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Natural Lands Department

Project Paradise Planning to 2015

RBG contribution to the HHRAP for the restoration of the wetlands

Draft

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Overview

Natural Lands Goal

To manage Royal Botanical Gardens' conservation lands as integrated sanctuaries in the context of their international and local significance, both ecologically and culturally by enhancing, restoring and maintaining habitats and linkages in balance with the public need for spiritual renewal and exploration.

Wetland Goal

Create the underlying conditions for ecosystem recovery while maintaining system connectivity.

Long Term Objectives

- recover inflowing water quality to meet provincial water quality objectives for aquatic life.
- restore natural water cycle patterns.
- remove non-native species dominating the system.

Key Plans

- City of Hamilton Storm water Master plan
- City of Hamilton Wastewater Master plan
- Conservation Authorities watershed plans - various

Further, through ongoing monitoring it has become clear that a significant driver of the carp population success and unbalanced fish populations are related to its ability to survive harbour anoxia, and thus upgrade of the Woodward Ave. Wastewater Treatment Plant, an element of the Wastewater Master plan, is important despite the fact that waters do not flow directly into the wetlands.

Summary

The Royal Botanical Gardens has been providing protection, stewardship and restoration of our wetland holdings since the 1940's. This has included many projects from planting programs to hydraulical manipulations, to carp exclusion to wetland plantings and species reintroduction's. Inflowing water quality has also always been at the forefront, and as an example the local municipalities that discharge wastewater into the properties have always maintained the highest quality effluent standards in the region. Under the current Great Lakes Water Quality Agreement the two remaining wetlands retained within the RBG property holdings gained addition interest with the formation of the HHRAP, with a new initiative - Project Paradise unveiled in 1993. This was structured both to set a restoration course, as well as to generate a fund raising brand.

Project Paradise is a restoration initiative of the Lake Ontario wetland complex's principally protected within the RBG natural sanctuaries as part of the Hamilton Harbour Remedial Action Plan (HHRAP). The HHRAP is the result of the identification of highly degraded Great lakes areas (Area of Concern) by the International Joint Commission (IJC) as part of the Great Lakes Water Quality Agreement. The area covered includes 2 river mouth coastal marsh complexes, the Cootes Paradise and Grindstone Marshes totaling approximately 400 hectares in size, and including over 30km of shoreline, and 25 subwatersheds. Locally these areas represent 99% of the remaining undisturbed harbour area shoreline, and 95% of the remaining wetland habitats. These are also the largest wetlands in the western half of Lake Ontario and the only coastal marsh protected within the Niagara Escarpment World Biosphere Reserve. Dominant watersheds are Spencer Creek (270km²) and Grindstone Creek watershed (89km²), two of the healthiest watersheds remaining on Lake Ontario, with over 95% of the Spencer Creek watershed contained within the provincial Greenbelt. The Lake Ontario water cycle variations can result in all or none of the area flooded, and typically annually cycle across 1/3 of the area.

Primary Problem

Historical loss of the entire wetland plant community in areas flooded for periods longer than 1 month = 250 ha, a result of extremely high Eurasian common carp (*Cyprinus carpio*) densities (800kg/ha) resulting in collapse of broader ecosystem function and extirpation of species. The high density of carp resulted in the loss of the marsh channels allowing contained inflowing contaminants to disperse throughout the marsh, with the carp also being the primary source of suspended sediment and associated phosphorus in the water column. Measurable impacts occur at densities over 20kg/ha. Location connects to international systems through migratory birds and fisheries of Lake Ontario

Secondary Problem

Degraded inflowing and system dominance by various non native species. Inflowing water issues are highlighted by bacteria, phosphorus, sediment, and nitrogen compounds. Non native species represented >90% of the biological system at the beginning of the Project Paradise highlighted by common carp, Eurasian manna grass (*Glyceria maxima*), giant reed, (*Phragmites australis*) and mute swan (*Cygnus olor*).

Issues Summary

- Physical destruction of plant communities and impairment of water quality by carp
- Dominance of non-native species
- Suspended sediment levels and phosphorus levels exceeding guidelines for aquatic life.
- Turbidity preventing light penetration to the bottom for plant growth
- Localized contamination from sewage/urban watersheds
- Modified water cycles - both Lake Ontario and inflowing rivers.
- Extirpation of species
- Ditching of Lower Spencer and Chedoke Creeks

Strategies

HHRAP related

1. Achievement of water quality targets through restoration of inflowing water and exclusion of common carp (*Cyprinus carpio*).
2. Restoration of plant community through elimination of Common Carp and rebalancing of Canada goose population.

Table 1. HHRAP delisting targets and measures for the RBG wetlands

Measure	Objective	2009 Average	Pre Restoration (1990)
Vegetated Area	380 hectares	130 hectares	60 hectares
* Water Clarity	>150cm	46 cm	<30cm
* Total Phosphorus	<50 ug/l	117 ug/l	270 ug/l
* Total Suspended Sediment	<25mg/l	28 mg/l	65mg/l
* Chlorophyll a	<20ug/l		
* Unionized ammonia	<0.02ug/l	<0.01ug/l	<0.02ug/l
* Dissolved Oxygen	>5mg/l	>5mg/l	>5mg/l

- measured at monitoring stations CP1 and GC2

These wetlands contribute to numerous other beneficial use impairments (BUI's) and delisting targets of the remedial action plan.

Other RBG Natural Lands management related objectives to wetlands

3. Reduction to non dominance status for historically dominating invasive species
4. Restoration of natural water cycle patterns
5. Community involvement and outreach
6. Removal of historical infilling
7. Stabilization of collapsing shoreline bluffs
8. Reestablishment of cattails, wild rice and white water lily as the dominant plant species
9. Reestablishment of Yellow Perch as the dominant animal species
10. Reintroduction of extirpated species.
11. Documentation of species at risk
12. Protection of undisturbed core areas for sensitive species through strategic alignment public access points
13. Water access available at Princess Point and Valley Inn.

Actions

1. Reduce common carp densities to <20kg/ha to allow plant growth through the use of fish barriers, while maintaining system connectivity with fishways.
2. Replacement of the decaying Grindstone marsh carp barrier structures.
3. Habitat modification of turf habitats and missing shoreline riparian zones favouring Canada Geese.
4. Accelerate restoration of marsh river channels for containment of inflowing contaminants with targeted restoration projects at Spencer Creek, Grindstone Creek and Chedoke Creek
5. Recovering inflowing water quality through
 - a. direct support and input to Wastewater and Storm water Master Plans and Conservation Authority Watershed Plans
 - b. community involvement in activities to educate about the importance of CA Watershed Plans and the City of Hamilton Storm water and Wastewater Master Plans.
6. Community engagement and education focused at the Fishway, Nature centre programs, public speaking engagements, and volunteer opportunities
7. Monitoring to provide the evidential basis for remedial action efforts of both the RBG and partner agencies undertaking activities on the waters that flow into our wetlands.
8. Monitoring – to provide updates on the status of the delisting criteria.
9. Carp removal from Long Pond marsh and other locations as needed
10. Recovery of natural water cycles through direct input to the St. Lawrence Board of Control.
11. Planting at collapsing shorelines during low level water years.
12. Establishment of Special Protection Areas, and adjacent visitor destination points
13. Reconstruction of shoreline access and parking improvements at Valley Inn and Princess Point.
14. Training you professionals in the field of environmental stewardship
15. Supporting organizations implementing projects that improve water quality flowing into our wetlands
16. Providing support to partner agency research and monitoring programs.
17. Volunteer opportunities to allow citizens to experience the wetlands as well as better understand the issues affecting the wetlands.
18. Educational opportunities through wetland school programs, interpretive signage, the RBG website, open houses and communication of monitoring results
19. Participation of selected HHRAP technical committees including the Cootes Paradise water quality committee.

Important Background Documents

1. Biological Inventory of RBG Natural Lands (RBG 1985)
2. Past and Present Limnological Conditions of Cootes Paradise (RBG 1985)
3. HHRAP Stage 1 & 2 (1992), and Stage 2 update (2002)
4. HHRAP loadings Reports (1996, 2002, 2009)
5. Water Quality Study of Cootes Paradise (MOE - 1976)
6. Cootes Paradise Study (MOE – 1986)
7. West Pond Study (1999 RBG)
8. Nutrient Status of Cootes Paradise Marsh (RBG 2001)
9. Sediment Quality review 1 & 2 (RBG 2006, 2008)
10. Bathymetry / Sedimentation (RBG 1999, 2007)
11. Water levels Implications – (RBG 2004)
12. Water levels Scenarios Review – (RBG 2007)
13. Creek loadings Study 2008 (RBG 2009)
14. Project Paradise Season Summaries – (RBG 1999 – 2009)
15. Target Plant Communities of RBG wetlands (RBG 2004)
16. Fish community use of Cootes Paradise Marsh (Theysmeyer 1999)
17. Carroll's Bay Recovery Strategy 2009

Relevant Strategies

In planning for the future, Royal Botanical Gardens has identified a number of Strategies and Plans that align with the mandate of Gardens, and may help guide stakeholders in relation to their involvement.

- Federal Biodiversity Strategy
- Lake Ontario Binational Biodiversity Conservation Strategy
- Lake Ontario Management Plan
- Provincial Biodiversity Strategy
- Canada-Ontario Water Quality agreement
- Federal Invasive alien Species Strategy
- Great Lakes Wetlands Conservation Action Plan.
- City of Hamilton Storm water Master Plan
- City of Hamilton Wastewater Master Plan
- Grindstone Creek Watershed Plan
- Hamilton CA Subwatershed Plans - various
- MNR Hamilton Area Fisheries Management Plan
- North American Waterfowl Management Plan
- Shorebird Management Plan
- Niagara Escarpment Plan
- The Greenbelt Plan
- Species at Risk Recovery Plans - various

Non native species - the Major Threat

Common carp – historically reached 90% of the biomass of the marsh biomass, equivalent to an estimated 800 kg/ha, resulting in loss of most native species across all biological community levels, including plants invertebrates, fish, birds, mammals, and multiple species at risk. Associated issues begin at densities of over 20kg/ha. Common carp arrived in the late 1800's and were established as a dominant species by the 1940's. Between 1937 and 1950 most of the wetland loss occurred. Key drivers of carp population include eutrophication of the marsh, anoxia and ammonia issues of the hypolimnetic zone of the harbour, excessive inputs of watershed sediment, and alteration of the natural marsh water cycle.

Table 2. Identified areas contributing to the historical success of common carp.

Life History	Issue	Strategy
Reproduction	Favoured by the regulation of Lake Ontario – typical regulated peak seasonal shoreline flooding aligns with reproductive habitats (June spawning – flooded vegetation)	1. Long term - Return variability to seasonal water level peak, and return peak period to May. 2. Short term - Exclude carp from reproductive habitats
Summer Habitat	Favoured by turbid open water river mouth marshes and backwaters.	1. Reduce turbidity of inflowing water, nutrients and fine particulate. 2. Short term – exclude carp from river mouth habitats with barriers and by returning of Old Desjardins Canal remnant to wetland depth
Wintering habitat	Favoured through high tolerance to elevated ammonia and depressed dissolved oxygen levels in Hamilton harbour.	1. Address ammonia and dissolved oxygen issues in harbour.
Feedback loop 1 – <i>Vacant niche</i>	Open niche created by loss of wetland vegetation in the wetland areas.	1. Exclude carp from wetlands 2. See actions related to restore inflowing water quality 3. Reestablish natural water cycle patterns
Feedback loop 2 – <i>Lack of Predators</i>	Lack of predators to maintain a balanced system.	1. Restore wetland habitat, as most any omnivorous marsh species will eat young carp. 2. Promote success of Bald eagles, mink, Northern Pike & Muskellunge for moderate sized carp.

Secondary Invasive Species

Species	Status
European manna grass	Covers 90% of the meadow marsh habitats as monocultures
Phragmites	Localized monocultures cover less than 10 hectares
Red Canary Grass	Localized, suppressed by European Manna Grass
Purple loosestrife	Sporadic and controlled by introduced beetles
Crack Willow	Dominant wetland tree species
White perch	Currently declining, in the 1900's a top 3 fish species
Round Goby	Locally abundant in Grindstone Creek and Carroll's Bay marsh.
Goldfish	Increasing, recently reached status as a common species
Red ear slider	Rare
European Mute Swan	Dominant breeding waterbird

Restoration of Plant Community

The boundary between the perennial emergent's and submergent wetland vegetation is a function of the water cycle. The boundary results at the point where in 4 out of 5 years permanent flooding occurs, also stated as the shoreline interface of the lowest summer water level elevation. Within the submergent area of Lake Ontario coastal marshes and addition high disturbance portion occurs dominated by the annual wild rice (*Zizania sp.*), a result of substantial average annual water level fluctuation (70 cm).

Key plants

- Meadow marsh – lakebank sedge
- Emergent Zone - cattail,
- Transition Zone - wild rice
- Submergent zone - white water lily.

Key Activities

Meadow Marsh - Keystone plant cattail (*Carex lacustrus*)

- elimination of dominating European manna grass (*Glyceria maxima*). Options include drowning, herbicide and smothering.

Emergent Marsh – Keystone plant cattail (*Typha sp.*)

- Common carp control through operation of carp barriers and fishways to protect reeds from being crushed during spawning activities
- Canada goose control through egg oiling reestablishment of natural predators and habitat modification.
- Fencing of emergent seedlings in low water years.

Transition marsh - Keystone plant cattail (*Zizania sp.*)

- Common carp control through operation of carp barriers and fishway to protect seedlings from uprooting, and to maintain water clarity
- Marsh river channel restoration using cattail planting and natural sedimentation processes to facilitate restoration of marsh river channels to protect habitat from damaging inflowing waters
- Seeding with wild rice in inlet areas, as conditions become appropriate. Inlets include MacLanding, Double Marsh, Princess Point Bay, Hickory Bay and Blackbird Marsh and Osprey Marshes in the Grindstone System.

Submergent Marsh - Keystone plant cattail (*Nymphaea sp.*)

- Common carp control through operation of carp barriers and fishway to protect seedlings from uprooting, and to maintain water clarity
- Marsh river channel restoration using cattail planting and natural sedimentation processes to facilitate restoration of marsh river channels to protect habitat from damaging inflowing waters
- White water lily added to inlet areas, as conditions become appropriate. Inlets include MacLanding, Princess Point Bay, Hickory Bay

Monitoring

Table 1. Anticipated monitoring activities related to HHRAP

Connection	Monitoring Category	2011	2012	2013	2014	2015
Delisting, Efficacy measure	Water Quality	X	X	X	X	X
Efficacy measure	Sediment Character		X			
Efficacy measure	Sedimentation Rates			X		X
Delisting	Plant Community - Submergents	X	X	X	X	X
Delisting	Plant Community - Emergents	X		X		X
Efficacy measure	Fishway + Salmon Redds	X	X	X	X	X
Efficacy measure	Fisheries – carp/ overall YOY	X	X	X	X	X
Community Involvement	Marsh Monitoring Program	X	X	X	X	X
Plant protection	Goose / Swan Nests	X	X	X	X	

1. Water

- annual / biweekly, standard, creeks, restoration sites, delisting stations

Single season projects

- McMaster Storm drain (2011).
- W1 (2012)
- Delsey Creek (2013)
- W5 (2014)
- McMaster Storm Drain (2015)

2. Sediment Chemistry – (updated 2012)

3. Sediment Deposition Rates – updated in 2013

4. Fishway (annually).

5. Fish -Young of the year monitoring (annually – August 32 sites)

6. Fish – Salmon (annually, Spencer and Grindstone Creek)

7. Plant community

- - submergent (annually 32 sites)
- - emergent coverage (2011, 2013, 2015)
- – emergent plant community (2013)

8. Nesting geese/swans.

9. Marsh Monitoring Program.

10. Photo records of key restoration sites updated – (Westdale, Spencer Delta, West Pond, MacLanding, Carroll’s Bay, Pond 1, Grindstone Elbow).

Other Wetland Monitoring

11. Endangered Species Monitoring

12. Migratory waterfowl – annually fall

13. Pre European bathymetry map – by sediment cores (student project)

14. Bathymetry Map – updated 2013

15. Invertebrates – (student project?)

16. Mussels – (biannually – species richness/ relative abundance)

17. Phytoplankton – (student project?)

18. Zooplankton – (student project?)

19. Aquatic Mammals

20. Groundwater Springs map.

Projects

Table 3. HHRAP related projects summary table (summary text available later in document)

System	Project Title	Lead	Started	Completed	2011-2015
Cootes Paradise Marsh	Aquatic Nursery	RBG	1995	2005	
	Cootes Paradise Fishway	RBG	1995		X
	Desjardins Canal – West end	MOE?	1972		X
	Spencer Creek Project	RBG	2001		X
	Wild Rice Project	RBG	2001		X
	Princess Point	RBG	1999		X
	Shoreline Restabilization	RBG	1980		X
	Hickory Brook Floodplain	RBG	1995	1997	
	Long Valley Brook marsh	RBG	2003	2006	
	Sewer Overflow tanks	City	1990	2011	
	Dundas Wastewater improvements	City	1919		X
Aquadam	RBG	1994	1996	- still clean up	
Grindstone Creek Marshes	Grindstone Creek Delta	RBG	1999	2001	X
	Carroll's Bay	RBG	2006		X
	Valley Inn Access Remediation	Cities	2004		X
	Grindstone Marsh Boardwalk	RBG	1995	1996	
General	Hendrie Valley Ponds	RBG	1994	1999	X
	Monitoring – Water Quality	RBG	1972		X
	Monitoring – Sediment Quality	RBG	1976		X
	Monitoring – Vegetation	RBG	1950		X
	Monitoring – Fauna	RBG	1949		X
	Community Involvement	RBG	1942		X
	Public Education	RBG	1942		X

Other Potential RBG Projects

- Amalgamate/centralize marsh monitoring program data within the GIS system
- Clean up submergent data (for species richness)
- Planting's data, digitized to GIS (success failure/report)
- Substrate type mapping for the GIS system.

Other Potential Future Projects

1. Water Quality and Quantity Reporting & Communications position
2. Marsh River Channel restoration – Spencer, Grindstone and Chedoke Creeks
3. Old Desjardins Canal Project
4. Wastewater treatment upgrade
5. Leachate mitigation - Olympic Drive landfill
6. Marsh Observation Towers
7. Species Reintroduction

General Capital Projects

Onsite

1. Carroll's Bay western shoreline repair
2. Special Protection Areas – Carroll's Bay, South Pasture Swamp, Spencer Creek Floodplain, and Westdale Inlet.
3. Desjardins Canal Environmental Restoration Project
4. Chedoke Creek / Princess Point bay river channel recreation
5. Channel resurrection
6. Sunfish/Long Pond Invasive fish management structure repair
7. Osprey Marsh Berm rebuild
8. Blackbird Marsh Berm rebuild
9. Renaturalization Rip Rap shoreline removal
10. Mercer's Glen reconnection
11. President's Pond watershed redirection
12. Spencer Floodplain Manna Grass control
13. Hickory Island Shoreline stabilization/colonial nesting bird protection
14. Fishway - Water quality meter
15. Fishway – renewable energy project
16. Flood grate modification
17. Web cam at the Fishway
18. Capture of Olympic Drive Landfill leachate
19. Weir removal on Desjardin Canal

Off site

20. Upgrade of the Dundas Sewage Treatment Plant
21. Location and repair of sewer cross connections in the watershed
22. Storm water management in the historical urban areas
23. Relocation of McMaster Storm Drains to Spencer Creek
24. Modification of the flow management from Christie Reservoir (Spencer Creek).
25. Landfill leachate collection at the Olympic Drive landfill.

Planning

- Post HHRAP Involvement
- HHRAP planning Workshop 2012
- Planning for the #403 expansion

Table 4.HHRAP Related Committees

<i>Lead</i>	<i>Alternate</i>	Committee	Lead Group
Dolf Dejong	Tys Theysmeyer	BAIT - Bay Area Implementation Team	Environment Canada
Jennifer Bowman	Tys Theysmeyer	HHRAP Fish and Wildlife committee	Conservation Halton
Tys Theysmeyer	Jennifer Bowman	HHRAP Water Quality Committee	Ministry of Environment
Jennifer Bowman	Tys Theysmeyer	HHRAP Wildlife Committee	City of Hamilton
Tys Theysmeyer	Barb McKean	HHRAP Access and aesthetics	Waterfront Trust
Tys Theysmeyer	Jennifer Bowman	HHRAP Technical Team	Ministry of Environment
Tys Theysmeyer	Jennifer Bowman	HHRAP Cootes Paradise Water quality	Royal Botanical Gardens
Jennifer Bowman	Tys Theysmeyer	HHRAP Toxic Sediment Committed	Environment Canada
Tys Theysmeyer		Watershed Stewardship task group	HHWSP
Tys Theysmeyer	Jennifer Bowman	Windermere Basin committee	City of Hamilton
Jennifer Bowman	Tys Theysmeyer	Spencer Creek Barriers committee	Hamilton Conservation Authority
Jennifer Bowman	Tys Theysmeyer	Hamilton Fishing Derby committee	Waterfront Trust
Tys Theysmeyer	Jennifer Bowman	Spencer Creek Subwatershed Planning	Hamilton Conservation Authority

Outreach and Education

Community Involvement

Public involvement is essential and the Gardens partners with groups such as the [Bay Area Restoration Council](#) and the RBG Auxiliary to engage the community to participate and learn how they can be involved in the stakeholder plans that affect inflowing water. In addition monitoring results of the ongoing wetland recovery are presented each February at an open house at the RBG Main Centre. Other opportunities to involve the public include marsh replanting events, monitoring of amphibians, shoreline and stream cleanups, Turtlewatch and the Cootes Paradise Fishway.

Education

Both the Royal Botanical Gardens and the Bay Area Restoration Council undertake educational programming directed at restoration of the wetland. At the Gardens the main display at the nature centre features the history of the wetland and its restoration, and several programs about wetland health and watershed connections are available. The most popular of these are those based at the Cootes Paradise Fishway. The Bay Area Restoration Council visits local schools to provide presentations to a variety of grade levels. Programs are focused on the watershed health, and its importance to the health of wetlands and the bay.

Points of Engagement

1. Fishway interpretation and signage. RBG educational school programs, RBG, NIC and main centre displays & trail interpretive signage.
2. Webpage for water quality / Fishway webcam
3. Colonial nesting birds Hickory
4. Restoration planting fence signs
5. Turtle nesting signs
6. Web page upgrades with reports
7. Annual open house
8. Annual workshop
9. Project Paradise 2012 Dinner

Available factsheets

Cootes Paradise Fishway, Coastal Marshes Natural Fish Hatcheries, Grindstone Marshes, Amphibians, Waterbirds

Watersheds

<i>System</i>	<i>Creek Name</i>	<i>Regulatory Agency</i>	<i>Municipality</i>
Cootes Paradise System	1. Spencer Creek	Hamilton Region CA	City of Hamilton
	2. Ancaster Creek	Hamilton Region CA	City of Hamilton
	3. Borer's Creek	Hamilton Region CA	City of Hamilton
	4. Delsey Creek	Hamilton Region CA	City of Hamilton
	5. Mink Brook	Hamilton Region CA	City of Hamilton
	6. Spencer Oxbow/Presidents Pond	Hamilton Region CA	City of Hamilton
	7. Mac Landing Creek	Hamilton Region CA	City of Hamilton
	8. Double Marsh Springs	Hamilton Region CA	City of Hamilton
	9. Westdale Creek	Hamilton Region CA	City of Hamilton
	10. Chedoke Creek	Hamilton Region CA	City of Hamilton
	11. Corner Brook	Halton Region CA	City of Hamilton
	12. Highland Creek	Halton Region CA	City of Hamilton
	13. Hickory Brook	Halton Region CA	City of Hamilton
	14. Long Valley Brook	Halton Region CA	City of Hamilton
	15. Marsh Boardwalk Brook	Halton Region CA	City of Hamilton
	16. Lilac Dell Brook	Halton Region CA	City of Hamilton
Grindstone Marsh System	17. Grindstone Creek	Halton Region CA	City of Burlington
	18. W1 – Snake Rd 1	Halton Region CA	City of Burlington
	19. W2 – Snake Rd 2	Halton Region CA	City of Burlington
	20. W3 - Cemetery	Halton Region CA	City of Burlington
	21. W4 – Hwy 6	Halton Region CA	City of Burlington
	22. W5 – Upper Long Pond	Halton Region CA	City of Hamilton
	23. W6 – Middle Long Pond	Halton Region CA	City of Burlington
	24. W7 – Lower Long Pond	Halton Region CA	City of Burlington
	25. South Pasture Swamp	Halton Region CA	City of Burlington
		Springs brook	

Other Natural Lands Initiatives - Summary

Trails Management

The trails management program endeavors to minimize human disturbance with educational signage and high quality destination points, i.e. directing visitation, and is strategically structured to provide large undisturbed habitats through designation of Special Protection Areas – areas without trails.

Species at Risk

The species at risk program has the objectives of providing regular status updates (every 3-5 years) for all species. In addition, two species populations at Royal Botanical Gardens (red mulberry and club-rush) represent the critical remaining proportions for Canada, and as such are the focus of research initiatives. During status updates, management issues are identified resulting if future actions. To provide addition protection for concentrations of species at risk, the gardens has branded specific off trail areas as Special Protection Areas. This is done to further minimize off trail activities as well as to further emphasize the unique nature of the property. The areas currently include two locations in Cootes Paradise, and one location in Hendrie Valley.

Table 5. Wetland related species at risk

<i>Endangered/ Threatened</i>	<i>Special Concern</i>	<i>Extirpated</i>
Blandings Turtle	Black tern	Chorus frog
Eastern Spiny Softshell Turtle	Northern Map turtle	Jefferson Salamander
Stinkpot Turtle	Snapping Turtle	King Rail
Prothonotary Warbler	Bald Eagle	Yellow Rail
Acadian Flycatcher	American White Pelican	Hills Pondweed (?)
Least Bittern	Yellow Breasted Chat	Redside Dace
Eastern Pond Mussel	Common Nighthawk	Bridle Shiner
Spotted Gar	Chimney Swift	Lake Sturgeon
	Water Shrew	Atlantic Salmon
	Northern Brook lamprey	Grass Pickerel
		Chorus frog

Forest Protection

The old growth forests of the Gardens represent roughly 25% of the property, and are the only relatively intact habitats located in the many ravines and along the escarpment. Due to the varied landscape and southern location the forests contain very high biodiversity with a mix of northern and southern species, and contain a number of many large (honour role) trees. The forest stewardship program integrates with the trail management and wetland restoration programs to minimize human disturbance, and actively undertakes removal of non-native shrubs and trees and the renaturalization of forest gaps. Monitoring includes forest plant community structure, soil characterization and breeding bird communities.

Old field/Active field Restoration

Historically most of the local tablelands were cleared and farmed, and one of the historical farmhouses remains on the property today. This building currently operates as an RBG staff facility and the head office of the Bruce Trail Conservancy. Restoration of fields is currently in the habitat assessment stage, but is anticipated to include initiatives such as prairie reestablishment, ephemeral pond recreations, and non- native species removal. Similar restoration is currently occurring at the primary visitor site on the south shore of Cootes Paradise, Princess Point through the use of controlled burns and inoculation with appropriate plant species.

Past Wetland Recovery Projects list

The Cootes Paradise Fishway

Common carp – historically reached 90% of the marsh biomass, equivalent to an estimated 800 kg/ha, resulting in loss of most native species across all biological community levels, including plants invertebrates, fish, birds, mammals, and multiple species at risk. Associated issues begin at densities of over 20kg/ha. Common carp arrived in the late 1800's and were established as a dominant species by the 1940's. Between 1937 and 1950 most of the wetland loss occurred. Key drivers of carp population include eutrophication of the marsh, anoxia and ammonia issues of the hypolimnetic zone of the harbour, excessive inputs of watershed sediment, and alteration of the natural marsh water cycle.

Aside from the carp exclusion function, the operation provides valuable monitoring information of water quality and fish populations, a primary visitor contact point, rich public educational experiences, and the elimination of harbour powerboats from the sensitive and shallow habitats of Cootes Paradise. Over time the excluded carp population is expected to dramatically decline, as Cootes Paradise also represents the primary spawning location for carp (*Cyprinus carpio*) at the western end of Lake Ontario.

Hendrie Valley Floodplain Ponds

The ponds are a 15 hectare oxbow pond system located along the floodplain of lower Grindstone Creek, within the Gardens' Hendrie Valley Sanctuary. Restoration of three of the four ponds were the first projects undertaken (1994) within the Remedial Action Plan, as the wetlands were the primary remaining spawning location of northern pike. Even though the inflowing waters were good, maintained by several large springs, the wetland plants and flooding patterns were significantly degraded. The initial attempts at restoration proved unsuccessful. However once the carp were successfully excluded in 1999, the ponds rapidly restored themselves, and are now among the finest examples of oxbow wetland habitat at the western end of Lake Ontario. The ponds also no longer provide new carp to broader system. Restoration of the fourth pond – closest to the lake, and which was not spring feed, was initiated in 2001. As with the other ponds, it requires ongoing management to ensure carp exclusion while maintaining native fish migrations including species such as the pike. This pond has proven more challenging to maintain carp exclusion, however, with ongoing efforts it continues to restore itself. General visitor access to the pond system was also reconstructed with the creation of a new 0.5 km long raised boardwalk (1996), amalgamating several previous trails into the Grindstone Marsh Trail, and providing an elevated view of the area.

The Spencer Creek Project

Cootes Paradise Marsh represents the river mouth of Hamilton Harbours main tributary Spencer Creek, with Spencer Creek connected to slightly more than half of all lands draining to the harbour. This project involves the reestablishment of the missing marsh portion through Cootes Paradise. Channel loss was a result of a variety of activities. In the 1800's the lower reaches were ditched, first behind a now abandoned rail line (1852), and then into the Desjardins Canal (1870's). Subsequently the last 4-5 km of channel just upstream of Hamilton Harbour were completely lost with the loss of the wetland plants in Cootes Paradise. With the exclusion of carp in 1997, these plants are returning, helping to provide a framework for channel formation. In addition in 2001, the creek channel was shifted out of the Desjardins Canal, through removal of debris at a weak point along the canal edge. This weak point happens to be just adjacent to historical ditching point. This allowed the creek to begin channel reformation through natural sediment depositional processes and plant growth. The reestablishment of the channel is critical for protecting the sensitive habitats of Cootes Paradise from contaminant spills upstream, as well as reestablishing a migratory corridor for various species, including people and their canoes. This project moves at the rate of natural processes, but continues to be enhanced through strategic wetland plantings at the mouth of the ever lengthening channel. As of 2009, about 1 km of new channel had reformed.

The Christmas Trees (Grindstone Creek Delta)

The project is located at the mouth of Grindstone Creek in the Hendrie Valley Sanctuary. As with Cootes Paradise Marsh, the loss of wetland plants resulted in the loss of the last several kilometres of wetland river channel at the Grindstone Creek Delta. In January of 2000, following the success of the previous years' smaller-scale pilot projects, the Gardens implemented an innovative experiment wetland restoration project re-establishing a portion of the channel as well as creating carp barriers to protect a portion of the wetland. Used Christmas trees, collected by local municipalities, were formed into riverbanks, helping to recreate 1 km of natural channel and redefine three wetland regions. These areas are Osprey Marsh, Blackbird Marsh, and Sunfish/Long Pond. Five small carp barrier structures were inserted into the banks blocking carp access to the wetlands while maintaining the natural flow of water and movement of organisms.

In January 2001 in the Valley Inn Area, the Christmas tree barrier project entered its final phase, crossing Sunfish Pond/Long Pond - the historical outflow link from adjacent Cootes Paradise. Through this project, 13 hectares (32 acres) of wetland habitat are being recreated at the Grindstone Creek Delta. The new habitat provides the needed conditions for the return of abundant plant growth and already attracts wetland wildlife, migrating waterbirds and spawning fish. As with the other carp exclusion projects, the restriction of carp from their reproductive areas is expected to result in the collapse of the overall carp population. Over time, the Christmas trees naturally biodegrade, leaving a build-up of sediment and reeds as a riverbank. As the height of the riverbanks must be maintained above the lakes maximum level to prevent carp access, the riverbanks are regularly augmented with additional trees until sufficient sediment has accumulated.

The Cootes Paradise Water Quality Model

Completed in 2007, the purpose is to demonstrate how the quality of inflowing waters and changing precipitation patterns affect marsh phosphorus levels. Designed to build on the HHRAP contaminant loading reports, the project models various water supply scenarios with outputs available at intervals of days. The focus of the model is the most challenging contaminant in the marsh, the excessive phosphorus. Water & phosphorus sources built into the model include groundwater, direct precipitation, urban and rural runoff, CSO's, wastewater treatment effluent and sediment reflux from historical accumulations. The results of the model demonstrate that the quality of water from both the urban runoff and wastewater treatment plants are dominant during the dryer periods, while during wetter periods the rural watershed is the most significant.

Lake Ontario Water Level Regulation Reviews

As a local contribution to the review of Lake Ontario regulation, initiated by the International Joint Commission (IJC), the Gardens examined and summarized the effects the past 50 years of regulation has had on its wetlands. In addition, the Gardens provided suggested regulation scenario criteria that would benefit Cootes Paradise Marsh. Subsequent to this, the Gardens provided a review of three preferred regulation alternatives put forward through the IJC study. Two of the three proposed regulation scenarios were considered beneficial to Cootes Paradise marsh based on the water cycle patterns they produced.

Wild Rice Reintroduction

Historically, wild rice (*Zizania sp.*) dominated the local wetlands, with this species ideally suited to the highly variable water level regime of Lake Ontario. The variability places extensive disturbance on the wetland through regular flooding, drying, and freezing, favouring "annual plants" such as wild rice. This species was lost from the areas many decades previous, however only a few years into the current restoration process, a few individual plants spontaneously appeared in the recovering Hendrie Valley Ponds. These plants were southern wild rice (*Zizania aquatic*), a species nearly extirpated from Canada. This inspired a project focused on re-establishing the species starting in 2001.

With the assistance of Lakehead University, several locations around the wetlands were identified and temporary enclosures were erected at five locations. Out of these five, only one location near the mouth of Spencer Creek has shown the ability to allow the rice to persist on its own. In the remaining locations, they

were unable to survive due to a variety of issues affecting the fragile seedling stage, including goose herbivory, carp uprooting and smothering by algae blooms. Ongoing projects are underway to improve these environmental growing conditions to the point where the species can again be successful. Wild rice is considered one of the cornerstone plants of the Gardens' wetlands. To ensure this short lived species is not extirpated again, a captive population is maintained within the Gardens' plant propagation area.

The Aquatic Nursery

The Aquatic Nursery was initiated in 1994 by the Royal Botanical Gardens to supply plants for the restoration of Cootes Paradise marsh. The need for the nursery was identified as a priority, as studies of the degraded wetland seed bank indicated that little to no seed remained, and many of the previously existing native species were extirpated. At its peak the nursery produced 40,000 plants per year covering over 40 locally collected species. By 2004 the nursery was no longer necessary following the re-establishment of most plant species, and has been largely closed down. However it does continue to be used to maintain a source population of southern wild rice (*Zizania aquatica*). White water lilies (*Nymphaea sp.*) also continue to be an important plant for reintroduction. Due to its tremendous recovery success in some of the restoration areas, its tubers are now readily available to be gathered from these wild populations for transplant to other locations.

Carroll's Bay Project

Carroll's Bay Marsh is at the mouth of the Gardens' Grindstone Creek properties in the north-west corner of Hamilton Harbour. The 30 hectares of Carroll's Bay Marsh were the least impacted of the Gardens' wetlands at the beginning of the wetland restoration program in 1994, and as a result contains remnant populations of a variety of historically abundant species, particularly turtles. Unlike the other wetlands of the Gardens, this area cannot be protected from destruction by common carp or inflowing poor water quality. Currently, it benefits from restoration projects in the adjacent wetlands and the harbour and it is anticipated that these will ultimately result in its recovery. The inflowing waters now also benefit from the removal of the Waterdown Wastewater Treatment Plant from Grindstone Creek (2010).

In addition, being openly connected to the harbour and sheltered by Carroll's Point, it receives frequent visits from motorized watercraft, people not understanding the very shallow nature of the waters. The motorized watercraft disturb wildlife (especially basking turtles), slice up remnant water lilies, and in the shallow waters can actually kill turtles with the propellers. In 2006, in an effort to reduce the pressure on this important sanctuary and to promote its ecological values, a buoy line was installed, marking the shallower wetland portion off-limits to motorized watercraft.

Combined Sewer Overflow Mitigation

Just upstream of Cootes Paradise are a number of combined sewer overflow locations. Combined sewer overflows are locations where sewers spill into local creeks when rainwaters overflow the combined storm water/waste water system. Between 1996 and 2010 these were mitigated by the City of Hamilton through the creating of holding tanks and diversion weirs. Locations include two along Chedoke Creek (*Main-King St-1996, Royal Ave-2008*), one on Westdale Creek (*Sterling St-2005*), and one on Ancaster Creek (*Ewen Rd-2010*). These changes intercept approximately 95% of all sewer overflow waters and divert them from Cootes Paradise for treatment at the local Wastewater Treatment Plan. The volumes are enormous, equivalent to just over 1.5 billion litres (the entire volume of Cootes Paradise marsh) in an average rainfall year (~900mm). Water quality improvements are significant and will be examined in detail during 2011.

Wastewater Optimization

In 2005 the King St. Waste Water treatment plant underwent optimization through the creation of a stabilization tank connected to the facility. The plant drains into Cootes Paradise marsh at the head of the Desjardins Canal. The tank is operated by the City of Hamilton with the purpose of maintaining a stable flow through the plant to obtain maximum treatment performance. Downstream water quality monitoring to date

indicates that water quality is improving, however, it is still the source of substantial nutrients, including toxic levels of nitrates.

Kaydrage Landfill Leachate Collection

The Kaydrage Landfill, also called West Hamilton is located within the southeast corner of Cootes Paradise Marsh against the Burlington Heights sand bar, in the mouth of Chedoke Creek. The landfill is among the earliest created within the City of Hamilton, initiated in the mid 1800's and closed in 1970s. The landfill covers about 20 hectares of Cootes Paradise marsh and is managed by the City of Hamilton. Since 2008 a leachate collection system has been operating to intercept and treat leachate water before it reaches Cootes Paradise and Chedoke Creek. The full effects of this have yet to be assessed, however the water in this area of Cootes Paradise is visibly improved.

The Desjardins Canal Project

This project focuses on water and sediment quality issues in the western 1 km of canal at the back of Cootes Paradise Marsh. The canal is owned by the City of Hamilton and is dredged into the floodplain of Spencer Creek portion, with Hamilton Region Conservation Authority and Royal Botanical Gardens owning the adjoining areas. The project has been ongoing since the 1970's, when studies of the area by the MOE (1972,1976) identified contaminant issues related to historical uses of the area, and ongoing issues related to the discharge of the King Street (Dundas) Wastewater Treatment Plant. Contaminants were dredged from the canal in 1979, and a bubbler system and water level control weir were installed in the section upstream of Olympic Drive in an effort to improve wastewater effluent quality before reaching Cootes Paradise marsh. The system was abandoned in favour of a Wastewater Treatment Plant upgrade (to tertiary) in 1985.

In 1999 and 2005 the site was revisited to update information, with several additional actions identified. The first of these was implemented in 2003 by the Hamilton Region Conservation Authority, and involved the reconnection of this section of the floodplain with the floodwaters of Spencer Creek through the installation of a floodway culvert. The culvert was inserted into the nearby rail trail - an artificial berm that had isolated the creek floodwaters from its floodplain since the 1850's. The new culvert now allows clean waters and sediment to reach the canal during the spring floods. Ongoing water quality monitoring is demonstrating continual improvements since this reconnection was completed, and a reassessment of sediment conditions will occur in 2012. Further reclamation of the area as visitor focal location is currently underway through the Dundas Eco-Gateway Project.

Long Valley and Hickory Valley Projects

Long Valley and Hickory Brooks are a pair of adjacent creeks draining abandoned agricultural lands to the north of Cootes Paradise. Over time, massive erosion from the agricultural fields infilled the creek mouth areas at Cootes Paradise. In 1995 in the floodplain of Hickory Valley near the creek mouth, RBG and several partners completed an amphibian habitat creation project in which two hectares of the of the floodplain was remodeled. This included removal of an existing obsolete water control structure and creation of four ponds of varying depth. In 2004, a similar project was undertaken at the mouth of Long Valley Brook. In this case, 0.5 hectares of silt was dredged and piled into features. This includes over 20 mounds and a large knoll. Diverse wetland vegetation and fish and wildlife - in particular amphibians, have successfully recolonized both sites. Future securement and rehabilitation of the now abandoned farm fields is an objective of the Cootes to Escarpment Park System.

Aquadam™

Prior to installation of the Cootes Paradise Fishway a temporary exclusion structure called the Aquadam™ was tested. The purpose was to isolate a portion of the wetland and artificially lower water levels, removing carp and promoting seedling germination on the exposed sediments. The artificial lowering of the water was an attempt to create conditions that rarely occur for the regulated waters of Lake Ontario.

In 1994, a length of dam was installed, measuring 1.8 m (6') high, 5.4 m (18') wide and 585 m (2 100') long isolating an 11 ha (27 acre) expanse along the north shore of Cootes Paradise Marsh. After several attempts, the water was pumped from the area and 3,100 carp were removed, equal to a density of 795kg/ha. Substantial emergent plant seedlings were seen sprouting on the exposed mudflats. However, this success was to be short-lived, as a number of problems, including product malfunction and vandalism eventually forced RBG to abandon the project.

Princess Point Habitat Modification

Canada Geese were favoured by historical habitat modification at Princess Point through the creation of turf area that extended to the shoreline, and the loss of shoreline emergent vegetation within the marsh. Between 2000 and 2006 250m of riparian habitats were re-established along the open perimeter of section of the shoreline. Starting in 2005 turf mowing practices on the point were modified to reduce the turf area, and have successively decreased the area each subsequent season. Currently remaining turf mowing activity is focused on the maintenance of meadow paths, and a picnic area adjacent to the newly established canoe launch to the marsh. With the associated reduction in turf grass and ongoing "don't feed the geese sign" the geese numbers have decline sufficiently such that in 2009 volunteer marsh plantings of cattails have been initiated along the shoreline to facilitate their reestablishment.

Community Involvement

Public involvement is essential and the Gardens partners with groups such as the [Bay Area Restoration Council](#) and the RBG Auxiliary to engage the community to participate and learn how they can be involved in the stakeholder plans that affect inflowing water. In addition monitoring results of the ongoing wetland recovery are presented each February at an open house at the RBG Main Centre. Other opportunities to involve the public include marsh replanting events, monitoring of amphibians, shoreline and stream cleanups, Turtlewatch and the Cootes Paradise Fishway.

Education

Both the Royal Botanical Gardens and the Bay Area Restoration Council undertake educational programming directed at restoration of the wetland. At the Gardens the main display at the nature centre features the history of the wetland and its restoration, and several programs about wetland health and watershed connections are available. The most popular of these are those based at the Cootes Paradise Fishway. The Bay Area Restoration Council visits local schools to provide presentations to a variety of grade levels. Programs are focused on the watershed health, and its importance to the health of wetlands and the bay.