Section 1 ENGLISHMAN RIVER ESTUARY FISH SURVEY AND WATER QUALITY REPORT

1.1 Fisheries Goals And Objectives.

The Fisheries Goal is to make recommendations for a future Estuary Management Plan.

The Englishman River estuary has long been the subject of harmful human development. Its mudflats were scoured by historic log boom and sorting operations. Agricultural development added dykes, fill, pastures and non-native plants. More recently there have been several resort developments that scar the natural landscape with excavated ponds, building foundations, rip rap and removal of vegetation. The City of Parksville has designed several storm drains to enter the lagoon area while withdrawing river water just upstream of the estuary. Upland logging, farming and urbanization continue to influence the water quality and quantity that is delivered to the estuary.

There has not yet been a Management Plan to address these development impacts.

The Fisheries Objectives to accomplish this task are:

1. *Conduct a fisheries inventory of the estuary over the 2007 and 2008 period.*
2. *Incorporate public participation, education and awareness of the estuary fisheries resource.*

These objectives will bring information on the estuary to light as to what fish species are using the estuary. Determination of the fish species will provide direction on the habitat requirements, which leads to the activities required for habitat restoration in an Estuary Management Plan. The second objective will create the public interest in the estuary and help answer the question of how and who will get the Estuary Management Plan implemented. Training volunteers from the local community to be stewards of the estuary creates the support we need for a long-term approach.

SALMONIDS

Historically Chum (*Oncorhynchus keta*) and Coho (*O. kisutch*) salmon have been the two most dominant species. The Englishman River watershed is also inhabited by Chinook (*O. tshawytscha*), Pink (*O. gorbuscha*) and Sockeye (*O. nerka*) salmon. Steelhead Trout, Resident Rainbow (*O. mykiss*), sea run and resident Cutthroat (*O. clarki clarki*) are also present[1]. Steelhead populations are currently at severely reduced levels[2]. The provincial government has classified the Englishman River as a sensitive stream.

Salmon and some trout are anadromous species. These fish begin their lives in freshwater, migrate to estuaries as juveniles then on to various feeding areas in the Pacific Northwest while maturing, finally returning to the estuary to ready for their spawning entry to lay their eggs in fresh water and die. All use the estuary for varying periods for development as juveniles and returning adults

ESTUARIES

Estuaries are transitional areas between fresh and salt water. This environment is a place where salt water is diluted by freshwater flow. Fish species found here come from both fresh and salt water ecosystems and can tolerate these varying saline conditions. The chemical and physical characteristics of an estuary can change dramatically from day to day, week to week, and month to month. Because of that, it is important that the fish in these conditions can tolerate an ever changing environment. Consequently, this limits the number of fish species that can live in an estuary. Although the number of species inhabiting an estuary is limited, the high abundance of nutrients found there can support a large concentration of individuals.

Estuaries typically act as staging areas for anadromous fish, causing them to remain there for several days or weeks before finally moving upstream. Estuaries can also act as a nursery for young allowing some fish to spend the first few months to a year of their life in estuaries before heading off into the ocean.

True estuarine fish spend their entire life cycle in estuaries. The Shiner Perch (*Cymatogaster aggregate)*, Three-spine Stickleback (*Gasterosteus aculeatus)* and Sculpin species (*Leptocottus armatus, Oligocottus maculosus, Clinocottus embryum,* and *Ascelichthys rhodorus)* are able to survive in areas of varying salinity. The variety and high concentration of food found in an estuary creates an inviting ecosystem for these fish [3]. The Staghorn Sculpin (*L. armatus)* and Shiner Perch are two species that are considered estuarine - nondependent marine fish. These fish are commonly found near the oceanic mouth of estuaries but do not depend on it to complete their life cycles. Usually nondependent marine fish make up about half the species found in an estuary and are typically abundant seasonally or in areas with high salinity[4]. Estuarine dependent marine fish spend at least one stage of their life cycle in estuaries, using them as spawning grounds, as nurseries for young, or as feeding grounds for adults. Starry flounder (*Platichthys stellatus)* spawn adjacent to the estuary, so when their young hatch they will migrate into the nutrient rich estuary where they will feed and grow [5].

1.2 Methods

1.2.1 Survey Area:

The Estuary was broken into areas determined by their physical differences with respect to tide

[1] Brown et al. 1977
[2] Wightman et al. 1998
[3] Annand et al. 1993
[4] Moyle &Cech, 2004
[5] Moyle & Cech, 2004

and location. Four sample sites were chosen for this study (Figure 1.1) These sites included the Beach, Dyke, River, and Lagoon.

Beach Site: Located on the east shore of the estuary, the gravel beach is adjacent to the exit of the Englishman River. The beach has a flat aspect with a wide tidal area. The slope of the survey area is less than 1% gradient resulting in a long beach line that extends over 300m at low tide in the survey area. The substrate is primarily gravel and cobble with sandy pockets throughout. We sampled this site at low tides only. Access was through San Pareil to the beach parking lot at the end of the spit.

Dyke Site: A man-made fill of gravel, cobble and sand, built over 40 years ago, that bisected the upper intertidal marsh with the lower river and estuary. The Dyke was breached in 1981 and the opening is now approximately 30 m wide. Approximately 100 m of Dyke remains deflecting water away from the upper lagoon. The Dyke is partially vegetated (Crab Apple, Nootka Rose) and gradually eroding, resulting in areas only 2-3m wide on the top. The substrates of the adjacent wetted area are made up of a cobble/gravel edge with a flat sandy bottom approximately 15-20 m wide. The site was sampled at moderate to high tides.

River Site: The lower river channel is 25-30 m wide. It has a gravel/cobble substrate with shallow pools and glides when sampled at low tide. At low tide, all fresh water flows through this site. The bank edges are gravel and sand and there is virtually no instream cover other than the occasional boulder.

Lagoon Site: This area receives most of its upland water from Mills and Bagshaw Street storm culverts located 1.5km upstream at the top of the intertidal area. It has a 10m wide channel that tapers to 2m up at the storm culverts. Shallow perennial pools that are flooded every high tide, remain at low tide. The lagoon has a muddy substrate with a grassy sedge perimeter. We sampled fish at rising to high tide levels. There are large man-made pools excavated west of the Lagoon that are connected at high tide. These pools are perennial but not sampled due to limitations on access and equipment. Access to the Dyke, River and Lagoon was through the park gate at Shelly Road.

Figure 1.1 Map of the Fish Seining Sites of the Englishman River Estuary.

Photo Page – Seine sites

1.2.2 Survey Methods

Schedule: The survey schedule was determined in advance by selecting dates when we could begin at the Beach Site at Low Tide and then work our way up to the River, Dyke and finally, Lagoon sites at High Tide. The schedule was then published and emailed to the MVIHES Project Coordinator, Faye Smith.

Volunteer Coordination: Once field days were established, the sampling was lead by the project Biologist (Dave Clough, RPBio) or another environmental professional (Brad Remillard, BSc B.I.T, Boone Barber BSc, Jack Newman, Fisheries Technician). The MVIHES Volunteer Coordinator, Ronda Murdock, contacted volunteers before the sampling date. Faye was on-site to meet and greet the volunteers and direct them to survey areas. She distributed equipment among volunteers, provided drinks and snacks, as well as recorded data and took photographs.

A typical sample day would begin at the Beach at low tide. The number of volunteers ranged from 5 to 15 persons per sample site. They ranged in age from students to retirees, all with strong personal convictions about environmental stewardship. Volunteers were offered responsibilities before work was undertaken for duties such as; carrying the equipment, setting the net, removing the fish, recording data, taking pictures and water quality measures. The voluntary jobs were generally kept by the same people through the study. Training was done before sampling to familiarize volunteers on equipment and safe sampling techniques. Careful fish handling was stressed (maintain wet hands, avoid exposure of fish to sunlight, air or dropping on to ground).

Equipment: In 2007 we used a 6.1m wide rectangular shaped beach seine. In 2008 we had a larger net custom made that had an 11.2m wide opening that had a V shape to taper to a collection sock. Equipment used is listed below:

- Small Net - 6.1m wide & 1.2 m ht. ¼ inch mesh (green) with lead and cork lines.
- Big Net - 11.2m wide & 1.82 m ht. ¼ inch mesh (green) with lead and cork lines.
- Tow ropes – floating ½ inch nylon, tied to either net end, 4m long
- Wading staffs (2) – 2.0m by 1.5 inch diameter to support ends of net from folding in and for lifting lead line over debris while in tow. Also used as wading staffs.
- Large Collection Tub (50 l), with grass, leaves or kelp to calm fish.
- Fine mesh dip nets for sorting fish – 4-10 inch (4)
- Sorting tubs, buckets, length boards and viewing tanks
- Battery powered aerator, oxygen meter, thermometer
- Chest waders and PFD's for everyone near water
- Waterproof Camera, data sampling papers, GPS

Sampling: Sampling at each site took between 40 minutes and 2 hours depending on weather, tide, number of sets and fish captured. The sampling was undertaken by first running the net perpendicular to shore to the end or to the point the lead line is still attached to bottom. The shorter net (6m) was walked along the beach for the length of the net then turned to shore, essentially catching a 6m square area. The longer net (11.7m) was set perpendicular to shore. The deep end was swept in an arc back to shore around the shallow end pivot. Care was taken not to disturb the sample area prior to setting the net.

The net was retrieved slowly to ensure the lead line stayed on the bottom and the float side of the net stayed at the surface. Net pulling required 4-6 persons to maintain the opening and pull against the drag of bottom and current. We used wading staffs to support the sides of the net and push the lead line down as we hopped it over rough surfaces such as boulders. We also placed cobbles in the net to ensure the net stayed flush to bottom and had a bag in it rather than a tight stretch from lead to float line. The net was closed at the shore with the lead line and edges beached first. A belly of net mesh ballasted by rocks remained in the water to keep fish alive while being picked from the net. The net was picked by a row of 6 to 8 volunteers along the net opening, using their hands and soft mesh dip nets to remove the fish into the collection tub.

A large fish capture tub (50L), and several collection pails (20L & 4L) were filled with water just prior to sorting the fish. A volunteer assistant was designated responsible for the buckets being ready. They had clean water with seaweed for cover ready for arrival of fish. The water was monitored for oxygen and temperature to ensure it was kept at ambient conditions. We changed the water at 5 minute intervals with buckets so our battery powered aerators were never used.

Captured fish and invertebrates were identified, recorded, photographed and then released. We returned the fish to suitably deep water preferably located near cover habitat (plants or rocks). Depending on capture efficiency another set was done if the count was very low. Faye, or sometimes a volunteer, recorded on a data sheet the number of fish and species captured at each set and site.

1.3 Results

1.3.1 Total Fish Captured in 2007 and 2008 surveys.

The 2007 estuary survey resulted in a total of 326 fish captured during the sampling period of June and July. Table 1 shows the results with areas and times not surveyed left blank.

Table 1) Total Fish Captured in 2007 Sampling Period.

Year:	**2007**						
Site	**March**	**April**	**May**	**June**	**July**	**August**	**Total**
Beach				58.0	18.00		76
Dyke				6.0	97.00		103
River				42	39.00		81
Lagoon					66.00		66
Total:				106.0	220.0		**326**

In 2008 the sampling was conducted during the months of March to August and yielded a total 1329 fish captured in the estuary (Table 2).

Table 2) Total Fish Captured in 2008 Sampling Period.

Year:	**2008**						
Site	**March**	**April**	**May**	**June**	**July**	**August**	**Total**
Beach		20.0	111.0	124.0	15.0	16.0	286
Dyke	34.0	313.0	126.0	53.0	9.0	111.0	646
River	81.0	19.0					100
Lagoon	62.0		46.0	36.0	19.0	134.0	297
Total:	177.0	352.0	283.0	213.0	43.0	261.0	**1329**

1.3.2 Species Captured in 2007 and 2008.

We captured 20 different species of fish in the 2007 and 2008 surveys. They have been grouped into five fish categories according to the 1993 study . We captured fewer fish in 2007 than 2008 due to the shorter sampling period and frequency. Fish species are identified by location and date of capture in Appendix 1 for 2007 and Appendix 2 for 2008.

All Salmon captured were juveniles smolts with parr marks faint or non-existent. As noted, Sculpin species were the most common, with Staghorn Sculpins by far the most abundant (see Sculpins below). Fish were identified using several reference keys (Hart 1973)[6] and (Lamb & Edgell, 1986)[7] and photos taken of any difficult to identify species for later confirmation. The Midshipman, Gunnels, Buffalo Sculpin and Tube Snouts were perhaps the most striking in colour and shape.

There was little mortality in fish handling. One Midshipman was stepped on as well as a few

[6] J.L. Hart. 1973. Pacific Fishes of Canada, Fisheries Research Board, Ottawa

[7] Lamb, A. & P. Edgell, 1986. Coastal Fishes of the Pacific, Northwest.Harbour Publishing, Madeira Park, B.C.

crushed shrimp from the rocks at the net bottom. All fish appeared otherwise to be in good health upon release shortly after capture (between 5 –20 minutes). No parasites or disease were observed on fish examined.

Table 2.1). Species Captured, Englishman River Estuary, 2007 & 2008.

Common Name	Species	2007	2008
Staghorn Sculpin	*Leptocottus armatus*		
Tidepool Sculpin	*Oligocottus maculosus*		
Calico Sculpin	*Clinocottus embryum*		
Rosy Lip Sculpin	*ascelichthys rhodorus*		
Buffalo Sculpin	*Enophrys bison*		
Total Sculpin		86	792
Shiner Perch	*Cymatogaster aggregata*	18	121
Three Spine Stickleback	*Gasterosteus aculeatus*	123	48
Starry Flounder	*Platichthys stellatus*		
Juvenile Sole	*Pleuronichthys sp.*		
Arrow Goby	*Clevelandia ios*		
Kelp Greenling	*Hexagrammos decagrammus*		
Pipe fish	*Syngnathus griseolineatus*		
Cling Fish	*Gobiesox maeandricus*		
Plainfin Midshipmen	*Porichthys notatus*		
Tube snout	*Aulorhynchus flavidus*		
Rockweed Gunnel	*Apodichtys fucorum*		
Total Other Fish Species		96	277
Pink Salmon	*Oncorhynchus gorbuscha*	0	71
Chum Salmon	*Oncorhynchus keta*	0	8
Chinook Salmon	*Oncorhynchus tshawytscha)*	2	12
Coho Salmon	*Oncorhynchus kisutch*	1	0
Total Salmon		3	91
Total Fish		326	1329

2.1 Sculpins

Sculpins were the dominant species captured at every site, comprising of over 45% of the total individuals captured in both survey years. Staghorn Sculpins comprised the majority of this group, with Tidepool, Rosy Lip, Calico and Buffalo found in low numbers. Amongst the survey areas, Sculpins were found in highest numbers at the River with 29 found in 2007 and 497 found at the Dyke in 2008. The fewest Sculpins were found at the Dyke in 2007, with 3 found and 66 found in 2008 at the Lagoon. Sculpin numbers were highest earlier in the spring than the other top species. In 2007, the highest number of Sculpins found was in June with 55 individuals captured. In 2008, the highest number of Sculpins was in April with 342 captured.

2.2 Shiner Perch

Shiner Perch were not distributed evenly throughout the estuary. These fish were found in the open tidal areas. The highest numbers were found at the Beach in both survey years with 18 in 2007 and 65 captured in 2008. In 2007, Shiner Perch were not captured at the River nor the

Lagoon. In 2008, the fewest Shiner Perch were found at the Dyke and the Lagoon with zero and two captured respectively. In 2008, 54 were captured in one set at the Dyke during high tide.

2.3 Three Spine Stickleback

Three Spine Stickleback were captured at every site, however their populations were not evenly distributed. Three Spine Stickleback were found in highest numbers at the Dyke with 75 found in 2007 and 44 captured in 2008. In 2007, the fewest number of Stickleback found was at the Lagoon with 8 captured. In 2008, the Lagoon and the River each captured a single Stickleback. Three Spine Stickleback were found in highest numbers in July in both years, as the new brood of the year emerged.

2.4 Other Fish Species

This grouping of fish was not distributed evenly throughout the estuary. The "other fish species" were found in highest numbers at the Lagoon in both survey years with 50 captured in 2007 and 165 captured in 2008. They consisted of Flounder, Sole, Midshipmen, Arrow Goby, Greenling, Tubesnout, Clingfish and Gunnel. The fewest number of "other fish species" was found at the Beach in 2007 with 11 captured, and at the River in 2008 with 2 captured. The highest number of "other fish species" found in 2007 was in July with 81 captured. In 2008, the highest number of "other fish species" found was in August with 120 captured.

2.5 Salmonids

Chum: In 2007, there were no Chum captured at any of the sites. In 2008, Chum were found only at the Beach site. A total of 8 individuals were captured in May (3) and June (5).

Chinook: Chinook were only found in two locations, the Beach and the Dyke. In 2007, two Chinook were found, one at each of the above sites. In 2008, Chinook were found only at the Dyke, with 12 captured. In 2007, one fish was found in each of the survey months, June and July. In 2008, the highest number of Chinook captured was in June with 10 captured.

Pink: Pink were found at every site, with a higher population at the Lagoon. The Pink salmon captured during the survey period were all found in 2008. In 2008, the highest number of Pink salmon was found at the Lagoon with 62 captured. In 2008, the highest number of Pinks captured was in March with 65 found. No Pink salmon were captured in 2007 which largely due to the short sample season and lack of a hatchery release in 2007.

Coho: Coho were not found throughout the estuary, with only one Coho was captured. This Coho was found at the Beach in June of 2007. In 2008, no Coho were captured at any of the sites.

1.3 Spatial Distribution of Fish within Sample Areas, 2007.

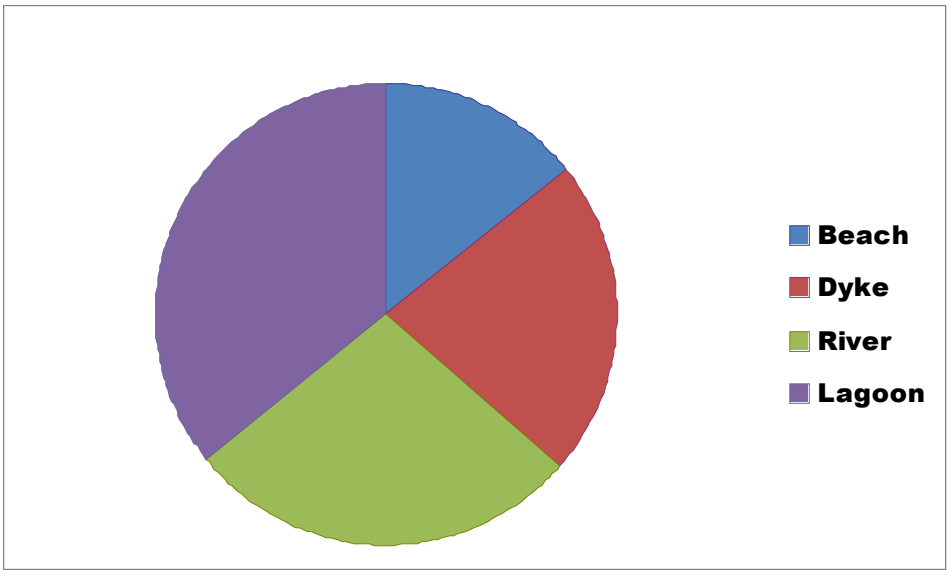
The sampling methods resulted in fish being captured by single or repeated net passes with the swept area calculated to determine the number of fish captured per square meter. The density of fish per square meter of net area for each location in 2007 is shown in Table 4 and Figure 2 below. The average density of fish was 0.412 fish per square metre in 2007. The density of fish fluctuated between the two months surveyed with the overall trend towards increased fish in July over June.

Table 3.1) Fish density (F/m^2) at each site in 2007.

Site	March	April	May	June	July	August	Avg.
Beach				0.390	0.081		0.235
Dyke				0.081	0.652		0.366
River				0.564	0.349		0.457
Lagoon					0.591		0.591
Avg:				0.345	0.418		0.412

The Lagoon location had the highest fish density (primarily Sculpins). The lowest density of fish was at the Beach in 2007. Ease of fish capture may have played a role in the high numbers for the Lagoon site. We were able to stretch the net from bank to opposite bank blocking off the outside escape route of fish.

Figure 3.1) Total Fish Density (F/m^2) by Location, 2007.



1.4 Spatial Distribution of Fish within Sample Areas, 2008.

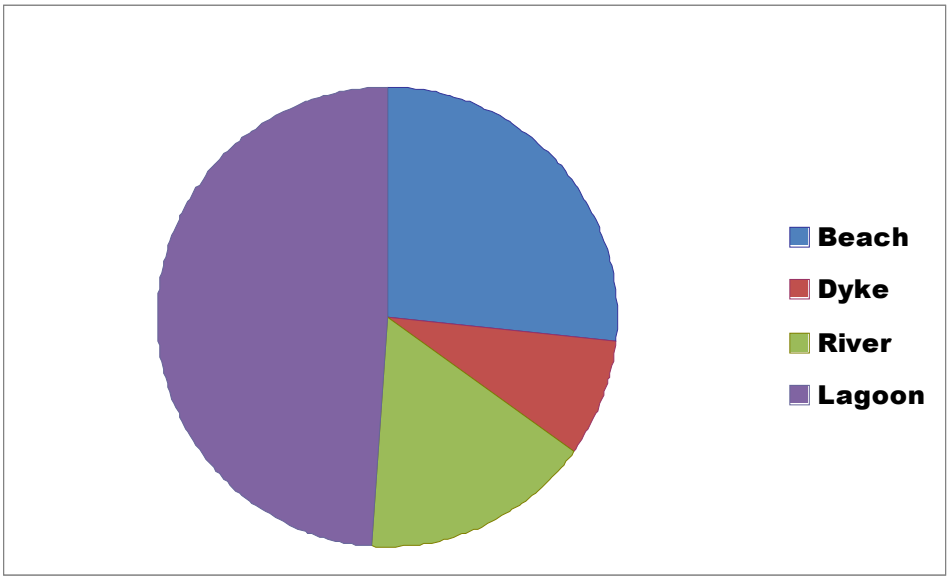
March and August were the months of highest fish abundance and the overall density was higher than the 2007 year. Figure 4 overleaf identifies the breadth of the salmon habitat distribution in the estuary.

Table 4.1) Fish density (F/m^2) at each site in 2008.

Site	March	April	May	June	July	August	Avg.
Beach		0.537	0.818	0.457	0.076	0.054	0.388
Dyke	0.152	2.804	0.320	0.269	0.046	1.127	0.786
River	0.544	0.170					0.357
Lagoon	1.666		0.467	0.183	0.193	1.361	0.774
Avg:	0.788	0.170	0.535	0.303	0.105	0.847	0.576

The 2008 results show the density of fish was greatest at the Dyke (Table 5 & Figure 3). The lowest density was with the River scoring the fewest fish. The Dyke is actively eroding and one day will wash away as the river takes its toll. This will likely change conditions in the lagoon area, which the Dyke segregates from the River.

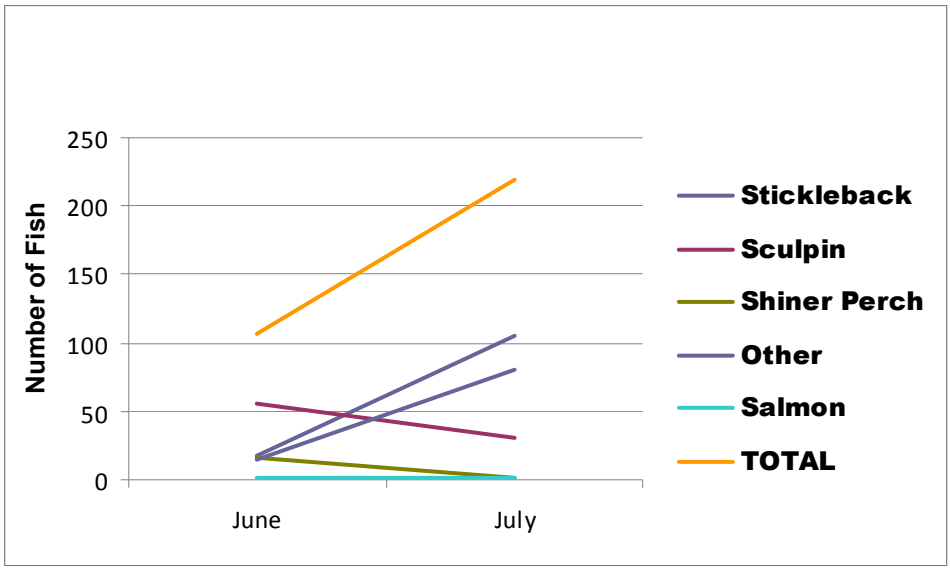
Figure 4.1). Total Fish Density (F/m^2) by Location, 2008.



1.5 Temporal Distribution of Fish within Sample Areas, 2007 & 2008.

In 2007, only 5 sample days in June and July were done. The total number of fish at each site varied over time. The changing numbers reflected our observation of one species becoming prevalent in the capture site. Stickleback or Sculpins would typically dominate one site over other species. It may be tied to their growth and maturity rates. Salmon juveniles (Coho & Chinook) were only captured in the June surveys.

Figure 5.1) Monthly Fish Abundance trends over survey period, 2007.



In 2008, there was sampling from March to August. The salmon juveniles were all captured from March to June with none captured in April, July or August. The highest number was Pink Salmon found on the March 30 set (62). The highest Chum count was on June 2 (5). The highest number of Chinook was on June 29 (10). No Coho were captured in 2008.
In 2008 the highest single capture of fish was found at the Dyke in April with a total of 313 individuals captured. This 2008 sample consisted of four species: Threespine Stickleback, Sculpins, Starry Flounder and Arrow Gobies. A complete distribution of fish capture results is in Appendix 1 (2007) and Appendix 2 (2008).

Figure 5.2) Monthly Fish Abundance trends over survey period, 2008.

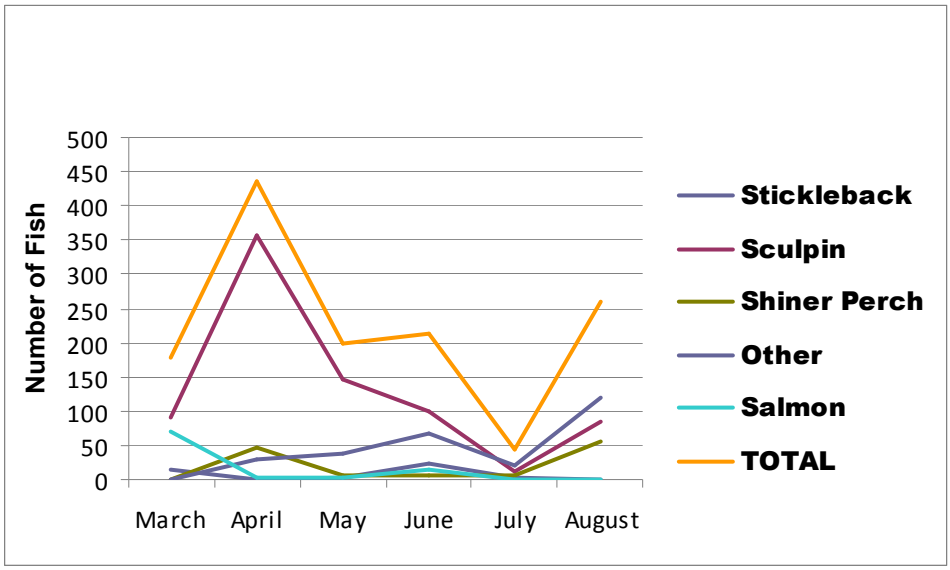


Figure 1.4.0: Salmon Habitat Distribution.

1.6 Water Quality

Water quality was sampled in the field with instruments during our fish captures, from grab samples examined by labs and Environment Canada monitoring in the river.

6.1) Field Water Sampling.

Our field water quality collections sampled each site for: Temperature, Conductivity, Dissolved Oxygen and Salinity in 2008. Only Temperature was sampled in 2007 due to lack of equipment.

The table below identifies the averaged values taken from multiple dates at each site, each sampling period. The results were highly variable and generally based on the tide and time of day. Generally we observed that 2008 was cooler than 2007. The Beach site with direct connectivity to Georgia Strait was coolest with highest salinity. The Dyke site had the lowest salinity as it was the highest site up the River and most influenced by fresh water. The Lagoon always had the highest Temperature and lowest Oxygen levels, again expected given that it was located in a semi–isolated area (behind the dyke).

No location had lethal water quality. The range of temperature varied from 7C to 23.5C with the seasons and tides. Oxygen, taken just below the surface, ranged from 7.1 to 11.6 ppm. The Salinity depended on tides, we had a high of 25% to a low of 0.5%. Conductivity generally followed Salinity levels except in the Lagoon, where Conductivity measures remained above 200*uS* when Salinity was 5%. This may be the result of retention of conductive elements (dissolved ions, particulates) behind the Dyke or influence from the two Storm Water discharge sources from city streets found above this location.

Table 6.1) Field Water Quality Measurements 2007 & 2008

	Temperature (C)		Oxygen (ppm)	Conductivity (*u*S)	Salinity (%)
Year	**2007**	**2008**	**2008**	**2008**	**2008**
Beach	15.60	14.14	9.50	212.5	17.31
Dyke	17.96	14.16	NA	74.5	9.0
River	18.10	16.17	9.70	222.0	18.4
Lagoon	20.50	16.92	8.90	241.0	16.3

6.2) Laboratory Analysis of Water Samples

In 2008, bottles of water from storm outfalls that enter the Lagoon area and the River were sent to laboratories for analysis. The complete data set is in the Appendix 3. The September 25 samples were an attempt to collect “First Flush” samples that would have the accumulations of the summer period rinsing into the watershed. The extensive water parameters are summarized in the Table 6.2 below for Nutrients, Coliform, Metals and PAH’s. The table shows which general parameters were below or above B.C. Standards for water quality for fish or drinking water.

Table 6.2) Summary of Storm Water Quality per B.C. Standards.

Site	Nutrients	Coliform	PAH	Metals
Bagshaw	Pass	Fail	Fail	Fail
Turner	Pass	Fail	N/a	Fail
Mills	Pass	Fail	Fail	Fail
Martindale	Pass	Fail	N/a	N/a

The Nutrients in the water quality results show no concerns for lack of or over-loading. The pH, Nitrate and Nitrite were measured. Additional readings of Ammonia, Nitrogen, Ortho-phosphate and Phosphorous could determine limitations or excesses in productivity.
The Coliform samples were very high in all sites. The sources can only be speculated on as sampling to determine the source was not done. The high inputs at the street drainages at Bagshaw, Turner and Mills are likely from urban garden runoff of manure or cross connections of sewage lines. The Martindale site receives Shelly Creek runoff from an agricultural area where unfenced cattle may be a source. Addressing the Coliform inputs could attenuate nutrient overloading and its attendant problems of anoxia in shallow, low flush areas.

The Poly Aromatic Hydrocarbons (PAH) are a concern from oils and industrial sources; Pyrene was the biggest concern exceeding the standards with Benzo-Pyrene and Benzo-anthracene at detectible levels. PAH were only measured at Bagshaw and Mills culverts, which drain urban streets in Parksville.

There were many Metals over the limit in all four sites. Aluminum, Cadmium, Copper, Iron, and Zinc were the biggest concern. Sources of Metals from the City Streets were not known. This would involve tracing upstream to source the elements if possible.

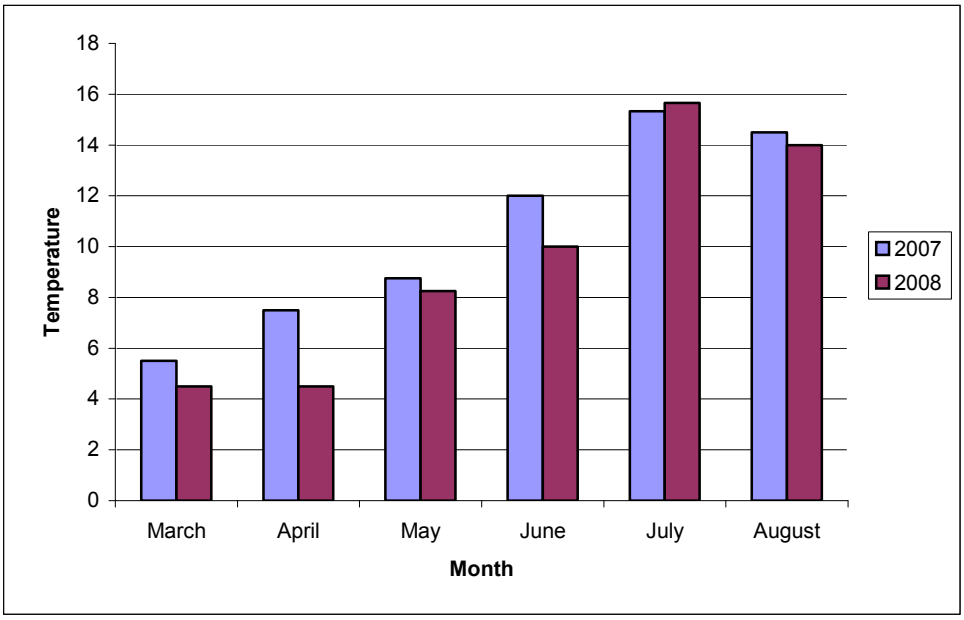
6.3) River Water Temperature

This data was taken from Water Survey Canada web site for the Englishman River at the old highway bridge. We found that during our March to August sampling period, the river was warmer in 2007 than 2008 (Table 6.3.). The 2008 year was noticeably cooler, something that was felt by the volunteers as well. The warmer temperatures result in faster growth and earlier departure of salmon smolts from the estuary.

Table 6.3) Average River Water Temperature , 2007 & 2008.

Year	2007	2008
Average Temperature	**10.6**	**9.5**

Figure 6.3) Average Monthly River Water Temperature, 2007 & 2008



The MVIHES has also taken water quality samples over many years at storm water outlets that lead into the Lagoon as well as samples at the River (Appendix).

1.7 Volunteers

The volunteers ranged in age from pre-school to retirees. Most were from the surrounding area. There were some with science background but for most this was a first time experience with the project.

Table 7.1) Volunteer Effort 2007 & 2008 Fish Sampling.

Month/Year	Number Of Volunteers	Volunteer Effort (hours)
June 2007	16	64
July 2007	13	96
March 2008	4	32
April 2008	32	128
May 2008	16	108
June 2008	17	104
July 2008	9	52
August 2008	11	64
Total	**118**	**648**

The Volunteers contributed 118 person days and 648 hours to the project. This is an invaluable contribution by the citizens of the area. Large scale sampling programs could be prohibitively

expensive if not for the community donating their personal time to environmental stewardship.

The Volunteers learned scientific collection protocols of;

- Fish Identification through hands on learning, fish guidebooks and keys
- Fish Capture skills through proper net setting, fish handling, storage and measuring
- Water Quality Sampling was trained using field instruments in Oxygen, Conductivity, Salinity, Temperature.

Many of the participants had previous training with a certificate from Pacific Streamkeepers Federation. Many had experience with sampling, restoration or education programs undertaken by area Societies in past projects.

1.4 Discussion

Comparisons with 1993 Study

The intent of this study was to compare our fish sampling results with the 1993 survey. The Pacific Estuary Conservation Program (P.E.C.P.) sponsored the report: The Englishman River Estuary by C. Annand, A. Hillaby and J. Naylor, published in September 1993. The survey covered Fish, Benthos, Epibenthos, Water Chemistry, Vegetation and Birds. They were assisted by a team of field of study experts from various agencies on Vancouver Island[8]. We have attempted to imitate the same methods where possible within the resources available, to compare ecological values of then and now. This report looks only at the Fish Populations and Water Chemistry conducted in 2007 and 2008. Further areas of studies are being undertaken by other authors on behalf of the MVIHES; Estuary Vegetation characteristics by Ron Beuchert, Eel Grass, Shoreline mapping and Pelagic Fish by Michele Deakin.

Sampling Methods

The 2007 and 2008 Fish surveys are compared to the earlier estuary study. There were some differences. In 1993, only May and June were sampled. They primarily used a boat-towed seine net and surveyed in most of the same areas of our study. In 1993, the survey was conducted for only May and June but 97 samples were taken covering an area of over 18,300m^2. The 2007 – 2008 study was during an eight month period, with 72 seines conducted and less sample area 4030m^2 with the smaller nets. Thus in 1993, with only two months they covered over four times as much area as the later samples.

Although the 1993 study was conducted for a shorter period, the result of more fish captured was due to a larger area being seined, with more seines set. Each seining period used two different nets. In 1993, a large beach seine (area of 232m^2) and a stick seine (area of 84m^2) were used. In the latter survey, two beach seines were used (areas of 98m^2 and 37m^2).

The later samples with smaller nets are easier for volunteers to sample with. They can be belayed by 4 people (two in a pinch) and require no boat. We found we could carry the 11.1m wide net to the site with two people and deploy the equipment in less than 30 minutes at any site. Pop up nets were considered for the estuary studies. They would have a better element of surprise for more wary fish species. These nets were considered too technical to assemble and operate for the project.

The 11.1m net appeared to work well as a collection device; fishing all the habitat types and depths and catching more fish species than the 1993 study. We feel this size net is well suited to the activity objectives of sampling and community involvement.
The two studies did not seine at the same sites, resulting in the presence and absence of some species. The 1993 survey exhibited higher weighted densities in sites that were not utilized by the 2007-2008 survey and vice versa.

Fish Population Changes

There were 5,256 fish captured in 1993 with 326 (Table 1.1) and 1329 fish (Table 1.2) in 2007 and 2008 respectively. Fewer fish are the result of less sampling rather than less fish as described below.

[8] Bruce Hillaby -DFO, Neil Dawe- CWS, Bill Austin- Koyhotan Labs, Bev Bravender -DFO, Bruce Bennett CWS, Judy Hillaby, RPBio, Rusty Joerin -Nature Trust, Dave Carriage -field studies, Ken Ryan -historian, Margaret Wright –DFO.

The variety of species increased from 15 in the 1993 study, to 20 in the 2007-2008 study (Table 2.1). The 2007-2008 study had a longer survey period. This longer period allowed the opportunity to capture fish that make use of the estuary at different times of year. The latter study caught the migration of Pink Salmon smolts through the estuary in the months of March and April that the 1993 study missed.
The 2007-2008 project surveyed slightly different areas than the 1993 study which may also explain the different species. A Plainfin Midshipman, Kelp Greenlings and Rockweed Gunnels were captured only at the Beach site in the 2007-2008 study. None of these fish were captured in the 1993 study which surveyed on the north side of the river only. The Beach site is unique with its long flat tidal area that has a sandy substrate for most of its area. Having the same sampling locations and consistent methods between the two studies would have allowed for better comparisons of results. Other species of fish we did not capture known to migrate through the area are Searun Cutthroat and Steelhead. These fish enter the estuary as large smolts and likely are too few and fast to capture easily with this method.

Total Fish Densities:

The fish densities were generally higher in 2007/2008 than in the 1993 study. We compared the five groups of fish used in the 1993 study with the later study (Sculpins, Stickleback, Shiner Perch, "Other fish species" and Salmon).

Table 8.1: Fish capture results 1993, 2007 & 2008.

Year	Total Fish (N)	Survey Area (m^2)	Density Fish/m^2
1993	5256	18364	0.286
2007	326	1042	0.313
2008	1329	3046	0.436

It is hopeful that the estuary fish population is increasing as the sample results indicate. This result is a gross average of all species of fish. We may have skewed the numbers with a lucky capture of a large school of Stickleback, Sculpin or Goby. There is not enough data to determine any trends in the gross data yet. More sampling is required.
Further understanding of individual fish life history patterns with respect to the Englishman Estuary is required to determine population trends. There is a lack of knowledge on their time of emergence as foraging fish and their habitat preferences throughout their life history. Species-specific studies with sampling at different life stages are required. Knowing we have 20 fish using the estuary is the tip of the iceberg with respect to knowledge. We now need to break out the individual habitat requirements through their life history to determine population trends.

Individual Species Densities
The highest weighted densities were spread evenly throughout the study years. No specific study year tended to exceed the others. For instance, the 1993 study had the highest fish densities for Chinook (0.008 f/m^2), Chum (0.021 f/m^2) and Stickleback (0.130 f/m^2). The year 2007 had the highest densities of Coho (0.0010f/m^2) and "other fish species" (0.092f/m^2). In 2008 were the highest densities of Pink (0.23 f/m^2), Sculpins (0.260 f/m^2) and Perch (0.040 f/m^2). These results show the spread of sampling results over all years indicating presence and a variety of abundances that are not understood.

Salmonid Species Distribution
We suspect the 1993 and 2007 studies captured no Pink Salmon as they started too late (May and June respectively). The Pink Salmon may have left the estuary before net sampling in 1993 and 2007, as we captured them all in March and May during 2008. The Pink Salmon numbers are also

be tied to the timing and number of hatchery releases that have been done every year since 1992. The emergence of Pink Salmon at the hatchery is tied to water temperature and egg take dates. Given they are emerging at similar dates as native stocks the timing appears normal.
Chum usually emerge and enter the estuary after Pink. They were captured only in the months of May and June at the estuary.
Coho are next to migrate; usually leaving the river from April to June with peak migration in mid May. These fish were found in the estuary from May to July.
Chinook are last to leave the river, they migrate in May and June. They were captured in the estuary in May, June and July. Again hatchery releases have occurred since 1992 where pre-smolts are fed in rearing channels as they grow and acclimatize from Big Qualicum to Englishman. The release timing is similar to the native pattern targeted to leave as smolts generally between May 25-June15.
Less is known about the life history of other species of fish in the estuary. It was obvious during the six month long 2008 study that the common fish such as Stickleback, Perch and Sculpins, were growing in size and weight. With the equipment and resources, a length and weight study is recommended in any future studies of all fish. This extra handling aspect was deemed too lengthy for the volunteer based program we had at the time. There was also much scrutiny over our methods during the permit applications from at least three agencies concerned about sampling disturbance or mortality. With all of the volunteers now skilled in fish capture and handling (and the agency confidence in volunteers hopefully improved) it could be used in the near future using these experienced people.
While more research is required, it is important to note that the residency period in the Englishman Estuary by juvenile salmonids is at least from March to July. We surveyed on two dates in three locations in August 2008 and captured no salmonids. It appears the majority of juveniles have left the area by then. There are other life stages of Salmonids[9] that remain in the estuary or arrive through the early summer. Sea-run cutthroat are year round estuary residents. Steelhead adults leave the river after post-spawn feeding as late as June. Pink Salmon adults arrive in July. Coho adults arrive in August and Chinook are at the beach in September. Historically, there may have been more overlap of species age classes of salmonids with abundance and diversity.
The Lagoon, Dyke and Beach had the majority of fish populations including salmon. The Dyke had the lowest fish densities. The gravel fill is rapidly eroding along the Dyke and the opening to the Lagoon could easily be doubled at any flood event. This will cause additional flushing to the Lagoon area, which will change the dynamics considerably. Fish will likely benefit as this was the historic condition of the estuary before a farm and park were attempted over the last 40 years. The vegetation, insect community, water quality will likely change as more fresh water enters at low tide and more salt water enters at high tide.

Water Quality Comparisons

Field sampling was done in 1993 and in 2007 and 2008 (Table 6.1).The Temperature, Salinity, Conductivity and Oxygen were taken. No significant concern was observed in these results. All were found to represent best the daily cycle of tide movement and almost always in the range tolerable for Salmonids and other estuarine fish species. No grab samples of storm water culverts were done in 1993.
The 2008 results (Table 6.2) indicate toxic water is entering the estuary. It is likely a direct result of growing urbanization of the watershed contributing unacceptable levels of Coliform, PAH and Metal. It is important to continue the monitoring of water quality in future years in order to protect the estuary from one of the most direct ways to kill off all aquatic life. This sampling information is invaluable in determining the sources of pollutants and developing a point source reduction plan. Our field sampling did not routinely include the storm water culverts. These sites should be surveyed with field equipment regularly as it is a fast and cheap indicator of water quality issues. Grab samples sent to laboratories for full spectrum analysis are still important to verify any field

[9] Unpublished & published swim surveys and assessments, D.R. Clough 1981-1998

sampling concerns. We recommend grab samples continue be done at first flush every fall at the storm drain sites. Further sampling through other seasons and a control site in the river above the storm pipes is also recommended if funding permits. Continued pressure on water protection agencies is needed to get their expertise and budgets involved. Both the Ministry of Environment and Fisheries and Oceans have assisted or done their own studies in the past. It is important to coordinate this activity. It may be in the best interest of the City of Parksville as their water intake is located just above the estuary in the river. Urban run off impacts at Shelly Creek will influence the City drinking water. The knowledge of this concern may encourage the City planning and engineering staff to promote greener roads and subdivisions using grass swales and rain gardens for biofiltration. Remediation at the existing outfalls could also be done; engineered filters are available that can remove metals and PAH's.

The Water Survey Canada site had no temperature records for 1993 to compare with the later dates. The WSC site did have discharge data that could be compared with the later study years. The data shows that 2007 had the highest discharges and 1993 the lowest for the survey period.

Table 8.3) Mean Discharge 1993 compared to 2007 & 2008

Month/Year	1993	2007	2008
March	21.80	29.90	11.30
April	14.20	11.90	7.20
May	11.10	10.30	14.70
June	6.17	6.65	7.90
July	1.34	3.63	2.80
August	0.95	1.74	1.80
Total	**55.56**	**64.12**	**45.70**

1.5 Conclusions

Goals and Objectives Achievements

The Fisheries Objectives of this study were:
1.) Conduct a fisheries inventory of the estuary over the 2007 and 2008 period.
2.) Incorporate public participation, education and awareness of the estuary fisheries resource.

The fisheries survey and public participation were incorporated in a two-year study. The survey results offer a baseline for understanding the fish species dynamics in the estuary. Over 650 hours of public participation was involved in addition to possibly equal time by society members and staff involved in the project. It was not a small task to complete; thanks goes to the MVIHES members, volunteers, staff and agency people whom assisted. The success will be measured in the usefulness of this effort in continued protection of the estuary.

Summary Conclusions

- There were 20 species of fish found in the Englishman Estuary during the sample period.
- Three Spine Stickleback, Staghorn Sculpin and Shiner Perch were the most common fish.
- Pink were the most common salmon. Chinook, Coho and Chum were also captured.
- All fish were evenly distributed through the Beach, Lagoon and Dyke with fewest along the River.
- Salmon juveniles were captured in the estuary from March to July but not in August.
- There appeared to be no changes in fish population abundance since the 1993 study although methods for sampling were different.
- Water quality from the City storm drains that enter the estuary is poor in terms of Coliform, Metals and PAH.
- Volunteers contributed approximately 650 hours towards the fish surveys. These surveys could not have been done without their help.

1.6 Fisheries Recommendations

1. More sampling of the estuary fish populations is needed. Fish samples should continue with a more directed intensity to distribution, residence period and growth. Directed species specific studies should be encourages for key abundance species such as Stickleback, Sculpins and Salmon.

2. Water Quality sampling should continue at the storm drain outfalls to monitor the toxins entering the estuary.

3. Water quality management needs to be done to address the current level of pollution entering the estuary.

4. Encourage continued volunteers and stewardship with the project. Establish training courses on estuarine surveys for the volunteers.

5. Involve other agencies in the surveys, analysis and plans.

6. Establish a management plan for the estuary to ensure its integrity.

1.7 References

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Appendix 1.1 2007 Fish Species Summary, Englishman Estuary Seine Net Results.

Site	DATE:	Stickleback	Sculpin	Shiner Perch	Starry Flounder	Sole	Midship men	Pink	Chum	Coho	Chinook	Arrow Goby	Greenling	Pipe fish	Gunnel	Tubesnout	Clingfish	Total
Beach	June 28/07	15	23	16	2					1	1							58
Beach	July 22/07		1		6							1						8
Beach	July 29/07	1	5	2										1	1			10
Total:		**16**	**29**	**18**	**8**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**76**
Dyke	June 28/07	3	3															6
Dyke	July 8/07		1		2													3
Dyke	July 15/07				2													2
Dyke	July 15/07	74	2		14													90
Dyke	July 22/07	1									1							2
Total:		**78**	**6**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**103**
River	June 28/07	0	29		2							11						42
River	July 8/07	17	5															22
River	July 22/07	4	9		2							2						17
Total:		**21**	**43**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**13**	**0**	**0**	**0**	**0**	**0**	**81**
Lagoon	July 8/07		5		12							13						30
Lagoon	July 15/07	8	3		21							4						36
Total:		**8**	**8**	**0**	**33**	**0**	**0**	**0**	**0**	**0**	**0**	**17**	**0**	**0**	**0**	**0**	**0**	**66**

Appendix 1.2 2008 Fish Species Summary, Englishman Estuary Seine Net Results.

Site	DATE:	Stickleback	Sculpin	Shiner Perch	Starry Flounder	Sole	Midshipmen	Pink	Chum	Coho	Chinook	Arrow Goby	Greenling	Pipe fish	Gunnel	Tubesnout	Clingfish	Total
Beach	April 20		20															**20**
Beach	May 5		14	47	1	6		1	1					2	11			**83**
Beach	May 25	1	14	7	3				2					1				**28**
Beach	June 2		11			3			5				7		13			**39**
Beach	June 8		48			1							2		1			**52**
Beach	June 16		13	6									10		1	3		**33**
Beach	July 14		4	4			1						3	3				**15**
Beach	August 18		13	1									1				1	**16**
Total:		**1**	**137**	**65**	**4**	**10**	**1**	**1**	**8**	**0**	**0**	**0**	**23**	**6**	**26**	**3**	**1**	**286**
Dyke	March 30		14															**14**
Dyke	March 31	14	3					3										**20**
Dyke	April 21	1	304		2							6						**313**
Dyke	May 12		63		10						2	15						**90**
Dyke	May 26	3	33															**36**
Dyke	June 29	24	18		1						10							**53**
Dyke	July 27	2	5											2				**9**
Dyke	August 10		57	54														**111**
Total:		**44**	**497**	**54**	**13**	**0**	**0**	**3**	**0**	**0**	**12**	**21**	**0**	**2**	**0**	**0**	**0**	**646**
River	March 30	1	74					5				1						**81**
River	April 20		18		1													**19**
Total:																		
Lagoon	March 30							62										**62**
Lagoon	May 26		37		6							3						**46**
Lagoon	June 29		10		20	6												**36**
Lagoon	July 27	2	3	2	2							10						**19**
Lagoon	August 10		16		3							115						**134**
Total:		**2**	**66**	**2**	**31**	**6**	**0**	**62**	**0**	**0**	**0**	**128**	**0**	**0**	**0**	**0**	**0**	**297**

Appendix 1.3 Englishman River Storm Water Quality Samples 2008

	Parameters																	
	Site	**BC Water-Drinking (1)**	**BC Water Aq. Life**	**Bagshaw**		**Bagshaw**		**Bagshaw**		**Turner**		**Mills**		**Mills**		**Mills**		**Martindale**	
	Date			25-Sep-08	P/F	06-Nov-08	P/F	12-Dec-08	P/F	25-Sep-08	P/F	25-Sep-08	P/F	06-Nov-08	P/F	12-Dec-08	P/F	06-Nov-08	P/F
	Temperature																		
	Salinity																		
Turbidity	TDS -FR	500	1000	94	P			122	P	70	P	42	P			15	P		
	Non FR	10% incr	10% incr																
	Turbidity	5-10%incr	5-10%incr							4.5	P	18	P						
	Colour	15 Pt-Co	0-300																
Oxygen	Oxygen																		
	BOD			<5.0	P					<5.0	P	<5.0	P						
Nitrogen	Total Ammonia (NH3+NH4)		0.10																
	Nitrate (NO3-)	10	200	0.2	P					<0.1	P	0.1	P						
	Nitrite (NO2-)	1	0.06	<0.1	P					<0.1	P	<0.1	P						
	Organic Nitrogen																		
	Kjeldahl Nitrogen																		
	Total Nitrogen																		
	Ortho-phosphate (PO4-3)																		
	Phosphorus (P)	0.10	.05-0.15																
pH	pH	6.5-8.5	6.5-9	7.5	P					7.5	P	7.5	P						
Carbon	Carbon, Organic TOC																		
	Carbon, Inorganic																		
Hardness	Ca Mg							46.9	P							74	P		
	CaCo3	200	500					47.6	P	30	P	15	P			75.2	P		
	Alkalinity		<20																
Coliform	Total Coliform			>20000	F					>20000	F	>200000	F						
	Fecal Coliform			>2000	F	2200	F			>200	F	>2000	F	1700	F			2500	F

PAH	Acenaphthene	0.01ug	0.1ug	<0.1	P							<0.1	P						
2-7 rings	Acenaphthylene			<0.1	P							<0.1	P						
	Acridine		.05ug	<0.05	P							<0.05	P						
	Anthracene			<0.1	P							<0.1	P						
	Benzo(a)anthracene		.1ug	0.01	P							<0.01	P						
	Benzo(a) pyrene	.01ug		0.02	C							0.01	C						
	Benzo(b)Flouranthene			0.02	C							0.02	C						
	Benzo(g,h,I) perylene			<0.1	P							<0.1	P						
	Benzo(k)flouranthene			<0.02	P							<0.02	P						
	Chysene			<0.1	P							<0.1	P						
	Dibenzo(a,h)anthracene			<0.01	P							<0.01	P						
	Flouranthene		.2ug	<0.1	P							<0.1	P						
	Flourene			<0.1	P							<0.1	P						
	Ideno(123-c,d,)pyrene			<0.1	P							<0.1	P						
	Naphthalene			<0.1	P							<0.1	P						
	Phenanthrene			<0.1	P							<0.1	P						
	Pyrene		.02ug	0.08	F						n/a	0.04	F						
	Quinoline			<3.4								<3.4							
Organics	Chlorophenyls/Dioxins	.06pg/l																	
PCB's	Polychlorinated biphenyls		.0001ug																
Halides	Chloride																		
	Flouride	1-1.5	0.2-0.3																
Metals	Aluminum	0.20	0.1	2.12	F			0.08	C	0.169	F	1.07	F			0.15	C		
	Antimony			0.0013	P			<0.05	P	<0.0002	P	0.0007	P			<0.05	P		
	Arsenic			0.0012	P			<0.05	P	<0.0002	P	0.0004	P			<0.05	P		
	Barium			0.018	P			0.009	P	0.007	P	0.01	P			0.006	P		
	Berylium			<0.0001	P			<0.001	P	<0.0001	P	<0.0001	P			<0.001	P		
	Bismuth																		
	Boron			0.22	C			0.02	P	0.016	P	0.014	P			0.02	P		
	Cadmium	5.00	.017ug	0.00009	C			<0.005	F	<0.00001	P	0.00002	F			<0.005	F		
	Calcium			8.5	P			13	P	9.8	P	4.3	P			18.9	P		
	Chromium		0.0089	0.0133	F			0.009	F	0.0013	F	0.004	C			<0.005	P		
	Cobalt			0.0012	P			<0.005	P	<0.0001	P	0.0006	P			<0.005	P		

Copper	500ug	2 ug @ 50mg	0.029	F			<0.005	C	0.002	C	0.012	F			<0.005	C		
Iron		0.3	2.52	F			0.105	C	0.2	C	1.21	F			0.243	C		
Lead	10ug	3ug @ 8mg	0.0076	P			<0.05	P	0.0003	P	0.0033	P			<0.05	P		
Lithium			0.002	P					0.003	P	<0.001	P						
Magnesium			2.6	F			3.5	F	1.3	F	1	F			6.5	F		
Manganese			0.84	F			0.033	C	0.012	P	0.042	P			0.052	P		
Mercury	1ug	.02ug																
Molybdenum	0.25	1.0	0.001	P			<0.01	P	<0.001	P	<0.001	P			<0.01	P		
Nickle			0.0034	P			<0.02	P	<0.0005	P	0.0017	P			<0.02	P		
Phosphorus		0.01mg/l	0.12	C			<0.1	P	<0.05	P	0.09	C			<0.1	P		
Potassium			1.1	P			1	P	<0.4	P	0.6	P			1	P		
Selenium			<0.0002	P			<0.05	P	<0.0002	P	<0.0002	P			<0.05	P		
Silicon			4.76				2.28		2.25		2.34				4.74			
Silver	.05ug	0.1ug @100mg	0.00005	P			<0.01	P	<0.00001	P	0.00002	P			<0.01	P		
Sodium			5.6	P			61.6	C	5.5	P	3.2	P			13.6	P		
Strontium			0.034	C			0.041	P	0.046	C	0.02	C			0.064	C		
Sulphur							1.62								1.85			
Thallium			<0.00005	P					<0.00005	P	<0.00005	P						
Tin			0.001	P			<0.05	P	<0.001	P	0.001	P			<0.05	P		
Titanium			0.159				0.004		0.0089		0.0736				0.008			
Vanadium			0.0086	P			<0.01	P	0.0009	P	0.0051	P			<0.01	P		
Zinc	5.00	7ug@90mg	0.085	F			<0.05	C	0.004	C	0.043	F			<0.05	P		

Fish Photo Plate 1 – Volunteer Effort

Fish Photo Plate 2 – Volunteer Sampling