THE MILLSTONE WATERSHED

WATERSHED FISH PRODUCTION PLAN AND ATLAS

Prepared By

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1.0 Summary: "Salmon in the City

The Millstone Watershed Production Plan and Atlas has been prepared to highlight the watershed production opportunities, especially for coho salmon in the Millstone watershed located in Nanaimo, British Columbia.

Using existing information and several compiled inventory databases, this document encapsulates, identifies, and graphically illustrates first and second order habitat opportunities that are available, or could become available, through a program of fishway development and habitat restoration.

Historically, most of the production potential of the Millstone watershed remained inaccessible to returning coho salmon and sea-run trout due to three significant cascades, each of which formed migration barriers in Bowen Park approximately 1-2 km. above tidewater in Nanaimo. The high quality fish habitat of the mainstem Millstone R., tributaries, and some lakes above these migration barriers offers a significant opportunity to build new runs of coho salmon. As large sections of the river flow through urban, suburban, and agricultural areas, there are some habitats that have been degraded and these have been identified in the Millstone Watershed Production Plan and Atlas for restoration.

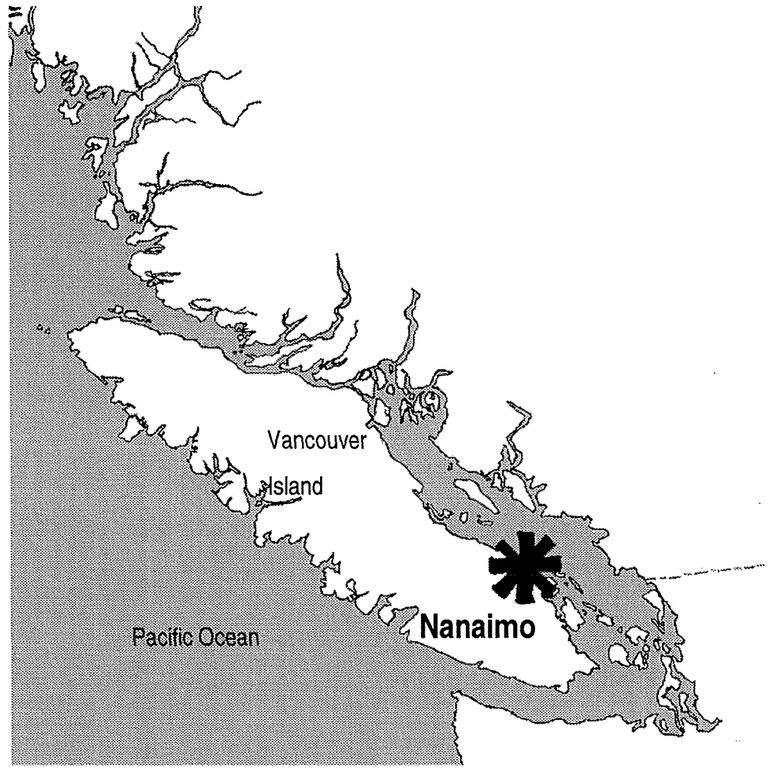
The overarching goal of the Millstone Watershed Production Plan and Atlas is to stimulate new partnerships within the community and to develop a new community based way of doing business. The help to create new sustainable runs of salmon, and possibly trout, into this watershed by the year 2000, possibly as a community millennium project.

To do this, the Millstone Watershed Production Plan and Atlas identifies the amount, location and quality of fish habitat. As a first implementation step, the plan recommends a conservative strategy to colonize coho fry above the migration barriers in the Millstone watershed beginning in the spring of 1998. To support these coho, after they have gone to sea in the spring of 1999, and upon their return as mature adults in the fall of 2000, a plan of action is proposed. During the next 3 years an initiative to design and then construct fishways and provide permanent access to the abundant, good quality, spawning and rearing habitats in the Millstone watershed is proposed.

To support this goal, and to harness the educational and economic benefit of a sustainable salmon run through the heart of Nanaimo, the Department of Fisheries and Oceans has encouraged a new business model by establishing a partnership with the Community Futures Development Corporation of Central Island. CFDC in turn, have proposed to co-ordinate a round table of interested community organisations and offered administrative, media, budgetary and program support services, under the banner, "Salmon in the City"

The initial focus will be:

- For the two fish barriers located in Bowen Park - the plan encourages co-operative development of fishways and education/interpretation facilities.
- For areas of degraded or eroding stream banks on private land - the plan recommends joint action between land owners and stream restoration initiatives.
- For the "Salmon in the City" partnership – the plan initiated a Public Meeting, organizes media program, and solicits broad membership from interested organizations in the community and develop funding initiatives as appropriate.



2.0 Background to the Opportunity in Nanaimo

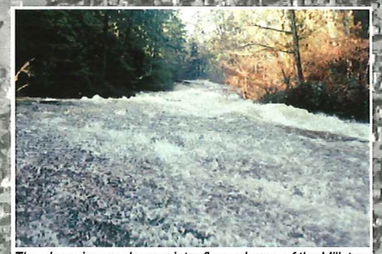
The Millstone River watershed largely situated in the City of Nanaimo includes an area of about 100 square km. and is believed to be the largest urban watershed on the B.C. coast that is inaccessible to salmon due to a migration barrier. The watershed is considered to have an extraordinary potential to support a sustainable coho population due to its high biological complexity, numerous lakes, and large, low gradient floodplain and adjoining wetlands.

In 1982, a fishway was constructed at the first falls in Bowen Park in downtown Nanaimo by the Nanaimo Fish and Game Club and the Department of Fisheries and Oceans. It was hoped, at that time, that this new fishway would provide upstream access and build new runs of coho and steelhead. It would also offer a convenient source of coho brood stock collection for the Nanaimo River Hatchery. Acquiring coho brood stock has always been a limiting factor for the Nanaimo R. Hatchery. Eventually, it was ascertained that the first fishway in Bowen Park provided access above the falls, however, the remaining two cascades upstream were found to be barriers to coho migration.

More recently, the Nanaimo River Hatchery's coho brood stock strategy has focused on Napoleon Creek. In the early 1990s, the Pacific Salmon Foundation, and the Dept. of Fisheries and Oceans, contributed jointly to the construction of three coho rearing ponds adjacent the Nanaimo River Hatchery which is located several kilometres south of the Nanaimo City limits. The Nanaimo R. Hatchery and the new coho rearing ponds are situated on the Harmac-Pacific property through which flows Napoleon Creek, a tributary of the Nanaimo River.

In 1996-7, a new concrete fishway was constructed by Harmac-Pacific on Napoleon Creek as part of an upgrade to their facilities and water supply system for the Harmac Pulp Mill. Prior to that, spawning coho could not gain access to upper Napoleon Creek. When the first coho adults produced from the new rearing ponds

The raised pipe under the Millstone river in the foreground may be a fish barrier.



The above image shows winter flow volumes of the Millstone River at the second chute above fish ladder.

The photo is taken at the same location as the adjacent image and illustrates summer flow.

The fall at the fishway in Bowen park is a barrier to fish passage.

STOCKING SUMMARY WESTWOOD ROAD

1981	0
1982	0
1983	0
1984	0
1985	10,029
1986	11,334
1987	0
1988	7,540
1989	8,606
1990	9,000
1991	11,093
1992	11,389
1993	8,299
1994	0
1995	8,000
1996	8,415
1997	0
TOTAL	93,705
1998	10,333
1999	TBA
2000	TBA

STOCKING SUMMARY QUARTERWAY, BOWEN ROAD

1981	0
1982	0
1983	4,000
1984	0
1985	5,040
1986	8,942
1987	29,546
1988	1,500
1989	3,000
1990	4,000
1991	4,000
1992	0
1993	4,261
1994	0
1995	4,000
1996	0
1997	0
TOTAL	68,289
1998	17,511
1999	TBA
2000	TBA

STOCKING SUMMARY BUTTERTUBS, PRYDE AVE.

1981	0
1982	0
1983	0
1984	0
1985	0
1986	0
1987	0
1988	2,500
1989	3,748
1990	4,000
1991	4,000
1992	3,746
1993	3,000
1994	26,607
1995	5,000
1996	0
1997	5,000
TOTAL	57,601
1998	9,245
1999	TBA
2000	TBA

POTENTIAL INTERPRETATION SITE
Side channel: habitat viewing.

POTENTIAL ENHANCEMENT SITE
Bowen Park: remove migration barriers.
Refer to Table 5.1.

STOCKING SUMMARY MILL ST. FOOT BRIDGE

1981	0
1982	0
1983	0
1984	0
1985	2,581
1986	0
1987	0
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	2,581
1998	18,055
1999	TBA
2000	TBA

MILLSTONE RIVER

DAROUGH CREEK

BUTTERTUBS EAST MARSH

BUTTERTUBS WEST MARSH

MILLSTONE WATERSHED BOUNDARY

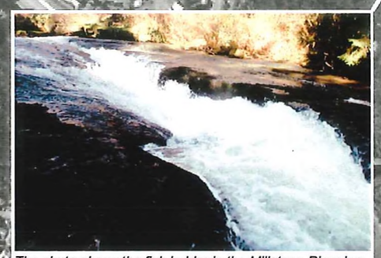
CAT STREAM

KEY PLAN

LEGEND

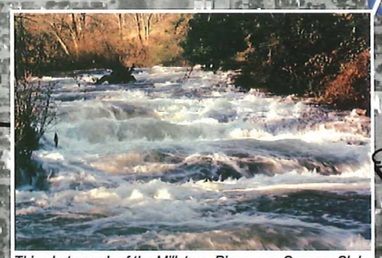
- GOOD COHO HABITAT
- MODERATE COHO HABITAT
- POOR COHO HABITAT
- BLOCKAGES & BARRIERS TO MIGRATION
- POTENTIAL ENHANCEMENT / RESTORATION SITES
- POTENTIAL INTERPRETATION SITES
- REACH BREAKS
- LOW SUMMER FLOW - REACH DRIES UP
- STOCKING LOCATION
- MILLSTONE WATERSHED BOUNDARY
- MUNICIPAL BOUNDARY
- LAKE
- MARSH / WETLAND
- WATER COURSE
- DIRECTION OF FLOW

This example of a typical reach of the Millstone River shows excellent coho rearing habitat.



The chute above the fish ladder in the Millstone River is a fish barrier.

The photo above is of the Millstone River above the fish ladder in Bowen Park. Note the fish barrier in the middleground.



This photograph of the Millstone River near German Club shows the first set of passable cascades.

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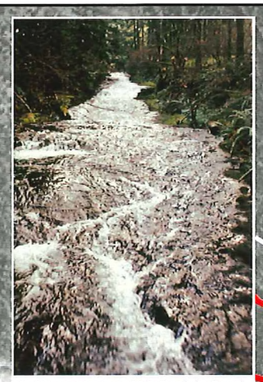
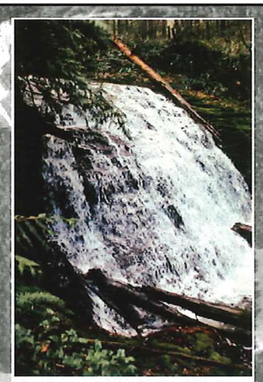
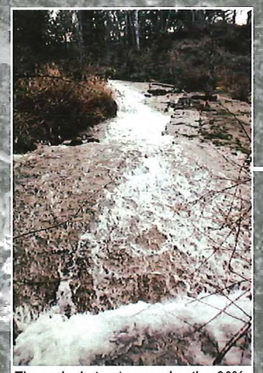
WATERSHED ATLAS AND FISH PRODUCTION PLAN 1:10000



A view upstream of McGarrigle Creek near Jingle Pot Road.



The six metre fall in McGarrigle Creek. is a barrier to fish passage.



The rock-chute at approximatley 20% slope prevents fish passage in McNeil Creek

The perched culvert in the background of the photo is a fish barrier.

The photo of Cathers Lake shows small trout rising near the oulet of the lake.

STOCKING SUMMARY
E. WELLINGTON RD.

1981	0
1982	0
1983	0
1984	0
1985	4,258
1986	0
1987	0
1988	8,126
1989	10,000
1990	9,500
1991	10,000
1992	0
1993	11,000
1994	10,831
1995	10,336
1996	0
1997	10,000
TOTAL	84,051
1998	15,499
1999	TBA
2000	TBA

MORGAN CREEK

SARISTON CREEK

CATHERS LAKE

MCNEIL CREEK

MUNICIPAL BOUNDARY

POTENTIAL RESTORATION SITE
Erosion control. Refer to Table 5.1.

WITCHCRAFT LAKE

WESTWOOD LAKE

KEY PLAN

8 4 7 3 6 2 1 5

LEGEND

- GOOD COHO HABITAT
- MODERATE COHO HABITAT
- POOR COHO HABITAT
- BLOCKAGES & BARRIERS TO MIGRATION
- POTENTIAL ENHANCEMENT / RESTORATION SITES
- POTENTIAL INTERPRETATION SITES
- REACH BREAKS
- LOW SUMMER FLOW - REACH DRIES UP
- STOCKING LOCATION
- MILLSTONE WATERSHED BOUNDARY
- MUNICIPAL BOUNDARY
- LAKE
- MARSH / WETLAND
- WATER COURSE
- DIRECTION OF FLOW

THE MILLSTONE WATERSHED
WATERSHED ATLAS AND FISH PRODUCTION PLAN 1:10000

The Millstone river at Jingle Pot Road lacks adequate tree canopy along the stream bank.

STOCKING SUMMARY JINGLE POT ROAD

1981	0
1982	0
1983	0
1984	0
1985	3,100
1986	0
1987	0
1988	7,500
1989	8,000
1990	5,000
1991	8,000
1992	8,040
1993	11,000
1994	9,000
1995	9,000
1996	12,663
1997	10,010
TOTAL	91,313
1998	21,753
1999	TBA
2000	TBA

STOCKING SUMMARY DIVER LAKE

1981	0
1982	0
1983	0
1984	0
1985	0
1986	0
1987	10,173
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	10,173
1998	0
1999	TBA
2000	TBA

STOCKING SUMMARY DURNIN ROAD

1981	0
1982	0
1983	0
1984	0
1985	3,000
1986	18,994
1987	22,744
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	44,738
1998	11,420
1999	TBA
2000	TBA

STOCKING SUMMARY NEUFIELD ROAD

1981	0
1982	0
1983	0
1984	0
1985	0
1986	8,018
1987	0
1988	4,000
1989	4,864
1990	5,000
1991	5,485
1992	3,750
1993	6,000
1994	0
1995	5,000
1996	0
1997	5,074
TOTAL	47,191
1998	14,955
1999	TBA
2000	TBA

STOCKING SITE MCCLURE CREEK OFF MUNROE RD.

1998	0
1999	0
2000	0

FALL STOCKING SITE MCCLURE MARSH OFF MUNROE ROAD

1998	5,000
1999	TBA
2000	TBA

POTENTIAL STOCKING SITE
Beaver Creek at the Baijich Farm on Jingle Pot Road.

POTENTIAL RESTORATION SITE
Area requiring riparian vegetation. Refer to Table 5.1.

POTENTIAL RESTORATION SITE
Area requiring riparian vegetation. Refer to Table 5.1.

POTENTIAL ENHANCEMENT SITE
Morgan Creek, repair collapsed culvert, near Millstone River. Refer to Table 5.1.

The culvert at McClure Creek and Jingle Pot Road is an obstruction that prevents fish passage as it is perched over one metre above plunge pool.

The diverted channel above lacks riparian vegetation and is adjacent to livestock fields. Fish habitat may be damaged by bank erosion and water contamination.

Livestock access at McClure Creek is causing bank erosion and damaging stream habitat.

LEGEND

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- MODERATE COHO HABITAT
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- POTENTIAL INTERPRETATION SITES
- REACH BREAKS
- LOW SUMMER FLOW - REACH DRIES UP
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- WATER COURSE
- DIRECTION OF FLOW

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WATERSHED ATLAS AND FISH PRODUCTION PLAN 1:10000

MILLSTONE WATERSHED BOUNDARY

UPPER MILLSTONE

LONG LAKE

DIVER BROOK

POTENTIAL ENHANCEMENT SITE
Possible water management opportunity.
Refer to Table 5.1.

KEY PLAN

LEGEND

- GOOD COHO HABITAT
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- DIRECTION OF FLOW

THE MILLSTONE WATERSHED
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BENSON CREEK

LUCID LAKE

Lucid Lake.

KEY PLAN

8 4
7 3
6 2 1
5

LEGEND

- GOOD COHO HABITAT
- MODERATE COHO HABITAT
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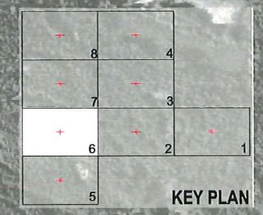
THE MILLSTONE WATERSHED

WATERSHED ATLAS AND FISH PRODUCTION PLAN 1:10000

BENSON CREEK

MCCLURE CREEK

BENSON CREEK



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- DIRECTION OF FLOW

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BENSON CREEK

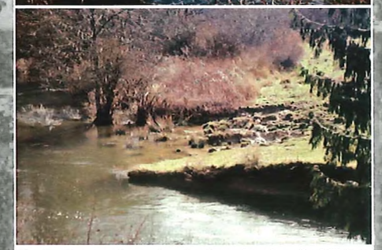
MILLSTONE RIVER

AMMONITE FALLS

MCCLURE CREEK

STOCKING SUMMARY
BIGGS ROAD

1981	0
1982	0
1983	0
1984	0
1985	0
1986	0
1987	0
1988	7,687
1989	0
1990	5,000
1991	8,680
1992	0
1993	5,855
1994	9,000
1995	9,000
1996	0
1997	10,010
TOTAL	55,232
1998	15,227
1999	TBA
2000	TBA



The two images above show bank erosion along the Millstone River at Biggs Road.

LEGEND

- GOOD COHO HABITAT
- MODERATE COHO HABITAT
- POOR COHO HABITAT
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- DIRECTION OF FLOW

THE MILLSTONE WATERSHED

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UNNAMED CREEK

METRAL CREEK

HEIKKILA CREEK

BRANNEN LAKE

PENSON CR.

MILLSTONE R.

STOCKING SUMMARY
BRANNEN LAKE

1981	0
1982	0
1983	0
1984	0
1985	26,077
1986	48,046
1987	39,268
1988	0
1989	0
1990	0
1991	0
1992	0
1993	0
1994	0
1995	0
1996	0
1997	0
TOTAL	113,391
1998	29,000
1999	TBA
2000	TBA

Above is a view of Brannen Lake and the outlet.

KEY PLAN

LEGEND

- GOOD COHO HABITAT
- MODERATE COHO HABITAT
- POOR COHO HABITAT
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- POTENTIAL ENHANCEMENT / RESTORATION SITES
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returned to Napoleon Creek in the fall of 1997, an abundant source of coho brood stock was finally available. From these building blocks, a renewed Millstone watershed strategy and "Salmon in the City" program was envisioned beginning in 1998.

A fundamental first step for "Salmon in the City" was the creation of a Millstone Watershed Fish Production Plan and Atlas which is intended to describe and graphically display opportunities available for coho salmon and trout employing the Community Greenway (1995) planning approach.

The following Millstone Watershed Production Plan and Atlas has been prepared to:

- Identify the extent of the Millstone watershed, its sub-basins, and reach units.
- Identify spawning and rearing habitat potential for coho and chum salmon, and trout species.
- Identify and describe migration barriers and provide access recommendations.
- Recommend coho fry colonization densities (spring and fall releases) for each stream reach beginning in 1998.
- Recommend fisheries production opportunities and recognize impediments.

The following synopsis of habitat and coho colonization estimates of the Millstone watershed was considered a critical first step in the creation of an overall strategy for a broad based community program. Building upon this work, subsequent community based initiatives under the theme, "Salmon in the City" have been developed.

3.0 Description of the Millstone Watershed

Overview

The following summary has been compiled from several sources, including the Nanaimo Urban Stream Report (1994). Other documents used in this plan are cited in the bibliography. There are over 20 streams in the watershed; 10 significant streams are summarized in Table 1. There are nine lakes and wetlands summarized in Table 2.

Low Flow

Many of the tributaries to the Millstone River have little, or no stream flow in summer. McGarrigle, McNeil, McClure, Sabiston, Morgan and Darough Creeks all dewater during arid periods. Summer flow in the lower reaches of Beaver Creek are maintained by water upwelling from two mine ventilation shafts.

Habitat Areas

Descriptions of the stream habitat areas in Tables 1 and Table 2 are from McNaughton and Dafoe (1998) and Pick and Septav (1979).

Water Quality

Most creeks contain elevated nitrate and phosphate levels. This may not necessarily be detrimental, since these are key nutrients that support many aspects of the food chain. All creeks have elevated levels of some metals, usually iron and zinc summarized in Table 3. This is not surprising as there are hundreds of galvanized (zinc-coated) steel culverts installed under roadbeds. The seasonal temperature and dissolved oxygen profiles are not available for most of the streams in the watershed.

Riparian Zones

Most stream reaches have adequate riparian cover. Some areas such as the banks of McClure Creek near Munroe Rd. have been subjected to riparian degradation and stream bank erosion as a result of cattle grazing.

Fish Barriers

There are a number of locations where fish migration is prevented by falls, perched culverts, or low flows. By far, the most significant of these is the series of three cascades on the mainstem Millstone R. in Bowen Park approximately 1-2 km. above tidewater. The construction of a fishway at the first falls in 1982 did not resolve the migration problem in Bowen Park. These cascades are believed to be a barrier in most flow conditions. Other examples of fish migration problems further upstream are:

- The upper 800 metres of Beaver Creek are dry in summer. This situation isolates Diver Lake and Long Lake for 3 - 6 months of the year.
- A culvert on McNeil Creek is perched above bedrock and the chute immediately downstream has a slope of 30 degs. forming a barrier to migration.
- There is a 6-metre falls on McGarrigle Creek, 100 metres downstream from Jingle Pot Rd..
- Darough Creek is cut off from Westwood Lake by a dam and is dry for most of the year.
- The outlet to Cathers Lake is a fish barrier, even with flow as the culvert is angled at 45 degs.. Most of the year the Cathers L. outlet is dry.

Table 1: Stream Summary - Fish Populations and Key Issues

Stream Name	*Habitat area m²*	*Species*	*Issues*
Millstone River	44,636	cutthroat; *Salmo clarki.* rainbow; *Salmo gairdneri,* colonized coho, *Oncorhynchus kisutch* chum*; Oncorhynchus keta*	Low summer flow, little scour action, few pools. Depressed D.O. & elevated temperatures (Lauinger and Larke, 1986). Chum are only found in 1st .
Benson Creek	1,850	Cutthroat, rainbow	Low summer flows; fish habitat assessment is needed.
Other tributaries to Brannen Lake	unknown	unknown	Includes Metral, Heikkila, Hoskins, Caillet, and Jepson Brook. Little information available; all have low summer flows. Hoskins Creek "blew out" during construction in Feb. 1998.
Upper Millstone	2,000	Stickleback.	Low summer flow, poor water quality. Barrier at headwaters outlet.
McClure Creek	2,000	cutthroat, rainbow	Low summer flow; status of the marsh is unknown. The course of this creek needs to be ascertained; mapped locations.
Beaver Creek	2,300	cutthroat, rainbow	Low summer flow. A car wreck should be removed; it is downstream from Jingle Pot Campground.
McGarrigle Creek	2,500	cutthroat, rainbow	Low summer flow. Unlicensed pumps installed by residents. Siltation from McNeil Creek.
McNeil Creek	500	cutthroat, rainbow	Earth-moving by property owners caused siltation in 1994.
Morgan Creek (McCormack)	800	cutthroat, rainbow	Headwaters used for irrigation. Summer flow is negligible.
Sabiston Creek	unknown	None found	Drains Cathers Lake; dry most of the year.
Darough (Westwood) Creek	unknown	None found	Cut off from Westwood Lake by the dam. Dry for most of the year.

Table 2: Lake Summary - Fish Populations and Key Issues

Lake	Habitat Area	Species	Issues/Uses
Brannen Lake	110 ha.	Cutthroat, rainbow, kokanee*, coho	Brannen L. is one of only two lakes in Nanaimo where motor boat use is permitted. Significant new development along lakeshore.
Westwood Lake	60 ha.	Bass, cutthroat, rainbow	Low impact recreation uses include fishing and swimming. The shoreline contains a well-used walking trail, no motors allowed.
Long Lake	35 ha.	Bass, cutthroat, rainbow	Intensive recreation and motor use permitted; users include; float planes, waterskiers, sea-doos, canoes, rowing course, fishing and swimming. The shore has been degraded by encroachment and landscaping.
Diver Lake	15 ha.	Bass, cutthroat, rainbow	Low impact recreation uses include fishing, swimming and canoeing
Cathers Lake	8 ha.	Cutthroat, rainbow	Recreational fishing; no motors allowed. Stocked by Malaspina University-College hatchery, and MELP
Witchcraft Lake	6 ha.	Cutthroat, rainbow	Fishing.
McClure wetland	8 ha.	Cutthroat,	Imminent development pressure; the creek may have been diverted, recently.
Buttertubs Marsh West		Colonized coho, Stickleback	High temperatures in summer, excellent accessible overwintering habitat for coho
Buttertubs Marsh East		Stickleback	High temperatures in summer, inaccesible to overwintering coho due to water control structure.
Rutherford Marsh	2 ha.	unknown	3 metre drop in outlet control structure

* kokanee reported in Brannen L., pers. comm. Paul Preston.

Table 3: Summary of Water Quality Data, Some Values Measured in 1994

Creek	Assay	Abnormal Result	Min. of Env.,Lands & Parks Water Quality Criteria (Source/Reference???)
Upper Millstone	Iron	1.02 mg/L	0.3 mg/L
Beaver Creek	Phosphorus	0.02 mg/L	0.015 mg/L
	Zinc	0.08 mg/L	0.03 mg/L
McNeil Creek	Zinc	0.06 mg/L	0.03 mg/L

Millstone River

Location
Millstone R. flows 12.8 km from Brannen Lake into the Nanaimo Inner Harbour adjacent the Nanaimo River estuary. The Millstone stream gradient averages 0.7% which typifies a low energy system with little scour action. There are a series of three cascades in Bowen Park 1-2 km. above tidewater which form a barrier to migration. There is extensive and excellent pool habitat in the mainstem above these barriers in Bowen Park, and spawning substrate in the upper 1 km reach downstream of Brannen Lake. There is also extensive spawning gravel areas in tributary streams to the Millstone R..

Pick and Septav (1979) estimated that the mainstem habitat area was 44,636 m^3, comprised of 60% pool, 16.5% glide, 12.2% flat, 2% riffle, 1.8% bedrock and 7% type unknown. Recent observations indicate that the section immediately downstream from Biggs Rd. has potential spawning habitat, with gravel substrate and a gradient of 1%.

Previous Studies:
- Pick and Septav (1979) found cutthroat throughout the system, but found no evidence of any rearing coho. Low summer flow was assessed to be (0.9 m3/min) and summer water temperatures were 21oC.
- In a study by Lauinger and Larke, (1986), to assess the Millstone R. potential for coho fry colonization, the mainstem habitat was described as 25% pool, which is in contrast to the 60% described in the study by Pick & Septav.
- In a study by Hurst, to assess the Millstone R. potential for coho fry colonization, an 18% fry to smolt survival rate was assessed in 1985.
- In 1994, the Malaspina College Greenways Study produced a detailed instream habitat and riparian zone assessment. In-stream flows were reported at that time to be negligible.

Fish Populations
Native cutthroat are present throughout the Millstone R. Trout are stocked in the Millstone watershed lakes by M.E.L. P. Coho fry are found each year in areas that have been colonized by the Nanaimo R. Hatchery fish. Kokanee populations exist in Brannen Lake (pers. comm. Paul Preston). Millstone R. tributaries, eg. Beaver, McGarrigle, McNeil Creeks have extensive areas of spawning gravel and should offer excellent reproduction capability.

Issues/Comments
- Migration barriers in Bowen Park prevent access to the Millstone watershed for anadromous species.
- The fish ladder at the first falls in Bowen Park on the Millstone may need cleanout and service cascades immediately upstream.
- Water licences issued for the Millstone often exceed discharge in summer (DFO Subdistrict #17 Stream Summary Catalogue).
- The coho fry colonization program in the Millstone R. has only been infrequently monitored for smolt survival and adult spawner returns.
- Summer extreme low flow is estimated to be approximately 100 litres per minute in Bowen Park.
- During freshet, the Millstone R. is often discoloured due to elevated siltation.

Recommendations
- Resolve the migration barrier caused by the two cascades above the first falls/fish ladder to allow access to anadromous fish
- A migration problem may also persist at the first series of cascades immediately above tidewater, and also at the concrete weir downstream of Bowen Rd..
- Consider radio tagging returning adult coho in 1998 to assess migration behaviour at the falls.
- Consider releasing mature spawners into the Millstone above barrier in 1998-2000 and assess areas used for spawning employing radio telemetry and subsequent coho fry survival in these selected spawning locations.
- Assess the spawning habitats in the vicinity of Brannen Lake.
- Temperature and dissolved oxygen profiles should be assessed over the low flow summer period.
- Mark all the colonized fry with an adipose clip and differntially mark the coho fry designated for Brannen Lake.
- Assess coho fry rearing factors in Brannen L. (and Millstone R.) that might limit production or affect trout fishery in Brannen L..
- Assess the survival of the 1998 coho fry colonization by undertaking a downstream trapping.
- Assess the growing chum population that utilizes the lower Millstone R. above tidewater, (1996 and 1997 pers. comm. reports from DFO Fishery Officer, H. Poschmann)

Benson Creek

Location
Flows approximately 13 km from Lucid Lake into Brannen Lake. A 30 metre falls upstream from Brannen Lake is an insurmountable fish barrier.

Fish Populations
Cutthroat trout can be found in the upper Millstone R., upstream from the Nanaimo Parkway (minnow trapping, April 1998), and can be observed in summer in isolated pools near Biggs Rd..

Issues/Comments
- Low summer flows limit fish production.
- Adjacent land development is imminent and increases risk to fish production.

Recommendations
- Benson Creek should be assessed as it probably contains the best spawning habitat in the area.

Upper Millstone

Location
Flows 2 km. from the pond near Rutherford Mall to Brannen Lake.

Fish Populations
No fish in the upper reaches in 1994. The upper Millstone was dry above the railway culvert. Stickleback and cutthroat were found in the marsh area near Brannen Lake at mouth of the creek, and above the Nanaimo Parkway.

Issues/Comments
- There is a 3 m. vertical drop in the outlet culvert under the Island Highway.

Recommendations
- Summer flow may be slightly augmented by the gradual release of water from the headwaters pond near Rutherford Mall.
- The creek needs a clean-up operation to remove garbage in the gully.
- May be possible to backwater culvert to afford upstream access.

Other Tributaries to Brannen Lake

These include Heikkila, Metral, Caillet and Hoskins Creeks, Jepson Brook and Flynnfall Creek, the main tributary to Benson Creek. There is no information on file for these streams but most are known to dewater in summer.

- All these smaller streams should be assessed for seasonal flows, and for fish habitat values.

Beaver Creek

Location
Flows 2.3 km. from Diver Lake to the Millstone River. Water from two springs maintains the stream flowing during arid periods. The upper 800 m. of the creek dewater in summer as does Diver Brook.

Fish Populations
Cutthroat.

Issues/Comments
- Low summer flows currently limit fish production.

Recommendations
- Flow augmentation could be accomplished by a control structure on Long Lake, or on Diver Lake. This has been considered but was preempted by protests from lakeside residents (pers. comm. Peter Law).
- Removal of car in the creekbed , downstream from the Jingle Pot Campground.

McClure Creek

Location
Flows from the northeast slope of Mount Benson to the Millstone River, passing under Jingle Pot Rd. and through a 1 km. wetland near Munroe Rd. The stream course is not accurately mapped. The 1989 RDN cadastral maps identifies the creek flowing southeast to Newfield and Maxey Rd., whereas the current recent RDN cadastral map shows it flowing 1 km to the northwest.

Fish Populations
Cutthroat trout have been identified upstream from Jingle Pot Rd. and are present throughout the system.

Issues/Comments
- Culvert at Jingle Pot Rd. is perched 1.5 metres above the plunge pool and is a fish barrier.
- Extreme low summer flows are evident for most of the watercourse.
- The stream passes through cattle pasture and bank erosion is evident near Munroe Rd..
- In one location, the stream has been partially diverted to allow cattle access.

Recommendations
- McClure Creek should be accurately mapped and assessed for fish habitat values.
- Setback fencing is recommended where fish habitat damage is occurring due to cattle access.
- The McClure Creek wetland may be the largest underutilized fish habitat area in the watershed and is a fall coho fry planting candidate.

McGarrigle Creek

Location
Flows 4.1 km from Witchcraft Lake to the Millstone River. Most of this stream is in the Regional District of Nanaimo. Partial diversion of McGarrigle Cr. into Westwood Lake was completed by the City of Nanaimo via a constructed channel to maintain summer water levels in Westwood Lake. The lower reaches are subject to development pressure. Unlicenced water intakes have been noted. Water quality is good. In 1992, local residents reported a heavy siltation event.

Fish Populations
Cutthroat are found throughout the creek. Coho fry were found in 1994 near the Millstone River and were believed to have been colonized by the Nanaimo R. Hatchery.

Issues/Comments
- The outlet from Witchcraft Lake is a log weir which is a barrier to fish migration. It is approximately 80 years old and should be inspected for safety reasons.
- The rock cascades and the 6-metre falls downstream from Jingle Pot Rd. are a barrier to fish migration.
- The lower reaches, near the Millstone River, are subject to dewatering in summer.

Recommendations
- Water diversion to Westwood Lake should be reviewed.

McNeil Creek

Location
Flows 1.7 km. from Westwood Lake to McGarrigle Creek.

Fish Populations
Cutthroat trout throughout. There is significant woody debris upstream from Jingle Pot Rd.. Habitat is limited by low summer flows. The perched culvert at Jingle Pot Rd. and the cascades immediately downstream are barriers to upstream migration.

Issues/Comments
- The outlet from Westwood Lake runs dry in summer. Flow is maintained from a small tributary and marsh upstream from Jingle Pot Rd..
- The infilling of land at the corner of Jingle Pot Rd. and East Wellington Rd. in 1994 caused trees to fall into the creek and caused significant siltation. The site has since greened up. The creek has burst the banks upstream from Jingle Pot Rd. and has washed out into the BC Hydro road easement.

Recommendations
- Land development near Jingle Pot and East Wellington Rd. should be closely monitored.
- The stream banks need restorative work along the BC Hydro road easement.

Morgan (McCormack) Creek

Location
Flows 830 metres from near Westwood Lake (no direct connection), through East Wellington Rd. to the Millstone River.

Fish Populations
Cutthroat were found in small residual pools in 1994.

Issues/Comments
- The stream was dry in August 1994.
- Where the creek has dewatered, there are white deposits on the stream-bed, and the conductivity of the water is high from dissolved minerals. Water quality was within M.E.L.P. criteria in 1994.
- The headwater pond is licenced for crop irrigation and the stream banks have been cleared of vegetation degrading fish habitat upstream from East Wellington Rd.
- A drainage ditch/pipe transport water into the creek downstream from the road. A collapsed culvert, at the mouth of the creek needs to be replaced.

Recommendations
- An assessment of the drainage ditch should be undertaken.
- Assess headwater pond.
- Culvert near mouth needs to be replaced.

Sabiston Creek

Location
Flows 400 m. from Cathers Lake to the Millstone River. Flow is intermittent and controlled by stoplogs at the lake outlet.

Fish Populations
May have cutthroat in winter near Millstone R. Cathers Lake stocked annually with cutthroat trout from Malaspina University-College Hatchery; recreation for local children.

Issues/Comments
- Sabiston Creek offers little opportunity for enhancement. Cathers Lake is surrounded by residential property but still supports trout populations. The lakeshore habitats would benefit from improved riaparian cover.

Darough (Westwood) Creek

Location
Flows 1.2 km from the foot of the dam at Westwood Lake to the Millstone River. Dry in May, 1994. There are a few residual pools in the gully, but no fish have been observed.

Issues/Comments
- Poor water quality and low summer flow.
- There are two barriers to migration - in the stream, which limit fish access from the Millstone River, and the creek is isolated from Westwood Lake by the dam.

Recommendations
- The gully is strewn with garbage and a clean-up is recommended. There is little opportunity for enhancement.

Northfield Marsh - North of the Parkway

The pond has been observed to support fish (pers. comm. John Baldwin, MELP Water Branch), and should be investigated. A temperature/D.O. profile of the marsh and the outlet stream along the Parkway should be taken. Cutthroat trout spawn in the ditch along the parkway, but the fry are unable to reach the Millstone River, as the ditch dewaters

4.0 Summary - Coho Colonization

To establish the numbers of coho fry to be colonized in the Millstone watershed beginning in 1998, it was necessary to determine the amount of habitat, and then estimate the quantity of coho fry to colonize that the habitat could reasonably support. Using various production estimates from a variety of sources, a conservative number of coho fry were determined by reach. Beginning in 1998, the Millstone R. coho fry were marked by removing the adipose fin, and the Brannen L. coho fry were differentially marked with an additional right maxillary clip.

Estimating Available Habitat

The first challenge was to establish how much rearing habitat would be available above Bowen Park for coho to utilize. This information comes from a variety of sources. The most recent and complete information is contained in the detailed stream inventory work completed by Malaspina University-College in 1994. This inventory reports that there is more than 87,000 sq. m. of low gradient habitat "run" which would provide excellent coho rearing habitat. Stream inventories undertaken previously had reported a significantly smaller amount of this type of coho habitat (44,636 sq. m.). Coho colonizing estimates developed for this production plan use the more conservative estimate of available habitat.

The Nanaimo Urban Stream Report (1994) also recorded additional habitat areas for some of the main tributary streams along the lower sections of the Millstone R. These estimates are summarized in Table 4.1.

In order to estimate the total available habitat for additional minor streams not included in the existing inventory, an estimate based on stream gradient has been calculated. Note that the habitat values for these streams have been included for information, but are not included as part of the calculations for coho colonization estimates.

Gradient	***Coho Habitat Type***
0%-2%	Good
2%-5%	Moderate
>5%	Poor

Details about the amount of available habitat in the Millstone watershed are summarized in Table 4.1. As a conservative principle;

- Stocking estimates use the lowest estimate of habitat available on for the Millstone R. mainstem.
- None of the habitat potential of the Millstone tributaries which have inventories completed was included in coho colonization estimates.
- None of the habitat potential for streams without inventories was included in coho colonization estimates.

Lake Habitat

The ability of lakes within the watershed to support coho fry was estimated as a separate exercise. Habitat estimates for each of the five lakes is illustrated in Table 4.2 on the following page. Habitat capacity in lakes suitable for coho fry was calculated in a variety of ways including:

- Total area of the lake,
- Area of the lake less than 3 m. deep,
- Length of shoreline of the lake

Stream Reach Estimates for Colonizing Coho

A variety of coho colonizing models were considered to provide a range of estimates for evaluation and comparison in streams and in lakes. Each of the models is based on recent experience in other similar watersheds.

Department of Fisheries and Ocean staff estimate that good coho stream habitat can support between 3 and 6 fry per sq. m. (M. Sheng). For moderate habitat DFO uses a measure of 1 to 2 fry per sq. m.

An assessment was also prepared for this report by M.E.L.P.(R. Ptolemy). The results of this assessment are illustrated in the Coho Colonization Recommendations in Table 4.3.

Lake Stocking Estimates

Coho fry colonization estimates have been prepared for each of the five lakes in the Millstone watershed.

- Ron Ptolemy MELP 29,000 fry
- Tom Brown DFO 3.5 fry / lin. m. of shoreline
- Mel Sheng DFO 2500 fry/hectare
- R. Bams DFO/PBS 1000 fry/hectare
- Brian Anderson DFO 1500 fry/hectare

Coho colonization of of Westwood Lake, Long Lake, and Diver Lake were not considered in the 1998 plan until further investigations about access for smolt scan be undertaken. Cathers Lake was not considered for coho colonization because of access and water quality concerns. McClure Creek marsh was considered for its potential as a fall colonization site.

Coho Colonizing - Summary

Based on the models previously described, and as a result of discussions of a technical review session with M.E.L.P. and DFO representatives, the following coho fry colonization recommendations are provided.

1. The Millstone R. mainstem is to be colonized with 134,000 coho fry in 1998 evenly distributed along its length at available stocking locations. This number is derived by using only habitat available in the Millstone R. mainstem using the most conservative estimate available.

2. Brannen Lake is to be colonized with 29,000 coho fry. Brannen Lake is the only lake in the system to be colonized in 1998. The estimate recommended is based on calculations by the Ministry of Environment and is subject to some assessments required to determine the survival and effects on stocked trout populations in the lake.

3. McClure Creek Marsh is to be colonized in the fall with 5000 coho fry.

Table 4.1 Stocking Summary for Coho Colonization

Watercourses	Reaches	Issues	Species					Summary											Habitat								
			Cutthroat	Rainbow	Coho	Chum	Stickleback	1:5000 Habitat Coverage	Area of Habitat Previous Records, (C. Thirkill)	Stream Gradients less than 2% High Coho	Stream Gradient 2% - 5% Moderate Coho/High Trout	Stream Gradient 5%-20% Poor Coho/Moderate Trout	Stream Gradients greater than 20%	Area of Riffle with Gravel sq. m. (moderate Coho)	Area of Riffle Without Gravel sq. m. (poor Coho)	Runs (Flats and Runs) sq. m. (good Coho)	Pools sq. m. (Good Coho)	Ponds and Marshes sq. m.	Good Summer Coho Habitat	Moderate Summer Coho Habitat	Additional Good Coho Habitat available in the fall	Additional Moderate Coho Habitat available in the fall	DFO Precautionary Estimate	Fall Stocking Using DFO Stocking Assumptions Precautionary Estimates	DFO Aggressive Estimates	Fall Stocking Using DFO Stocking Assumptions Agressive Estimates	MELP Stocking Assumptions (As prepared by Ron Ptolemy)
Darough Creek	Millstone to Westwood Lake	Dry most of the year						✔																			
Sabiston Creek	Millstone to Cather Lake	Dry most of the year						✔	*										*	1	1	1					
McNeil Creek		earthmoving by property owners caused siltation in 1994	✔					✔	500														0	0	0	0	6,832
McGarrigle Creek	Millstone to McGarrigle Creek Falls	Low summer flow. Unlicensed pumping, siltation.	✔		✔			✔	2500										2500				7,500	0	10,000	0	12,904
Millstone River	Intertidal	Low flow system in summer, little scour action, few pools. Low D.O. and high temperatures	✔		✔	✔		✔															0	0	0	0	
	Intertidal to Top of Bowen							✔															0	0	0	0	
	Falls to City Boundary							✔															0	0	0	0	
	City Boundary to Barren Lake							✔															0	0	0	0	
Totals from all watercourses above this line									44,636					16185.5	223.4	87143.29	7141.5	0	44,636	0	49,649	16,186	133,908	165,132	178,544	230,966	105,586
Morgan Creek (McCormack)	Millstone to Westwood Lake	Low summer flow, Headwaters used for irrigation	✔					✔	800					0	0	1265.5	0	7458.4	800	0	7,924	0	2,400	23,772	3,200	31,696	500
Beaver Creek	Millstone to City Boundary	Low summer flow	✔		✔			✔												0	0	0	0	0	0	0	
	City Boundary to Sloan Road							✔															0	0	0	0	
	Sloan Road to Diver Lake							✔															0	0	0	0	
	Total								2,300					0	690.9	0	0	226.5	2,300	0	0	0	6,900	0	9,200	0	1,497
Diver Brook (Beaver Creek)	Diver Lake to Long Lake							✘	2,310	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a		2,310				6,930	0	9,240	0	
McClure Creek		Low summer flow, status of marsh unkown.	✔					✘	2,000	869.44	509.1	3765.4	655.15	n/a	n/a	n/a	n/a		2,000				6,000	0	8,000	0	960
Benson Creek	Brannen Lake to Ammonite Falls	Low summer flows; fish habitat assessment is needed	✔	✔				✘	1,850	585.4	1002.3	286.8	906.5	n/a	n/a	n/a	n/a		1,850				5,550	0	7,400	0	1,110
	Upstream of Ammonite Falls							✘	1,850	0	0	854.7	1764.2	n/a	n/a	n/a	n/a		1,850				5,550	0	7,400	0	1,110
Upper Millstone	Brannen Lake to Rutherford	Low summer flow, low water quality. Barrier at headwater outlet.					✔	✘	2,000	586	1230.2	639.2	**0**	n/a	n/a	n/a	n/a		586	1,230			2,988	0	4,804	0	1,384
Other tributaries to Brannen Lake		Low summer flows; fish habitat assessment is needed																									
	Flynnfall Creek*							✘	0	0	0	2,215	631						0	0			0	0	0	0	
	Hoskins Creek*							✘	0	n/a	n/a	n/a	n/a						n/a	n/a				0		0	
	Caillet Creek*							✘	0	n/a	n/a	n/a	n/a						n/a	n/a				0		0	
	Jepson Brook*							✘	0	n/a	n/a	n/a	n/a						n/a	n/a				0		0	
	Heikkila Creek*							✘	0	494	294	2,653	1,919						494	294			1,777	0	2,566	0	900
									0	0	0	679	260						0	0			0	0	0	0	
									0	0	0	322	313						0	0			0	0	0	0	
	Metral Creek*							✘	0	65	263	132	0						65	263			459	0	787	0	0
	Copley Brook*							✘	0	n/a	n/a	n/a	n/a						n/a	n/a				0		0	
																							0	0	0	0	
	* Indicates habitat estimates developed from slope analysis of upper watershed.																										
																							179,962	188,904	241,141	262,662	132,783

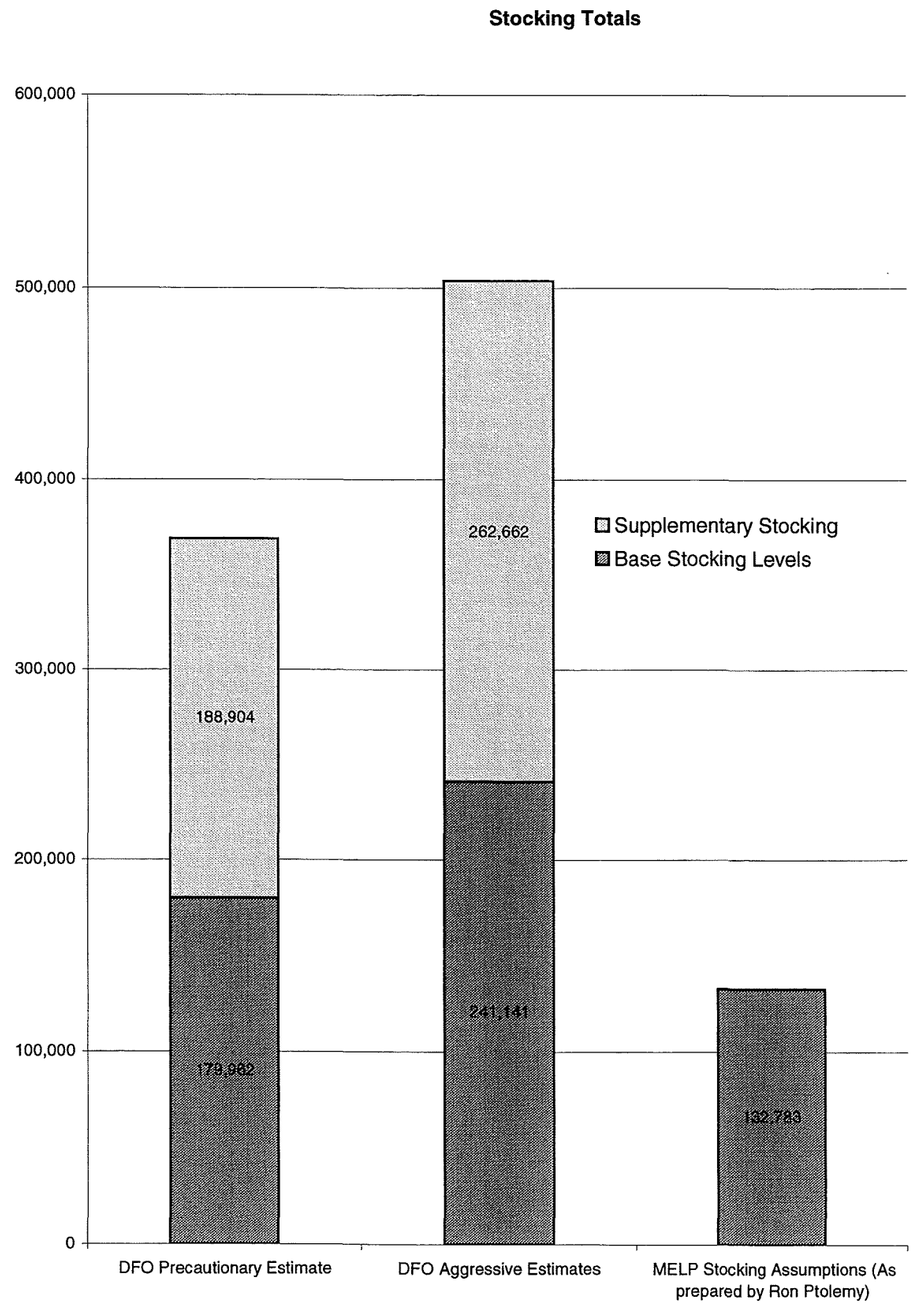
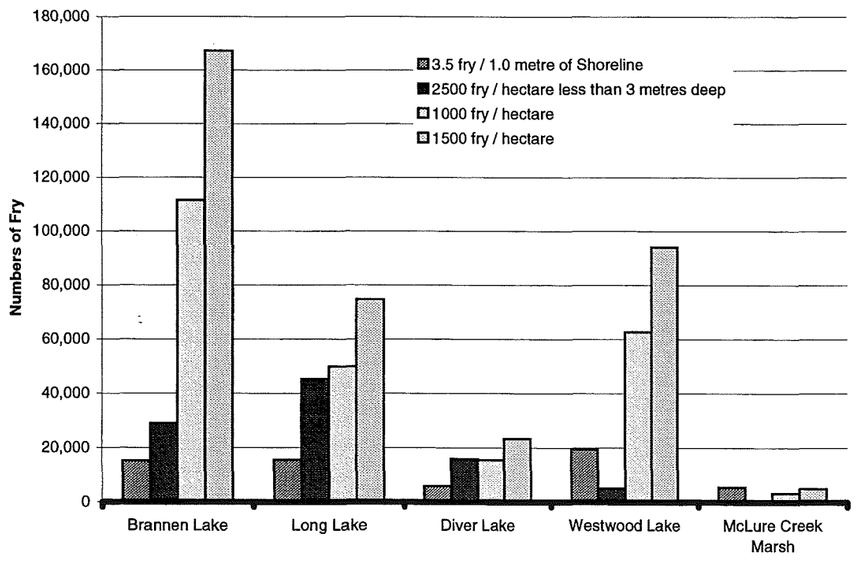

Stocking Totals
600,000
500,000
400,000
300,000
200,000
100,000
0
188,904
179,962
262,662
241,141
132,783
Supplementary Stocking
Base Stocking Levels
DFO Precautionary Estimate
DFO Aggressive Estimates
MELP Stocking Assumptions (As prepared by Ron Ptolemy)

Table 4.2 Stocking for Lakes in the Millstone Watershed

Lakes	Area sq. m. Total	Area sq. m. less than 3m depth	Perimeter lin. m.	Tom Brown 3.5 fry / lin. m. shoreline	Mel Sheng 2500 fry/hectare	Bams Tech Report #1933 1000 fry/hectare	Brian Anderson 1500 fry/hectare
Brannen Lake	1,115,000	116,000	4,336	15,176	29,000	111,500	167,250
Long Lake	498,000	181,000	4,435	15,523	45,250	49,800	74,700
Diver Lake	155,400	63,500	1,676	5,866	15,875	15,540	23,310
Westwood Lake	627,000	20,300	5,532	19,362	5,075	62,700	94,050
McLure Creek Marsh	33,333		1,586	5,552	0	3,333	5,000
Cathers Lake*	46,455		1,381	4,834	0	0	0
Total Lake Stocking				61,478	95,200	242,873	364,310

Lake Stocking



5.0 Action Plan

The first component of the action plan is

1. Coho colonization of the Millstone R. beginning in 1998.

The second component is:

2. Development of fish access beyond the cascades in Bowen Park.

Without spawner access above Bowen Park cascades, the productive capacity of the Millstone watershed will require annual colonization of fry, and a sustainable run cannot develop.

The action plan described in Table 5.1 embraces the potential of a sustainable run of coho and encourages the development of facilities that can describe all aspects of the fishery, fish habitat and provide on-site viewing of fish migration.

Coho Colonization

This report develops the coho colonization plan in some detail and the action plan identifies specific locations for the distribution of coho fry along the Millstone R. and Brannen L.

Improving Fish Passage

In addition to the major fish passage concerns described in the introduction to this section in Bowen Park, the action plan chart highlights a number of additional locations where fish passage concerns should be reviewed.

Riparian Enhancements

Many opportunities for riparian enhancement exist along the length of the Millstone R. and its tributaries. Specific opportunities are noted along the upper reaches of the Millstone R. where grazing by cattle has removed enough vegetation to result in streambank erosion.

Many other locations have also suffered from tree and understorey removal. Riparian enhancement projects in some of these locations are recommended to help restore the productive capacity of the watercourses.

Habitat Complexing

Several locations along the course of the Millstone R. have been identified as significant opportunities to create or improve existing habitat for coho.

Spawning Platforms

Improvements for spawning gravel are identified in Bowen Park and for tributaries from Brannen Lake.

Side Channel Development

An excellent semi-natural side channel opportunity exists at the north end of Bowen Park. This type of project will improve fish habitat and afford an excellent spawning area, and because of its public location provide interpretive opportunities as well.

Flow Control

One of the most significant difficulties in improving the habitat quality of the Millstone system is the problem of low summer flows. Most of the Millstone tributaries run dry in the late spring or summer months and may restrict migration of coho fry or smolts. Several specific opportunities have been identified for review.

Water Quality

Water quality is an important factor in the overall productivity of the watershed. Like flow control however, the actions that improve water quality are applicable throughout the watershed.

Public Access

Trail access to the parts of the Millstone R. which located on public land can diminish fish production if they are poorly designed, located or not carefully constructed and maintained. Trails immediately adjacent to streams often create conflicts as riparian vegetation is damaged, or erosion occurs which reduces egg survival due to sediment pollution of the spawning beds. In spite of these potential conflicts with trails, the value of trails to the community as a recreational amenity, increases individuals enjoyment, awareness and sensitivity toward the fragile urban streams. Therefore Greenways and trails are an integral part of successful fish production planning.

Public Information

Communicating the stewardship message is always an important aspect of fish production planning. We encourage a broad review of the opportunities available in the Millstone watershed to link community based planning of fish production and recreational, educational and economic approaches.

Successful and effective Nature Centres which communicate the importance of natural systems to thousands of daily visitors exist. Examples of similar education and interpretation facilities that are already operating as not-for-profit foundations are included in the appendix of this report. There is a significant communication and education opportunity that could be developed as part of a "Salmon in the City" community based initiative.

We encourage a Millstone Stream Keepers organization to adopt this stream and encourage the Community Futures Development Corporation of Mid Island to the champion for a long term "Salmon in the City" program.

Table 5.1 Millstone River Coho Production Enhancements

Watercourses			Actions										
	Reaches	Issues	Coho Colonization		Improving Fish Passage	Riparian Enhancements	Habitat Complexing	Spawning Platforms	Side Channel Development	Flow Controls	Water Quality	Public Access	Public Information/ Interpretation
Millstone River		Low flow system in summer, little scour action, few pools. Low D.O. and high temperatures											
	Intertidal												
		Right bank needs to be cleaned-up. Remove scrap metal.										Provide direct access along the streambank to upstream parks	Signage at the estuary, Lion's Great Bridge, etc.
	Intertidal to Top of Bowen Park												
			Mill Street foot bridge	18055	Add baffles and/or notches to rock ledges to improve habitat complexity	Streamside protection and fence and/or railing where park trail passes close to stream	Rock blasting of rock ledges to increase pool habitat	Add baffles to encourage development of gravel spawning platforms	Construct side channel adjacent to soccer field at the top end of Bowen Park				
			Bowen Road	17511	Design and construct fish passage to lower falls								
					Design and construct fish passage to upper chute								
	Top of Bowen Park to Jingle Pot Road												
			Pryde Avenue	9245	Improve upstream migration over weir	Consultations with private landowners about riparian restoration and maintenance			Construct side channel at north end of playing fields adjacent to weir	Construct flow control in conjunction with side channel		Trail development and access control	Signage and viewing facilities in conjunction with side channel construction
			Westwood Road	10333									
			East Wellington Road	15499	Fish access improvements for winter habitat in Buttertubs					Consider opportunities to provide a pulse flow in May or June to encourage fish outmigration			
			Durnin Road	11420									
			Neufield Road	14955									
			Jingle Pot Road	21753									
			Landmark Cresent										
			Biggs Road	15227									

Table 5.1 Millstone River Coho Production Enhancements													
Watercourses			Actions										
	Reaches	Issues	Coho Colonization		Improving Fish Passage	Riparian Enhancements	Habitat Complexing	Spawning Platforms	Side Channel Development	Flow Controls	Water Quality	Public Access	Public Information/ Interpretation
	Jingle Pot Road to Brannen Lake												
		Streambank erosion				Encourage fencing and other grazing controls to provide riparian vegetation		Improve spawning gravel					
	Total			134000									
Darough Creek													
	Millstone to Westwood Lake	Dry most of the year											
Sabiston Creek													
	Millstone to Cather Lake	Dry most of the year								Review flow control from Cather Lake to provide additional spring/summer flow opportunities			
McNeil Creek													
		earthmoving by property owners caused siltation in 1994			Consider opportunities to improve fish passage from Westwood Lake	streambank stabilization and riparian planting							
Morgan Creek (McCormack)													
	Millstone to Westwood Lake	Low summer flow, Headwaters used for irrigation			Work with BC Hydro and property Owner to upgrade culvert					Review upstream irrigation impacts to fish habitat			
McGarrigle Creek													
	Millstone to McGarrigle Creek Falls	Low summer flow. Unlicensed pumping, siltation. Dewaters in Summer								Flow control from Westwood Lake would improve the spawning and rearing habitat.			
Beaver Creek													
	Millstone to City Boundary	Summer flow is maintained by water frome a abandoned mineshaft				riparian planting							
	City Boundary to Sloan Road	Summer flow is maintained by water frome a abandoned mineshaft											

Table 5.1 Millstone River Coho Production Enhancements

Watercourses			Actions										
	Reaches	Issues	Coho Colonization		Improving Fish Passage	Riparian Enhancements	Habitat Complexing	Spawning Platforms	Side Channel Development	Flow Controls	Water Quality	Public Access	Public Information/ Interpretation
	Sloan Road to Diver Lake	Dewaters every summer											
Diver Brook													
	Diver Lake to Long Lake												
McClure Creek													
		Low summer flow, status of marsh unkown.	Repair damaged streambanks. Install fencing to limit access by cattle. Assess year-round water quality.										
Benson Creek													
	Brannen Lake to Ammonite Falls	Low summer flows; fish habitat assessment is needed											
	Upstream of Ammonite Falls	Resident cuttroat trout											
Upper Millstone													
	Brannen Lake to Rutherford	Low summer flow, low water quality. Barrier at headwater outlet.											
Other tributaries to Brannen Lake													

Table 5.1 Millstone River Coho Production Enhancements													
Watercourses			Actions										
	Reaches	Issues	Coho Colonization		Improving Fish Passage	Riparian Enhancements	Habitat Complexing	Spawning Platforms	Side Channel Development	Flow Controls	Water Quality	Public Access	Public Information/ Interpretation
	Flynnfall Creek	Low summer flows; fish habitat assessment is needed											
	Hoskins Creek	Assessment needed.											
	Caillet Creek	Assessment needed											
	Jepson Brook	Assessment needed											
	Heikkla Creek	Assessment needed											
	Metral Crek	Assessment needed											
	Copley Brook	Assessment needed											
Lakes													
	Brannen Lake			29000									
	Long Lake												
	Diver Lake												
	Westwood Lake												
	McLure Creek Marsh		Fall planting	5000		Maintain existing riparian habitat				Ensure adequate storage to maintain winter habitat			
	Cathers Lake*												

6.0 Appendices

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Abbreviations

M.E.L.P.: Ministry of the Environment, Lands and Parks.
DFO: Department of Fisheries and Oceans.
LWD: large, woody debris.
Coho : Coho salmon *Oncorhynchus kisutch.*
Chum: Chum salmon: *Oncorhynchus keta*
Cutthroat: Cutthroat trout *Oncorhynchus clarki.*
Rainbow: rainbow trout *Oncorhynchus mykissi.*

Quidi Vidi Rennies River Development Foundation

April 24, 1998

Doug Blackhouse
Lanarc Consultants Ltd.
Suite 12, 20 Front Street
Nanaimo, BC
V9R 5H8

Dear Mr. Blackhouse::

As per our conversation on April 22, 1998, the following is a brief history of the Quidi Vidi Rennies River Development Foundation and its activities over the past 12 years.

The Quidi Vidi Rennies River Development Foundation, a non-profit, charitable organization, was formed in 1985 by a group of concerned citizens to improve, enhance, maintain and conserve the integrity of the aquatic resources of Rennies River; Leary's Brook; Virginia River; Quidi Vidi Lake and such other tributaries, headwaters and watersheds in relation to the Rennies River watershed system.

The Foundation completed a 10 year master-plan to direct development along Rennies River and its watershed area, describing the nature and distribution of planned facilities. What has resulted is an integrated and comprehensive open space facility providing the citizens of St. John's and visitors to our city increased recreational and leisure time opportunities and improved conservation of resources.

The master plan was developed by professional landscape architects, environmental and resource planners and was reviewed during an extensive public consultation process. The objectives of the master plan were, as follows:

MAY - 4 1998

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Box Five, Nagles Place, St. John's, Newfoundland, A1B 2Z2
Telephone: (709) 754-3474, Fax: (709) 754-5947

* To identify and demonstrate the unique environmental and social features of the Quidi Vidi / Rennies River area.

* To establish the role played by this area in meeting the open space requirements of the St. John's urban Region.

* To enhance the tourism potential of the City's open space resources.

* To prepare guidelines to assist planners and decision makers in long - term development of the City's open space resources.

* To provide recreation and conservation standards for future development.

* To designate required physical facilities and services.

* To ensure economically viable concepts and designs.

Two of the Foundation's major interests in the context of the master plan's objectives were to identify and demonstrate the unique environmental features of the Quidi Vidi /Rennies River watershed system and to develop wildlife and habitat conservation standards for future development.

Wildlife on the Rennies River is extremely varied and provides opportunities for fishing, birdwatching, etc, which enhanced the educational and recreational aspects of the development. It has been noted that Rennies River has the largest population of brown trout in North America.

A landscape development program was identified establishing the need for dense continuous vegetation along the stream banks. Of critical importance was the use of local species ensuring compatibility with the existing natural varieties and the use of fruit producing trees and shrubs essential to the food chain. The vegetation selected had to be substantial enough to support the stream banks and to protect against erosion, particularly in the lower sections of the river, where there was an erosion problem. The upper section required a planting scheme that would serve as a sponge to soak up excess water during periods of heavy rain.

..... 3

While restoring the habitat along Rennies River / Quidi Vidi Lake, the Foundation also developed a conservation - oriented linear park along the entire length of the river system, being extremely careful not to disturb the natural outline of the river banks. The 7.5 km walking trail provides users with a constantly changing landscape, reflecting the dynamic nature of the river.

The landscaping program included the enhancement of natural conservation zones as well as a formal design approach in high usage areas to reflect the "urban park" nature of the development.

Funding for this development was given by the City of St. John's; the Government of Newfoundland & Labrador; the Government of Canada; as well as corporate and private donations.

It was the objective of the Foundation to provide opportunities for the general public to develop a stronger awareness of the importance of conserving and protecting our natural environments within urban areas and beyond that, to develop an understanding of the intricate ecological relationships and the need for intelligent use and management of waterways and associated fish and wildlife resources.

The Newfoundland Freshwater Resource Centre (more commonly known as THE FLUVARIUM) culminated from several years of growth, with input from various interest groups, professionals and the public at large. It was originally envisaged as just a "window on a stream" (Fluvarium) , to promote the conservation of Rennies River and its abundant trout population but with the interest of several Government funding agencies and corporate sponsors, the "window on a stream" (Fluvarium) grew into The Newfoundland Freshwater Resource Centre, housing the only public Fluvarium open to the public year round.

The Fluvarium's main components include:

* The Fluvarium (a series of 9 viewing windows allowing the visitor to peer into a living stream (Nagle's Hill Brook) which flows into Long Pond; Long Pond flowing into Rennies River.

* A series of exhibits and interpretation programs focusing on river ecology.

..... 4

* A multi-purpose space for meetings, conferences and workshops; audio-visual presentations, weddings, social events, etc.

* Outdoor interpretation, enhancement and habitat protection areas, interpretative trails; lookouts and signage.

At the time of its inception, Long Pond was the only protected tract of marshland within the St. John's Urban region, providing shelter and habitat to a variety of resident and migratory water birds. The tributaries of Long Pond provide extensive spawning and rearing habitat for brown and brook trout populations.

The Fluvarium is a major component of the Foundation's master plan and was fully endorsed by environmental, recreation, conservation and tourism groups within the province. It offers educational and tourism attractions. Over 12,000 school children participate in our programs yearly and we receive over 30,000 visitors per year.

Although funding was available for the construction phase of the development, the Foundation receives NO OPERATING FUNDING OF ANYKIND for the work we are continuing to do.

We raise the necessary funds through admissions, building rentals, corporate and private donations and of course, fund-raising projects, such as the Great Annual Rennies River Rubber Duck Race.

There have been many ups and downs along the way, but we are proud to say that we are now in our 13th year of development.

I hope that the information I have provided is helpful to you and your organization. I have enclosed a complete set of our quarterly newsletters for your reading enjoyment. If I can be of further assistance, please do not hesitate to contact me.

Regards,

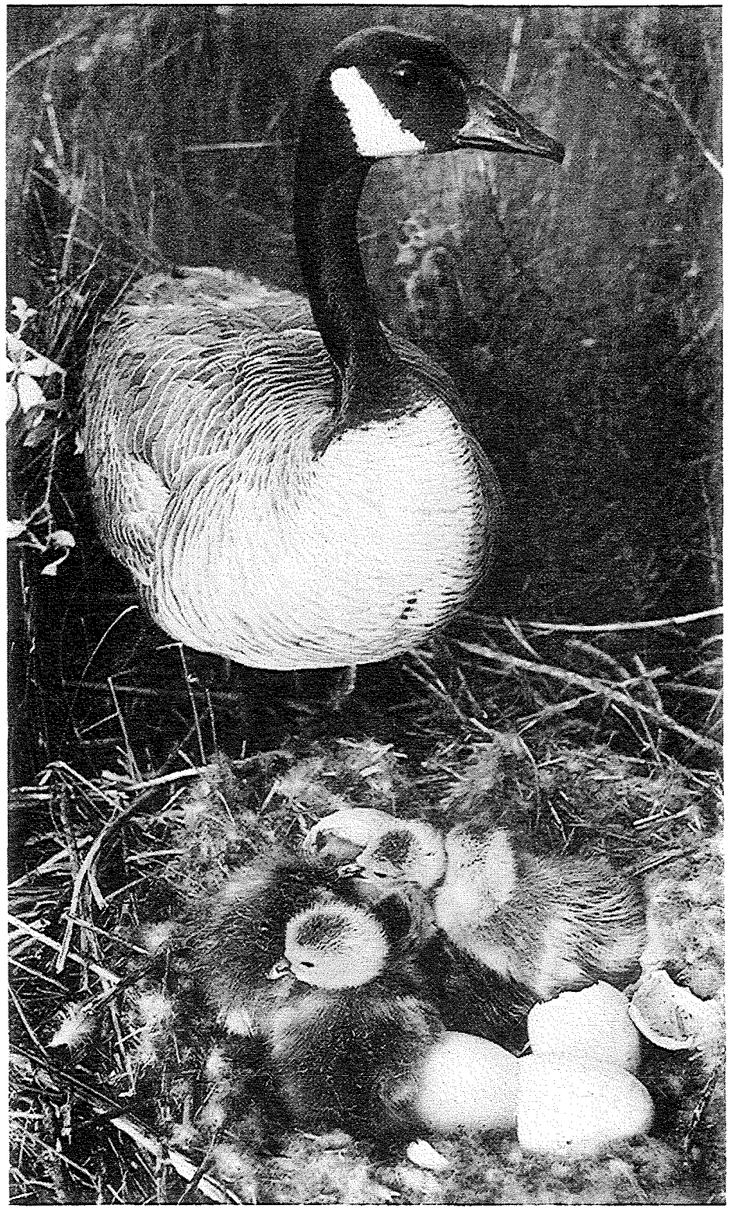
Debbie Picco Garland
Administrator

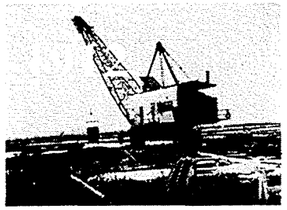
/djpg1147
Enclosure(s)

"Education in the art and science of keeping this planet habitable for all forms of life."

Dedicated to providing funding and facilities for education in the art and science of keeping this Planet habitable for all forms of life.

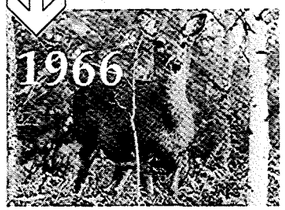
1961 McCreary Rd.,
Winnipeg, Manitoba
R3P 2K9
Phone (204) 989-8355
Fax (204) 895-4700





Canada Cement Company began extracting clay.

Canada Cement employees released three pairs of geese.



Wildlife Foundation of Manitoba incorporated.

Habitat Conservation Winnipeg Wood Duck Project

The Fort Whyte Nature Centre

The Vision

Over the last 25 years, the trustees of the Fort Whyte Foundation and the members of the Board have guided the Fort Whyte Centre's development from nature centre to conservation centre -- to environmental education centre.

At each stage we were responding to a changing public perception of the human place in the scheme of things: first as interested spectators of the natural world; then as managers and conservers of the world's resources; and now the participants we must all be, in every hour of every day, in the sustainable life of the planet.

As this public perception has changed and strengthened, the demand for holistic environmental education has exceeded the capacity of what has been authoritatively called "...one of the premier interpretive centres in the country."

Fort Whyte Centre for Environmental Education was designed to carry the message of interdependence to an ultimate 50,000 school students and adults annually. What seemed a formidable goal then is now but a benchmark against which the Centre measures the achievements of its education program enjoyed by well over 100,000 visitors annually.
This is the Fort Whyte Centre of today.

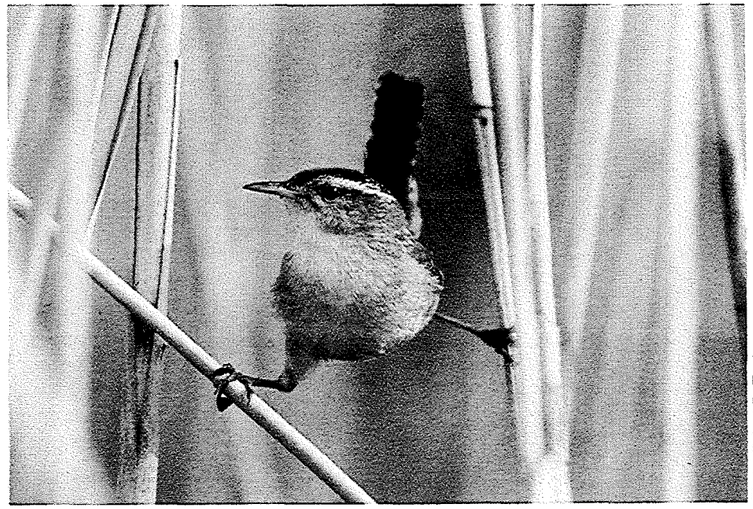


Photo: Robert R. Taylor

Building on the Vision

Located on a reclaimed clay quarry, the Fort Whyte Centre of today spreads over 200 acres of forest, lakes and self-guiding trails.
Marshlands ring with the song of red-winged blackbirds as floating boardwalks lead into the mystery of their habitat. Wildflowers fill the air with their sweet fragrance along the quiet aspen paths. Trail markers interpret the journey and bring visitors face to face with wildlife in its natural setting. White-tailed deer, mink, fox, racoons, a myriad of song birds and thousands of waterfowl are but a sampling of the wildlife community this natural urban oasis offers the visitor.

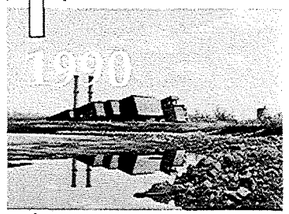
Agricultural demonstration plots feature native prairie grasses, shelterbelts and Manitoba's most important field crops. This giant outdoor exhibit depicts each crop's dollar value to farmers and some of their uses. It also chronicles the crop year from fall cultivation through threshing the following year. And nature's way of recycling is clearly demonstrated in various stages along the Compost Education Trail.

Environmental education continues inside the 10,000 square foot Interpretive Centre with numerous displays and exhibits... from "hands-on" study of native wildlife in the childrens' Touch Museum — to an underwater window on Manitoba's aquatic life in the Aquarium of the Prairies. A stunningly detailed diorama depicts our prairie soil evolution, degradation and the possibilities for its future. Visitors explore local and global energy issues in an interactive Energy Encounters exhibit. And a visit to the Centre is never complete without a peek into the Waterfowl Wintering Room and a little bit of browsing in the Gift Shop. Lecture theatres offer space for a variety of school, Day Camp and public programs — and the library offers volumes of information to help interpret our natural world.

From small beginnings in 1957, the Fort Whyte Centre has evolved to the premier educational facility it is today. Visitors have the opportunity to experience our natural world — to feel the magic of quiet places where wildlife and waterfowl live in perfect harmony — and to learn how we may all live sustainably.

The Future

- *Energy Encounters Exhibit*
- *Soil Diorama Completion*

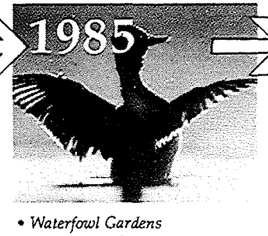


- *Lakeshore Enhancement*
- *Fish Stocking*

- *Aquarium of the Prairies*
- *Compost Trail*

1983 — *Fort Whyte Centre for Environmental Education*

- *Floating Boardwalks*
- *Self-Guiding Trails*

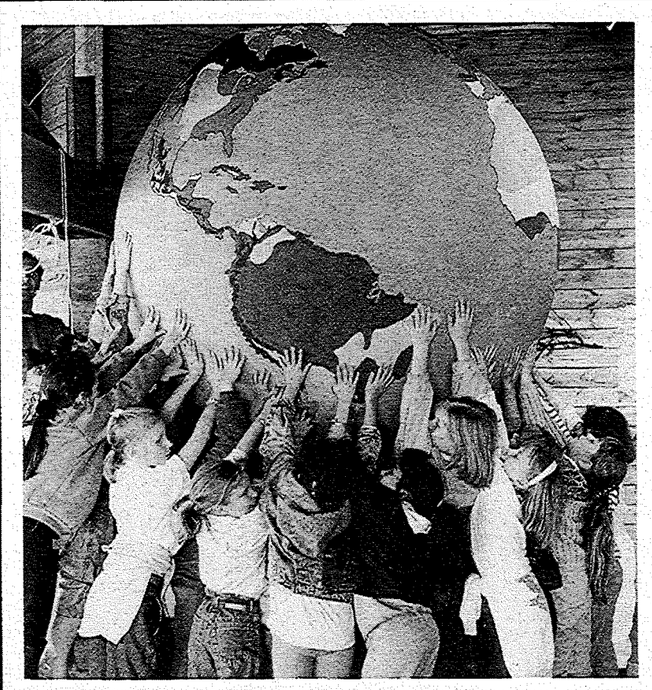


- *Waterfowl Gardens*
- *Buffer Land Purchase*
- *Kiwanis Building Renovation*

- *Kiwanis Touch Museum*
- *Nature Gift Shop*
- *Observation Beehive*

- *Agricultural Demonstration Plot*
- *Observation Tower*

Our Business: *Teaching Sustainable Living*



"Teach your children
What we have taught our children
That the earth is our mother
Whatever befalls the earth
Befalls the sons of the earth
Man did not weave
The web of life
He is merely a strand in it
Whatever he does to the web
He does to himself."

Chief Seattle 1854

The Program

ON-SITE

PUBLIC
(75,000+ annually)

SCHOOLS / YOUTH
(35,000+ annually)

WORKSHOPS

- Composting
- Grocery Challenge
- Wildlife
- Energy Conservation
- Water Conservation
- Household EcoTeams

EXHIBITS

- Soil Conservation
- Touch Museum
- Aquarium
- Beehive
- Compost Trail
- Energy Encounters
- Waterfowl Gardens

NATURAL HISTORY

GRADES K - 12
- Plants
- Animals
- Habitat
- Wetland Communities
- Forest Adaptations

SUSTAINABLE LIVING

GRADES K - 12
- Waste Minimization
- Consumer Power
- Energy Education
- Soil
- Water

RECREATIONAL PROGRAMS

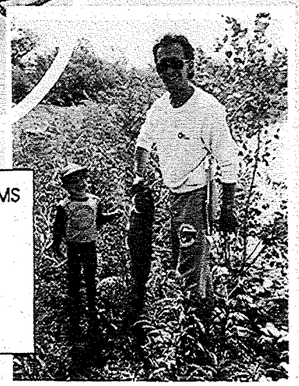
Allowing people to interact with their environment

SPECIAL EVENTS
- Winter Festival
- Fall Supper
- Harvest Days
- Country Fair
- Pancake Breakfasts
- Northern Living Festival

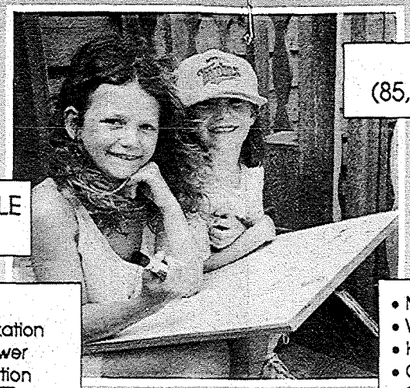
CRAFT WORKSHOPS
- Wheat Weaving
- Flower Pressing
- Nature Photography
- Decoy Carving
- Natural Dyes
- Moccasin Making

FAMILY PROGRAMS
- Tobogganing
- Ice-Skating
- Fishing
- Canoeing
- Birdwatching
- Dog-Sledding

CHILDREN'S PROGRAMS
- Fishing
- Insects, Wildlife
- Outdoor Cooking
- Nature Crafts
- Nature Day Camps
- Youth Corps

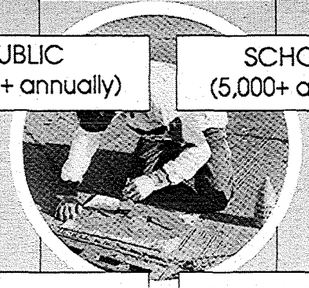


OFF-SITE



PUBLIC
(85,000+ annually)

- Malls, fairs
- Workshops
- Home Shows
- Compost Caravan
- Storm Drain Marking Program
- Green Lunch Program



SCHOOLS
(5,000+ annually)

- "Fort Whyte Centre On the Road"
- Teacher In-Services
- In-Class Sustainable Living Program
- Caretakers of the World

The facilities and programs of the Fort Whyte Centre operate in concert to provide environmental education to school/youth groups and the general public.

From kindergarten to high school level, over 35,000 students annually participate in the Centre's school and youth group programs. School programs are offered in both French and English. Natural history subjects provide a basic understanding of local and global ecosystems, while Sustainable Living programs provide insight into personal environmental impacts of everyday life -- emphasizing positive actions towards a sustainable lifestyle. Two hundred acres of forest, meadows, lakes and marshes serve as a giant outdoor classroom, with the Centre's indoor exhibits further enhancing the students' experience.

Public programs at the Centre are designed to inspire families and individuals with appreciation for our natural world. Seminars, hands-on workshops and recreational activities are offered throughout all seasons. These programs inspire concern for the health of the environment, and subsequently, action to ensure preservation of our natural assets.

Although the majority of the Centre's educational programming takes place on site, there is a growing demand for off-site presentations as well. Our outreach programs spread the message of sustainable living throughout Manitoba schools, trade fairs, business lunches, shopping malls, country fairs, exhibitions, recycling depots and parks.

Our business is teaching sustainable lifestyles, in the hope we may all become caretakers of the world for tomorrow's generations.

A Business
Building on Strength

As a privately operated, non-profit project of the Fort Whyte Foundation Inc., the Fort Whyte Centre prides itself upon being 85% privately funded, with user fee income accounting for nearly 50% of revenue.

Private sector donations and fundraising events represent over one-third of total revenue. Business and individuals are partners in environmental education through special programs such as the Class Act sponsorship of school field trips to the Centre and the Foster Parent Program through which donors share the care for our resident wildlife. Yearly sponsorships from private foundations and companies support many of the Centre's major exhibits such as the Aquarium of the Prairies, the Waterfowl Display Flock, and the Touch Museum.

Planning for the future and the Fort Whyte mandate of environmental education go hand in hand. Donors contribute to the Centre's Endowment Fund through direct donation, bequest by will, in memoriam contributions, or planned giving programs.

Some of Our Fundraising Programs:

- Employee Family Visit Program
- Corporate Sponsorships
- Great Getaway Raffle
- Country Fair
- Limited Edition Art Prints
- Winter Festival
- Foster Parent Program
- Class Act Program
- Endowment Fund
- Sunset Barbecue

ANNUAL OPERATING BUDGET BREAKDOWN

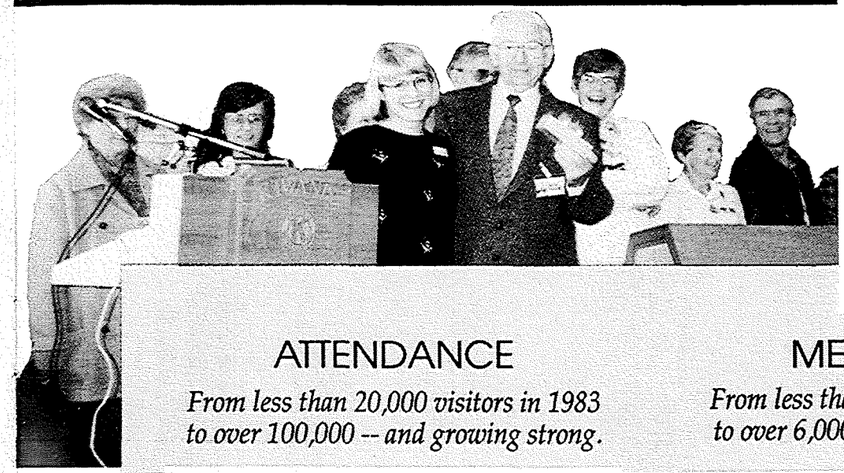
REVENUE

EXPENDITURE

Volunteers

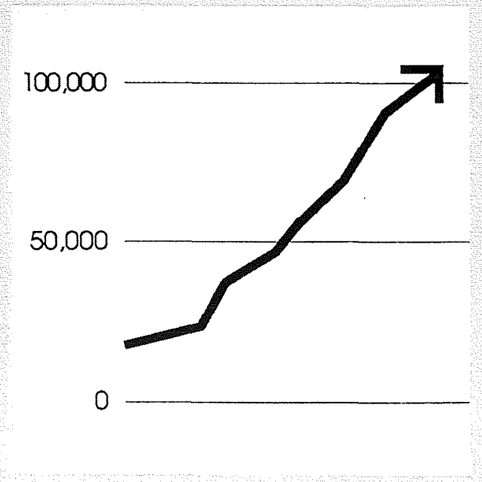
Volunteers are the lifeline of the Fort Whyte Centre. They are active in all facets of the Centre providing interpretation in school and public programs, visitor reception, office administration and promotional awareness through various fundraising programs, displays and special events.

Over 200 volunteers annually donate more than 14,000 hours of work -- equivalent to nearly 7 full-time employees. Placing a dollar value on their time and commitment is impossible -- *their contribution is priceless.*



ATTENDANCE

From less than 20,000 visitors in 1983 to over 100,000 -- and growing strong.



MEMBERSHIP

From less than 500 members in 1983 to over 6,000 – and growing strong.