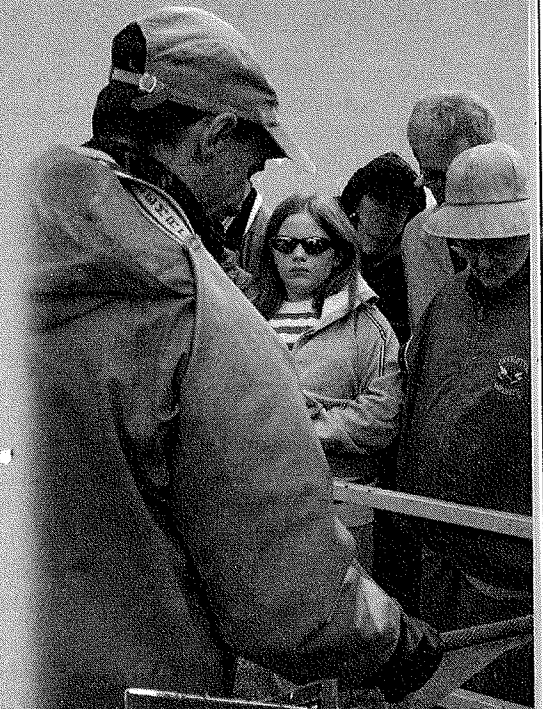



# Cootes Paradise Fishway

**T**he Cootes Paradise Fishway is strategically located in the connecting channel between Cootes Paradise marsh and Hamilton Harbour. The Fishway consists of two parts, a barrier and a fishway. The barrier section addresses one of the major factors contributing to the degradation of the Royal Botanical Gardens marshlands, the Asian carp. The fishway portion maintains movement of native fish species between the harbour and marsh. Since operation began in 1997, there have been substantial improvements in all aspects of the marsh ecosystem, including water quality, aquatic plant densities, and fish and wildlife communities. The Fishway also provides an excellent interpretive point for visitors to learn about the marsh restoration, observe many of Canada's native fish, or just enjoy a view of the marsh and surrounding natural lands.

## Carp

Since the 1930's, 50 years after their first introduction to North America, the removal of carp was deemed as a necessary step for restoration of the RBG marshlands. Accordingly various attempts have been made to address this, from commercial carp fishing and net barriers in the early 1950's, to the current Fishway. What is it about carp that makes them such a problem for marshes, and what was the idea behind its construction of this structure that has finally defeated them?

Carp have evolved to exploit a river-mouth environment. Rivers provides a constant supply of fine sediment and nutrients to the river-mouth, generating a shallow, warm, well-fertilized environment, otherwise known as a marsh or estuary. These conditions generate an incredibly rich and diverse ecological habitat, second in productive capacity only to the tropical rainforests. Carp forage in the most productive portion of this environment, the bottom, and have evolved a long protrusible mouth for sucking up portions of the bottom. From these bottom sediments they sort out their food, the clams, snails, and worms. As a result of the rich food supply, carp grow very fast, up to 1 kg/year, and reach very large sizes, up to 28 kg (60 lbs), and 120 cm (4 ft.). The combination of their large size and foraging behaviour result in an ability to turn up substantial portions of the bottom. Larger individuals are literally able to suck up the equivalent of a cup full of bottom sediments at a time. This causes uprooting of aquatic plants and muddying of the water, and when the carp occur in large numbers, results in substantial loss, and even elimination of aquatic vegetation. Since all of our native species have evolved around the presence of aquatic vegetation, the loss of it results in the collapse of the marsh ecosystem. At the same time, since carp are specifically adapted to foraging in the soft rich bottoms found in river-mouth marshes, other aquatic habitats are essentially free of the impacts of carp.

Prior to the implementation of the Fishway, Cootes Paradise had an estimated carp population of between 50,000 and 80,000 adults, translating into a density of approximately 800 kg/ha. These carp concentrated in the flooded vegetation to spawn, and with the small amount of vegetation remaining in the marsh, incredible carp densities of 5,000 fish/ha or 10,000 kg/ha occurred. The goal of the Fishway is to reduce the density of carp to less than 50kg/ha, equivalent to less than 6000 individuals. At this density the rate of aquatic plant growth exceeds the rate of carp uprooting. During the first year of Fishway operation, 1997, the number of carp was reduced to 4,000-5,000 adults, a reduction of about 95%. This number has continued to drop, with monitoring in 1999 indicating a total of about 400 large adults remaining in the marsh.

## How does the Fishway work to exclude carp?

The exclusion of carp from Cootes Paradise involves a number of important principles, and some geographical luck. The most important principle originates in the carp's annual life cycle which can be summarized as follows:

Spring: migrate upriver to floodplain areas to spawn in flooded vegetation,

Summer: return to river-mouth to forage and grow

Fall: leave river-mouth shallows for winter

Winter: remain dormant and inactive in deeper water until spring

As a result of instinctive behaviour, every fall the marsh is emptied of carp, and starts a new cycle every spring. The fact that the carp leave the marsh for the winter is what made the project possible. They leave the marsh for the winter to avoid the

inhospitable winter conditions. During the winter there is very little habitable water in the marsh. This is brought about by the declining fall water levels in Lake Ontario, and winter ice, which drive the fish from the marsh into the harbour. The avoidance of harsh winter marsh conditions has been happening for as long as winter has, and as a result most fish are instinctively triggered to leave the marsh when the cool fall weather arrives. To prevent the carp from re-entering the marsh, a practical method to block the entrance during the winter needed to be devised, a seemingly simple idea in theory, and one that was first recognized in the 1950s.

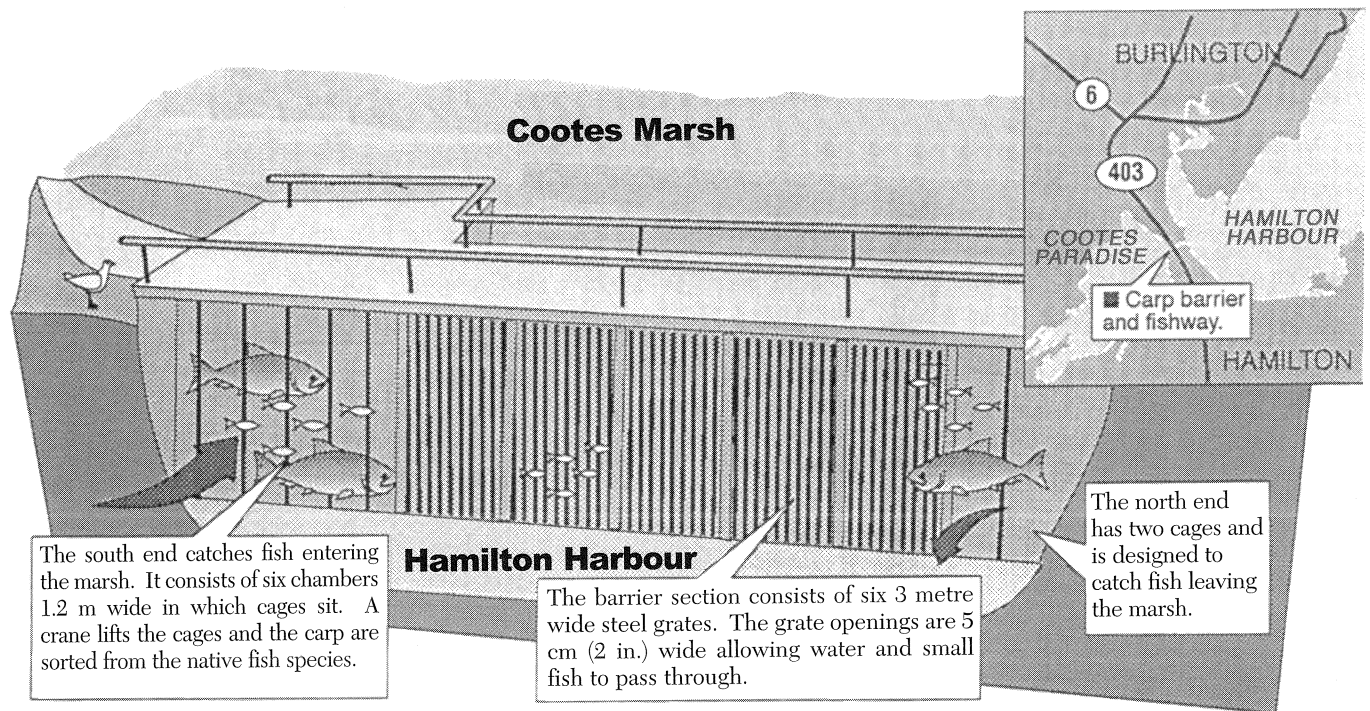
The actual physical geography of the area was a second important element making the exclusion of carp possible. The harbour and the marsh are isolated from each other by Burlington Heights, with the remnants of the Desjardin Canal the only connection. This manageable location positioned between the marsh and harbour, i.e. the summer and winter habitat of the carp, was the perfect situation for the project. This fortunate situation is not the case in many marshes, including the adjacent Grindstone Creek marsh. However, if the original connecting channel between Cootes Paradise still existed (Long Pond), then the Fishway could have been located at the Bailey bridge. This would have captured both Grindstone Creek marsh and Cootes Paradise behind a single barrier.

The final important element relates to the biology of carp. Carp migrate into the upper ends of marshes to reproduce. By excluding carp from Cootes Paradise, they are prevented from accessing their main spawning area, and although the excluded carp may spawn in other locations, the appropriate nursery conditions exist only inside the marsh environment, and so the young do not survive. This then means that the barrier only has to exclude mature carp. As carp grow very fast, and don't mature until they are 3 or 4 years old (35 to 45 cm long), the barrier needs to exclude large fish only.

The actual structure finally placed in the canal is essentially a large fish strainer. The barrier consists of a series of six large grates, 2.4m (8 ft) wide and 3m (10 ft) tall. The spaces between the grate bars are 5cm (2 in). This space was determined to be the largest space possible through which no mature carp could fit. This space is important to allow for water exchange between the marsh and harbour, an important factor in maintaining good water quality in the marsh, preventing flooding in low lying areas such as Dundas, and in allowing the free passage of smaller fish and wildlife.

## Why is the Fishway equipped with a fishway?

The Fishway grates not only strain out carp trying to enter the marsh, but other large fish species. To accommodate other fish species, the barrier is equipped with a Fishway. The Fishway employs 6 large cages (5 ft x 3 ft x 8 ft.) to catch and move fish both in and out of the marsh. To maximize the effectiveness of the Fishway, the entire structure sits diagonally in the canal. This directs migrating fish to the most upstream or downstream section, depending on their direction of movement. The baskets are strategically located at either end of the diagonal. Four baskets located at the upstream end are dedicated to passing fish into the marsh, while the remaining two are at the



downstream end, and pass fish out of the marsh.

In Lake Ontario there are potentially 46 species of fish that grow too large to pass through the barrier, and must use the Fishway to access the marsh and its tributary creeks. There are an additional 80 species which remain small enough to pass through the barrier's 5 cm grating system. Currently, we have 25 of the 46 species passing in and out of the marsh by way of the Fishway. Most are currently in very low numbers. Although the smaller species can actively pass through the barrier, many are caught incidentally in the baskets. To date 42 of these species have been captured in the Fishway baskets.

## What is the significance of moving fish in and out of the marsh?

From an ecological perspective, Cootes Paradise represents the largest river-marsh complex in western Lake Ontario, and is therefore the primary spawning and nursery area for the fish community of both Hamilton Harbour and western Lake Ontario. It is the shallow, warm, productive characteristics of the marsh that give it this status. As a result, massive migrations of spawning fish occur in and out of the marsh. If access to the marsh were denied, most species of fish would disappear, following in the footsteps of those which have already succumbed to the badly degraded habitat. This includes species such as muskellunge, whitefish, walleye, and sturgeon.

A simple scenario using one of our many fish species can help provide an understanding of the significance of the area, and why the migrations occur. If you consider a situation with two sets of spawning largemouth bass, one set in the marsh and one in the harbour, this is what we see. The baby bass spawned in the marsh exist in an environment with substantially more food, and much better shelter from predators. These differ-

ences are generated by the supply of nutrients from the river system, into a shallow relatively warm environment, and the accompanying dense growth of aquatic plants. The result is the baby bass of the marsh have a much higher rate of survival since they grow much larger, and are subject to much less predation. They become the bass that propagate future generations. It is hypothesized this is the main driving force behind imprinting, and the mass seasonal migrations between spawning grounds and summer and winter habitats. This principle of freshwater fisheries was only first illuminated during research done in support of the Hamilton Harbour Fish and Wildlife Restoration Project, and involved the Fishway.

Imprinting by fish on spawning grounds has significant implications for the restoration of our fish community. It means fish rarely change from established spawning areas, to explore new habitat like Cootes Paradise. Therefore in order to rebuild our fish community, we will have to do it from existing individuals imprinted on the marsh. It also means that the restoration of extirpated species, such as muskellunge and walleye, will require reintroduction of baby fish, fish of the age at which they will imprint on the marsh. It may also mean that to increase the genetic pool and improve the health of rare species populations such as pike and bowfin, individuals will be needed.

The Fishway represents one of the premier fisheries research tools on the Great Lakes, because of its strategic location between spawning and nursery habitat. It is not only used to collect information important to Project Paradise Restoration, but also for scientific publications for an international audience. Extensive data on fish movements, sizes, and associated environmental conditions are all documented. Accordingly in the first 3 years of operation, visitors to the Fishway have ranged from area residents and local school groups, to scientists, from around the world, including the United States, Africa, and Australia.



Tag #	Date	Direction	Length (mm)	Weight (gm)	Sex	Age	History
16021110	21-May-97	Out	675	2100	M	5	Recapture
16021110	26-Mar-98	In	712	3300	M	6	Recapture
16021110	07-May-98	Out	720	2535	M	6	Recapture
16021110	16-Apr-99	In	721	3370	M	7	Recapture

The above chart is an example of information being gathered on a single northern pike. It demonstrates the seasonal migration of this species in and out of the marsh, and its annual return to the marsh at spawning time (April). The chart also indicates the annual rate of growth at different ages, as well as the amount of weight lost during the spawning period in the marsh. When we consider all the tagged pike captured, we can determine survival rates both during the spawning period and from year to year. If we further combine the above information with associated environmental data collected at the Fishway, we can determine important environmental cues that trigger migration. The Fishway is able to capture more detailed population information more effectively than any previous field studies, because of the annual return of the same individual fish to Cootes Paradise

## Visiting the Fishway

Public access is allowed and welcomed on the Fishway when RGB staff members are present. The Fishway has already become a major attraction along the new waterfront trail connecting Harbour Front Park, and Princess Point. The trail opened on July 1, 2000. The Fishway has already become a popular part of the RGB Nature Centre programming, with hundreds of young children getting their first wet fish experience. A number of other attractions can be found at the Fishway. For most people the main attraction will be the viewing of native fish, most of which cannot be seen under any other circumstances. The Fishway is also an excellent vantage point to observe the marsh and some of its other wildlife, or to discuss other aspects of the restoration project with RGB staff. Remember to dress appropriately, as weather conditions at the Fishway are generally much cooler and windier than the surrounding areas.

When visiting the Fishway during operation, you can see for yourself how the Fishway baskets are lifted and emptied, and watch the professional Fishway technicians sort and record the catch. In fact the Cootes Paradise Fishway represents the premier location to see the native fish of Ontario up close. A popular and often wet visitor activity is to observe the carp take the "waterslide" back into Hamilton Harbour, while our native fish slide into the marsh. Annually more than 60 different species of fish are seen, making this location one of the highest diversity spots in North America. An average of 8 to 10 species are caught on any give day, with the mix of species changing with the seasons. This makes a visit to the Fishway always a unique experience. Generally, the spring is the busiest, with upwards of 2,000 fish handled some days, while mid summer is the quietest time, but every lift of a basket brings some fish.

If you're interested in visiting on a busy day, two environmen-

tal conditions, temperature and rain, can make the difference between seeing thousands of fish or just a few. Trends of warming weather increase activity moving into the marsh, while cooling trends

decrease activity of fish moving into the marsh but increase activity moving out of the marsh. Rain events trigger river spawning species to move so, for example, if you're interested in seeing a rainbow trout, visit after a rain in early March or early April. The chart found below can help provide you with a general guide if you're interested in seeing a particular fish species.

The Fishway has a number of interesting features for the visitor. From April to June you can see the featured fish of the day in an 300 litre aquarium. This tank is accompanied with an interpretive sign to provide an array of interesting facts about the featured species. Smaller viewing tanks accompany the RGB technicians providing the visitor with an up close view of all the species that are passing through. Posters with past years' fish catch totals can also be found, this information can also be found within the Science Department section of the RGB web site. When visiting the Fishway, if you're lucky you may also see a turtle. Annually about 30 migrating turtles are caught and released at the Fishway, with most occurring in the months of May and August.

Operation of the Fishway baskets is primarily dictated by the degree of seasonal fish activity, however, consistency of operation is maintained to accommodate public tours. The basic hours of operation during the past three years are as follows:

Nov to Feb: Closed for the winter,

March: Weather dependent 9-10:30 am. Operation is initiated by spring rain events. The baskets are lifted with increasing regularity as the month progresses.

April to June: Staffed Mon. – Fri., 8 am to 4 pm. The 6 baskets are lifted twice daily, 9-10:30 am, and 2:30-4 pm.

July to Aug: Mon., and Wed. 9-10:30 am, Fri. 2:30-4 pm.

Sept and Oct: Weather dependent. The day or two following a rain event. 9-10 am, and 3-4 pm. The fall operation (Sept and Oct.) is directed at fall spawning salmon and trout. These species spawn in Spencer's Creek and only move into the creek during the short period of elevated creek flows that following a rainstorm.

## The Future

The yearly catch totals of the various species have remained relatively constant during the first three years of Fishway operation. However, fish community monitoring in the marsh reveals that since the carp have been excluded, our native fish have been much more successful at reproducing. A hint of these changes was seen at the Fishway in 1999, but as most of these fish were still young and small enough to pass through the Fishway grate system the changes haven't been reflected

in the Fishway catches. In the year 2000 substantial increases in the catch of many species was anticipated, as fish produced in the marsh in 1997 would have both matured, and grown to a large enough size to require passage through the Fishway. This includes species such as northern pike, bowfin, and yellow perch. It is anticipated that catches of these species will at least double. When Fishway operation began in 1997, all three of these species populations were at critically low levels, almost extirpated from the marsh. The northern pike is a typical example of what became of most of our fish species. In the 1950s 20,000 to 30,000 individuals roamed the harbour, with Cootes Paradise as their main spawning area. In 1997 the total number of pike using Cootes Paradise had been reduced to 22 individuals. In the year 2000 this number climbed to 128 individuals, the beginnings of new future for this species.

Many fish species have not been able to persist through the pollution and habitat loss that besieged the area. Lost species such as walleye, muskellunge, and whitefish will in all likelihood have to be re-introduced as habitat restoration reaches acceptable levels. Habitat improvements in the tributary streams, outside the marsh in Hamilton Harbour are just as important. All these habitat improvements are goals of the Hamilton Harbour Remedial Action Plan, marking the beginning of a bright future in returning Cootes Paradise and Hamilton Harbour to one of the finest fisheries in all of Canada.

*Visitors Guide to the large size fish of the Fishway*

Species	Percentage by Month								Annual totals			
	March	April	May	June	July	Aug.	Sept.	Oct.	1997	1998	1999	2000
Bigmouth Buffalo	-	75%	25%	-	-	-	-	-	1	-	2	6
Black Bullhead	-	-	36%	12%	16%	32%	4%	-	1	2	21	67
Black Crappie	10%	53%	12%	6%	3%	9%	-	8%	29	4	10	3
Bowfin	7%	39%	26%	4%	7%	12%	3%	2%	21	21	25	36
Brown Bullhead	10%	19%	20%	27%	18%	4%	1%	1%	5,447	6,039	10,244	16,505
Brown Trout	-	8%	50%	-	-	-	-	42%	8	-	1	-
Channel Catfish	1%	2%	5%	36%	31%	21%	2%	2%	735	634	1,111	2,096
Chinook Salmon	-	-	-	-	-	-	-	100%	25	6	-	-
Freshwater Drum	-	2%	24%	44%	17%	12%	1%	-	1,007	1,503	1,186	1,240
Gizzard Shad	-	10%	12%	46%	27%	-	1%	4%	316	167	340	449
Lake Trout	-	10%	60%	-	-	-	20%	10%	3	2	5	-
Largemouth Bass	-	5%	65%	24%	-	6%	-	-	4	1	8	5
Longnose Gar	-	30%	50%	-	-	-	-	20%	2	-	-	1
Northern Pike	15%	40%	32%	8%	1%	3%	1%	-	39	28	44	175
Rainbow Trout	41%	6%	44%	8%	-	-	-	1%	228	154	46	213
Shorthead Redhorse	-	44%	56%	-	-	-	-	-	1	2	5	-
Silver Redhorse	18%	36%	27%	18%	-	-	-	-	4	-	3	3
Smallmouth Bass	-	5%	40%	13%	12%	30%	-	-	1	-	6	5
Walleye	25%	70%	5%	-	-	-	-	-	-	-	-	7
White Bass	-	13%	53%	27%	7%	-	-	-	5	1	4	3
White Crappie	-	20%	80%	-	-	-	-	-	-	-	1	-
White Perch	1%	38%	38%	18%	2%	2%	1%	-	40	36	79	130
White Sucker	20%	29%	46%	5%	-	-	-	-	2,742	1,595	1,637	4,947
Yellow Perch	5%	85%	10%	-	-	-	-	-	6	3	5	23
<b>Total</b>									<b>10,686</b>	<b>10,207</b>	<b>14,766</b>	<b>25,914</b>
Goldfish	16%	59%	12%	4%	3%	5%	1%	-	22	10	4	143
Carp	1%	10%	39%	41%	7%	1%	1%	0%	14,723	8,703	10,385	26,788
<b>Total Species</b>	<b>13</b>	<b>24</b>	<b>25</b>	<b>17</b>	<b>13</b>	<b>12</b>	<b>10</b>	<b>10</b>	<b>24</b>	<b>19</b>	<b>23</b>	<b>21</b>