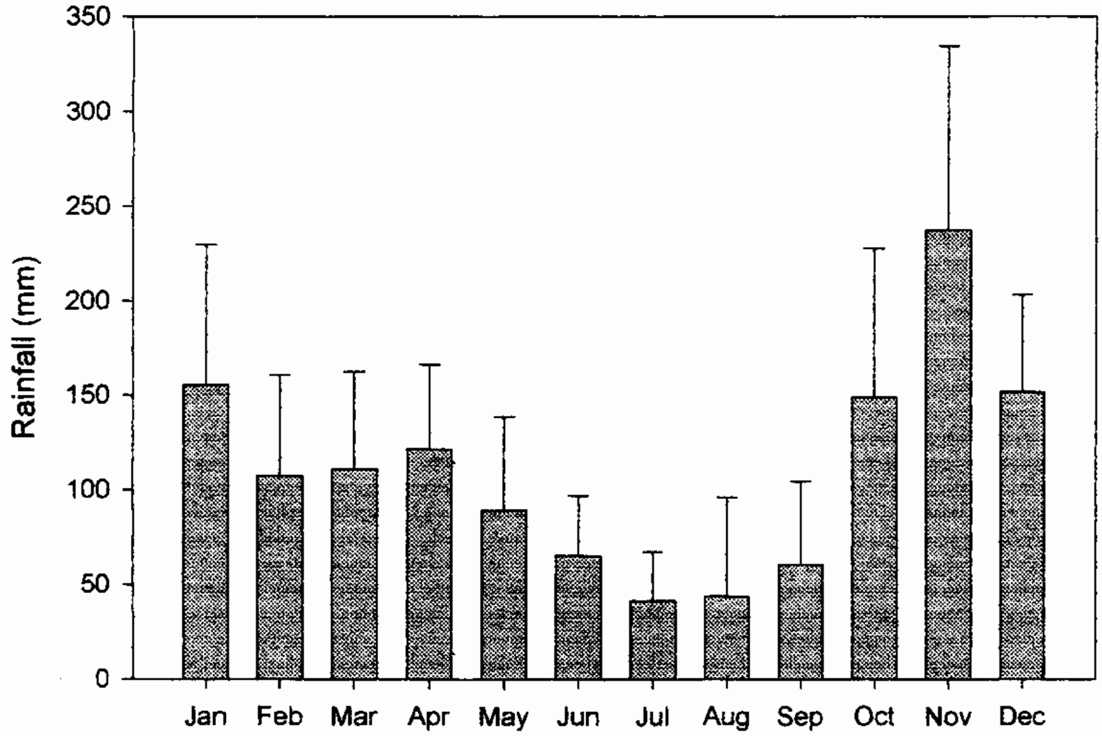

Figure 2: Mean monthly rainfall at Abbotsford Airport 1985 to 1996 (mean±S.D).

POTENTIAL HABITAT ENHANCEMENT METHODS

The effectiveness of different techniques for restoring and maintaining healthy populations of Salish suckers and Nooksack dace are untested. It is possible, however, to make informed speculations based on known life history characteristics and the major sources of habitat degradation observed in the streams. The techniques referred to throughout the report are briefly discussed below. Some are taken directly or modified from commonplace salmonid enhancement methods, others involve longer term changes in land development practices and will require policy changes. The list should not be viewed as comprehensive, particularly with respect to policy. The effectiveness of all methods should be tested experimentally with replications and appropriate controls. Response variables of interest will include individual growth and condition factor, survivorship, and recruitment rates, community composition and relative abundance of all fish species. Monitoring changes in channel morphology and macroinvertebrate diversity and abundance would also provide very useful information about the ecological effects of each technique.

Riffle Creation

Both Salish sucker and Nooksack dace spawn in gravel riffles and dace spend virtually their entire adult lives in riffles, with their highest densities being associated with cobble-sized substrate. All of the major sources of habitat degradation identified in these creeks - livestock trampling, narrowing of channels by reed canary grass, sedimentation from gravel pits and bank erosion, dredging and channelization, and decreased summer flows have one thing in common: they eliminate high quality riffle habitat. Methods of riffle creation for salmonid habitats are well developed (see Adams and White 1990; Newbury et al. 1997) and operate effectively when properly installed in gravel bed streams (House 1996). Structures installed in inappropriate substrates and/or without proper attention to principles of fluvial morphology, however, have very high failure rates (Frissell and Nawa 1992; Avery 1996). For adult dace habitat, patches of larger cobble (200mm +) should be included.

Habitat Complexing

Flood control measures such as removal of meanders and in-stream structure (large woody debris, boulders etc.) have greatly simplified much of the stream habitat within the study area. Such structure functions to maintain high quality pool habitat and spawning riffles (Bisson et al 1987), increase organic matter retention (Bilby and Likens 1980) and, consequently, support high levels of secondary production (Smock et al. 1989). Fish communities in complex reaches are also less impacted and recover faster from flood disturbances (Pearsons et al. 1992). Increasing in-stream complexity through such standard methods as root wad or boulder placements and creation of undercut banks will directly or indirectly benefit sucker and dace populations through all these mechanisms. Suckers in particular are likely to benefit given their preference for habitats with abundant in-stream and overstream cover (Inglis et al. 1992). Although overall failure rates of installed structures in the Pacific northwest have been very high (Frissell and Nawa 1992), installations in low gradient 2nd and 3rd order streams (such as those in the study area) have proven very robust (Heller et al. 1996). Project design will, however, require close attention to channel morphology, stream power, and sediment loads.

Lowland streams flowing through old-growth forest typically have at least 3 pieces of large woody debris (LWD) per channel width (Murphy and Koski 1989; Slaney et al. 1997). Maintaining a long term supply of this material requires a minimum buffer strip of approximately 30m width (the height of mature trees; Murphy and Koski 1989). Establishment of buffer strips this wide will be impossible over most of the study area due to competing land uses. Consequently, LWD will need to be artificially supplied over the long term if restored channel structure is to be maintained. Using a higher proportion of boulder clusters or similar more permanent structures could reduce this need, although their effectiveness relative to LWD needs to be studied.

Off-Channel Habitat Creation

Side-channels and lateral pool habitat is frequently lost through channelization or downcutting due to increased flood frequency (Booth 1990). These areas are critical habitats for rearing and refuge from high flows for many species (Hartman and Brown 1987; Pearsons et al. 1992; Kelsch 1994) and are virtually absent from large portions of the study area. Nooksack dace young-of-the-year inhabit shallow lateral pools (McPhail 1997) and Salish sucker juveniles are frequently caught in off-channel areas in summer (Pearson 1998) and may seek refuge from high winter flows there as well. Construction of side channels, pools, and/or low-elevation, frequently flooded "benches" along banks are potential enhancement strategies. In addition, connected roadside and agricultural drainage ditches need protection from uncontrolled dredging.

Livestock Fencing

The impacts of cattle access to streams include direct trampling of eggs, increased bank erosion, channel width, and stream sedimentation, reduced shade, increased temperatures and decreased water quality (Platts 1981; Armour et al. 1991). Indeed, cattle fencing is a cornerstone of salmonid habitat restoration programs in agricultural watersheds (Adams and Whyte 1990; OMNR 1984). All of the degradation mechanisms associated with livestock access are likely to impact populations of Salish sucker and Nooksack dace. The effects are also easily remedied by fence installation usually accompanied by riparian planting and alternative arrangements for livestock crossings and access to water.

Riparian Planting

Buffer strips of riparian vegetation provide a supply of large organic debris to the stream (Bisson et al. 1987; Murphy and Koski 1989), reduce stream temperatures and erosion, enhance bank stability,and improve water quality (Schlosser and Karr 1981; Murphy 1995). Effective buffer width varies considerably with channel size and type, adjacent land use and slope and level of protection required, but need to be at least 15 m under most conditions to preserve water quality and natural temperature regimes. (Castelle et al. 1994). For long term supplies of large woody debris, a minumum of 30m is generally required (Murphy and Koski 1989). Given its fundamental importance to maintaining channel structure and water quality, maintenance of natural riparian vegetation is likely to benefit Salish sucker and Nooksack dace populations in addition to those of most other native species.

Many reaches within the study area lack adequate shading and in-stream structure while bank instability is rampant. The width of existing vegetated buffer varies widely between creeks and reaches, but is often close to zero and fails to meet the minimum desirable widths cited above in the vast majority of locations. Planting permission and buffer widths on private land will be subject to negotiation with landowners, and in most cases is likely to be far less than 30m. Obviously, the maximum feasible width should be planted. Native species should be used in most cases, although rapidly growing non-natives (eg. hybrid poplar) underplanted with native species may be preferable when shade is urgently required. Young trees will need protection from beaver damage in most places.

Control of Reed Canary Grass

Although reed canary grass (*Phalaris arundinacea*) may be native to coastal B.C. (Pojar and Mackinnon 1994) it's rapid spread in the study area over the past 40 years has been facilitated by widespread agricultural usage. It has even been used to stabilize banks in enhancement projects in Enns Brook (Adams and Whyte 1990). Because of its ability to thrive in disturbed sites and to survive both extended inundation and well drained conditions canary grass frequently grows completely across the channel of disturbed reaches slowing flow, and trapping large amounts of sediment on the margins which narrows and deepens the channel. Although adult trout and juvenile salmonids thrive in some of these areas (eg. lower Fishtrap Creek), habitat complexity is much reduced as riffles and pools tend to be transformed into long runs. Canary grass is shade intolerant (Fidler and Fer 1994) and planting taller woody vegetation is likely to reduce its prevalence - which may reduce the need to clean ditches and, in the main creeks, increase channel complexity.

Stormwater Quality

The headwater areas of both Bertrand Creek and Fishtrap Creek (Enns Brook, East Fishtrap Creek, Clearbrook Drainage) receive untreated runoff from numerous urban storm sewer outfalls. Urban storm water contains a wide variety of contaminants including heavy metals. Zinc, copper, nickel and chromium concentrations were particularly high in street dirt and storm runoff in a recent study of the Brunette River (Healey 1997). Storm sewers can also be a major source of nutrient contamination in cases where cross connections between sanitary sewers exist.

Although water quality analysis was beyond the scope of this work, runoff toxicity and nutrient loads are likely to be a problem, particularly during low flow periods. Options to reduce contamination include education (to prevent dumping), installations of in-pipe oil/grease separators and sediment traps and end of pipe treatments including treatment wetlands. In-pipe treatments should be included in all newly constructed storm sewers and be retrofitted to existing ones as opportunities arise through routine maintenance and replacement activities. The Langley Environmental Partners Society has undertaken some education work in the form of storm drain marking in Aldergrove. Every opportunity to expand on this work should be taken.

Stopping and Reversing Hydrograph Changes

Many changes in landuse increase surface runoff and consequently reduce groundwater recharge through infiltration. Deforestation, agricultural drainage (ditching or tile drains), and urbanization all act in this way to shift the hydrograph (distribution of flows through time) to produce more frequent and severe winter flooding and reduced summer flows.

The effects of this change on fish and habitat are varied. Increased flooding may crush eggs or benthic fish by moving the gravel substrate (Seegrist and Gard 1972; Erman et al. 1988), and affect juvenile mortality (Schlosser 1985). Channel effects include, erosion, sedimentation and channel widening or incision(Booth 1990; Leopold 1994). There is evidence throughout the study area, particularly in Bertrand Creek, of severe bank erosion and some reaches within the study area that previously experienced perennial flows and supported healthy fish populations now run dry for weeks or even months each summer (eg. the upper Salmon River and Cave Creek).

Although stormwater detention ponds can offer some relief of flooding, detention volumes are routinely less than 10% of that required to maintain the pre-development stream hydrograph (Booth 1990). Furthermore they do little to address the problem of low summer flows. The long term solution to the problem must focus on reducing the amount impermeable area in the urban landscape. Key recharge areas such as wetlands, gravel aquifers and peat bogs need to be targeted for conservation. Municipal development guidelines should also require measures to increase infiltration in future developments and redevelopments. These would include curbless gutters, backyard swales, and most importantly, reductions in paved areas (ie. Street widths and parking space requirements).

METHODS

Stream Surveys

Surveys were conducted using a modified version of the overview survey technique of the Oregon Department of Fish and Wildlife (Moore et al. 1997). Reach lengths, cumulative lengths of channel hydraulic types, and locations of significant features were measured using a hip chain. In the occasional circumstances when the channel was impassable on foot (ie. long reaches of deep wetland) distances were measured on large scale (1:2000 -1:5000) aerial photographs using a map wheel. Calibration of this technique against reaches measured with the hip chain yielded results accurate to within 5%. Locations of reach breaks and some features were identified with a hand held GPS unit (Garmin GPS38). Wetted widths, bank full widths, mean channel depth, and bank full depth were estimated and periodically checked against a surveyors tape. Representative photographs of each reach were taken and temperatures were measured using a hand held thermometer.

Temperature Monitoring

Temperatures were recorded hourly between late June and October 9 at 18 sites (table 1) using electronic loggers (Optic Stowaway, Onset Technologies, Pocasset MA). Loggers were placed in shaded locations within the stream flow inside a cinder block.

From the continuous temperature records I calculated the number of degree-hours each month in excess of two arbitrary threshold temperatures (18 and 20°C). This measure is more physiologically relevant than either maximum temperature or number of hours over a threshold temperature, as both absolute values and duration of exposure are important. Temperature preferences and tolerances of Salish sucker and Nooksack dace are unknown, although circumstantial evidence suggests that they can withstand prolonged exposure to temperatures in excess of 21°C (Pearson 1998). Given the potential for important sub-lethal effects (eg reduced growth, susceptibility to disease and parasites) at lower temperatures, however, conservative threshold values seem appropriate.

Longitudinal profiles of daily maximum stream temperature were plotted at the daily maximum for selected dates to illustrate spatial relationships of warm and cool areas in the mainstems and tributaries of Fishtrap and Bertrand Creeks through the summer.

Table 1: Locations and placement periods of temperature data loggers during the summer of 1997.

	Reach #	Site #	Period	No. of Days	UTM
Bertrand at 0 Ave	B1	T1	06/19/97 10/09/97	112	N 5427833 E 534871
Bertrand at 252nd	B16	T2	06/25/97 10/09/97	106	N 5431769 E 534715
Bertrand at 264th	B24	T3	06/25/97 10/09/97	106	N 5431694 E 537078
Bertrand at 272nd Street	B28	T4	06/25/97 10/09/97	106	N 5431718 E 538748
Howes at 16th Ave	Not Surveyed	T5	06/25/97 10/09/97	106	N 5431038 E 537438
Cave at Burke Property **Location**	C2	T6	06/25/97 10/09/97	106	N 5427861 E 534666
Cave at 248th	C5	T18	06/25/97 07/25/97	106	N 5428322 E 533898
Pepin at 0 Ave	P1	T8	06/19/97 10/09/97	112	N 5427825 E 538657
Pepin at Bradner Rd	P17	T9	06/25/97 10/09/97	106	N 5430445 E 541906
Pepin Tributary at Columbia Bitulithic	Not Surveyed	T17	06/19/97 07/08/97	20	N 5430139 E 541170
Fishtrap at 0 Ave	F1	T10	06/19/97 10/09/97	112	N 5427886 E 543420
Fishtrap at Echo Rd	F2	T11	06/19/97 10/09/97	112	N 5430449 E 544035
Waechter at Hope Road	Not Surveyed	T12	06/19/97 10/09/97	112	N 5430493 E 544373
Fishtrap Tributary at Peardonville	Not Surveyed	T13	06/19/97 10/09/97	112	N 5432499 E 545159
Fishtrap d/s of Deacon Road	F12	T14	06/25/97 10/09/97	106	N 5433110 E 546164
Livingstone Ave Ditch at Gardner Park	F20	T15	07/25/97 10/09/97	76	N 5433372 E 546350
Enns Brook at Gardner Cres	F16	T16	07/09/97 10/09/97	92	N 5433479 E 546470
East Fishtrap at Charlotte Road	F27	T17	06/19/97 07/08/97	20	N 5434152 E 548056

Needs Assessment

The current conditions and restoration needs for each creek are presented on 3 spatial scales. The overview level provides a description of each watershed, the distribution of fish within it, and the major sources of habitat degradation at a catchment scale. The intermediate level subdivides each catchment into segments based on major changes in surrounding landuse and/or channel/valley morphology. Each segment is typically several kilometres in length, providing a useful scale for examining patterns within the watershed. Finally the reach scale, at which the habitat survey was conducted, provides a detailed look at local conditions and sources of degradation. The main body of the report contains the overview and segment scale material while the detailed reach descriptions and survey tables appear in Appendix 2 (under separate cover). Each potential enhancement site at the reach scale is assigned a priority (high, medium, or low) based on a rating system of weighted scores. The criteria considered were: potential benefit to Salish sucker and/or Nooksack dace populations within the reach (1-5 pts), potential benefits to sucker and/or dace populations within the watershed (1-20 pts), potential benfits to other species (1-5 pts), cost (1-4 pts), and physical access to the site (1-5 pts). Watershed scale priorities are discussed in the overview section for each creek.

Time constraints prevented completion of habitat surveys on the Salmon River and several potentially important tributaries of Bertrand and Fishtrap Creeks. Pending funding, we hope to complete the survey work during the summer of 1998.

Landowner Surveys

Landowners or tenants encountered in the process of gaining permission to access private land were interviewed using a standardized survey (appendix 2). The survey questions focused on the respondent's knowledge of the creek and its fish community and on land use practices likely to affect the stream.

OVERVIEW SCALE NEEDS ASSESSMENTS

Cave Creek

Overview

Cave Creek is the smallest of the Nooksack tributaries in Canada. Its main stem arises in a wetland very close to a headwater tributary of the Little Campbell River at 240th Street. It flows south and eastward through pasture and wooded areas for approximately 4 km to join Bertrand Creek about 250 m south of the American border (figure 3).

Although discharge is not presently monitored in the Creek, local landowners report that flow stops entirely for up to 2 months each summer. In dry years, only the deepest pools retain water throughout dry season. Temperature monitoring of one of these pools (T6) indicates that groundwater flows maintain cool temperatures (<18°C) on even the hottest summer days. In winter floods the river may rise 2 m or more above base flow.

Underlying soils are dominantly stony clays of glaciomarine origin and low permeability, although in most areas these are overlain by a thin layer of glacial outwash gravel and sand. The headwater reaches (C10 and C11) are underlain by peat (Johanson 1988) and, according to the current landowner, this area supported perennial wetland until dredged in 1969.

Given the low summer flows, the fish community is surprisingly diverse. Salish sucker, Nooksack dace, coho salmon, cutthroat trout (*Oncorhynchus clarki*), steelhead (*Oncorhynchus mykiss*) , largescale sucker (*Catostomus macrocheilus*), lamprey (*Lampetra sp.*), and the blue listed brassy minnow (*Hybognathus hankinsoni*) are all present as are two introduced species, fathead minnow (*Pimephales promelas*), and pumpkinseed (*Lepomis gibbosus*). All fish are restricted to isolated pools during the low flow period and mortality in the shallower, less shaded ones is high. A dam 350 m upstream of 248th Street poses a significant barrier to fish movement. Neither Salish suckers nor Nooksack dace were caught upstream of it and salmonids were very rare in apparently suitable habitat (figure 3; Pearson 1998).

Enhancement Needs

The habitat restoration priority for Cave Creek is increasing summer flows. Nooksack dace in particular are likely to benefit as their favoured riffle habitat is currently eliminated throughout the creek during the most productive time of the year. To this end, a feasibility study of restoring the dredged headwater wetland is currently in progress with the cooperation with Ducks Unlimited Canada. Fish access over the dam should be

OVERVIEW SCALE NEEDS ASSESSMENTS

Cave Creek

Overview

Cave Creek is the smallest of the Nooksack tributaries in Canada. Its main stem arises in a wetland very close to a headwater tributary of the Little Campbell River at 240th Street. It flows south and eastward through pasture and wooded areas for approximately 4 km to join Bertrand Creek about 250 m south of the American border (figure 3).

Although discharge is not presently monitored in the Creek, local landowners report that flow stops entirely for up to 2 months each summer. In dry years, only the deepest pools retain water throughout dry season. Temperature monitoring of one of these pools (T6) indicates that groundwater flows maintain cool temperatures (<18°C) on even the hottest summer days. In winter floods the river may rise 2 m or more above base flow.

Underlying soils are dominantly stony clays of glaciomarine origin and low permeability, although in most areas these are overlain by a thin layer of glacial outwash gravel and sand. The headwater reaches (C10 and C11) are underlain by peat (Johanson 1988) and, according to the current landowner, this area supported perennial wetland until dredged in 1969.

Given the low summer flows, the fish community is surprisingly diverse. Salish sucker, Nooksack dace, coho salmon, cutthroat trout (*Oncorhynchus clarki*), steelhead (*Oncorhynchus mykiss*) , largescale sucker (*Catostomus macrocheilus*), lamprey (*Lampetra sp.*), and the blue listed brassy minnow (*Hybognathus hankinsoni*) are all present as are two introduced species, fathead minnow (*Pimephales promelas*), and pumpkinseed (*Lepomis gibbosus*). All fish are restricted to isolated pools during the low flow period and mortality in the shallower, less shaded ones is high. A dam 350 m upstream of 248th Street poses a significant barrier to fish movement. Neither Salish suckers nor Nooksack dace were caught upstream of it and salmonids were very rare in apparently suitable habitat (figure 3; Pearson 1998).

Enhancement Needs

The habitat restoration priority for Cave Creek is increasing summer flows. Nooksack dace in particular are likely to benefit as their favoured riffle habitat is currently eliminated throughout the creek during the most productive time of the year. To this end, a feasibility study of restoring the dredged headwater wetland is currently in progress with the cooperation with Ducks Unlimited Canada. Fish access over the dam should be

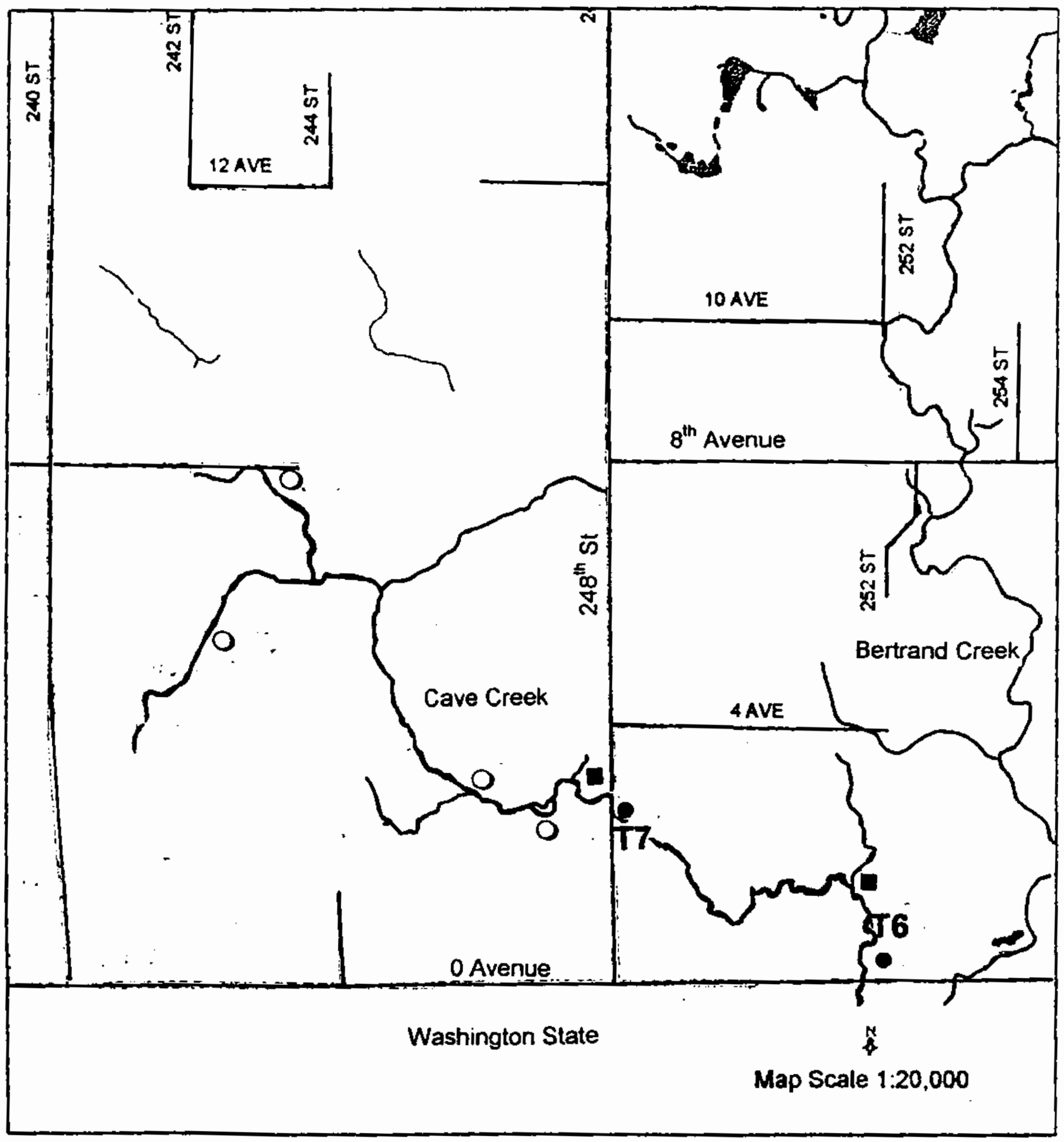

Figure 3: Distribution of Salish sucker (SSU) and Nooksack dace (NDC) and locations of temperature monitoring sites (T#) in Cave Creek. Distribution data is based on known collections between 1990 and 1998 (from Pearson 1998; ■ = SSU, ● = SSU and NDC, ❍ = neither SSU nor NDC).

improved and some reaches require livestock exclusion and riparian zone restoration. Fencing and planting is already underway on two of the key properties.

Bertrand Creek

Overview

Bertrand Creek's mainstem arises near the Fraser Highway just west of Aldergrove. After flowing through approximately 2.4 km of farmland north of the town, the creek enters the urban environment, continues south-east through it, then loops south and west through farmland in the low gradient middle reaches. Here it is joined by its major tributary, Howes Creek, before turning southward into the steeper, more pristine lower reaches (figure 4).

Surface soils in the watershed are primarily thin gravel and sand deposits over stony clays of glaciomarine origin and poor permeability (Johanson 1988). A portion of Howes Creek flows over the much thicker gravel deposits found to the east and is thought to supply water to nearby Pepin Creek through them (Johanson 1988). Although not monitored during the winter, discharge at 0 Avenue varies highly within the period of April through October (figure 5). Local people report that the downstream reaches of Howes Creek run dry in most summers.

Water temperatures are relatively high throughout the watershed, probably due to a high ratio of surface runoff to groundwater feeding the creek, a consequence of the naturally impermeable underlying soils. This is undoubtedly exacerbated by the urbanization of the headwaters and by the combination of low summer flows and lack of shade in many areas. Substantial warming occurs through the middle reaches in late summer (figure 6). This is of great concern as the otherwise excellent habitat of the lower reaches is inundated with water in excess of 20°C for extended periods of time (figure 7).

Nooksack dace are found throughout Bertrand Creek, and are quite abundant downstream of the 248th Street crossings. Salish sucker are known from only two locations since 1990 (at 256th Street and 26b Avenue; figure 4). Neither species has been found in Howes Creek in recent years although both were there historically (J.D. McPhail, University of British Columbia, pers. comm.). Other native species present include coho salmon, steelhead and cutthroat trout, largescale sucker, prickly sculpin (*Cottus asper*), three-spine stickleback, and lamprey. Pumpkinseed and black bullhead (*Ameirus melas*) have also been introduced (Pearson 1998).

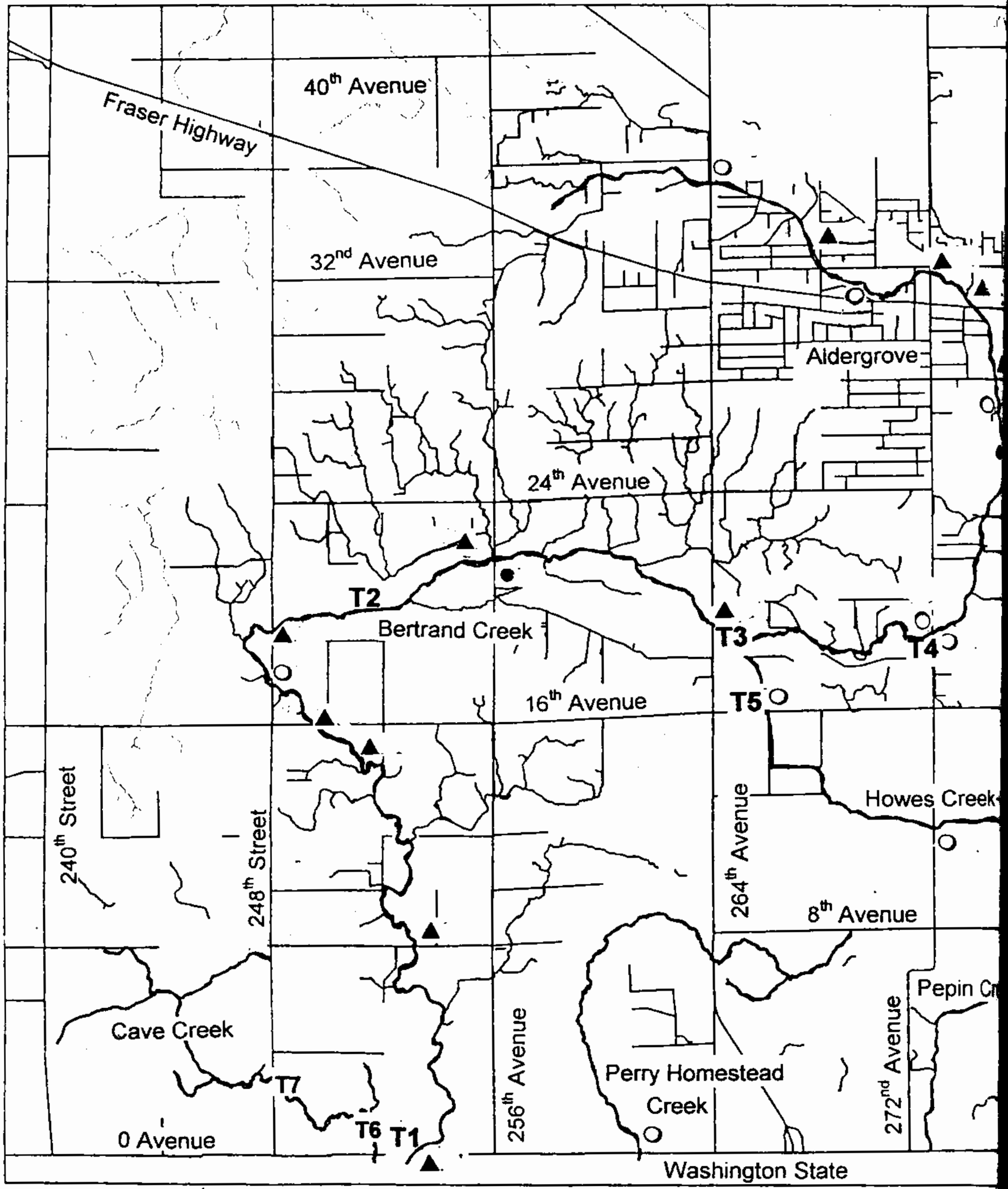

Figure 4: Distribution of Salish sucker (SSU) and Nooksack dace (NDC) and locations of temperature monitoring sites (T#) in Bertrand Creek. Distribution data is based on known collections between 1990 and 1998 (from Pearson 1998;▲= NDC, ● = SSU and NDC, ○ = neither SSU nor NDC).

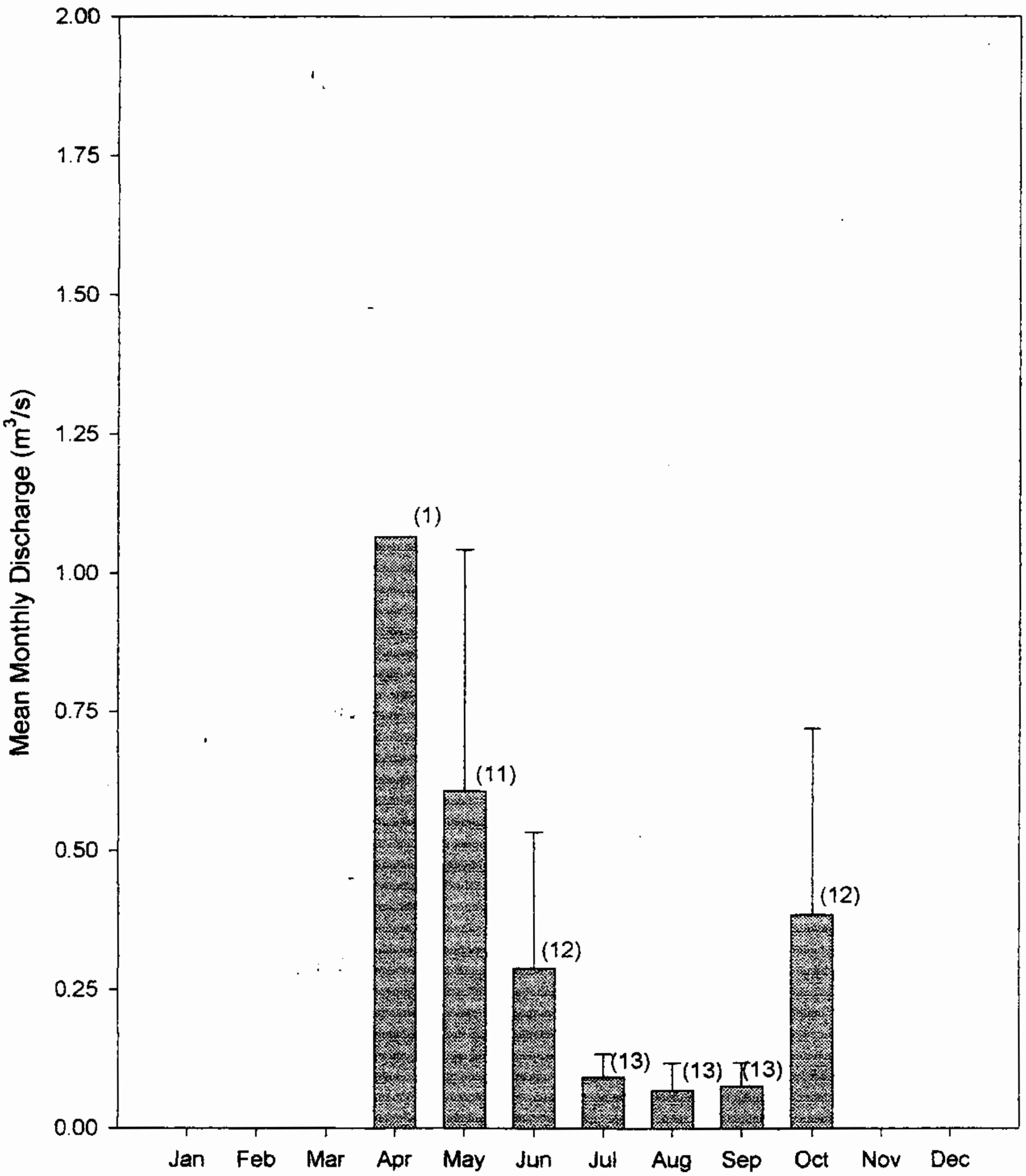

Figure 5: Mean monthly discharge of Bertrand Creek at 0 Avenue. Bracketed numbers indicate number of years of data (Water Survery of Canada, Vancouver).

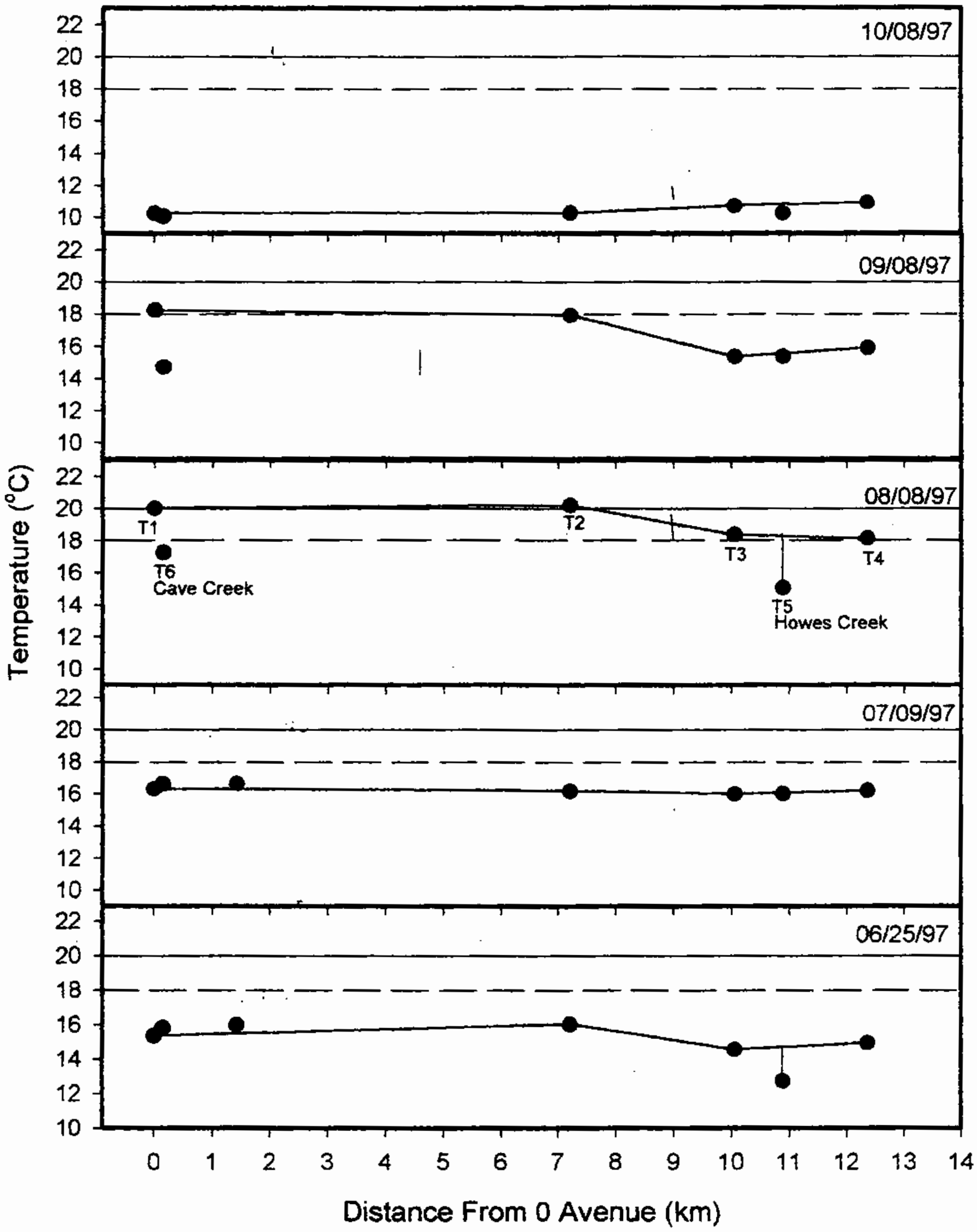

Figure 6: Longitudinal temperature profiles of Bertrand Creek and its tributaries at intervals during the summer of 1997. Temperatures are at the daily maximum (6 pm) on all dates.

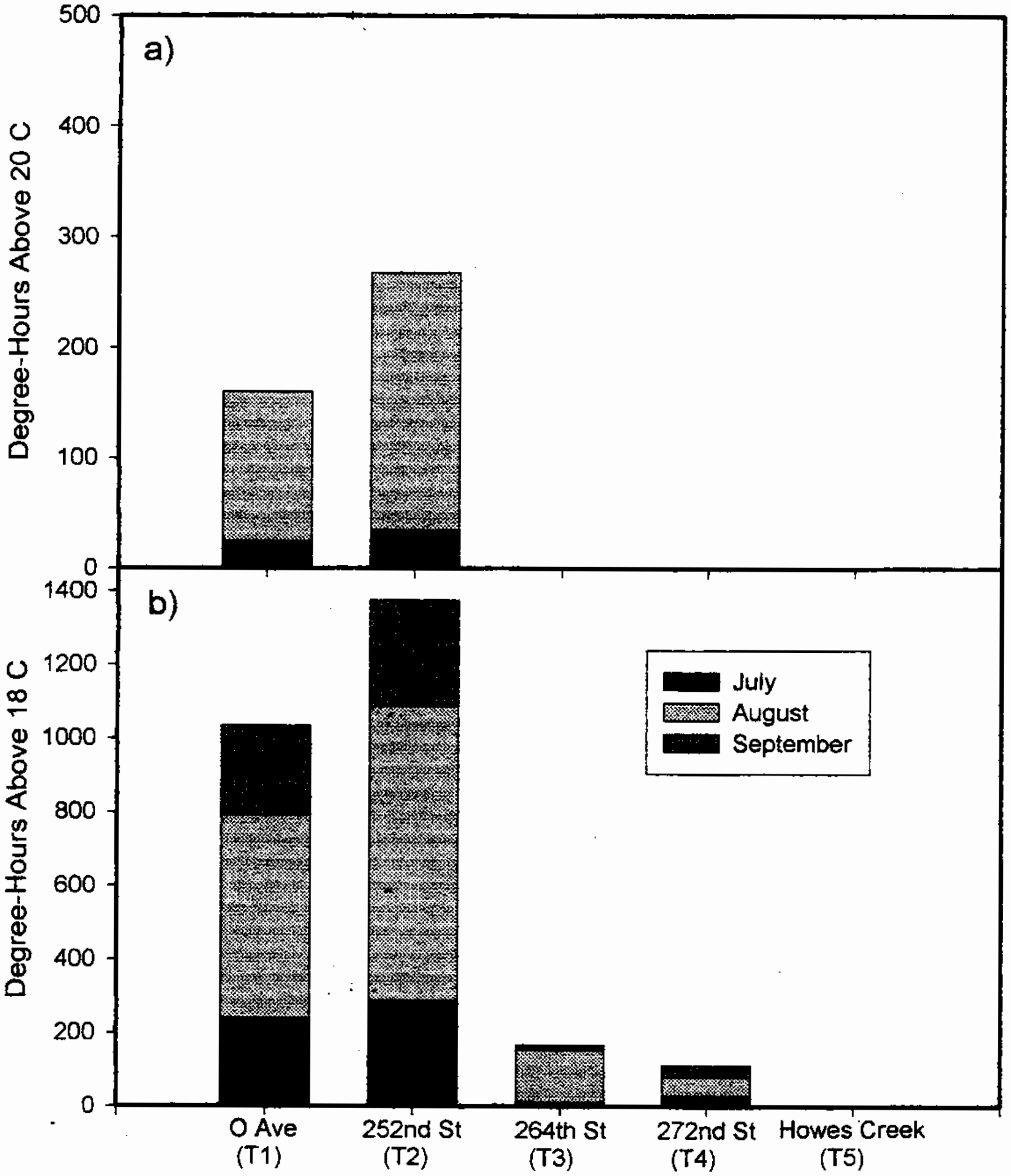

Figure 7:Monthly totals of degree hours in excess of a) 20°C and b) 18°C at Bertrand Creek monitoring sites during the summer of 1997.

Enhancement Needs

The major fish habitat problems vary along the creeks length. Years of dredging and channelization in the headwaters have deprived the stream of in-channel complexity, and off-channel refuges and rearing habitat. Local stewardship groups have completed a number of successful projects to alleviate this problem, but much more is required. The middle reaches suffer from these problems in addition to lack of riparian shading and extensive livestock damage. Fencing and planting of this segment is the highest priority for enhancement work because of its temperature influence on the highly productive lower reaches. The lower reaches also contain localized areas of cattle damage and bank erosion which should be addressed.

Pepin Creek

Overview

Pepin Creek arises in a recently (and illegally) filled wetland near the junction of Ross and Simpson Roads and flows south west through wetlands and beaver ponds for several kilometres to Aldergrove Lake Regional Park (ALRP). Midway through the Park the gradient increases and the channel develops a pool-riffle pattern. It exits the forest and flows through recently fenced cattle pasture and roadside ditch for the final kilometre before crossing the international border (figure 8).

The surface soils of the watershed are dominantly gravel and sand glacial outwash deposits. The creek itself, however, is underlain for much of its length by peat deposits (Johanson 1988).

Environment Canada maintains a seasonal flow gauge (May through October) in the ALRP near O Avenue. Although the winter high-flow period is not monitored, discharge (figure 9) appears markedly less variable than in Bertrand (figure 5), probably due to the reduced ratio of runoff to groundwater inflows associated with permeable watershed soils. Water temperatures in the mainstem were monitored at O Avenue and Bradner Road. Neither site exceeded 18°C at any time during the summer (figure10), probably due to the near complete shading of the mainstem channel over its length and to groundwater influxes from the surrounding gravel deposits.

The highest densities of Salish suckers within the study area are found in the farmland reaches of the ALRP (Inglis et al. 1992; McAdam 1995 MS). Both suckers and dace are also found throughout the remainder of the park and upstream to Bradner Road (a known spawning site; figure 8). Other species known from the lower and middle reaches are coho salmon, cutthroat and steelhead trout, three-spine stickleback, and lamprey. Largemouth bass (*Micropterus salmoides*) have been introduced to a pond

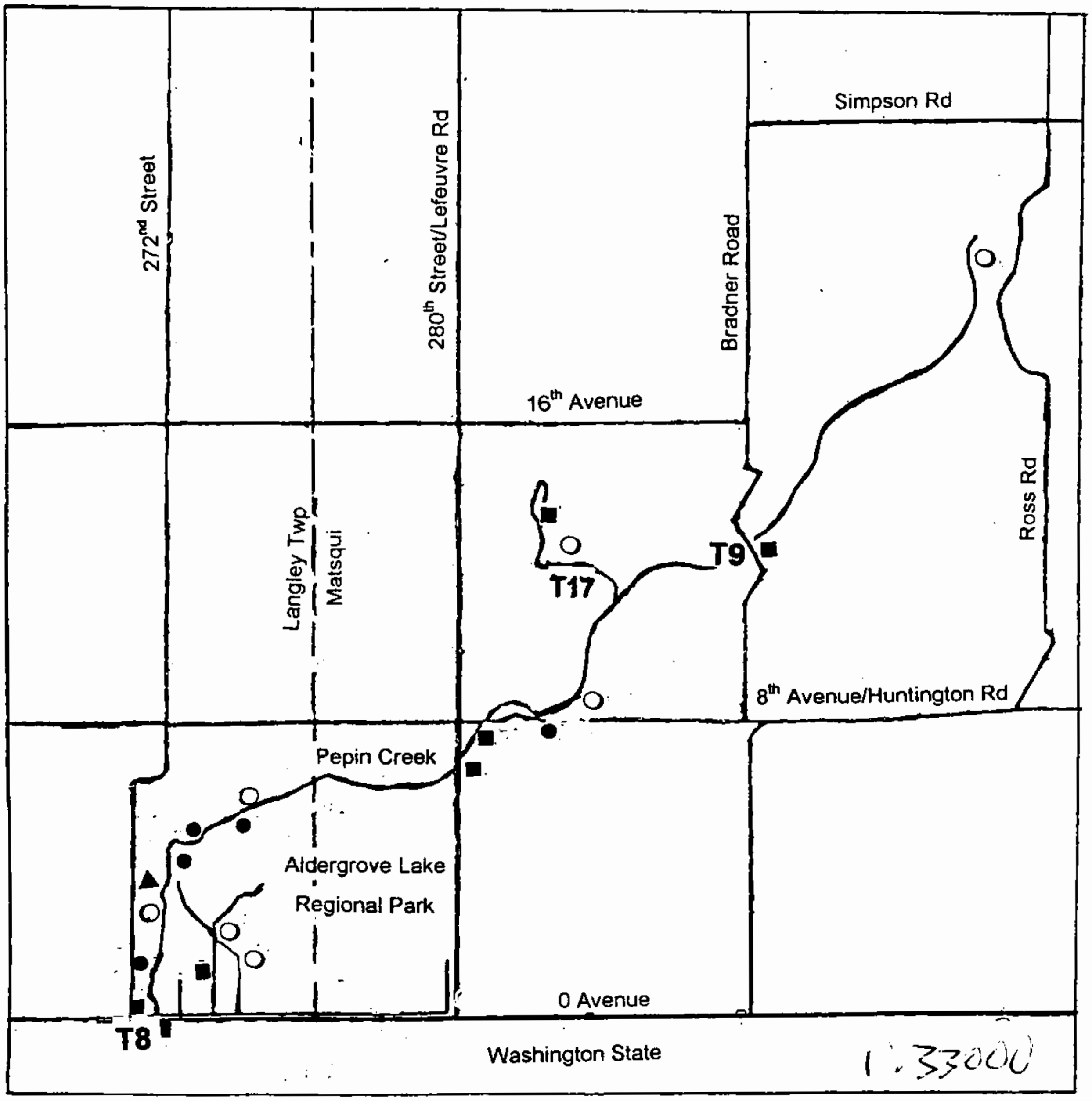

Figure 8 : Distribution of Salish sucker (SSU) and Nooksack dace (NDC) and locations of temperature monitoring sites (T#) in Pepin Creek. Distribution data is based on known collections between 1990 and 1998 (from Pearson 1998; ▲= NDC, ■ = SSU, ● = SSU and NDC, ○ = neither SSU nor NDC).

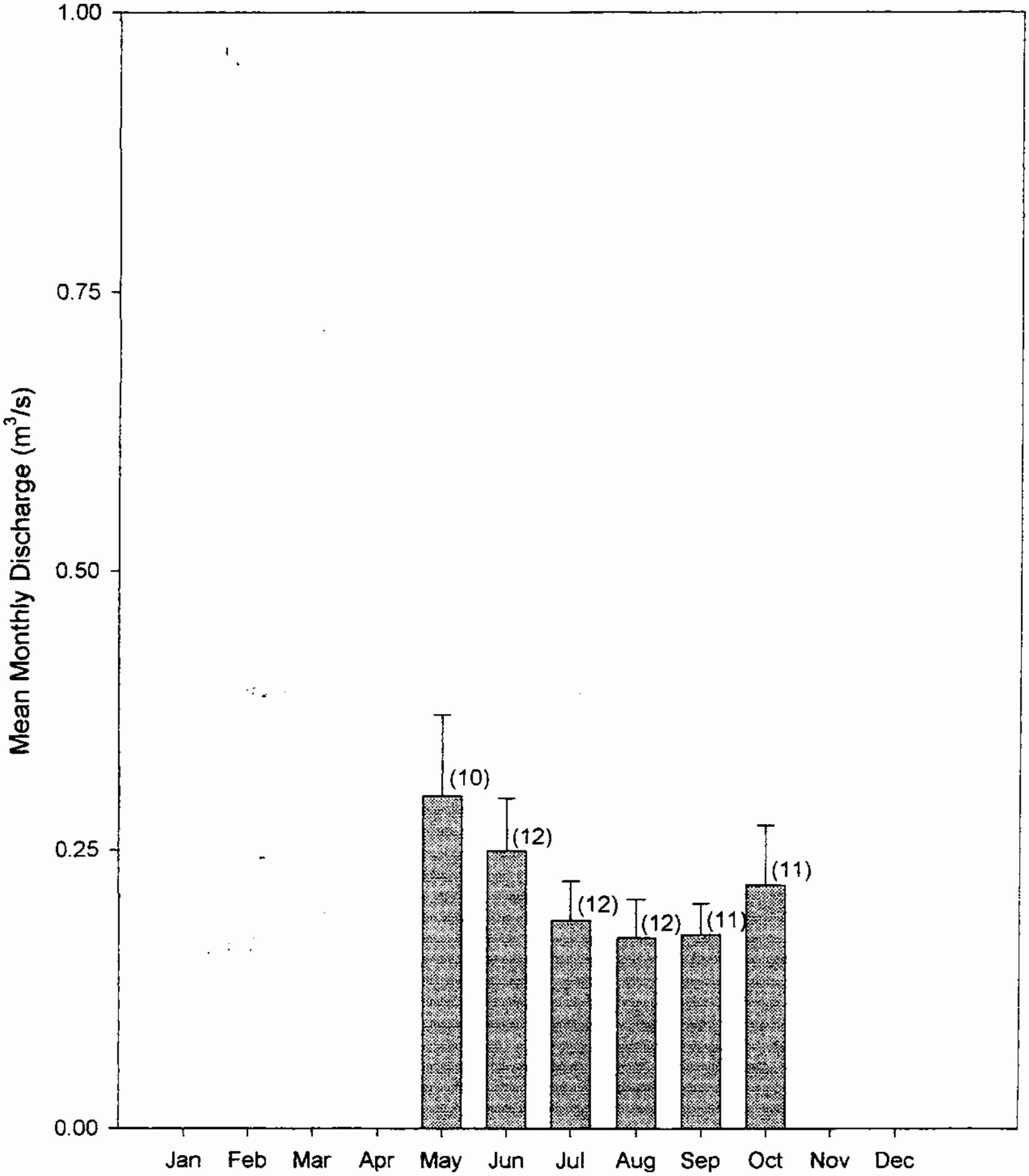

Figure 9: Mean monthly discharge of Pepin Creek at 0 Avenue. Bracketed numbers indicate number of years of data (Water Survery of Canada, Vancouver).

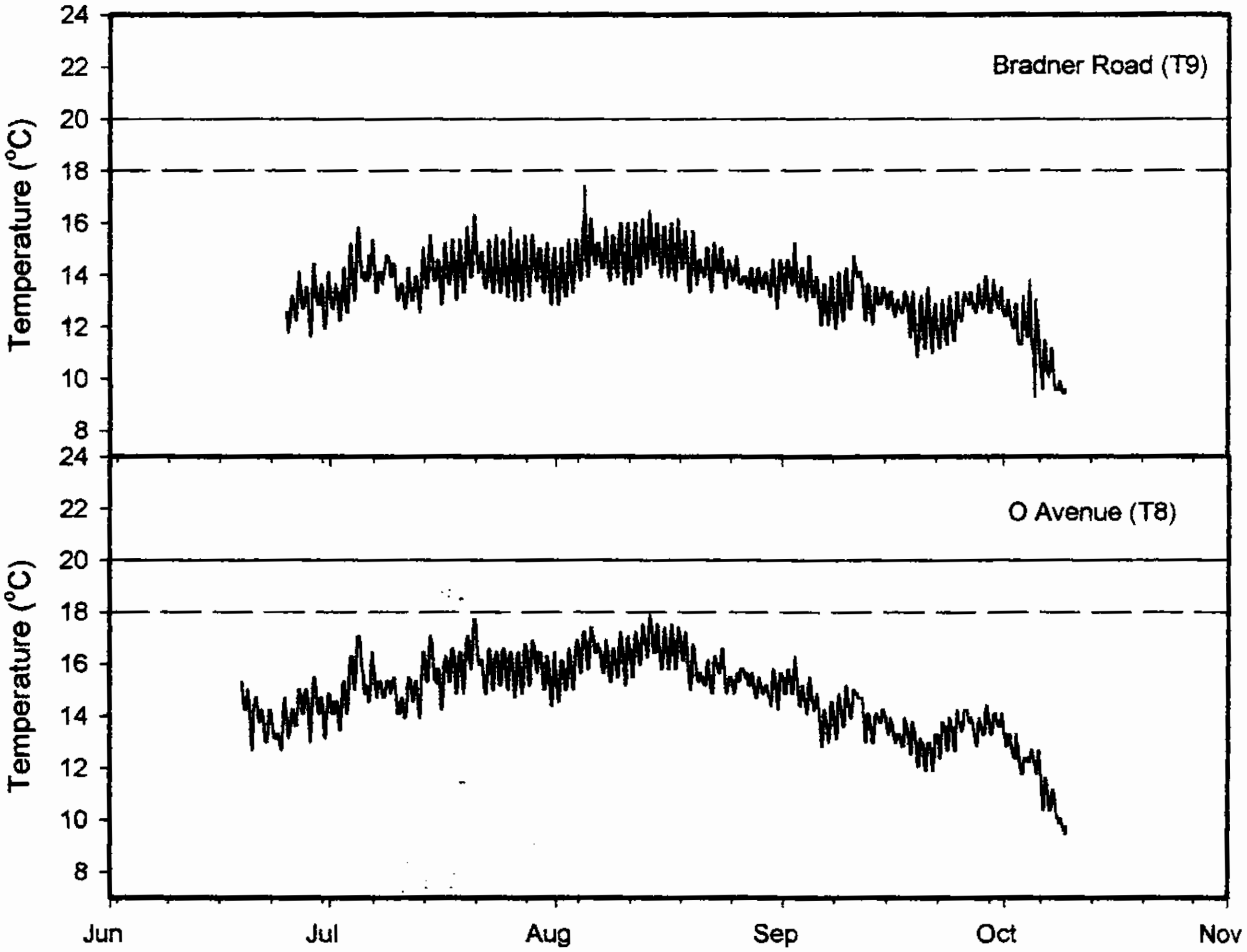

Figure 10: Summer water temperatures in Pepin Creek at 0 Avenue and Bradner Road in 1997.

feeding an unnamed tributary in the middle reaches. All but the sticklebacks appear to have been extirpated from the upper reaches by extreme sedimentation originating in headwater gravel pits.

Enhancement Needs

The most critical habitat problem facing the creek is massive sediment loading from gravel pits in the upper reaches. Over 1m of clay has been deposited in the channel for a distance of at least 1km downstream from the creek's origin. Cattle access has been largely curtailed in the lower reaches with fencing projects since 1995. Riffle creation and localized control of reed canary grass may benefit the sucker and dace populations of the farmed areas near 0 Avenue. Thinning the thick stands of riparian alder through the forested areas of the ALRP and underplanting them with conifers would greatly speed natural succession and the resupply of large woody debris to the stream.

Fishtrap Creek

Overview

Fishtrap Creek is fed by 5 main headwater tributaries. Three of them, Enns Brook, the Clearbrook Drainage, and East Fishtrap Creek arise in the rapidly expanding suburbs of Clearbrook. Upper Fishtrap Creek begins to the west around Highway 1 while Waechter Creek starts in agricultural lands to the south-west (figure 11). Adjacent landuse is dominantly urban and industrial north of Highway 1 and agricultural (mostly berry farms) between Highway 1 and the international border. Abbotsford Airport borders the middle reaches of the creek to the east. Virtually the entire length of the creek has been dredged and/or channelized (most of it on multiple occasions) to prevent flooding. East Fishtrap Creek was radically altered in the early 1990s by relocation of the lower reaches and conversion to stormwater detention pond over most of its length

Environment Canada installed a flow gauging station at the 0 Avenue bridge in 1984. Discharge was monitored between April and September or October until 1988 when it was extended to the full year. The Creek's hydrograph is highly variable, particularly in late fall and winter (figure 12). Mean monthly discharge over the period of record increases almost 10 fold between August and November. Although there are several instances of mean daily flows exceeding $8m^3/s$ since 1988, such high discharges are rare. As in most streams, the flows of Fishtrap Creek are lognormally distributed through time (figure 13). Discharges of 3 m^3/s, for example, were exceeded only 2.6% of the time.

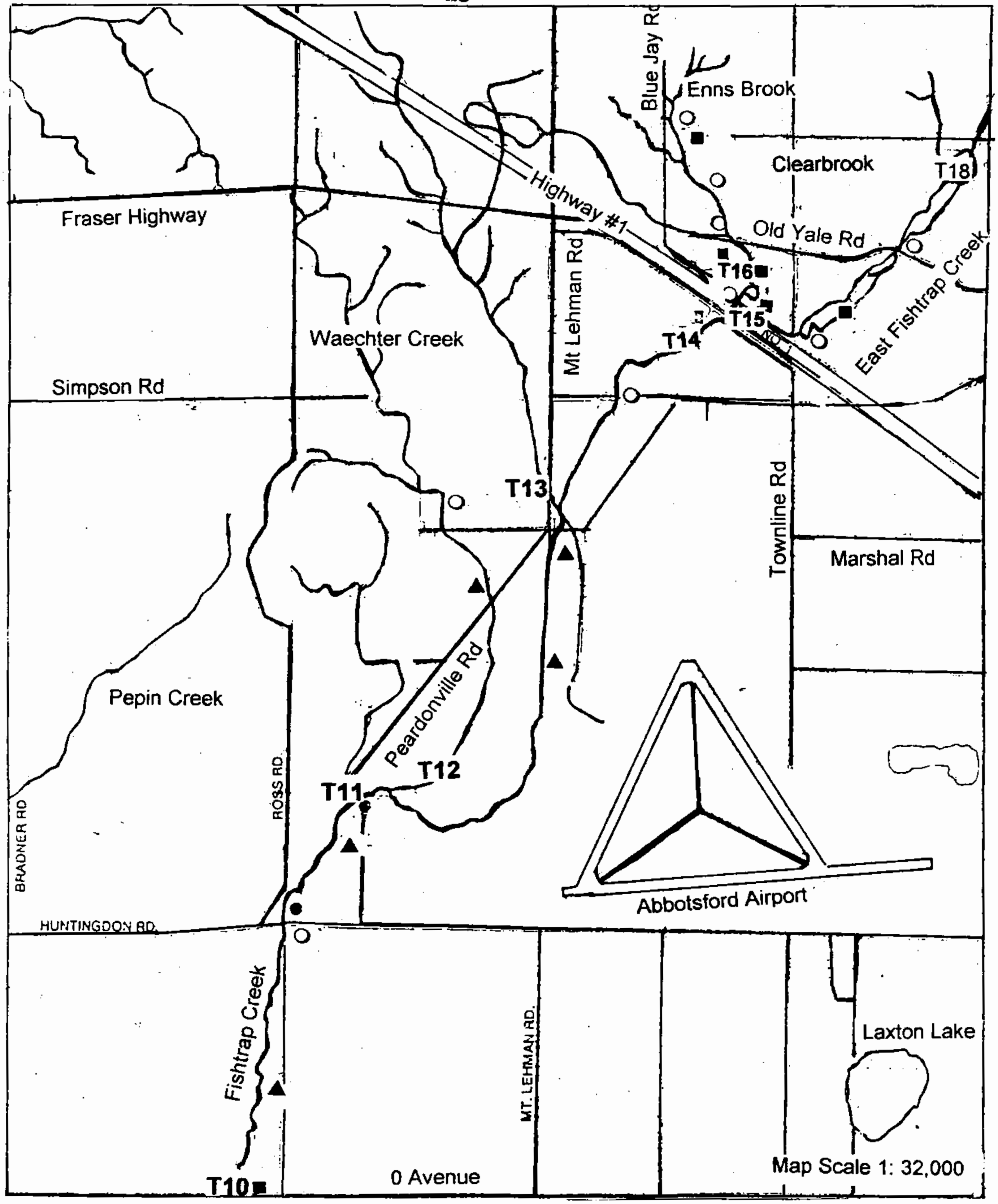

Figure 11: Distribution of Salish sucker (SSU) and Nooksack dace (NDC) and locations of temperature monitoring sites (T#) in Fishtrap Creek. Distribution data is based on known collections between 1990 and 1998 (from Pearson 1998; ▲= NDC, ■ = SSU, ● = SSU and NDC, ○ = neither SSU nor NDC).

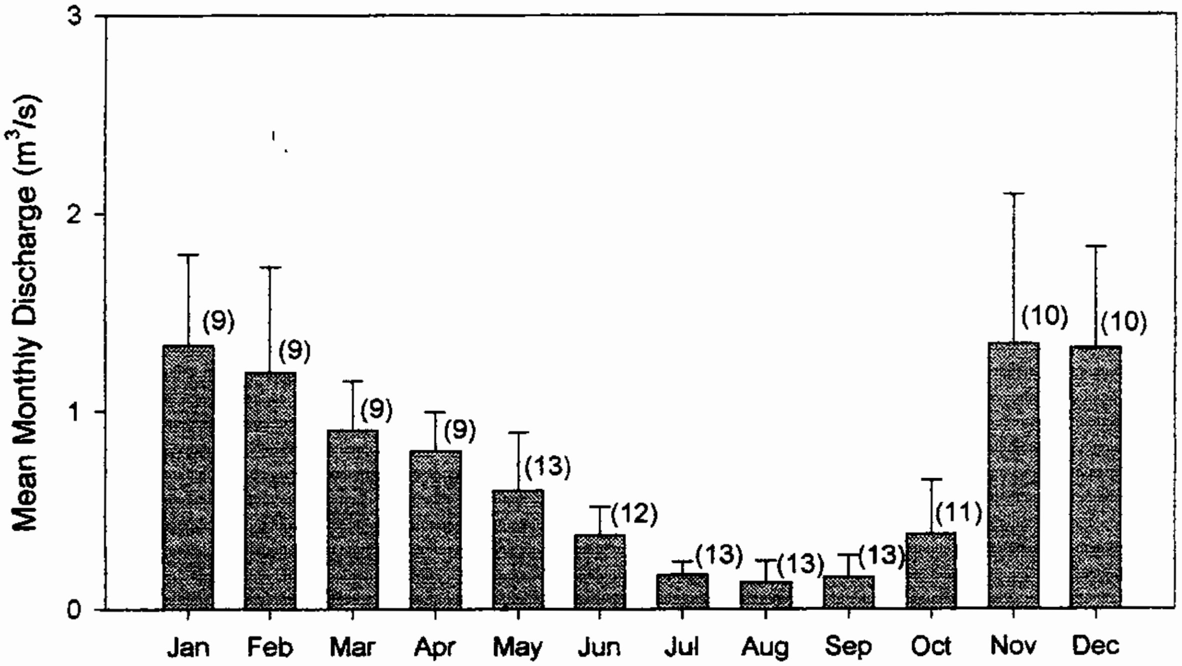

Figure 12: Mean monthly discharge of Fishtrap Creek at 0 Avenue. Bracketed num
indicate number of years of date (Water Survery of Canada, Vancouver).

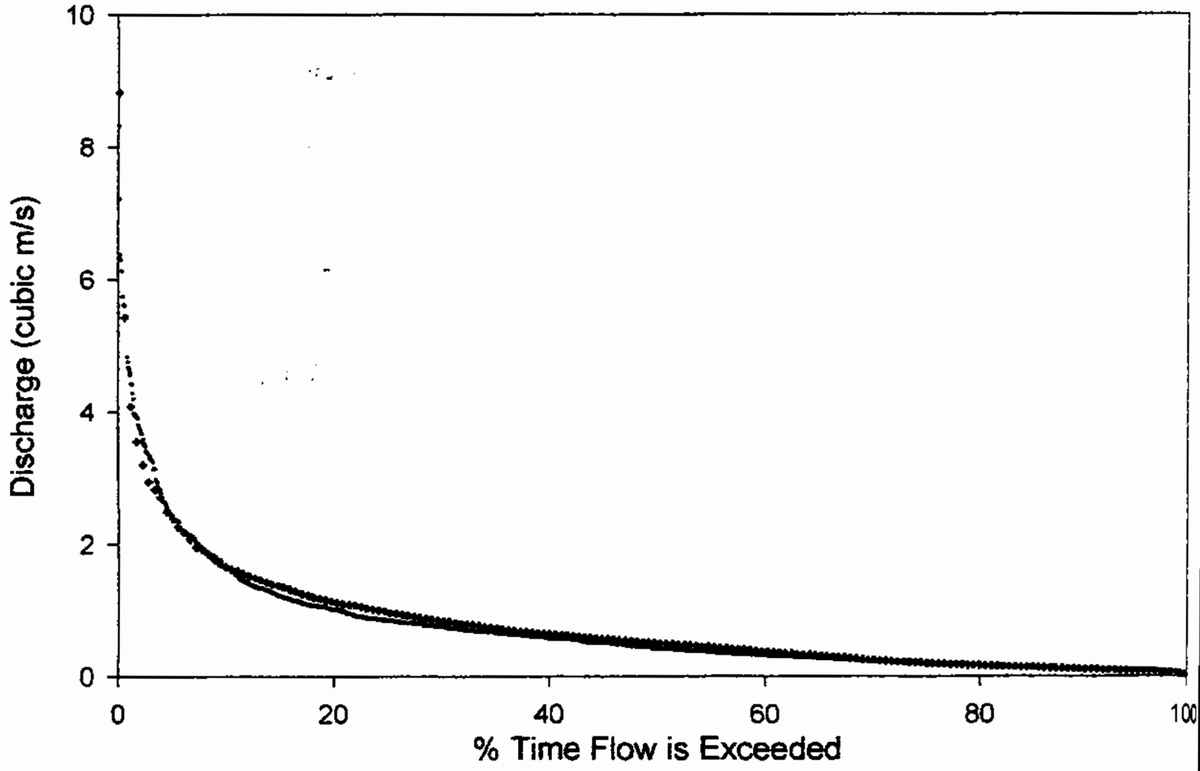

Figure 13: Flow duration curve for Fishtrap Creek, 1988-1996.

North of Abbotsford Airport , surface soils are a thin patchwork of gravel and sand deposits over relatively impermeable stoney-clays of glaciomarine origin. '. South of this point the overlying glacial outwash deposits of gravel and sand are much thicker and house an aquifer that provides the creek with large inflows of groundwater (Johanson 1988). Localized areas of the drainage areas are underlain by peat deposits. These are concentrated along mainstem adjacent to Abbotsford Airport and along East Fishtrap Creek (Johanson 1988).

Low densities of Salish sucker and Nooksack dace are found throughout the creek downstream of Highway 1 (figure 11). Before the lower reaches were dredged (1989-1992) both were apparently quite abundant there (J.D. McPhail, UBC, pers. comm.). Upstream of Highway 1 low densities of juvenile Salish sucker are found in Enns Brook (Pearson 1998). They were also found in East Fishtrap Creek prior to construction of the stormwater detention ponds (Inglis et al. 1992), but their continued presence in unconfirmed. Coho salmon, steelhead, cutthroat trout, largescale sucker, three-spine stickleback, lamprey and peamouth chub (*Nocomis biguttatus*) are also present. Pumpkinseed, largemouth bass and black crappie (*Pomoxis nigromaculatus*) have been introduced (Pearson 1998) and two pacific giant salamanders (endangered species) were caught at Simpson and Deacon Roads in 1995 (McAdam 1995, unpublished data).

The longitudinal temperature profile of the creek is complex (figure 14) with the lower reaches and upper Enns Brook remaining cool throughout the summer while East Fishtrap Creek and Lower Enns Brook reach temperatures in excess of 20°C for extended periods of time (figure 15). This high temperature zone appears to be caused by solar warming of ponded areas of East Fishtrap Creek and Enns Brook. Downstream these effects are mitigated by large inflows of cold groundwater.

Enhancement Needs

The main habitat problems in Fishtrap Creek are high summer water temperatures in the upstream reaches around Highway 1 and lack of in-stream complexity, off-channel habitat and riparian zone connections throughout most of the watershed. Riparian planting for temperature control in the headwaters and channel complexing initiatives (in conjunction with reed canary grass control) throughout the watershed are the overall enhancement priorities. In the longer term, measures to address stormwater quality and quantity in urban areas are required.

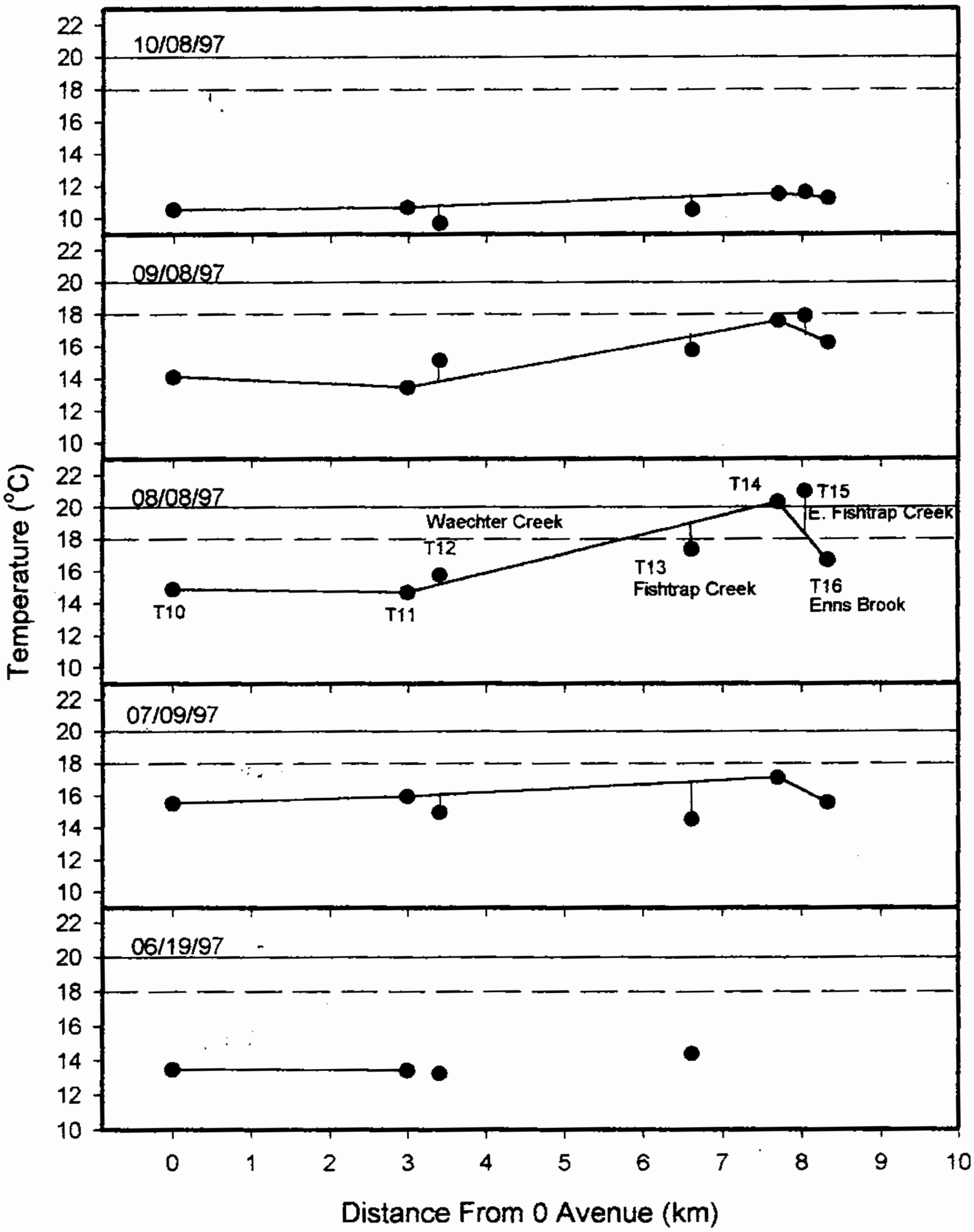

Figure 14: Longitudinal temperature profiles of Fishtrap Creekand its tributaries at intervals during the summer of 1997. Temperatures are at the daily maximum (8pm) on all dates.

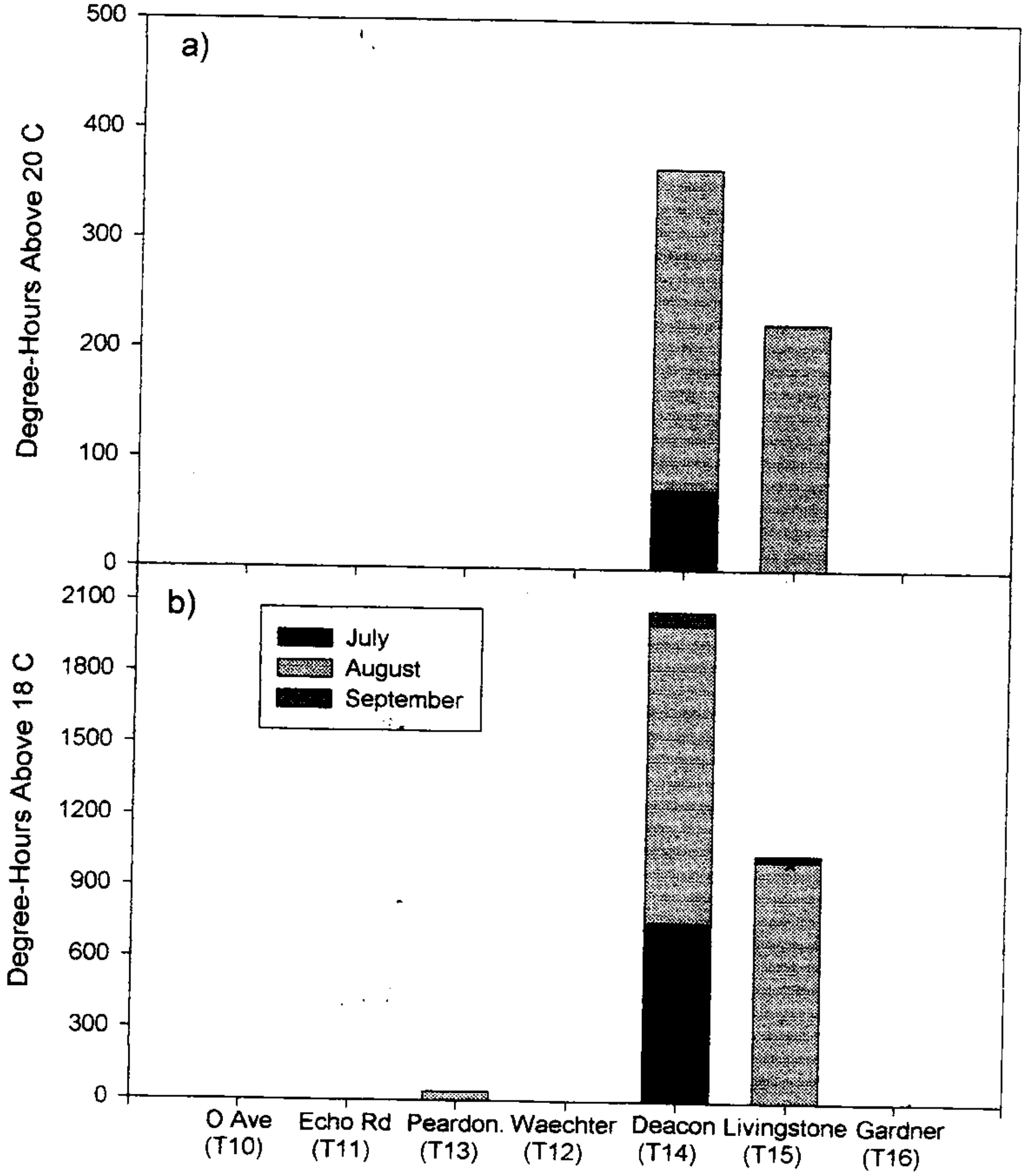

Figure 15: Monthly totals of degree hours in excess of a) 20°C and b) 18°C at Fishtrap Creek sites during the summer of 1997. * No data is available for the Livingstone Road. site in July.

SPECIFIC RECOMENDATIONS

The most important specific management recommendations arising from this study are summarized below. Their order does not indicate priority.

1. Continue contacting and working with landowners to install livestock fencing and/or riparian plantings. (MoELP/Stewardship Groups)

2. Encourage continuation of habitat complexing projects by local stewardship groups and expansion of their scope to include techniques likely to benefit Salish sucker and Nooksack dace eg. riffle creation. (MoELP).

3. Experimentally evaluate effectiveness of various restoration techniques in increasing populations of Salish sucker and Nooksack dace. (MoELP/Stewardship Groups)

4. Investigate the feasibility of restoring perennial flow to Cave Creek through the restoration of a headwater wetland on the Brightman farm. (MoELP/Stewardship Groups)

5. Improve fish access over the MacMillan Dam on Cave Creek (MoELP/Stewardship Groups).

6. Initiate a feasibility study and ascertain financial liability for removal of accumulated sediment from upper Pepin Creek. (MoELP)

7. Install oil/grease separators and sediment traps into all new storm sewers. Include retrofits of existing storm sewers in maintenance and repair projects as they arise. (Municipalities)

8. Modify development guidelines to require increased on-site stormwater infiltration. (Municipalities)

9. Continue door-to-door landowner contact and education. (MoELP/Stewardship Groups)

10. Initiate field workshops on identification and habitat requirements of Nooksack dace and Salish sucker for local stewardship groups, consultants and relevant MoELP, DFO, and municipal staff. (MoELP)

11. Extend monitoring period of Pepin and Bertrand Creek flow gauging stations to full year. (Environment Canada/MoELP)

12. Install a staff gauge to facilitate flow monitoring on Cave Creek (Stewardship Groups)

13. Locate spawning sites of Salish sucker and Nooksack dace for protection from impacts and monitor use annually (MoELP/Stewardship Groups)

14. Establish permanent population monitoring sites for Salish sucker and Nooksack dace on all creeks and collect density data at least annually. Electroshocking should not be used as the collection method. (MoELP/Stewardship Groups).

Suggested Population Monitoring Sites

Cave Creek:	Downstream side of 248th Avenue Reach C2 on Giacomazzi property
Bertrand Creek	Upstream side of 0 Avenue 28th Avenue in Aldergrove (both sides)
Pepin Creek	Leased Farm in ALRP Downstream side of Bradner Road
Fishtrap Creek	Downstream side of Echo Road Gardner Park East Fishtrap Creek detention ponds

INTERMEDIATE SCALE NEEDS ASSESSMENTS

Cave Creek

Cave creek is divided into 2 segments and 11 reaches (figure 16). Temperatures were monitored at two sites, both in Segment 1.

Segment 1: 0 Avenue to the Macmillan Dam (Reaches C1-C6; 1.77 km)

Channel structure is excellent through most of the segment, but it suffers from lack of summer flow. Reaches C1 and C5 have also been badly damaged by cattle and lack adequate shading, although fencing and replanting is underway on both. Reaches C2 and C4 have excellent pool-riffle structure, relatively abundant large woody debris, and substantial lateral pools and side channels - but only when there is adequate flow.

Despite the total absence of surface flow for over 4 weeks in late summer we found high densities of fish living in about 10 deep, well shaded pools that were concentrated in Reaches C2 and C5. We recorded water temperatures in one of these between June 25 and October 9 (T6; figure 17). It never exceeded 20°C and during the period that flow stopped completely, temperatures never exceeded 18°C and showed very little diel change (figure 18). This suggests that groundwater inflows are capable of maintaining cool temperatures in these pools at low flows. At higher flows the influence of upstream surface water (which is warmer than ground water in summer) increases and consequently water temperature tracks air temperature more closely (Ward 1985). Although larger and monitored for a shorter period of time, the pool at 248th Street showed slightly higher temperatures, probably due to it's shallower placement and larger, less shaded surface area (figure 17).

Segment 2: Dam to Headwater Marsh (Reaches C7-C11; 2.23 km)

The dam at the lower end of this segment was constructed in the 1940's to ensure an adequate water supply for livestock held downstream of 248th Street. It appears to be a significant barrier to fish movement. We did not find Salish sucker, largescale sucker, pumpkinseed, Nooksack dace, steelhead or cutthroat trout above in it 1997, although all were easily caught below. Only one juvenile coho salmon was collected upstream of the dam, although they were very abundant in pools a short distance downstream. In addition, the property owners report watching adult coho attempting and failing to cross the dam in October and observing several spawning in riffles just downstream of it. There is approximately 800 m of creek upstream of the dam (Reaches C7 and C8) which could provide suitable spawning and rearing habitat for Salish sucker and salmonids particularly if summer flows were increased. With increased summer flows the riffles through these reaches would also provide high quality Nooksack dace habitat.

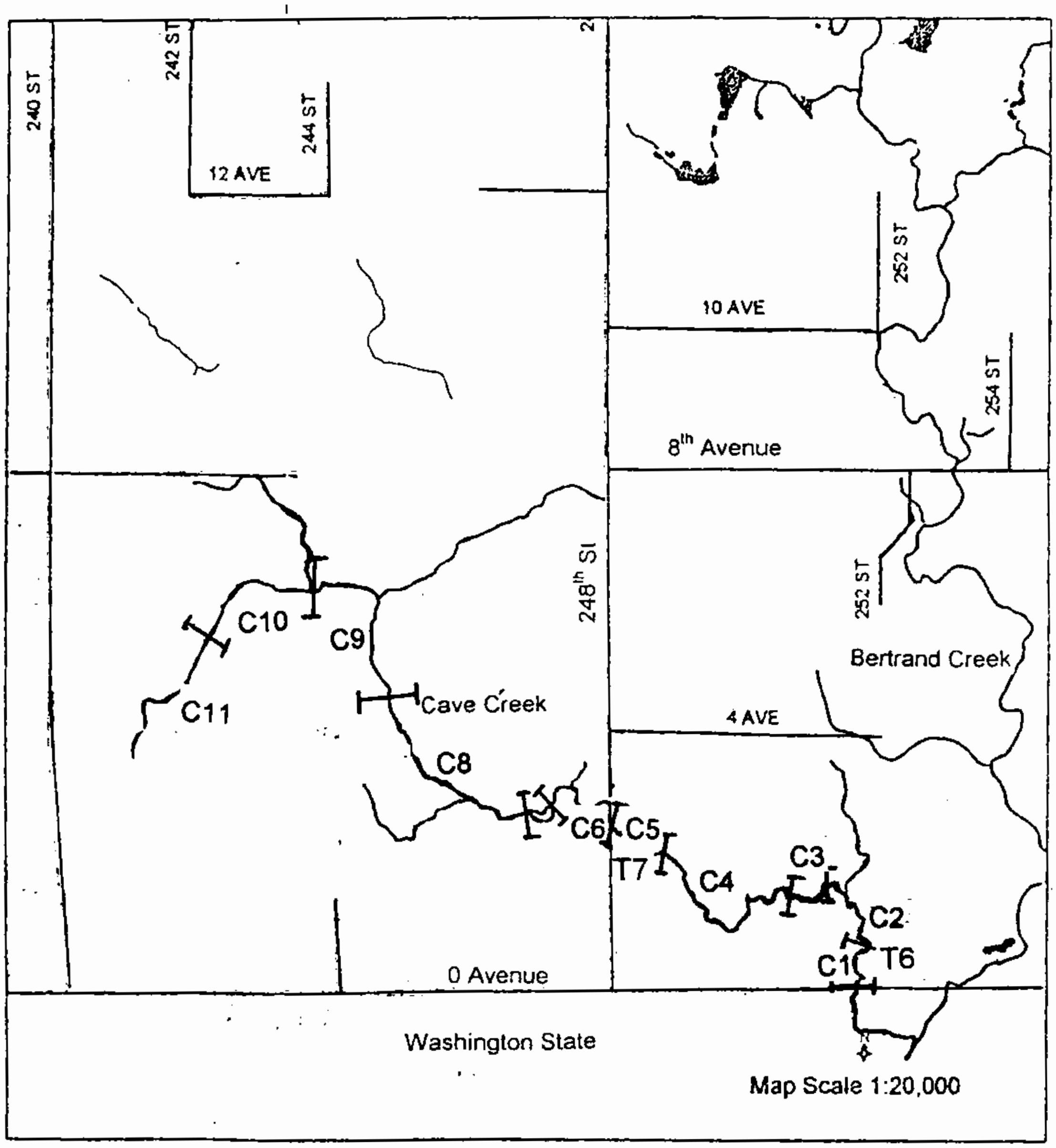

Figure 16:Tributaries and survey reach boundaries of Cave Creek.

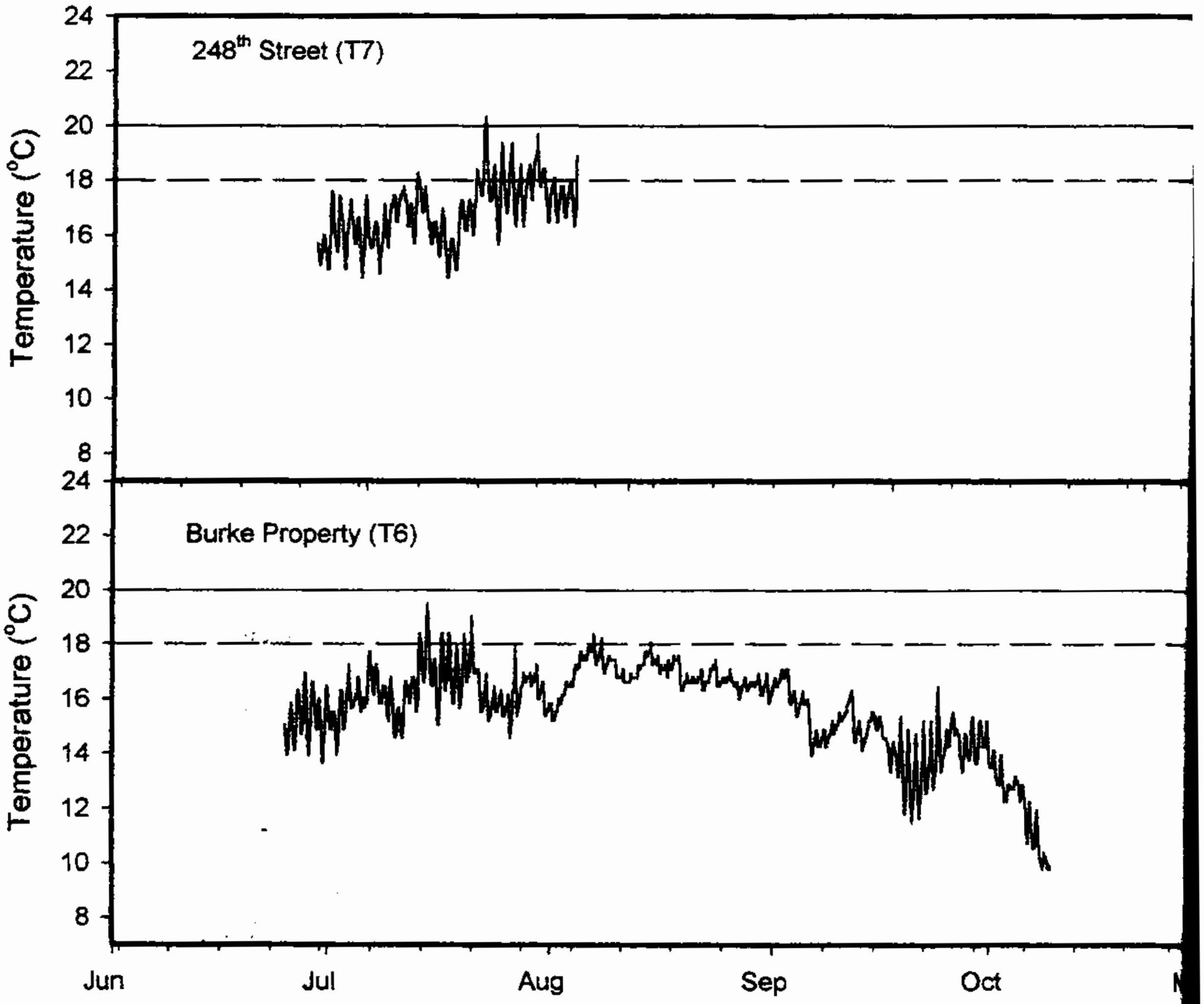

Figure 17: Water temperatures in two large pools of Cave Creek during the summer of 1997.

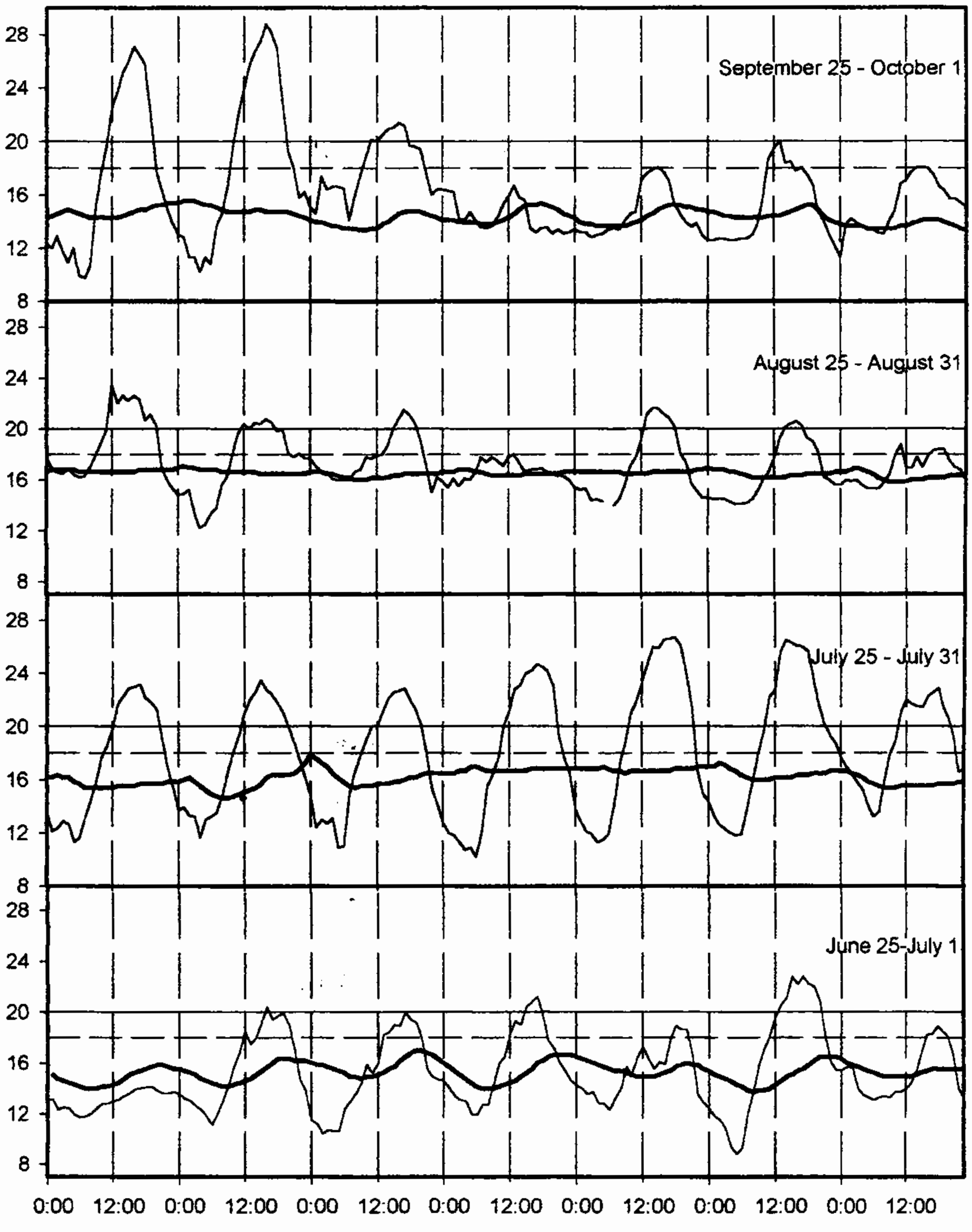

Figure 18: Water temperatures in the Burke pool (T6) of Cave Creek over several one week periods during the summer. There was no surface flow between late July and early September. The thinner line represents air temperature at Abbotsford Airport.

The upper reaches of the segment are much more physically degraded. The creek runs unshaded, and unfenced through open pasture for 500 m through Reach C9. On the afternoon of the survey (August 2, 1997) the water entering this reach from C10 was 15.5°C and flow was very low, although present. In the middle of the field, 100 m downstream the water had warmed to 23.5°C. Clearly shade planting and fencing would be of immediate benefit. Reach C10, just upstream, was a large wetland until it was dredged in 1969. It remains wet meadow and has potential to increase summer flows in the creek through a wetland restoration project. The present landowner, who grew up on the property, reports that prior to the dredging "suckers" and trout were common there. We caught only sticklebacks

Bertrand Creek

Bertrand Creek is divided into 5 segments and 40 reaches, although 2 of the segments were not surveyed. Temperatures were monitored at 5 sites (figure 19).

Segment 1. The Agricultural Headwaters (B40; 2.4km)

We were unable to survey this segment due to time constraints. From aerial photographs it appears to have been channelized and stripped of riparian vegetation for its entire length. On August 9, 1997 members of the Bertrand Creek Enhancement Committee discovered a fish kill at the lower end near 32nd Avenue. They recovered 16 dead cutthroat trout with fork lengths ranging from 142 to 271 mm (Pearson unpublished data). This suggests that high temperatures and/or oxygen depletion may be a problem in the area. The Langley Environmental Partners Society recently completed a riparian planting project at the downstream end of the segment.

Segment 2. The Urban Headwaters (Reaches B33-B39; 2.2 km)

Through the town of Aldergrove, channel structure is greatly simplified due to historical dredging and channelization activities. Numerous storm sewer outfalls discharge large volumes of runoff into the creek during rainfall events. Water temperatures were not monitored in this segment during the summer of 1997, but data loggers have since been placed at the upstream and downstream limits of the segment.

Local stewardship groups have completed a number of stream complexing projects in recent years. These include marsh benches, root wad placements, off-channel habitat construction, and riparian and wetland plantings. Much more of this type of work is needed. In the longer term, a reduction in stormwater runoff volumes and toxicity should be sought through increasing the infiltration capacity of the urban landscape. Existing and new storm sewers should be fitted with oil/grease separators and

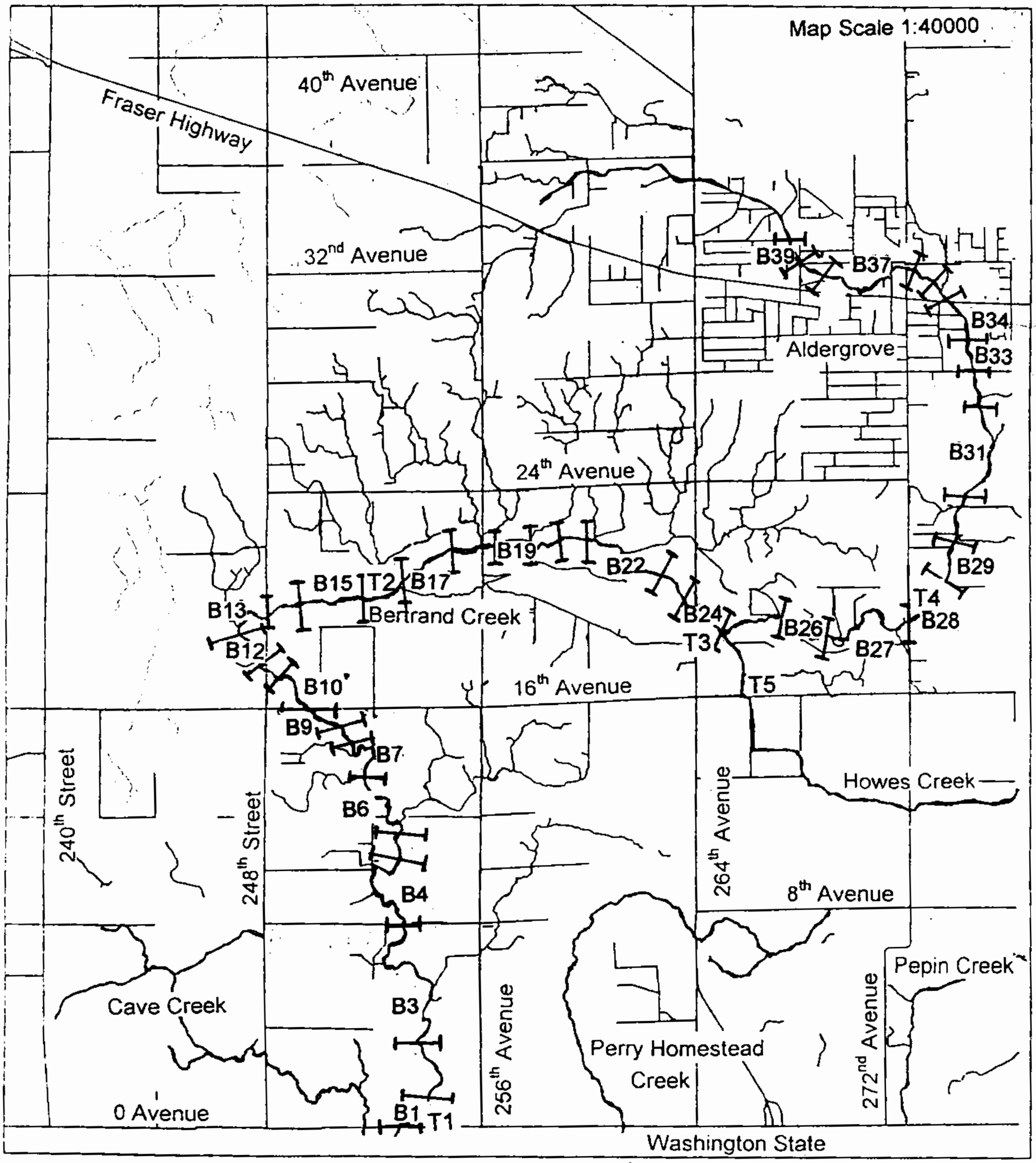

Figure19:Tributaries and survey reach boundaries of Bertrand Creek.

sediment traps. Riffle creation in areas with sufficient gradient would be beneficial for Salish suckers, salmonids, and particularly Nooksack dace as most reaches contain little of it at present.

Segment 3. The Middle Reaches (B18-B32; 6.65 km)

This segment is characterized by low stream gradient and few riffles (<15% of reach length). Upstream of Reach B27 (between 264th and 272nd Streets) the channel is well shaded for much of its length and some reaches are bordered by mature forest, however, channel structure throughout the segment is generally very degraded. Bank erosion and failure is rampant, particularly downstream of the Howes Creek confluence - a section also suffering from lack of in-stream complexity and riparian vegetation.

Water temperatures in Bertrand creek are more susceptible to elevation than are those in Pepin and lower Fishtrap Creek, due to lower groundwater inflows. The monitoring data indicates that significant warming occurs between 264th and 252nd Streets (figure 20; figure 21). This section is virtually without channel shading and suffers from extensive livestock damage and very low summer flows. The problems are most acute in reach B22. When surveyed on September 6, this shallow, unshaded, cattle trodden stretch of stream was choked with algae. The most urgent restoration needs in the segment are cattle fencing and riparian planting for shade. Other bank stabilization measures and a substantial amount of channel complexing will also be required before this segment supports a healthy fish community.

Segment 4. The Lower Reaches (B1-B17; 7.46 km)

In contrast to the middle reaches, habitat structure in the lower reaches is generally excellent. There are numerous deep pools, extensive high quality spawning riffles and plenty of large organic debris and off-channel habitat. This is reflected in the high diversity and abundance of the fish community (Pearson 1998). There are localized areas that need cattle fencing and/or riparian planting, but the two major habitat problems, high summer temperatures and severe localized bank erosion are caused by upstream influences. Water temperatures in this segment are particularly worrisome during late summer when they are at critical levels for salmonids for extended periods of time (figure 20). This segment is by far the most productive in Canada for Nooksack dace with densities at the reach scale at least an order of magnitude higher than anywhere else within the study area (Pearson unpublished data).

Segment 5. Howes Creek

Although we were unable to survey Howes Creek in 1997, we did monitor temperatures in a pool at 16th Aveneue (T5; figure 13). It remained quite cold throughout the summer, never exceeding 18°C although surface

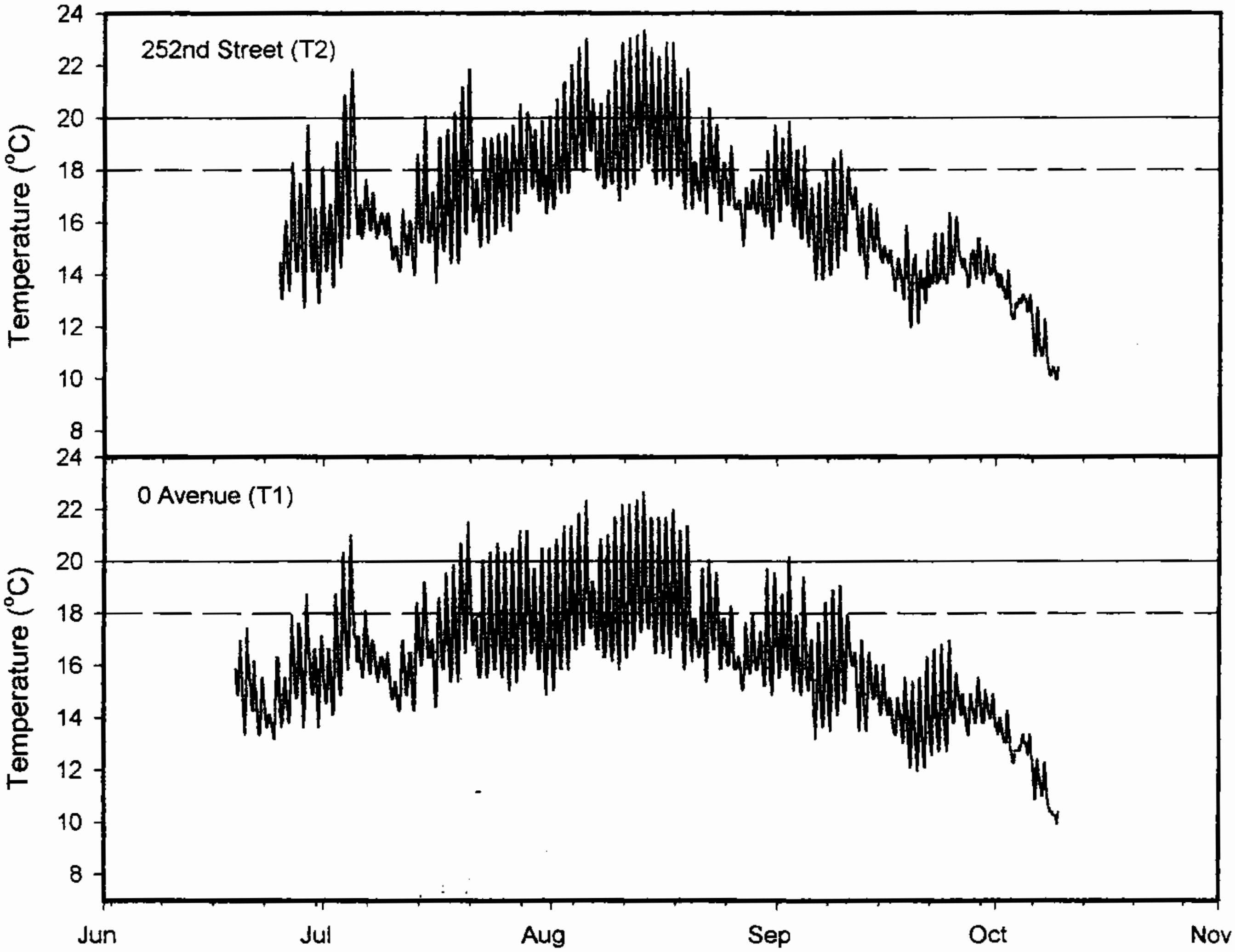

Figure 20: Summer water temperatures in the lower reaches of Bertrand Creek in 1997.

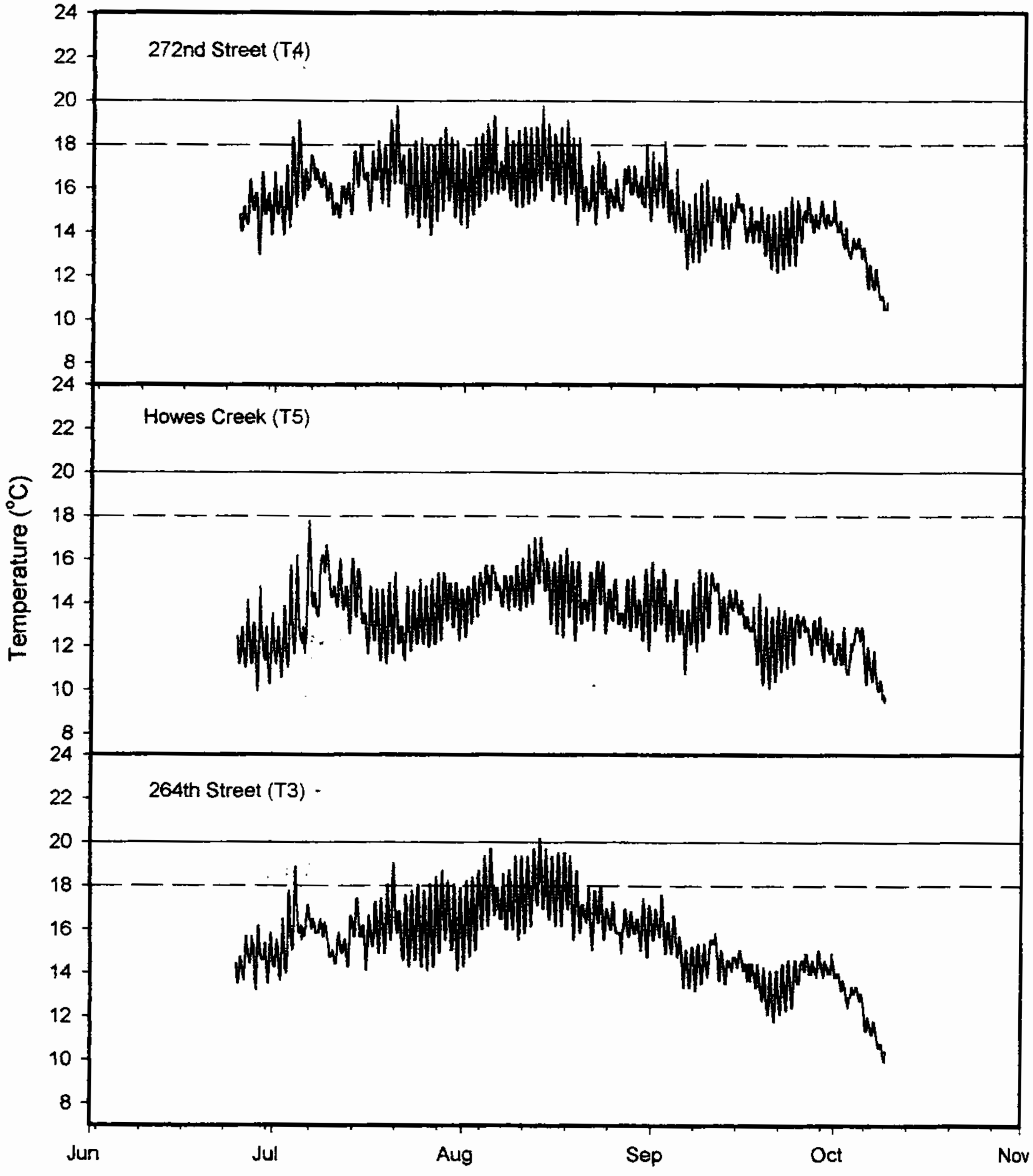

Figure 21: Summer water temperatures in the middle reaches of Bertrand Creek and in Howes Creek in 1997.

flow ceased for some weeks as it does most years between 16th Avenue and 272nd Street (F. Pepin pers. comm.). Much of Howes Creek appears channelized and without adequate riparian vegetation in aerial photographs. Its middle reaches flow over an area of deep gravel deposits and hydrogeologic data suggests that a portion of its water may feed nearby Pepin Creek via subsurface flow (Johanson 1988). Both Salish sucker and Nooksack dace are believed extirpated from Howes Creek (Inglis et al. 1992,1994).

Pepin Creek

Pepin Creek was divided into 3 segments and 17 reaches. Temperatures were monitored at 3 sites (figure 22).

Segment 1. Upper Reaches (P16,P17; 2.85 km)

The entire segment except for an 800 m stretch extending upstream from Bradner Road is underlain by peat deposits (Johanson 1988) indicating that it supported wetland historically. Long term residents (R. Telford, H. Bell, pers. comm.) report that prior to the arrival of beaver in this stretch in the mid 1960s, the channel was narrow, relatively deep, and flowed between moss covered banks. Trout and salmon were apparently abundant. Beaver activity has expanded since then and now virtually the entire segment is ponded. Salish suckers have spawned in the riffles around Bradner Road for many years (J.D. McPhail, University of British Columbia, pers. comm.) but now only a short (20m) section of this habitat type remains (immediately downstream of the road crossing).

The segment is now flanked on both sides by gravel pits for most of its length. Sediment loading from two of them has been very severe and little of it is flushed through the system due to the extensive beaver ponds and marsh lands downstream. The channel and ponds of reach P17 are now choked with clay more than 1m deep in most places. The current operators of the pit (Little Rock Quarries, Langley, B.C.) installed a series of settling ponds during the summer of 1997, but detention times may not be adequate to allow small clay particles to settle and no vegetation is yet established around them so erosion remains severe.

An unnamed tributary drains through the Columbia Bitulithic gravel pit from a pond on its northern edge (which contains Salish sucker) and enters the creek in reach P16. The tributary lacks any riparian vegetation for most of its length and receives massive sediment flows from the surrounding pit during rainstorms. Despite the high sediment loads, and very high summer water temperatures (figure 23), it does support low densities of cutthroat trout. It also appears to be perched, perhaps on a clay lens, as when we first observed the stream in May and June the gravel

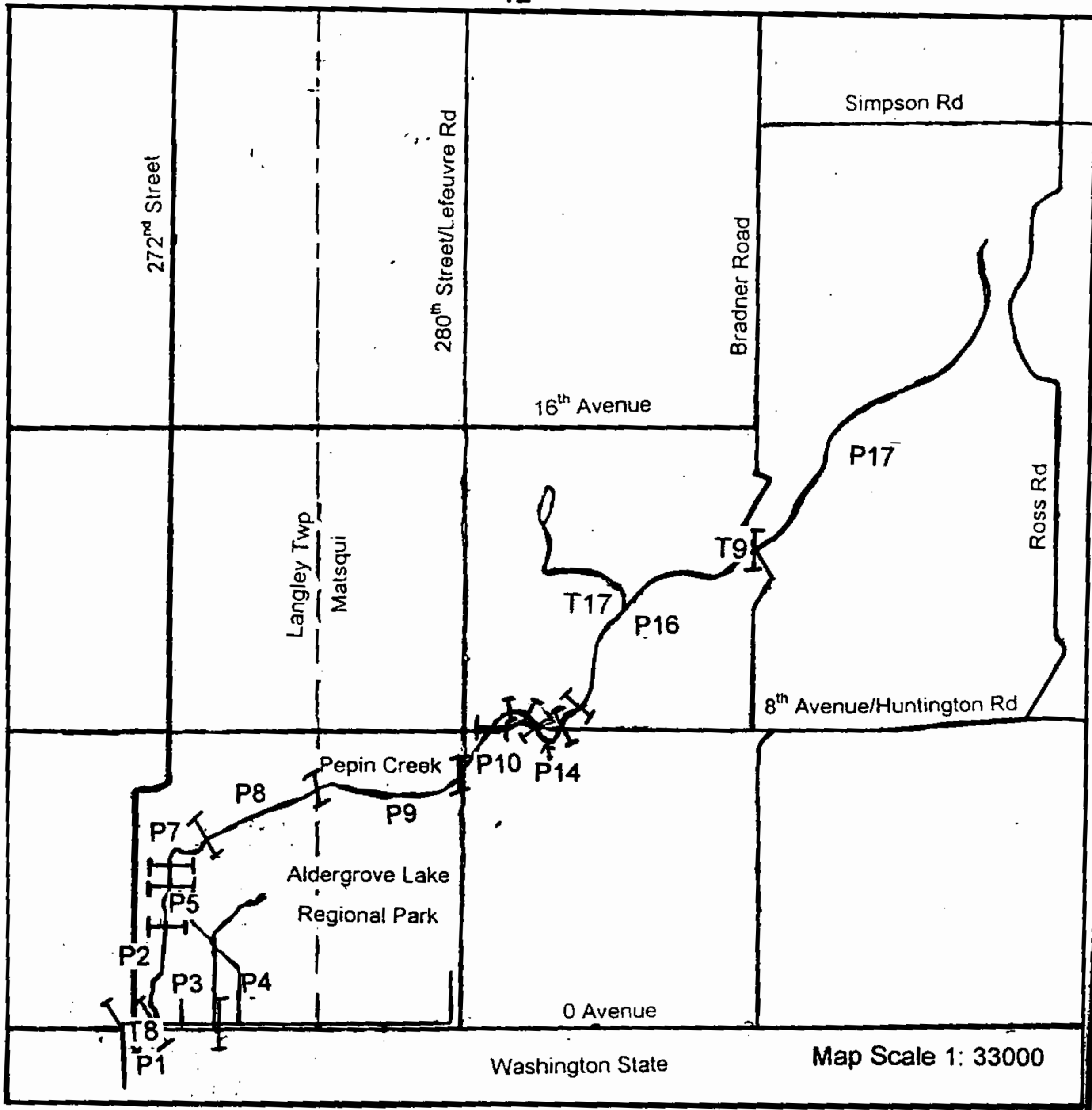

Figure 22: Tributaries and survey reach boundaries of Pepin Creek.

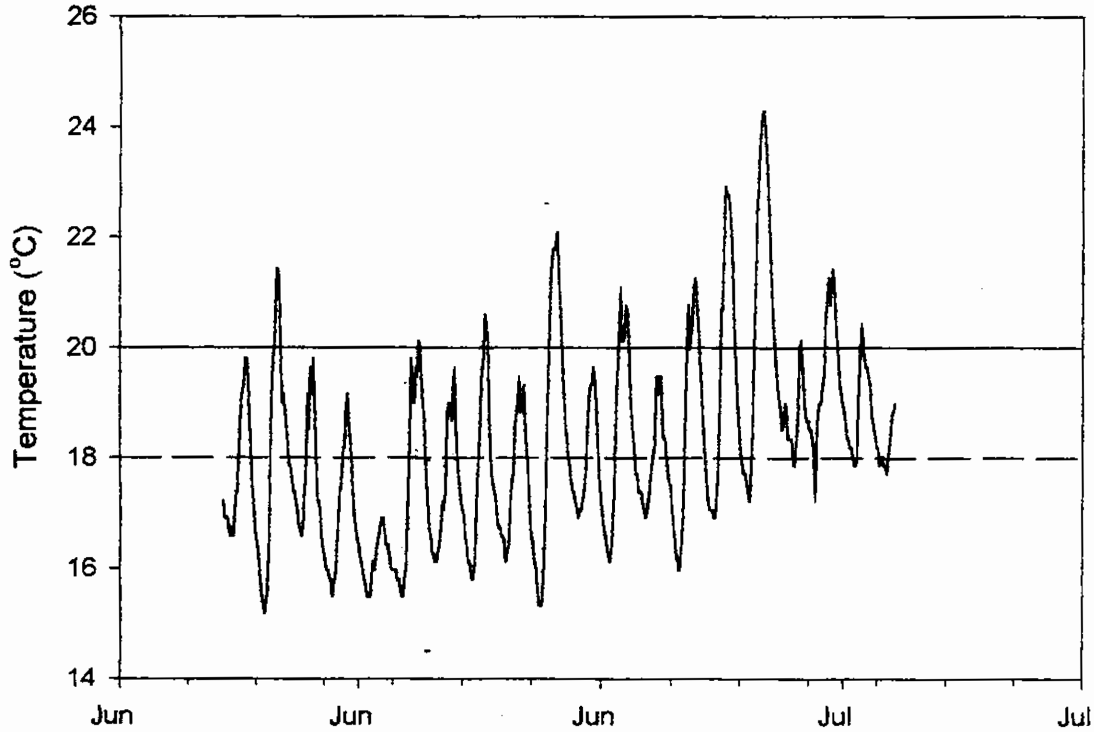

Figure 23: Summer water temperatures in an unnamed tributary of Pepin Creek flowing through the Columbia Bitulithic Ltd. property (T17).

to the north of it had been removed to within 2m of the bank to a depth of 4 m below the channel, leaving it flowing on top of a cliff. Columbia Bitulithic has since filled the hole in and has agreed to revegetate and fence off a 30m strip on both sides of the creek though the pit. Continuation of this work and clearing of the massive sediment load in Reach P17 are the main restoration needs for the segment. The beaver dams should be left in place, at least until much of the accumulated sediment is removed from behind them.

Segment 2. Middle Reaches (P9-P15; 1.83 km)

This segment is also swampy and low gradient except for a single short reach (P14) that loops south of Huntington Road and is steeper with two riffles. Through the rest of the segment, sediment is deposited a metre deep in some places. The fish community in segment would probably benefit from spawning riffle creation if a site with a suitable gradient can be located.

Segment 3. Lower ALRP Reaches (P1-P8; 25.13 km)

Within the forested area of the ALRP (P6,P7), this segment is in good condition with complex pool-riffle channel structure and a wide and active floodplain. Currently the riparian zone is dominated by alder, but remnant stumps indicate that large, old growth cedar grew there historically. The park setting offers an opportunity, in the long term, to reestablish a fully functional old growth riparian zone that would provide a sustainable supply of LWD to the channel. This could be promoted by selectively thinning the alder and underplanting it with cedar and hemlock.

Downstream, the riparian zone in the farmed reaches (P1-P5) is now almost completely fenced and is recovering rapidly from livestock damage. The drainage ditches from the surrounding fields that enter the creek via the 0 Avenue ditch support large numbers of juvenile coho salmon in addition to concentrations of cutthroat trout and, in summer, juvenile Salish suckers. We have been unable to locate the suckers in winter - probably because of their low numbers and the vast increase in off-channel habitat due to elevated water levels. Fred Pepin, a retired well driller, who grew up on the property reports that the mainstem of the creek through the farm was formerly much wider and contained abundant riffles. It has narrowed with the invasion of reed canary grass over the past 20 years and is now dominated by runs. The mainstem and drainage ditches may benefit from some riffle creation, and the placement of large organic debris, perhaps in conjunction with removal of the adjacent reed canary grass.

Fishtrap Creek

Fishtrap Creek is divided into 5 segments, 3 of which were surveyed. The survey includes 28 reaches and temperatures were monitored at 7 sites (figure 24)

Segment 1. The Urban Headwaters (Reaches F13-F28; 4.43 km)

This segment consists of East Fishtrap, the Clearbrook drainage and the upper, urbanized portion of Enns Brook. The three join via the ditches surrounding Highway 1 (Figure 25). At this confluence, water levels are controlled by a floodgate on the north side of South Fraser Way. The creek then continues south under Deacon Rd through a small industrial park to the downstream end of Reach 13. The entire segment is urbanized and receives large inputs of storm water during rainstorms.

East Fishtrap Creek was rerouted and ponded north of Highway 1 for stormwater detention purposes. The 'South Basin', between Highway 1 and Old Yale Rd (Reach F26) was constructed in 1992 and 1993 and the larger 'North Basin', between Old Yale Road and Charlotte Avenue (Reach F27), was completed between 1993 and 1995. Both were designed and built as multi-purpose facilities featuring integrated wetlands, interpretive trails and public pavilions. The ponds are designed to accommodate water level fluctuations of 1.5m while maintaining a maximum depth of 2m at low water levels. Total ponded area is approximately 10 ha (Lister 1990).

Enns Brook, although closely bounded by urban areas for its entire length upstream of Highway 1 remains quite cool and supports salmonids throughout the summer (Pearson 1998). Water temperature at Gardner Road (T16; Figure 26) reached 18°C on only 3 days during the summer of 1997. The water warms considerably, however, in Gardner Pond just upstream of Highway 1. On August 10, 1997 spot measurements revealed a 3.5°C rise through the pond from 16°C at the inflow in late morning. Lister (1990) reports a similar although slightly smaller increase.

Lister (1990) monitored stream temperatures and flows in the area prior to construction of the East Fishtrap Creek detention ponds. He found that East Fishtrap contributed approximately 50% of the 43 l/s in the mainstem downstream of Highway 1 in late June, but that this declined to about 20% of the 9.1 l/s at the end of July and that its flow stopped completely between mid-August and late September. Consequently, although quite warm, it had a negligible effect on downstream temperatures in late summer. Construction of the ponds has increased summer flows in East Fishtrap Creek and temperatures at Livingstone Road immediately upstream of it's confluence with Enns Brook are high, almost never dipping below 18°C during the month of August (figure 26). The combined effects of

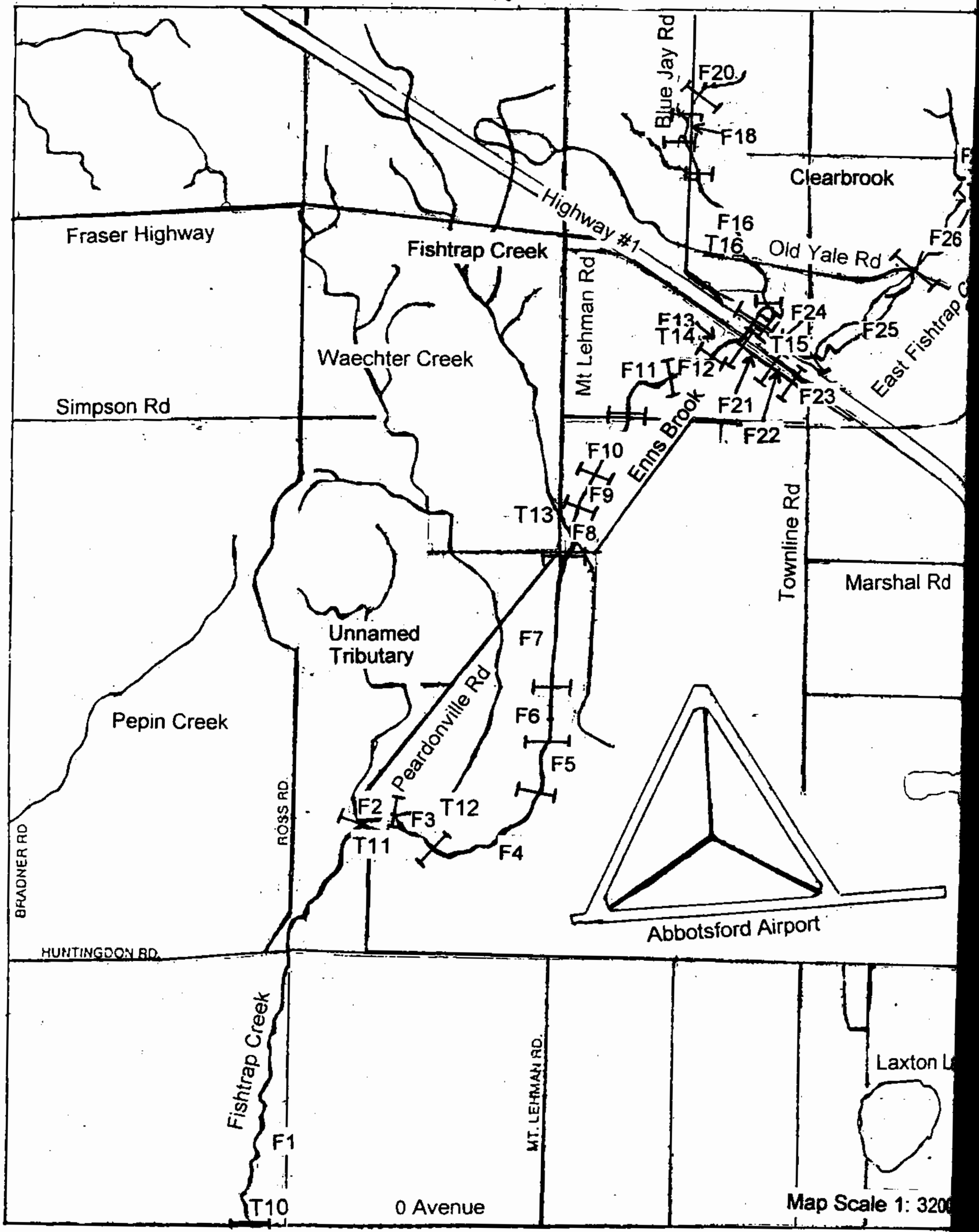

Figure 24: Tributaries and survey reach boundaries of Fishtrap Creek.

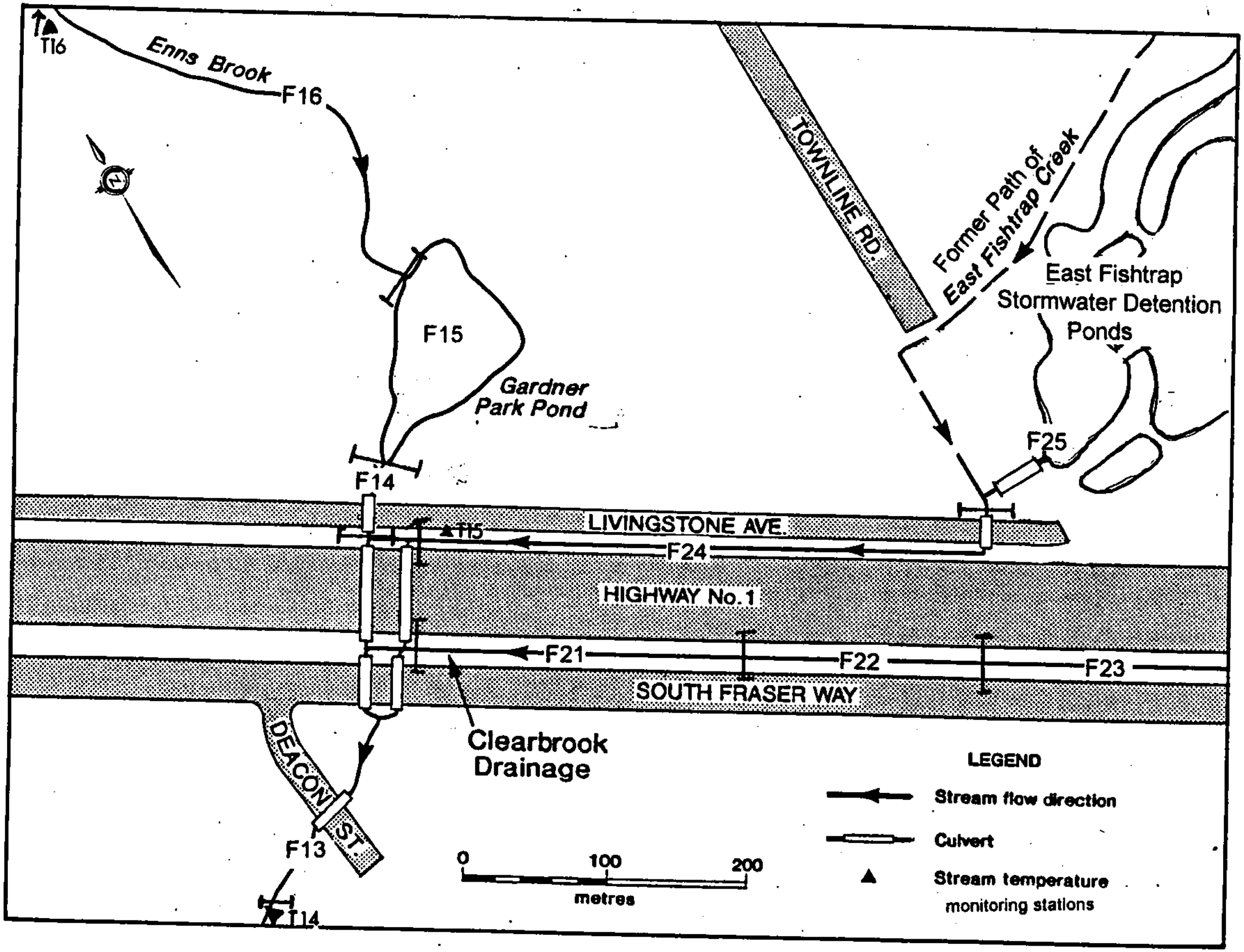

Figure 25: Drainage pattern and locations of temperature monitoring sites on Fishtrap Creek around Highway 1 (adapted from Lister 1990).

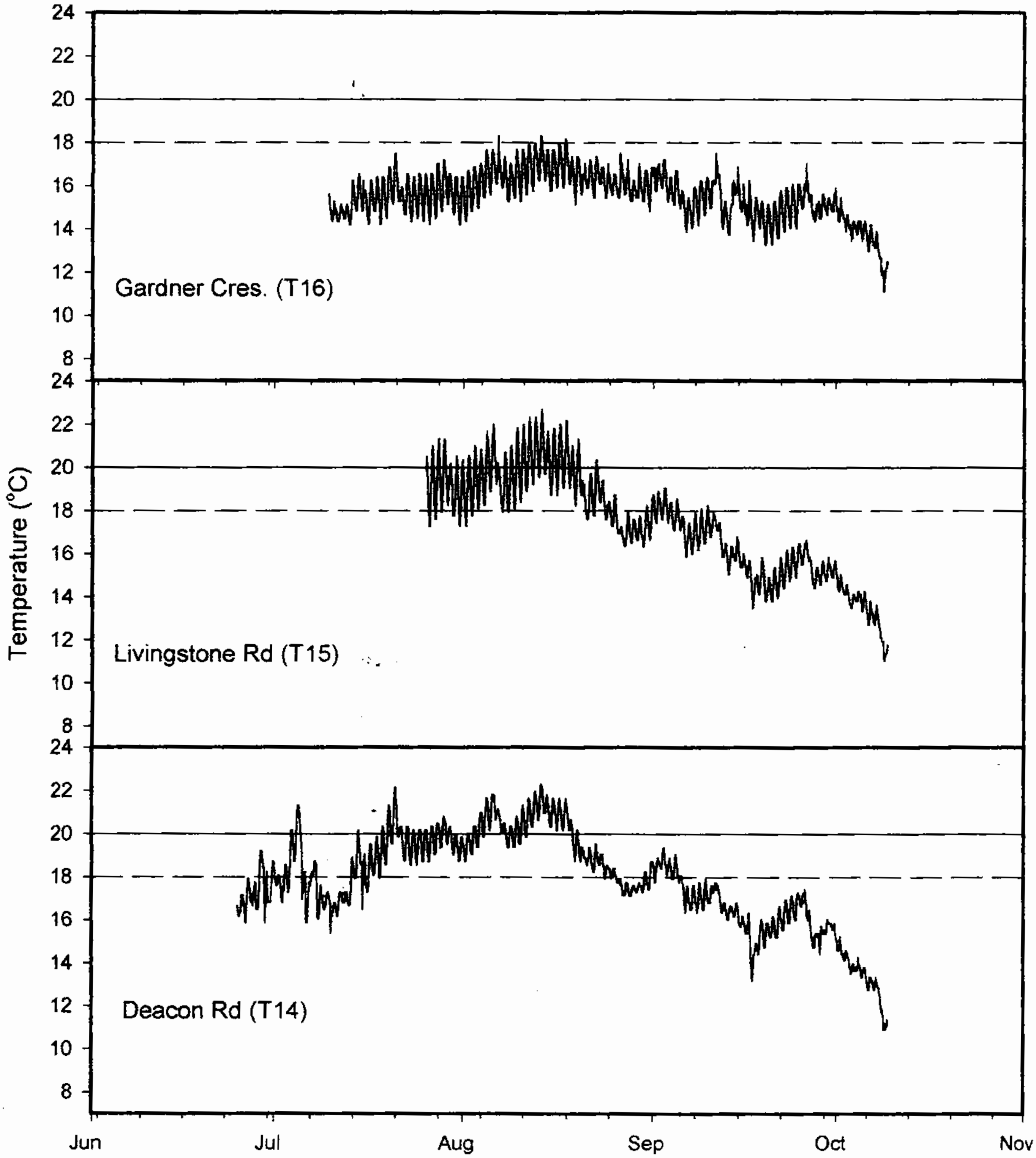

Figure 26: Summer water temperatures of Enns Brook and East Fishtrap Creek monitoring sites in 1997.

the ponds are seen at Deacon Road, downstream of Highway 1 where temperatures continuously exceeded 20°C for days during August.

Prior to construction of the detention ponds, the Clearbrook Drainage provided over half of the late summer flow to Fishtrap Creek below Highway 1. Despite little shading it remains very cool in summer and warm in winter due to groundwater inflows (Lister 1990; Pearson unpublished data) and consequently may act as a thermal refuge during both seasons.

Upstream of the East Fishtrap Creek ponds, at Charlotte Road water temperatures are also high (figure 27) and substrate sedimentation is severe, presumably from upstream storm water discharges and/or sediment escape from the subdivision construction underway upstream.

Although riparian plantings around the East Fishtrap and Gardner Ponds and along the Livingstone Avenue ditches would help alleviate high summer water temperatures, they are unlikely to have major impacts. Complete shading of pond surface area will not be possible, particularly in East Fishtrap Creek and given the long residence times of water in the ponds, warming seems inevitable. The situation is undoubtedly exacerbated by the high volumes of warm runoff channeled to the streams by the storm sewer system.

In-stream complexity is severely reduced due to channelization in the area downstream of Highway 1 and in the ditched portions of East Fishtrap Creek and the Clearbrook drainage (Reaches F13 and F21-F24). Channel complexing and off-channel habitat creation projects would be of great benefit to these areas and may be particularly important in the Clearbrook Drainage given its possible role as a thermal refuge.

Severe erosion and bank failure is common in Enns Brook above Gardner Park, probably due to increases in storm runoff associated with urban development. Increasing infiltration rates in new and existing urban developments is the only solution to this problem.

Segment 2. The Middle Reaches (Reaches F3-F12; 4.51 km)

This segment extends from the industrial park near Highway 1 downstream to the confluence with Waechter Creek. The stream gradient is very low and riffles rare (<10% length) except in reaches F6 through F8 which have moderate amounts of riffle (>15 %), but very compacted substrates. Upstream of Peardonville Road the floodplain is broad and the habitat dominated by alder swamp and wet meadow. Downstream of Peardonville the channel is quite straight and confined between high banks which are eroding badly. It has obviously been dredged historically and there is very little off-channel habitat. Creek volume increases rapidly and

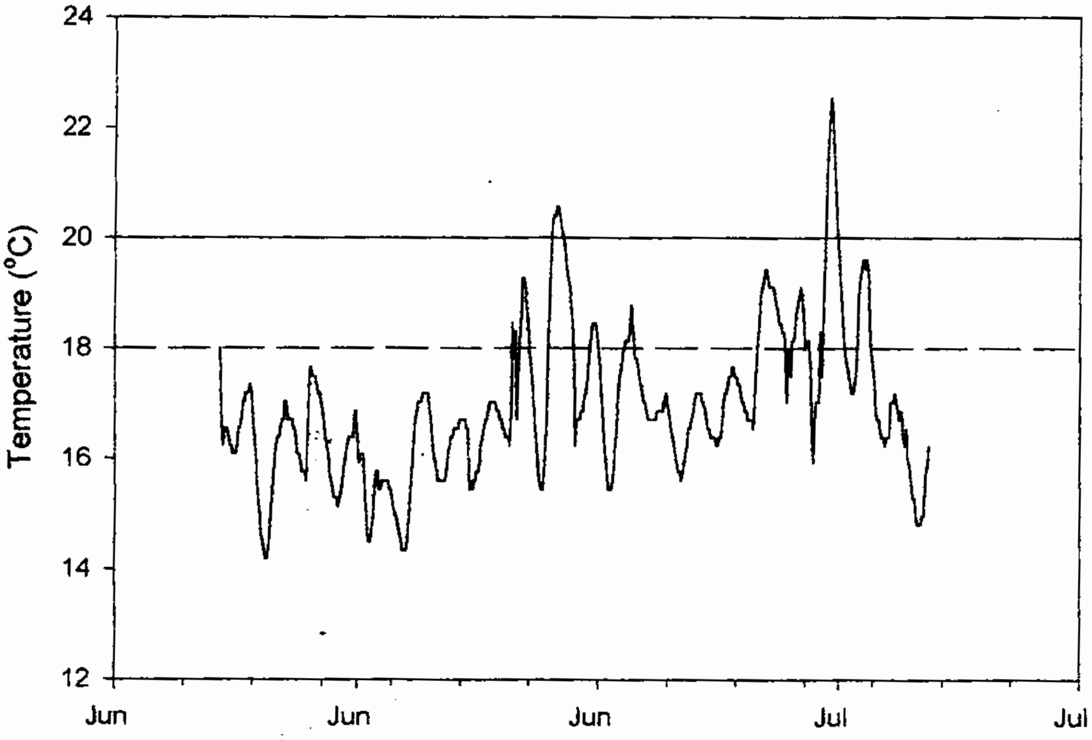

Figure 27: Summer water temperatures in upper East Fishtrap Creek at Charlotte Rd (T18) in 1997.

temperature decreases over the most downstream kilometre indicating large groundwater inflows. With the exception of Reach F11 which is forested swamp, the segment has very little riparian vegetation.

Restoration priorities are riparian planting, off channel habitat creation, and channel complexing initiatives. With their steeper gradients, reaches F6 through F8 would probably benefit from riffle creation and/or decompaction of existing riffle substrate. Additions of larger cobble (200+ mm) to them is likely to benefit Nooksack dace by increasing adult habitat. Cattle damage is evident at the Waechter Creek confluence and in Reach F10 (south of Simpson Road) and these areas would benefit from fencing. Increasing infiltration in upstream urban areas would help decrease bank erosion and failure. The upper reaches of the segment also suffer from the high summer temperatures created in the headwaters (see above). Temperatures upstream of Marshal Road (Reaches F8-12) all exceeded 18°C when surveyed on September 2, 1997.

Segment 3. The Lower Reaches (Reaches F1 -F2; 3.21 km)

Downstream of the Waechter Creek confluence the creek is deep, cold (figure 28) and clear due to large groundwater influxes. Prior to flood control dredging by the Municipality between 1989 and 1992, 30% of the habitat was riffle (Caverhill 1972) and Nooksack dace and Salish sucker were abundant throughout the segment (J.D. McPhail UBC, pers. comm.). Now there is virtually no riffle or off-channel habitat and densities of both species are alarmingly low. The banks are steep and high (>2m in most places) and lack woody riparian vegetation for most of their length. Reed canary grass covers the banks and in many places extends across the channel in summer. Adult and juvenile salmonids are common as the canary grass provides abundant cover. Restoration needs for dace and suckers are primarily riffle creation, shallow rearing habitats, and off channel refuges. In the long term riparian reforestation would provide the some of the large organic debris needed to maintain channel complexity and would reduce the prevalence of canary grass.

Segment 4. Waechter Creek

Waechter Creek flows south from around the Fraser Highway, to join the mainstem upstream of Echo Road. Water temperature at Hope Road never exceeded 18°C in the summer of 1997 (figure 29). Due to time constraints I was unable to survey the habitat. Inspection of aerial photographs, however, reveals that through its lower reaches (downstream of Marshal Rd) it flows through berry farms and a large nursery protected by a very thin band of riparian vegetation. Upstream of Marshal Road it flows through an extensive network of woodlots.

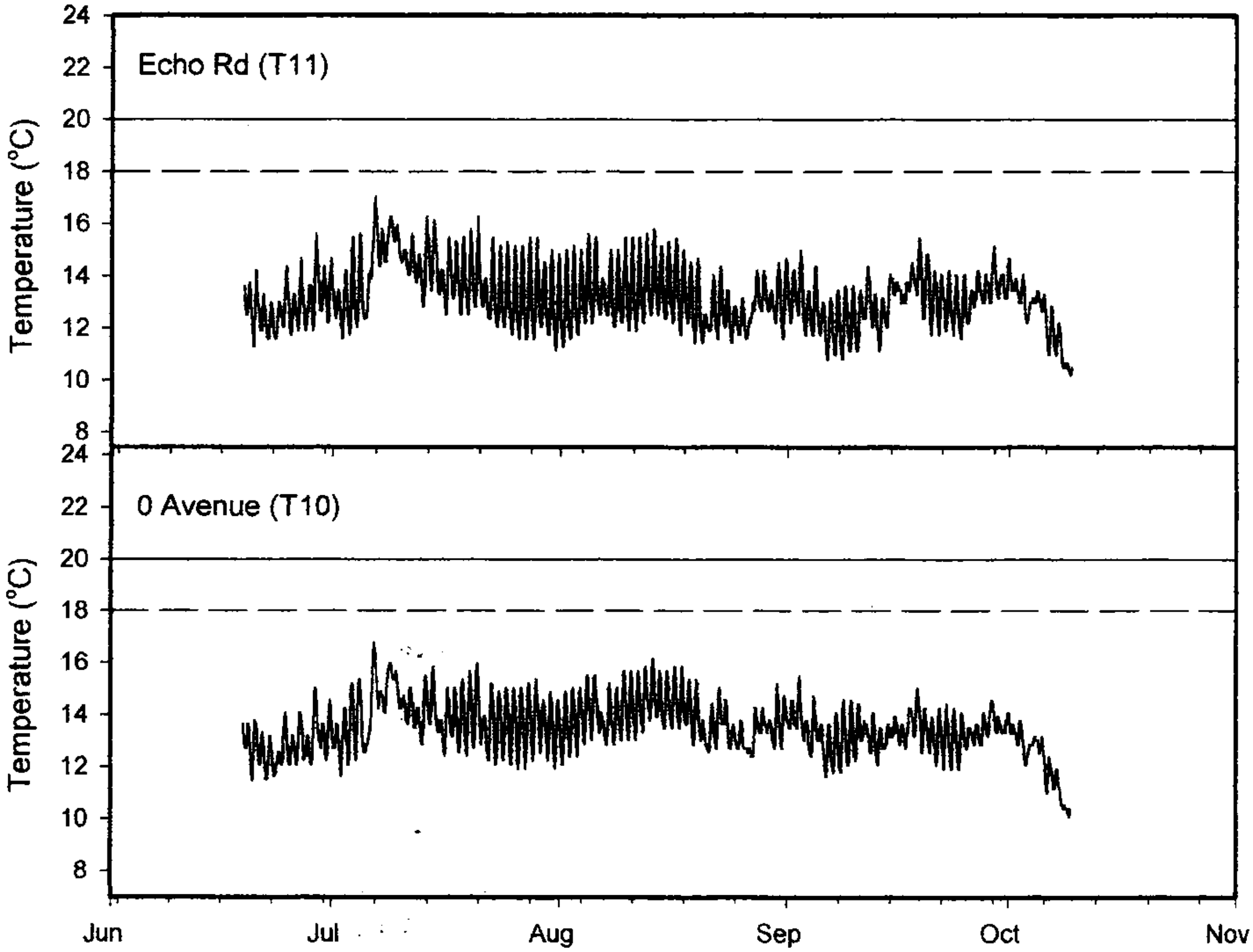

Figure 28: Summer water temperatures in lower Fishtrap Creek in 1997.

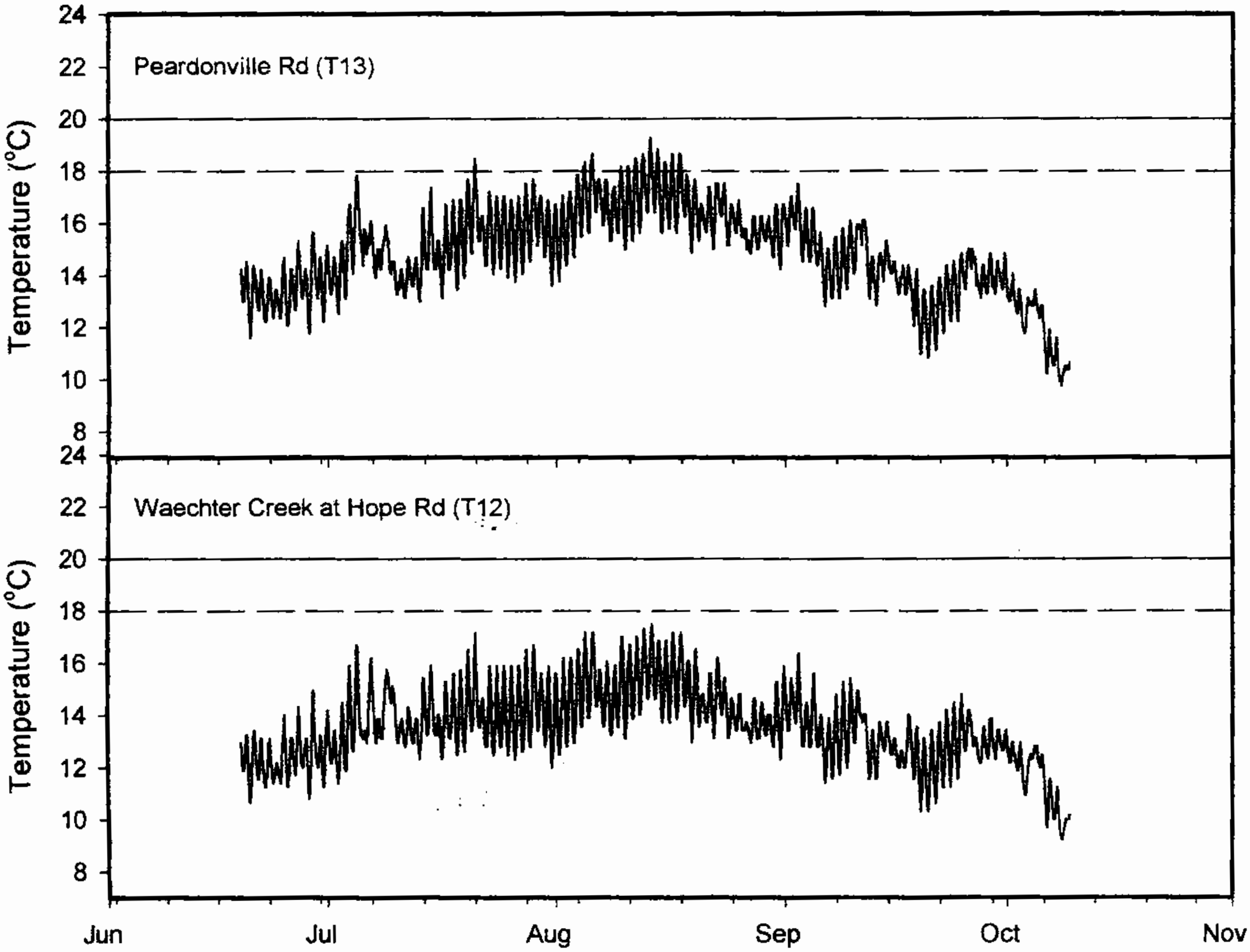

Figure 29: Summer water temperatures in Waechter Creek and upper Fishtrap Creek in 1997.

Segment 5. Upper Fishtrap Creek

Upper Fishtrap is relatively cool in temperature although slightly warmer than Waechter (figure 29). It was not surveyed in detail either, but aerial photographs show that for most of its length its riparian zone is intact.

LANDOWNER SURVEYS

We conducted a standardized surveys with those landowners encountered while sampling or when obtaining permission to cross private land. The survey and responses to selected questions appear in Appendix 1. Although far from exhaustive, and despite biases towards some watersheds and towards rural landowners, it did yield some interesting results. Over half of those interviewed had lived on their property for more than 20 years and only 14% of those surveyed held property of 5 acres of less as most of the land is within the Agricultural Land Reserve. Half of those surveyed had pumped their septic tanks within the past 2 years, but most of the remainder (40% of total) had either not had it pumped within the past 5 years or did not know when it had been pumped last. Many of the latter group were unaware that they had a septic tank.

With respect to Salish sucker and Nooksack dace, 40% of respondents were aware that the creeks supported endangered species of fish, although only half of these could name one of the species. Their awareness stemmed from a variety of sources, including interactions with MoELP staff and a 1995 education project by the B.C. Federation of Naturalists, but most had seen a newspaper article published within the past few years. Ten of the 36 respondents were unaware that the creeks contained salmon or trout.

When asked what they thought was causing perceived reductions in fish abundance or in "creek health" people often cited high runoff and erosion or pesticides. Not one person, however, mentioned water temperature, reduced habitat complexity in general or loss of specific habitat types like riffles or off-channel areas. Those that thought "creek health" was good or excellent tended to cite abundant plant growth, fish presence, and/or an abundance of terrestrial animals around the creeks as reasons. High levels of interest in the creeks and their health is indicated by the fact that 57% of those surveyed expressed interest in attending a meeting to learn more about the ecology of their creek and discuss what might be done to improve it.

The combined results suggest that landowners in general are very interested in the creeks, but that many have little understanding of what constitutes good fish habitat or of many of the most important sources of habitat degradation. In such a situation, public education about the fish community and its habitat requirements is both badly needed and likely to pay great dividends in terms of preventing future habitat destruction and securing landowner cooperation in restoration efforts.

LITERATURE CITED

Adams, M.A. and I.W. Whyte. 1990. Fish habitat enhancement: a manual for freshwater, estuarine, and marine habitats. Dept. Fisheries and Oceans Canada. DFO 4474. 330p.

Armour, C.L.,, D.A. Duff, and W. Elmore. 1991. The effects of livestock grazing on riparian and stream ecosystems. Fisheries 16: 7-11

Avery, E.L. 1996. Evaluation of sediment traps and artificial gravel riffles constructed to improve reproduction of trout in three Wisconsin streams. North American J. Fisheries Mgmt. 16:282-293

Bilby, R.E. and G.E. Likens. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61: 1107-1113

Bisson, P.A., R.E. Bilby, M.D. Bryant, C.A. Dolloff, G.B. Grette, R.A. House, M.L. Murphy, K.V. Koski and J.R. Sedell. 1987. Large woody debris in forested streams in the Pacific northwest; past present and future, p. 143-190 *In* E.O. Salo and T.W. Cundy (ed.) Streamside management: forestry and fishery interactions. University of Washington Press, Seattle, WA.

Booth, D.B. 1990. Stream channel incision following drainage-basin urbanization. Water Resources Bulletin 26: 407-417

Campbell, R.R. 1990. Rare and endangered fishes and marine mammals of Canada: The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Fish and Marine Mammals Subcommittee Reports VI. Canadian Field Naturalist 104: 1-6

Cannings, S. 1992. Rare freshwater fish of British Columbia. B.C. Conservation Data Center. Fisheries Branch, B.C. Ministry of Environment, Lands, and Parks, Victoria, B.C.

Castelle, A.J., A.W. Johnson, and C. Conolly. 1994. Wetland and stream buffer requirements - A review. J. Environ. Qual. 23: 878-882

Caverhill, P.A. 1972. Cloverdale stream survey: Fishtrap Creek. On file at B.C. Ministry of Environment Lands and Parks, Surrey.

Erman, D.C., E.D. Andrews, and M. Yoder-Williams. 1988. Effects of winter floods on fishes in the Sierra Nevada. Can. J. Fish. Aquat. Sci. 45: 2195-2200

Fidler, J. and F. Fer. 1994. Limit light conditions in the riparian stands along small streams. Lesnictvi (Prague) 40: 244-249 (Abstract only)

Frissell, C.A. and R.K. Nawa. 1992. Incidence and causes of physical failure of artificial habitat structures in streams of western Oregon and Washington. North Amer. J. Fisheries Mgmt. 12:182-197

Halstead, E.C. 1986. Ground water supply - Fraser Lowland, British Columbia. Inland Waters Directorate, Scientific Series No. 145, National Hydrology Institute, Paper No. 26.

Hartman, G.F. and T.G. Brown. 1987. Use of small temporary floodplain tributaries by juvenile salmonids in a west coast rain-forest drainage basin, Carnation Creek, B.C. Can. J. Fish. Aquat. Sci. 44: 262-270

Healey, M.C. 1997. Prospects for Sustainability: Integrative approaches to sustaining the ecosystem function of the lower Fraser Basin. Final report on the Tri-Council funded eco-research project at UBC.

Heller, D., K. Wieman, and D. Konnoff. 1996. A preliminary report on instream structure durability following 1996 floods. Province of British Columbia, Stream Restoration Bulletin, Streamline 1: 10

House, R. 1996. An evaluation of stream restoration structures in a coastal Oregon stream, 1981-1993. North American J. Fisheries Mgmt. 16: 272-281

Inglis, Susan, A. Lorenz, and M.L. Rosenau. 1992. Distribution and habitat of the endangered Salish sucker (*Catostomus sp*). Regional Fisheries Report No. LM230. Fish and Wildlife Management, B.C. Ministry of Environment, Lands, and Parks, Surrey, B.C.

Inglis, Susan, S.M. Pollard, and M.L. Rosenau. 1994. Distribution and Habitat of Nooksack dace (*Rhinichthys sp*). in Canada. Regional Fisheries Report No. 237. Fish and Wildlife Management, . B.C. Ministry of Environment, Lands and Parks, Surrey, B.C.

Johanson, D. 1988. Fishtrap/Pepin/Bertrand Creeks water management basin plan: Groundwater component. B.C. Ministry of Environment and Parks, Water Management Branch.

Kelsch, S.W. 1994. Lotic fish community structure following transition from severe drought to high discharge. J. Freshwater Ecology 9: 331-341

Kohut, A.P. 1987. Groundwater supply capability, Abbotsford Upland. B.C. Ministry of Environment, Water Management Branch, Groundwater Section, File 92 G/1 #49 (cited by Johanson 1988)

Leopold, L.B. 1994. A view of the river. Harvard University Press, Cambridge, Massachusetts

Liebscher, H., B. Hii, and D. McNaughton. 1992. Nitrates and pesticides in the Abbotsford aqufer, SE British Columbia. Inland Waters Directorate and Environmental Protections, Environment Canada. 83p

Lister, B. 1990. An assessment of the potential effects of a storm water detention project on fish habitat in East Fishtrap Creek, Districk of Matsqui. D.B. Lister and Associates Ltd., Clearbrook, B.C.

Lodge, D.M. 1993. Biological invasions: Lessons for ecology. TREE 8: 133-137

McAdam, S. 1995. MS. Unpublished manuscript. Available from Ministry of Environment Lands and Parks, Fisheries Research, 2204 Main Mall, University of British Columbia

McPhail, J.D. 1967. Distribution of freshwater fishes in western Washington. Northwest Science 41: 1-11

McPhail, J.D. 1987. Status of the Salish sucker, *Catostomus sp.,* in Canada. Canadian Field Naturalist 101: 231-236

McPhail, J.D. 1997. Status of the Nooksack dace, *Rhinichthys sp.*, in Canada. Canadian Field Naturalist. 111: 258-262

Moore, K., K. Jones, and J. Dambacher. 1997. Methods for stream habitat surveys. Natural Production Program, Oregon Department of Fish and Wildlife, Corvallis.

Murphy, M.L. and K.V. Koski. 1989. Input and depletion of woody debris in Alaska streams and implications for streamside management. North American J. Fish. Mgmt. 9: 427-436

Newbury, R., M. Gaboury, and D. Bates. 1997. Restoring habitats in channelized or unifor streams using riffle and pool sequences. In: P.A. Slaney and D. Zaldokas (eds.) Fish Habitat Rehabilitation Manual. B.C. Ministry of Environment, Lands and Parks, Watershed Restoration Technical Circular No. 9

OMNR. 1984. Community Fisheries Involvement Program. Field Manual. Part 1. Trout Stream Rehabilitation. Ontario Ministry of Natural Resources. Toronto, Ont. 273p.

Pearson, M.P. 1998. A review of the distribution, status, and biology of the Salish sucker (Catostomus sp.) and Nooksack dace (Rhinichthys sp.). Fisheries Technical Circular No. 101, B.C. Ministry of Environment, Lands, and Parks.

Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Trans. Am. Fish. Soc. 121: 427-436

Platts, W.S. 1981. Effects of Livestock grazing. Influence of Forest and Rangeland management on anadromous fish habitat in western North America. USDA Forest Service General Technical Report PNW-124

Pojar, J. and A. Mackinnon. 1994. Plants of the pacific northwest coast: Washington, Oregon, British Columbia and Alaska. B.C. Ministry of Forests and Lone Pine Publishing.

Schlosser, I.J. 1985. Flow regime, juvenile abundance, and the assemblage structure of stream fishes. Ecology 66: 1484-1490

Schlosser, I.J. and J.R. Karr. 1981. Riparian vegetation and channel morphology impact on spatial patterns of water quality in agricultural watersheds. Env. Mgmt. 5: 233-243

Seegrist, D.W. and R. Gard. 1972. Effects of floods on trout in Sagehen Creek, California. Trans. Am. Fish. Soc. 1972: 478-482

Slaney, P.A., and D. Zaldokas. 1997. Fish habitat rehabilitation procedures. B.C. Ministry of Environment, Lands, and Parks, Watershed Restoration Technical Circular No. 9

Smock, L.A., G.M. Metzier, and J.E. Gladden. 1989. The role of debris dams in the structure and functioning of low gradient headwater streams. Ecology 70: 764-775

Ward, J.V. 1975. Thermal characteristics of running waters. Hydrobiologia 125: 31-46

APPENDIX 1: RESULTS OF SELECTED LANDOWNER SURVEY QUESTIONS

General Questions

Number of Years Residing on Property

Creek	<1	1-5	5-10	10-20	>20	# Respondents
Bertrand	1	1	2	1	8	13
Fishtrap	1		3	3	6	13
Pepin		1			2	3
Cave		2		1	2	5
Salmon			1			1
Totals	**2**	**4**	**6**	**5**	**18**	**35**

Number of Acres Owned

Creek	<1	1-5	5-20	20-60	>60	# Respondents
Bertrand		3	3	4	3	13
Fishtrap		1	7	4	1	13
Pepin		1	1	1		3
Cave			1	3	1	5
Salmon				1		1
Totals	**0**	**5**	**12**	**13**	**5**	**35**

Years Since Septic Pumped.

Creek	<1	1-2	2-5	>5	?	# Respondents
Bertrand	3	4		2	4	13
Fishtrap	3	2	2	2	4	13
Pepin		1			2	3
Cave	1	2	1			4*
Salmon		1				1
Totals	**7**	**10**	**3**	**4**	**10**	**34**

*one landowner has installed a new in-ground treatment system

	Aware that there are endangered species of fish living in the creek?			***Can you name them?***		
Creek	**Yes**	**No**	**# Respondents**	**Yes**	**No**	**# Respondents**
Bertrand	6	7	13	4	9	13
Fishtrap	4	9	13	0	13	13
Pepin	2	1	3	1	2	3
Cave	1	4	5	1	4	5
Salmon	1		1	1		1
Total	**14**	**21**	**35**	**7**	**28**	**35**

	Number of People Naming a Salmonid When Asked to List Fish in the Creek		
Creek	**Yes**	**No**	**# Respondents**
Bertrand	10	3	13
Fishtrap	7	6	13
Pepin	3		3
Cave	4	1	5
Salmon	1		1
Total	**25**	**10**	**35**

Where did you learn about Salish suckers and Nooksack dace?

(respondents from all creeks combined)

- newspaper article
- a passing fisherman;
- Bertrand Creek Enhancement Committee
- Sign in Park and display at Aldergrove Mall
- newspaper article a long time ago; preserved specimen at museum
- LEPS visit; newspaper article
- newspaper article
- were mentioned one time when I called Ministry of the Environment
- contacted by Ministry of the Environment regarding a covenant on the creek when we purchased the property
- fisheries people talked to my dad
- Steve McAdam (*previous BCCF contractor*)
- told about by people working on salamanders
- Federation of B.C. Naturalists visited house
- I used to be a fish farmer

Bertrand Creek

Would you say that the abundance of fish has increased, decreased or stayed the same in the past 10 years? What do you think are the reasons for this change?

<u>Decreased</u>

- last saw spawning salmon 8 years ago; fishermen taking fewer fish

- pollution
- fewer coho especially in tributary (*near 8th Avenue*); bigger runoffs, overfishing; Trib now goes dry most years
- coho decreased sharply about 25 years ago, rumours of natives netting at mouth of Nooksack then; still see steelhead and salmon in spring;
- fewer fish jumping; creek has changed course eating into bank
- salmon decreased a lot in the late 60's; Aldergrove sewer system and to many dams and ponds downstream
- sewers in Aldergrove

Don't Know (4)

How would you describe the health of the creek on your property? Why?

Excellent

- water appears clear; no garbage
- lots of wildlife; runs unhindered here; probably a bit dry in summer

Good

- poor water quality when it gets low in summer
- see lots of fish (including 3 adult coho last winter); nice looking creek
- Aldergrove sewage plant closed; not much foam or growth to cause me concern;
- doesn't stink, but does get low in summer
- lots of growth, lots of animals - rabbits and coons

Fair

- general impression
- too little water in late summer

Poor

- foam on water; not much water this time of year
- foam on top

Has the health of the creek improved stayed the same or become worse in past 10 years? What are the reasons?

Improved

- less pollution from Aldergrove;
- less debris and foam on water now; coliform counts used to be very high
- less froth on the water than there used to be
- increased awareness and concerned citizens; closing of slaughterhouse

Stayed Same

- no change in flooding, lots of erosion and changes course often

Worse

- more building upstream; more runoff
- runoff has increased a lot since Aldergrove expanded; lots more flash flooding
- more flooding since roads paved; beavers have always been a problem here

Cave Creek

Would you say that the abundance of fish has increased, decreased or stayed the same in the past 10 years? What do you think are the reasons for this change?

Increased

- have increased in last 4 years since we came here, we see them more

Decreased

- same in last 10, but decreased after my father dredged the creek in 1969 to drain the swamp

Stayed Same (1)
Don't Know (2)

How would you describe the health of the creek on your property? Why?

Excellent

- lots of overgrowth, doesn't completely dry up; it could be improved in places, there is lots of bank erosion at high flows

Fair

- lots of fish and ducks, large schools of fish in the pond, lots of other wildlife
- lots of farm manure and runoff into it, cattle are in it, cedar shavings leach in

Poor

- goes dry now, before it was dredged I used to fish and catch suckers and trout
- just a drainage ditch in our opinion, when it rains it's just brown water coming down

Has the health of the creek improved stayed the same or become worse in past 10 years? What are the reasons?

Improved

- I think there is more fish in the pond
- fewer cattle are grazing and there are no more milk cows that can get in the creek

Stayed the Same (2)

- the damage all occurred earlier, when it was dredged

Pepin Creek

Would you say that the abundance of fish has increased, decreased or stayed the same in the past 10 years? What do you think are the reasons for this change?

Decreased

- lots of beavers now, but I don't really know
- gravel pit sediment is filling it in, the trout have all disappeared; neighbour filled in the wetland

How would you describe the health of the creek? Why?

Good

- It's better than the swamp downstream

Fair

- gravel pit makes it very muddy in the winter when it rains

Very Poor

- sediment from the gravel pit is completely choking it

Has the health of the creek improved stayed the same or become worse in past 10 years? What are the reasons?

Stayed the Same (1)

Worse

- sediment from the gravel pit over the last 5 years has destroyed it

Fishtrap Creek

Would you say that the abundance of fish has increased, decreased or stayed the same in the past 10 years? What do you think are the reasons for this change?

There are no fish

- there are no fish because it's too shallow and small (*Waechter*)
- never seen fish (*Waechter*)
- don't know but saw salmon last year
- don't know***

Decreased

- saw trout and salmon years ago; Fishtrap was barricaded by a farmer at Peardonville in 1987 and dried all the way down; oil spill residues
- land use changes, wetland drainage
- decreased a lot after the dredging in 1990
- I see less from the bridge, but I don't know why

How would you describe the health of the creek? Why?

Good

- looks good generally, lots of growth, but is muddy when it rains
- water is very clean and there is good growth on the plants, not stagnant, lots of activity (fish etc.)
- not too much erosion, lots of plant growth and shade; drainage is improved but storm water from Abbotsford might be causing problems, I don't know about the fish

Fair

- should be cleaned up, take out the dead shoots and grass to keep the water flowing (Waechter)
- trees are in the water and the creek is clogged (Waechter)
- needs to be cleaned out, remove underbrush and growth that is clogging the channel (Waechter)
- well shaded (Waechter)

LANDOWNER INTERVIEW

Creek ______________________________ Date ______________

Name: ______________________________ Phone ______________

Address/Location ____

____

____

____

Year Moved to Property ____________

Owners Name If Different ______________________________ Phone ____________

Property Size __________________ Length of Creek ______________

Dominant Land Use ______________________________________

Septic Tank ☐ Date Last Pumped ______________

Well ☐ Pump From Creek ☐ Permit # ___________

Livestock Access ☐ Number of Livestock _________

Fertilizer or Pesticide Applications ☐ Type _________________

Application Amount/Frequency _________________________________

____

What is the name of the creek flowing on your property?

____

Would you say you know the creek on your property.
very well ☐ reasonably well ☐ or not well at all ☐?

What species of fish live in the creek?

____

Would you say that the abundance of these fish has increased, decreased or stayed the same in the past 10 years? ____________

What do you think the reasons are for this change?
____

Are you aware that there are endangered species of fish living in this creek?
yes☐ no☐

Can you name them? ________________________________

Have you ever heard of Salish suckers or Nooksack dace?
yes☐ no☐

What do you know about them?
____
____
____

Where did you learn about these fish?______________________

Would you describe the health of the creek on your property as:
excellent ☐ good☐ fair☐ poor☐ or very poor☐

Why do you say that?
____
____
____
____
____

Has the health of the creek improved, stayed the same or become worse in the last 10 years?________________________________

What do you think has caused these changes?
____
____
____
____

To the best of your knowledge, does the creek overflow its banks on this property, every year, the occasional year, or never?
____

To the best of your knowledge does the creek every run dry during the summer on this property? ________________________________

What other sections of the creek do you have knowledge of?
1.________________________________

2.____
3.____

Would you describe the health of these sections as:
1. excellent ☐ good☐ fair☐ poor☐ or very poor☐
2. excellent ☐ good☐ fair☐ poor☐ or very poor☐
3. excellent ☐ good☐ fair☐ poor☐ or very poor☐

Why do you say that?
1.____
2.____
3.____

How have these sections of creek changed in the past 10 years?

____
____
____
____

Are you a member of a naturalist club or environmental organization?
yes☐ no☐
Which one?________________________

Would you be interested in:

☐ being informed of an information and discussion meeting about the creek which would involve other landowners, biologists and representatives of government agencies and industrial landholders?

☐being informed of volunteer activities such as tree planting and fish habitat restoration, aimed at restoring the watershed?

☐ discussing opportunities for improving the habitat value of the creek on your property for Salish suckers and Nooksack dace.

☐making an in-kind contribution to the project?

____
____

Who else do you know who is knowledgeable about the creek?
Name____________________ Phone_______________
Name____________________ Phone_______________