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2022 Status Update of Fish and Wildlife Populations and their Habitat in Cootes Paradise and Grindstone Coastal Marshes in support of HHRAP



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Document Description:

This document summarizes the long term trends and current status of fish and wildlife populations and habitat recovery progress for the two Lake Ontario coastal marsh areas within the properties of Royal Botanical Gardens. The report is in support of the Hamilton Harbour 2022 status review for Beneficial Use Impairments (BUI) numbers iii - Fish and Wildlife Populations, and xiv - Fish and Wildlife Habitat. This document is an amalgamation of technical documents provided by Royal Botanical Gardens through the HHRAP Fish and Wildlife Committee status review.

Executive Summary

The document summarizes changes in the fish and wildlife populations and their habitat of the western tip of Lake Ontario within Cootes Paradise and Grindstone Marsh as monitored between 1994 and 2022. Overall habitat has improved substantially but is less than half of final recovery targets, while fish and wildlife populations remain badly impaired with some notable successes. This report is in support of the Hamilton Harbour Remedial Action Plan (HHRAP) with the first technical document published in 1994. Fish and Wildlife populations for these areas have no HHRAP targets, while the habitat is measured through area of marsh vegetation coverage returned and various water quality parameters and are delisting criteria measures. At the outset of the HHRAP the marsh waters were extremely turbid (<30cm clarity), with any the remaining marsh vegetation almost entirely restricted to the seasonally flooded meadow area, and with the aquatic vegetation component essentially absent. Unique to this was out Grindstone Marsh were a mix of vegetation remained. In terms of the of the highly variable water levels of Lake Ontario most vegetation was missing below the average summer water level of 75masl, with the remaining meadow marsh habitat providing a total coverage of an estimated 15%, dominated by Eurasian plant species unsuitable for most marsh wildlife.

The status of fish and wildlife populations and habitat all remain impaired as of 2022. Overall, since 1994 there has been a substantial net improvement in marsh habitat, as result of specific projects to reduce inflowing sewage, manage Common Carp and Canada Goose vegetation browse, and eliminate invasive plant species from the meadow marsh areas. Inflowing water quality improvements are limited and localized; thus, the aquatic habitat component continues to be generally degraded and lacking. Water Clarity is variable averaging about 40cm with regular anoxic conditions. The 2022 CCME Water Quality Index (2001) for the middle Cootes Paradise was 46 and for Grindstone Marsh 38 representing degraded status (scale 1-100). The water quality is notably improved in sheltered inlets and interior ponds where waters are often clear, a direct effect of carp exclusion. Areas beyond the inlets are often hypereutrophic and affected by yet to be remedied impacts from urban stormwater, CSOs, and treated wastewater. The water conditions generate varies forms of algae that dominate and smother the aquatic habitat. At the same time, the Emergent Marsh habitat component has generally expanded year over year, with the lower water levels of 2021 providing a dramatic habitat recovery after 5 years of decline from very high lake levels and substantial sewage spills. The open water and the variable aquatic plant coverage allows for substantial wave fetch, continuing to erode sensitive shorelines. To remediate shorelines several small sections have been repaired through bioengineering. These sites remain at risk of further collapsing without the full establishment of aquatic vegetation to dampen the wave fetch. Large sections of damaged shoreline remain in need of stabilization including sites with old growth forest and archeology. Overall, the majority of wetland plant community habitat remains missing.

Fish and wildlife populations remain badly impaired, with fish populations continuing to decline save for a few species such as Bowfin and Brown Bullhead with nonnative species Rudd and Goldfish also now abundant. Despite this fish populations support a variety of fish eating birds, most notably an onsite Double Crested Cormorant nesting population as well as migratory species. Detailed monitoring of spawning success finds an abundance of young fish in May/June, dramatically reduced by late August. Wildlife populations are impaired due to the generally missing habitat, although several populations have increased with the habitat improvements. Wildlife exist as only small populations relative to overall habitat area. Several wildlife species have also been extirpated during this period including several turtle species and all early season breeding amphibian species. Semi successful amphibians included

American Toad, Green Frog and Gray Treefrog. Turtles are subject to a special separate recovery strategy to stop further extirpations, a focus of the RBG Site Specific Turtle Recovery Plan. Birds are dominated by Red Winged Blackbirds and colony of Double Crested Cormorants that have established a nesting site on a Cootes Paradise Island. Several extirpated bird species have also returned including Bald Eagle, Trumpeter Swan and Osprey, with a notable although small population of breeding Least Bittern. Occasional die offs of adult wildlife continue to occur. The specific reasons are not clear given the diverse array of continuing stressors but are essentially stressed animals succumbing to disease within an environment of variable conditions that are at times includes extremely poor water quality.

Measures of status include the following as of the end of 2022.

Measure	Location	Objective	1995 Averages	2022 Averages
Vegetated Area	Cootes Paradise	230 ha	26.59 ha	75 ha
	Grindstone Marsh	40 ha	11.26 ha	19 ha
CCME Water Quality Index	Cootes Paradise	N.A.	26	46
	Grindstone Marsh	N.A.	26	38
Water Clarity	Cootes Paradise	> 100 cm	< 30 cm	43 cm
	Grindstone Marsh			32 cm
Dissolved Oxygen	Cootes Paradise	> 5mg/l >85% of time	Inadequate Monitoring	Dramatic fluctuations, Impaired during overnights
	Grindstone Marsh			
Total Phosphorus	Cootes Paradise	< 30 µg/L	~270 µg/L	142 µg/L
	Grindstone Marsh			146 µg/L
Fish Populations	Cootes Paradise	Mesotrophic Fish Community	Carp Dominated	Bullhead dominated, fish populations lacking
	Grindstone Marsh			Sunfish dominated, fish populations lacking
Wildlife Populations	Cootes Paradise	Consistent with habitat available	Very small populations of many species	Impaired, largely missing
	Grindstone Marsh			Impaired, largely missing
Water Cycle	Cootes Paradise	Natural Pattern	Plan 1958D	Plan 2017 Flooding deviations
	Grindstone Marsh			
Carp Density	Cootes Paradise	< 20 kg/ha	800 kg/ha	5 kg/ha
	Grindstone Marsh			0-150 kg/ha

Habitat Measures

- Water Clarity at the center of each marsh has improved from an average of about 15cm of visibility in 1994 to 37cm - Cootes Paradise Marsh and 29cm Grindstone Marsh. At these monitoring sites the maximum clarity recording for the year was 56 and 67cm respectively.
- The waters continue to experience regular periods of anoxia and are generally classed as hypereutrophic by nutrient enrichment level.
- The 2022 CCME Water Quality Index Score for Cootes Paradise was 46 and for Grindstone Marsh is 38, poor to marginal water quality.

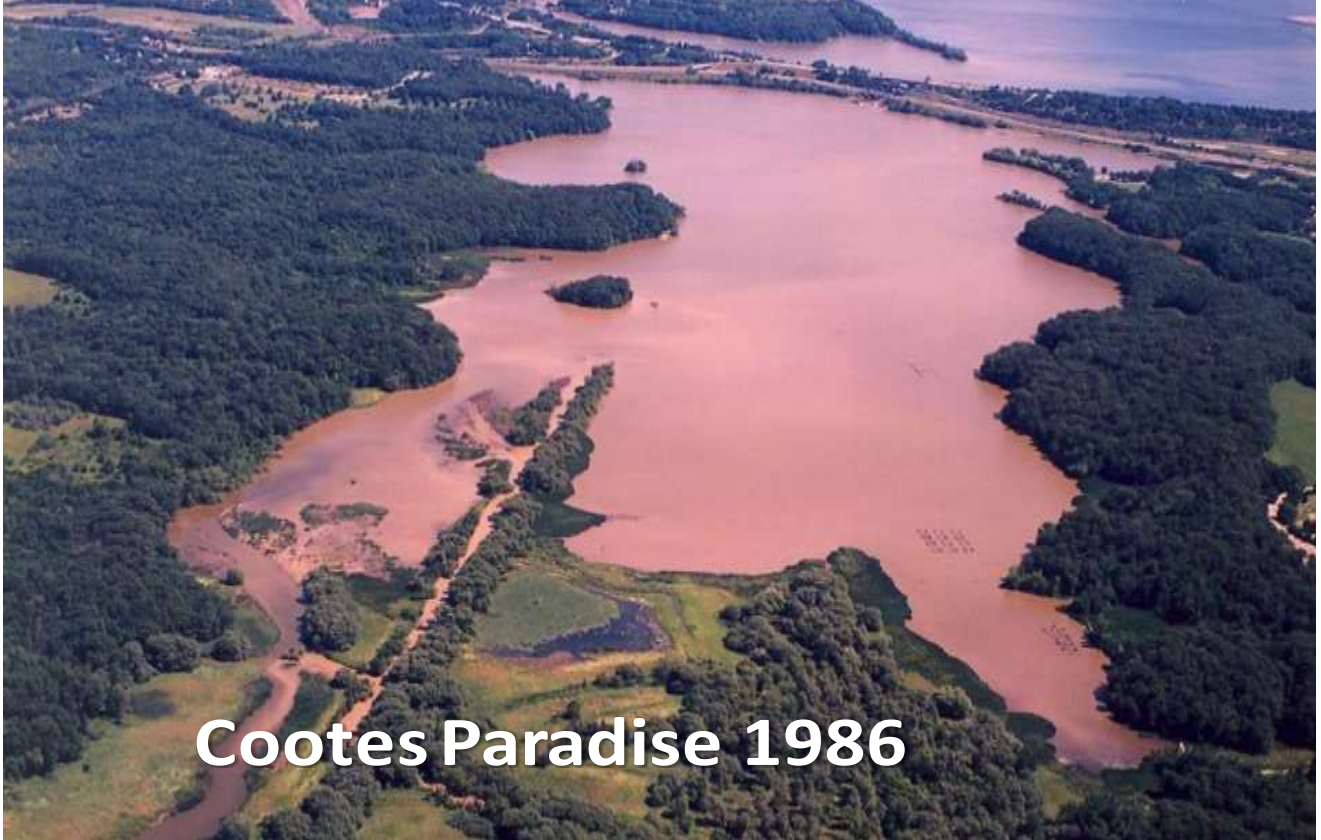
- Several Inlets and interior ponds in each of the marshes have dense and diverse marsh vegetation and clear water.
- Submergent aquatic plants overall have increased from 0.21ha to 27.82ha since 1994. This includes a temporarily lost in all areas but the interior ponds due to additional sewage spills between 2014 and 2020.
- Emergent marsh (reeds) oval has increased from 26.22 ha to 50.1ha since 1994.
- Spencer Creek delta in Cootes Paradise Marsh has returned as a large-scale defined feature. This area was formerly ditched into the Desjardins Canal and has since evolved through restoration work to a semi-diverse meandering delta and semi functioning watershed pollution biofilter protecting a large inner bay habitat area within Cootes Paradise.
- In the “Meadow Marsh” habitat large scale control measures for Invasive European manna Grass (*Glyceria maxima*) and Phragmites (*Phragmites australis*) has shown substantial success with returning native plant species coverage. Phragmites has been reduced from 9ha and 120 patches to scattered small new stands and one moderate sized stand in Grindstone meadow marsh area.
- Through reintroduction several essentially extirpated plant species have re-established in low numbers including Southern Wild Rice, Hardstem Bulrush, American Bulrush, Arrow Arum and Yellow Waterlily.
- An updated Lake Ontario water level regulation plan was initiated in January 2017 however due to extreme climate conditions since, the lake has operated with many plan deviations.
- 2021 marked a positive change from the past five years of decline for Cootes Paradise Marsh. Grindstone Marsh continued as largely degraded, with a few pockets of healthy habitat. Changes were spurred by the lowest water levels since the 1960s, removing problematic water. This exposed plant-less mudflats allowing for large scale seed germination and growth of a mixture of emergent vegetation.
- The formerly vegetated outer portion of Grindstone Marsh existing at the outset of the HHRAP now as no aquatic vegetation and only limited locations of emergent vegetation.

Fish and Wildlife Populations Measures

- Overall, many fish and wildlife populations remain at their original early 1990s populations or substantially declined with a few highlights.
- Fish populations overall are in decline, but species that have increased in abundance include Brown Bullhead, Gizzard Shad, Bowfin, Bluegill, Rudd and Goldfish and are many times their populations of 1994. Rudd is now an abundant non-native species, first noted in 1997.
- Amphibian species that have increased from nearly absent in 1994 include Gray Treefrog, Green Frog, and American Toad.
- Monitored aquatic mammals including mink, muskrat and beaver and have all increased from near zero population but continue to be uncommon.
- A few bird species formerly extirpated have reappeared through the work of broader scale

conservation efforts, including Trumpeter Swan, Bald Eagle, and Osprey.

- The Red-winged Blackbird is the most common species found as is abundant in the emergent marsh habitat areas, however most birds species have lower population counts except for the Least Bittern and Marsh Wren. Double Crested Cormorants are numerous with a breeding population of about 200 nests at Hickory Island in Cootes Paradise Marsh
- Two species of “Endangered” status turtles are now extirpated from the habitat of Grindstone Marshes Carrols Bay area. In addition, many adult snapping turtles have also been lost to roadkill and water quality issues particularly during the Chedoke spill period of 2014-18. RBG created a Turtle Recovery Plan independent of the HHRAP in 2014 due to the lack of wildlife population focus for the marsh habitats.
- Separately as monitored by DFO the harbour Common Carp population has dropped by about 85% although it remains a dominant fish of the local ecosystem with carp barriers suppressing the numbers for the marsh areas.
- During the past 5 years 6,881 carp have been physically removed from the marsh as a follow up to two years of record high lake levels (2017 & 2019). Since carp barriers were installed in the late 1990s, 40,037 large carp have been removed, largely from Cootes Paradise Marsh.



Aerial View of Cootes Paradise Marsh at the initiation of the HHRAP and in spring 2021.



Photos of the best quality habitat sites of Cootes Paradise Marsh - Upper Paradise Pond (above), and Grindstone Creek Marsh - South Pasture Swamp (lower).

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Introduction

This report summarizes trends in key habitat parameters, water quality index measures, and relevant fish and wildlife populations for both Cootes Paradise and Grindstone Creek marshes in support of the ongoing Hamilton Harbour Remedial Action Plan. Royal Botanical Gardens has been undertaking stewardship and restoration of wetland habitats focusing on Cootes Paradise and Grindstone Creek Marsh since the 1940's. These two wetlands are large scale rivermouth coastal marshes forming the western tip of Lake Ontario and intersected by the Niagara Escarpment. The marsh habitat is impacted by the stresses of inflowing polluted water, infilling of habitat, and dominance of Eurasian invasive species. Water quality conditions have been hypereutrophic since water quality monitoring was first undertaken in the 1940s, and reflective of the inflowing water quality stressors. Stewardship work has included many restoration projects ranging from wetland planting programs to hydrological manipulations, to carp exclusion, to species re-introduction. Concerns regarding inflowing water quality have always been at the forefront. RBG has regularly requested that local municipalities discharge wastewater into the marsh tributaries to the highest effluent standards available leading to a tertiary wastewater plant at West Cootes Paradise in the early 1980s. Water conditions however remain hypereutrophic. Under the Great Lakes Water Quality Agreement of 1970s, the two marshes retained within RBG property holdings gained additional interest with the creation of the Hamilton Harbour Area of Concern in 1985 as being the focal habitat left in Hamilton for restoration. RBG's wetland biodiversity conservation projects are also imbedded as part of the Niagara Escarpment World Biosphere stewardship.

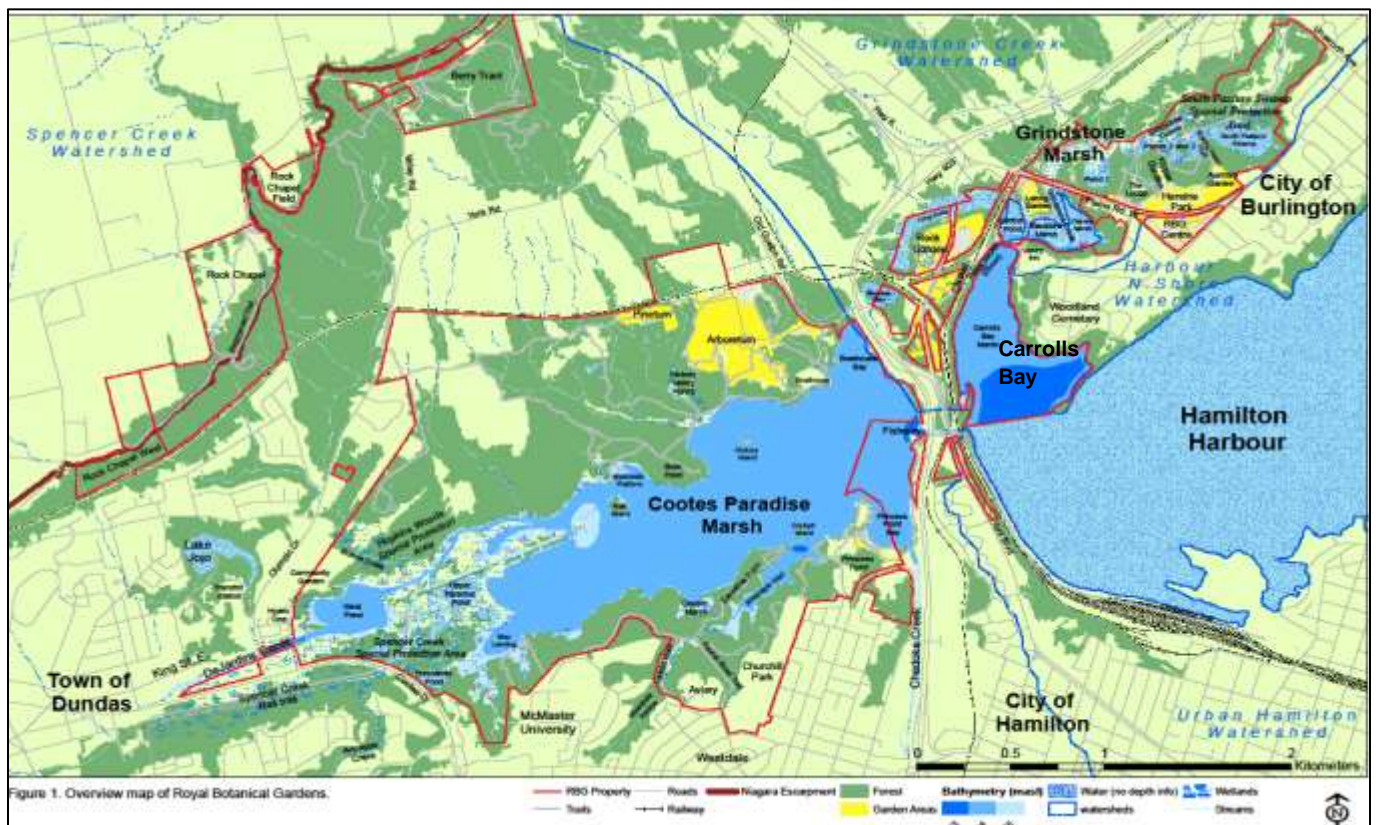


Figure 1. Royal Botanical Gardens Cootes Paradise and Grindstone Marsh overview map

The goal of the Hamilton Harbour Remedial Action Plan (HHRAP) established in 1992 is the restoration of a degraded Great Lakes area habitat (Area of Concern - AOC). The HHRAP area includes all Lake Ontario affected areas as well as lower end tributaries for the location West of Burlington beach. This includes the bay, and the large marshes within RBG as well as lower Grindstone and Spencer Creeks. While individual partner organizations have maintained monitoring programs and shared information at workshops and committees, the last detailed review and summary of status occurred in 2003 as part of Bay Area Implementation Teams HHRAP Stage 2 update (HHRAP 2003).

This report provides a status for HHRAP Beneficial Use (BUIs) for three issues

BUI iii - Degradation of Fish Population (indexed by DFO in the harbour)

BUI iii - Degradation of Wildlife Populations – “Other Wildlife”

BUI xiv - Loss of Fish and Wildlife Habitat

Of note, the HHRAP does not pertain to the entire area of RBG wetlands, focusing only on the highly impaired area as identified in the 1993 HHRAP Stage 1 Environmental Conditions Report. These areas included the seasonally flooded habitats of meadow marsh and emergent marsh, and the permanently flooded submergent marsh. The initial habitat targets for Cootes Paradise and Grindstone Marshes were estimated, set in the spirit of restoring the missing wetland and aquatic vegetation back to historical conditions (with no reference to species makeup). As such, target numbers originally identified to be restored have since been refined by RBG with detailed Geographic Information System mapping (ArcGIS).

The current HHRAP key habitat targets for the two coastal marsh systems are;

- Cootes Paradise Marsh - 230 hectares of vegetation coverage
- Grindstone Marsh – 40 hectares of vegetation coverage
- Water Clarity > 1 meter 85% of the time.
- Dissolved Oxygen > 5mg/l 85% of the time and without anoxia.

The Grindstone Marsh habitat target has proven to be challenging as total area of habitat lost in Grindstone Marsh continued to increase since the outset of the HHRAP. This was further confounded by the lack of initial habitat measurements of the area, resulting in a HHRAP target that underrepresented the growing missing vegetation. As of 1999 the missing vegetation had reached about 46 ha as essentially all remnant aquatic vegetation disappeared in the outer marsh area adjacent to Carroll's Bay.

Fish and Wildlife populations were also outlined in the original HHRAP Stage 1 Report (1993) as well as the Stage 2 Update (2003). Quantification of wildlife populations, and thereby include participating in the establishment of the Great Lakes Marsh Monitoring project currently administered through Birds Studies Canada. Most amphibian species remained in very low numbers, and few individuals of most mammal species could still be located. Fish were monitored by DFOs Great Lakes Lab for Aquatic Sciences. Above all else the Eurasian Common Carp (*Cyprinus carpio*) population was estimated to be about 100,000 fish and represented the majority of fish biomass. The carp densities in the marsh areas were estimated at about 800 kg/ha (Theijnsmeijer 1999). Restoration goals were to keep the carp

numbers under 50kg/ha initially, updating to 20kg/ha by 2003. Other more common fish species include Brown Bullhead, Alewife, and Pumpkinseed Sunfish. The most basic onsite management action is the temporary exclusion of the Common Carp through barriers until such time as mesotrophic habitat conditions have been restored.

Site Description

The two-wetland complexes extend up multiple watersheds, with the wetlands totaling approximately 400 hectares in size combined and include over 30 km of shoreline and 25 subwatersheds. RBG is the owner and steward of all of Grindstone Marsh and nearly all of Cootes Paradise Marsh. West of Cootes Drive Cootes Paradise Marsh is owned by Hamilton Conservation Authority, and portions of the old Desjardins Canal in the west marsh are owned by the City of Hamilton. As habitat to the region, these areas represent 99% of the remaining undisturbed harbour shoreline and greater than 95% of the remaining wetland habitats of the Hamilton AOC. These marshes are also the largest wetlands in the western half of Lake Ontario and the only coastal marshes found within the Niagara Escarpment World Biosphere Reserve. The marshes are directly connected to the Lake Ontario water level. Lake Ontario water cycle variations can result in all or none of the marsh area flooded, and the typical annual cycle moves across 1/3 of the marsh area (~70 cm annual fluctuation). The full range of water levels experienced during the report are a low of 74.2masl in fall 2012 and a high of 76.1 masl in spring 2019. Cootes Paradise Marsh and Grindstone Marsh for the purposes of the HHRAP are roughly bounded by the 76 msl contour (lake highwater level). Dominant watersheds are Spencer Creek (270 km²) and Grindstone Creek (89 km²). Although impaired, these watersheds are two of the healthier watersheds remaining on Lake Ontario, with over 95% of the Spencer Creek watershed contained within the Greenbelt.

Background

Historically, the shallow waters of both Cootes Paradise and Grindstone Creek marshes were fully vegetated, ~100% plant coverage (Painter et al. 1988; HH RAP 1992), and illustrated by historical photos, paintings, and further confirmed by bathymetric conditions (Tang et al. 2021; Theijsmeijer and Bowman 2022). These marshes represent large rivermouth marshes at the western terminus of Lake Ontario and as a result the plant community is a function of the wide-ranging water levels of the Lake as well inflowing tributaries. At extremes in high water this can create a shallow aquatic inlet, while during low water a largely drained wet meadow results. These fluctuations generate a diverse and changing plant communities from year to year. Between the 1930s and 1980s due to multiple stressors, vegetation coverage dropped by 85%, leaving both marshes with a total coverage of only about 15% of the area (Simser 1982; Painter et al. 1988; HHRAP 1992). This remaining coverage was largely within the meadow marsh zone (flooded on average once every five years) and the semi isolated interior creek-delta, oxbow ponds, and dominated by invasive grass species (Simser 1982). The recovery of these habitats and the associated fish and wildlife population is a fundamental goal of the Hamilton the multistakeholder Harbour Remedial Action Plan (HHRAP), lead by the federal and provincial governments through the Great Lakes Water Quality Agreement.

Initial HHRAP habitat vegetation coverage targets were established in the HHRAP Stage 2 technical document (1992) as part of initial program planning. At the same time early remediation efforts to understand and correct habitat loss began in the late 1940s, documented in various publications of the time. Stressors identified were significant inflowing pollution and introduced Common Carp (*Cyprinus carpio*) (refer to list in Theijsmeijer and Bowman 2022 Appendix). A broader effort was initiated under

the HHRAP, with additional resources from RBG starting in 1993 (Court et al. 2017). Support planning and monitoring was initiated with Department of Fisheries and Oceans research lab, GLLFAS, who provided a baseline for the submergent/ floating aquatic vegetation surveys, as well as the quantification of emergent marsh area and fish community (Theysmejer 1999; Court et al. 2017, HHRAP Stage 2 1992).

Cootes Paradise and Grindstone Marsh are coastal wetland systems connected to Lake Ontario and are the primary spawning grounds for most of Hamilton Harbour's fish populations and most of the wildlife species associated with the water environments remaining in the HHRAP project area. To track habitat conditions, annual aquatic vegetation monitoring has been occurring since 1995 in which submerged, floating, emergent, and meadow marsh vegetation identified and quantified (Court et al, 2017). Species composition at each vegetation level (emergent, submergent/floating, meadow marsh) are summarized to provide an overall assessment of the quality of those habitats. Habitat quality is also influenced by water clarity and oxygen content. Water quality monitoring has been ongoing in Cootes Paradise since 1972 by various agencies including the Ministry of Environment, Conservation, and Parks (MECP), McMaster University, and RBG (Bowman, 2022). It was determined that the largest stressors to both marshes include high turbidity (poor clarity), mainly caused by Common Carp activity, rain and seiche events, and excess nutrients caused by effluent from the Dundas WWTP or Chedoke Creek CSOs (Yang, et al. 2020, HHRAP Water Quality Subcommittee 2012). This report summarizes trends in key habitat parameters, water quality index measures, and relevant fish and wildlife populations for both marshes.

In addition, within the wildlife habitat management efforts to restore the plant community, plant species reintroductions and elimination of invasive grasses has also occurred. RBG has been implementing a long-term management plan for two invasive grass species (*Phragmites australis* and *Glyceria maxima*) currently dominating the emergent edges and meadow marsh areas. Interim observations are positive; however, a future report will review the progress in detail and the plant community transformation success to illustrate the current quality of this habitat restoration project with more data. RBG plant species reintroductions have been a long-standing project of the marsh restoration. Many extirpated plant species have been reintroduced including a focus on Southern Wild rice (*Zizania aquatica*). Other emergent marsh species have also been successfully reintroduced including Three-square/American Bulrush (*Schoenoplectus americanus*), Hardstem Bulrush (*Schoenoplectus acutus*), Prairie Cordgrass (*Spartina pectinate*), Pickerel Weed (*Pontederia cordata*), Arrow Arum (*Peltandra virginica*) and have expanding populations.

Marsh shoreline stabilization is an additional subproject within these areas, with eroding shorelines a consequence of lack of marsh vegetation and resulting wave impacts into steep sand glacial deposits. Restoration goals through direct planting intends to provide at least a 4m wide riparian zone to buffer the dramatically changing water levels. For these project sites the area closest to the waters' edge is planted with emergent plants (Cattails, River Bullrush, Hardstem Bullrush), and then shrub thicket species (Silky Dogwood, Sandbar Willow, Buttonbush) are planted in the drier parts of the shore. Where the slopes are more undercut or eroding rapidly, bioengineering in addition to planting has proven to be more effective. Techniques such as coir log and fascine installation have been implemented in a step like sequence at the base of the slope with planting occurring behind each log to further suspend sediment. These techniques have primarily been implemented on the shores around our island structures and along the south shore of Cootes. Fencing is further installed to prevent browsing, destruction by carp in higher waters, and to deter the public from disturbing the area.

Monitoring Methods

Water Quality

Water quality has been monitored annually in some form since 1972 at a variety of stations. Total stations monitored year to year vary slightly, but HHRAP delisting stations (CP2 and GC1) were consistent. Between 1994 and 2013, monitoring was biweekly, but in 2014 this protocol changed to weekly monitoring from May to September. Surface water grab samples were taken and sent to a certified lab facility for analysis on the same day. Samples are taken by boat, canoe or by wading offshore. Stormwater events were noted on samples collected within 24 hrs of a rain event of 4 mm or greater. Parameters measured at the lab include concentrations of phosphorous (ug/l), *E. coli*, various nitrogen compounds (mg/l), suspended solids (mg/l), and chlorophyll a (ug/l). In addition, measurements of associated parameters including temperature, pH, water depth (cm), Secchi depth (cm), turbidity (NTU), and dissolved oxygen (mg/l) are recorded on site with a field instrument (YSI probe). Additionally, RBG calculates a CCME Water Quality Index (WQI). CCME provides an application to automate the process that incorporates frequency, scope, and amplitude of the data and produces a number between 0 and 100, where 0 represents very poor water quality and 100 represents excellent water quality (CCME 2017). All water quality data collected by RBG can be found online at Great Lakes DataStream (<https://greatlakesdatastream.ca/>). Seasonal Water Quality Monitoring Background for HHRAP Delisting Stations and site-specific remediation actions in Cootes Paradise and Grindstone Marshes (Bowman & Theysmeyer, 2013)

Aquatic Vegetation Monitoring

Vegetation monitoring has been undertaken in Cootes Paradise and Grindstone Creek Marsh for several decades. The monitoring provides an index measure of area of plant coverage, species richness and percent native species. (Court, Bowman & Theysmeyer, 2017).

Aquatic Plant Early Season Monitoring: (2009 – present)

Occurring in late June/early July, 1 m by 1 m quadrat sampling occurs within electrofishing transects to better characterize habitat in the immediate area. A quadrat is placed within the transect three times, ideally one at the beginning, middle, and end of a transect, to produce three sample data points. All aquatic macrophyte species are identified from surface to bottom within the quadrat, and the percent cover is visually approximated, with coverage of filamentous algae also included. Additional species observed in the transect are not quantified but their presence/absence are noted. Plants are identified to species in the field; any that cannot be brought back and identified in lab by RBG's field botanist. Water quality data consists of water depth (cm), Secchi depth (cm), and turbidity (NTU) are also collected at each site (Figure 1). Total area of submerged vegetation (aquatic macrophytes) is calculated as follows: the sum of percent cover within each quadrat within a transect sampled is calculated for each marsh respectively, and that average percent cover is then divided by the total quadrats monitored in each marsh. The available aquatic area (wetted area in hectares) is then multiplied by the average percent cover of aquatic plants in the transects to calculate total hectares. The wetted area was determined from aerial photography with the most up-to-date emergent and meadow marsh areas, which represents the remaining area (other than open water or SAV areas) that could grow aquatic vegetation.

Aquatic Plant Late Season Monitoring: (1995 – present)

Occurring in August, aquatic macrophyte monitoring is done concurrently with fish community monitoring. In this instance, plant species and their associated percent cover are recorded within the 50-m long transects, and does not use the quadrat method. Plants were identified to species in the field; any that could not be identified were brought back and identified in lab by RBG's field botanist. Water quality data including water depth, Secchi depth, and turbidity were also collected at each site. Percent cover and total hectares was then calculated annually as per the process summarized for early season monitoring.

Emergent and Meadow Marsh Monitoring

The emergent and meadow marsh areas were summarized using aerial photography and ArcGIS, typically with new photos to analyze acquired every three years. The area that can support emergent and meadow marsh vegetation was determined using bathymetry and water levels, and dominant plant composition (i.e., *Typha sp.* representative of emergent area), thus producing a series of polygons. Utilizing ArcMap (most recent version 10.1), these base polygons were adjusted to the aerial photo to determine any expansion or regression in each area. The last full area update was based on 2019 aerial photos. However, due to dramatic growth and expansion in 2021, ground-truthing was done with a GPS by walking the outer edge of the main marsh areas to update the emergent data without aerial imagery confirmation, as no up-to-date imagery was available. Subtleties of interior (i.e. shallow side) emergent area change will be captured during subsequent photogrammetric assessment. Emergent plant community composition has not been quantitatively reviewed since the initial ELC work (2011); however RBG staff qualitative observations of community composition has been ongoing.

Invasive Grass Removal - *Glyceria maxima* and *Phragmites australis*

Two invasive plants species dominated the meadow marsh including *Phragmites (Phragmites australis)* and European Manna Grass (*Glyceria maxima*). Both species were present as large areas of monocultures when management started in 2001, and many different removal techniques were trialed. The best management strategy was determined to be herbicide treatments that used glyphosate as the active ingredient and became the focus beginning in 2013. Ecological Land Classifications (ELC) of Cootes Paradise and Grindstone marshes were done in 2011 and 2012, respectively, and plotted on ArcGIS with the use of aerial photos. These were used to delineate polygons that helped determine where the plants were present. Each stand was visited annually, assessed for invasive species presence, and herbicide application was implemented where necessary. Herbicide is not necessarily applied to any regeneration of plants at every stand every year. Time of year and weather help to inform which stands take priority. An external contractor is often brought in to assist as they are more equipped to handle the large areas.

Fish Community

Fish Community Monitoring has been ongoing through multiple projects tied to specific monitoring of projects, and particularly the status of the Common Carp. And includes the Cootes Paradise Fishway, Index Electrofishing, and targeted trap monitoring.

Fishway Operation (1996 – 2022) - Fishway Operation Manual v.3 (Theijsmeijer, Fishway Operation Manual v.3, 2022)

The structure operates seasonally by operating 1- 6 fish catching cages at a time, to facilitate the migration of fish impacted by the barrier, into and out of Cootes Paradise Marsh and associated tributaries. Operation begins each spring after ice out and typically continues until the fall salmon run is over. Inbound cages are first lifted, dumped into a holding tank, and then identified, counted, and sorted as they exit the tank. Native fish are allowed passage into the marsh while nonnative species (Common Carp, Goldfish and Rudd) are sent back out into the Harbour. The same is then repeated for the outbound cages with the only difference being that all fish are sent out into the Harbour as that is where they are intending to go. The frequency of lifts is dependent on the time of year and number of fish seen. As mentioned, all fish are counted as they pass through the Fishway and categorized as either incidental (<25 cm) or large (>25 cm). Large fish are selected at random to be weighed, sexed, measured, and tagged if necessary. Predatory fish (Bowfin, Northern Pike, Largemouth Bass) are checked for tags upon entry into the marsh, and if they are in good condition, may be inserted with a PIT tag for further tracking. The tagging helps to establish a more comprehensive timeline of fish passage into and out of the marsh.

Northern Pike Trap Monitoring (2001 – 2022) – Pike Report (Theijsmeijer & Court, 2018-2020 Status Assessment of Northern Pike at RBG Coastal Marshes, 2021)

Monitoring occurred in June and involved the deployment of customized plexiglass box traps (1ft x 2ft with a 15 ft lead) - referred to as pike traps, set for an overnight period (24 hr) in appropriate habitat conditions (about 2 ft of water) with the intent to capture YOY Northern Pike. Historically, monitoring had been focused on the upper floodplain ponds of Grindstone Creek Marsh as it was deemed the primary pike spawning habitat for Hamilton Harbour and was subject to specific HHRAP restoration projects (Fish and Wildlife Restoration Committee, 1991). These floodplain ponds have little (excluding Pond 1) to no lake level flooding influence under average water levels, resulting in more flooded habitat area during the spring. Habitat improvements in Cootes Paradise Marsh have warranted additional monitoring and have been included in the last decade. However, this unique to RBG sampling gear is limited by high water levels, contributing to site selection decisions. It should be noted that no monitoring occurred in 2021 due to a combination of factors: the low water levels in the spring and staffing restrictions due to COVID-19. In addition, monitoring in 2020 wasn't completed in its entirety due to COVID-19 restrictions.

Index Electrofishing Monitoring (1994 – 2022) - (Fish Community Monitoring Royal Botanical Gardens v.2, 2021)

Monitor sites were initially set up in 1994 and refined in 1995 with an intensive baseline monitoring program throughout multiple months of the year, summarized in Theysmeyer 1999. Monitoring since 2010 has occurred consistently during the end of August. On average, a total of twenty-six transects of 50m in length were sampled by boat in Cootes Paradise and an additional thirteen 50m transects were sampled either by wading or canoe in Grindstone. All transects were broken down into three habitat types; near shore, offshore and lower river, and were spaced as equally as possible throughout the marshes. The electrofisher was a 5PP Smith Root unit up until 2006, switching to the 1.5KVA unit subsequently. Shock was consistently administered between 4-6 amps; no uniform settings were established as conductivity greatly varies across the transects.

Fish were measured on site, with a fish count >10 being totalled. From 1994 - 1999 fish were weighed in the field using a portable scale (Theysmeyer 2000). From 2000 to present day, weight was not measured in the field, but was later calculated utilizing standard formulations to minimize stress levels in the fish. In addition, at the completion of each transect, time of day, electroshocking effort and settings and habitat conditions were recorded on a field data sheet.

Carp Removal (2000 – 2022)

Each year, carp removal efforts are made to attempt to eradicate Common Carp from the entire RBG coastal wetland system, at sites where issues have occurred. This is accomplished through electrofishing and/or seine or gill netting. In Cootes Paradise, this occurs annually from May to December. In Grindstone Creek Marsh the ponds are typically fished twice annually to correct issues: once in the summer, and once in the fall, usually by seining, to further ensure any carp are removed.

Wildlife Populations

Monitoring of multiple groups of wildlife has been undertaken in Cootes Paradise and Grindstone Creek Marsh for several decades. The monitoring provides an index measure of population status versus and total population status. Separately for turtles a total population inventory by species was resolved using Mark-Recapture (Harrison and Theijsmeijer 2014).

Migratory Waterfowl Monitoring.

Periodic monitoring of fall migratory waterfowl numbers was completed at RBG at similar sites used for summary in the HHAP stage 1 Summary Report. However, the diversity and changes of those populations is beyond the scope of this report as well as difficult to determine relevance due to the scale of non-local factors that affect migratory birds. Marsh Birds present during the summer season are captured in the Marsh Monitoring Program for Birds, with methods summarized below.

Marsh Monitoring Program Amphibians

The monitoring protocol is detailed by Birds Studies Canada the coordinating organization for the overall program. In summary, spring breeding frog and toad populations are indexed by volunteers through listening for calling adults at habitat sites. As such salamander species are not inventoried. The protocol requires volunteers to listen for numbers and species at a site within a 100m radius of a shoreline area after dusk. Species and numbers are estimated inside and outside this radius. The protocol is repeated 3 times throughout the spring to capture the different groups of amphibian species. The 3 visits are tied to progressing nighttime temperatures of 5C, 10C and 15C as thresholds for surveys and be separated by a minimum of two weeks. Survey #1 typically occurs in early April, while survey #3 is completed by mid-June. Grindstone and Cootes Paradise Marsh are part of the initial set of monitoring sites established across the Great Lakes in support of AOCs, piloted in 1994 and starting in 1995. This included 6 sites at Cootes Paradise and 3 sites at Grindstone Marsh. Sites without marsh habitat had no survey sites established as no breeding amphibians were present (RBG unpublished observations). Surveying sites lacking in any appreciable habitat continues to not occur.

Currently, 21 sites are regularly surveyed. RBG staff have consistently completed some of the monitoring stations to ensure continuity of data. Species IDs issues occur for some species with volunteers particularly tied to Chorus Frog for which confirmation work occurs by Tys Theijsmeijer by evening secondary surveys since 2011 (Western Chorus Frog a Species at Risk). In addition, due to

changing personnel and volunteers associated with the program over the years current site names and historical station names have changed multiple times. Cootes Paradise was originally Great Lakes marsh site 4 and Grindstone Creek Marsh was site 5. Cootes Paradise currently has four sub-route groupings totaling 16 sites while Grindstone Marsh has two sub-route groupings totaling 5 sites. Special project sites have also occurred over the years.

Marsh Monitoring Program Birds

The monitoring protocol is detailed by Birds Studies Canada the coordinating organization for the overall program. In summary, spring breeding bird populations are indexed by volunteers through listening for calling adults. The protocol requires volunteers to observe and listen for numbers and species at a site within a half-circle 100 m radius of a shoreline area either after dawn or before dusk. Species and numbers are estimated inside and outside this 100m radius. The protocol has evolved from emergent marsh specific nesting species to all birds present over time. The protocol is repeated twice throughout the spring to capture potential sub-stiles in breeding time arrival of the birds and potentially variable conditions at a site. The two visits occur between late May and early July and are separated by at least two weeks. Grindstone and Cootes Paradise Marsh are part of the initial set of monitoring sites established across the Great Lakes in support of AOCs, piloted in 1994 and starting in 1995. This included 6 sites at Cootes Paradise and 3 sites at Grindstone Marsh. Sites without any marsh habitat had no survey sites established as no breeding amphibians were present (RBG unpublished observations). Currently, 21 potential monitoring sites exist. RBG staff have consistently completed some of the monitoring stations to ensure continuity of data.

Winter Muskrat Den Counts

Winter Muskrat Dens are monitored across both marsh areas on an ongoing basis since 2005. Muskrat Dens are generally countable in winter as large mounds (houses/dens) of emergent marsh are constructed during the fall for overwintering. During the winter (typically January) an inventory of the dens is completed by walking across the frozen waters of the marshes. No effort is made to determine the number of muskrats present in a den. An unquantified number of muskrats also den in the banks of the lower river channels, with entrances submerged and thus not countable. This was substantially the condition at the outset of the HHRAP due to the lack of marsh vegetation. The muskrat dens surveys are also part of informing management work in Grindstone Marsh, informing where tunnels through carp exclusion berms may be.

Beaver Population Observations

Beaver presence has been noted on an ongoing basis during the HHRAP period through general observations. Total populations are typically not estimated although the extent of beavers in Grindstone Marsh is tracked as Beavers have been a management challenge tied to tunnelling through the existing carp management barriers. A detailed survey of active beaver lodges was completed in 2020 and 2021 in preparation for this status assessment. Surveys were completed by canoe during evening hours, with an active lodge confirmed by the presents of an adjacent beaver or beaver sounds emanating from the lodge.

Results

Water Quality (Marsh Habitat Conditions)

Water clarity while improved is generally less than 50 cm Secchi depth (Figure 2) and dissolved oxygen is impaired (Figure 3, Figure 4), and regularly less than 5mg/l during the summer season. Dissolved oxygen is occasionally near zero in midwater column, and at times is also supersaturated stressing aquatic biota, approaching 20 mg/L. This supersaturation is most notable in Cootes Paradise’s West Pond area located immediately downstream of the Dundas WWTP. Water clarity is not measured within the interior shelter pond areas but is generally observed to be clear as long as carp exclusion is maintained. At times during the spring as noted in the figures water clarity does occasionally exceed 1m of visibility in the centre station monitoring sites for Cootes Paradise Marsh. For Grindstone Marsh only during the record high water levels of 2019 did water clarity notably improve.

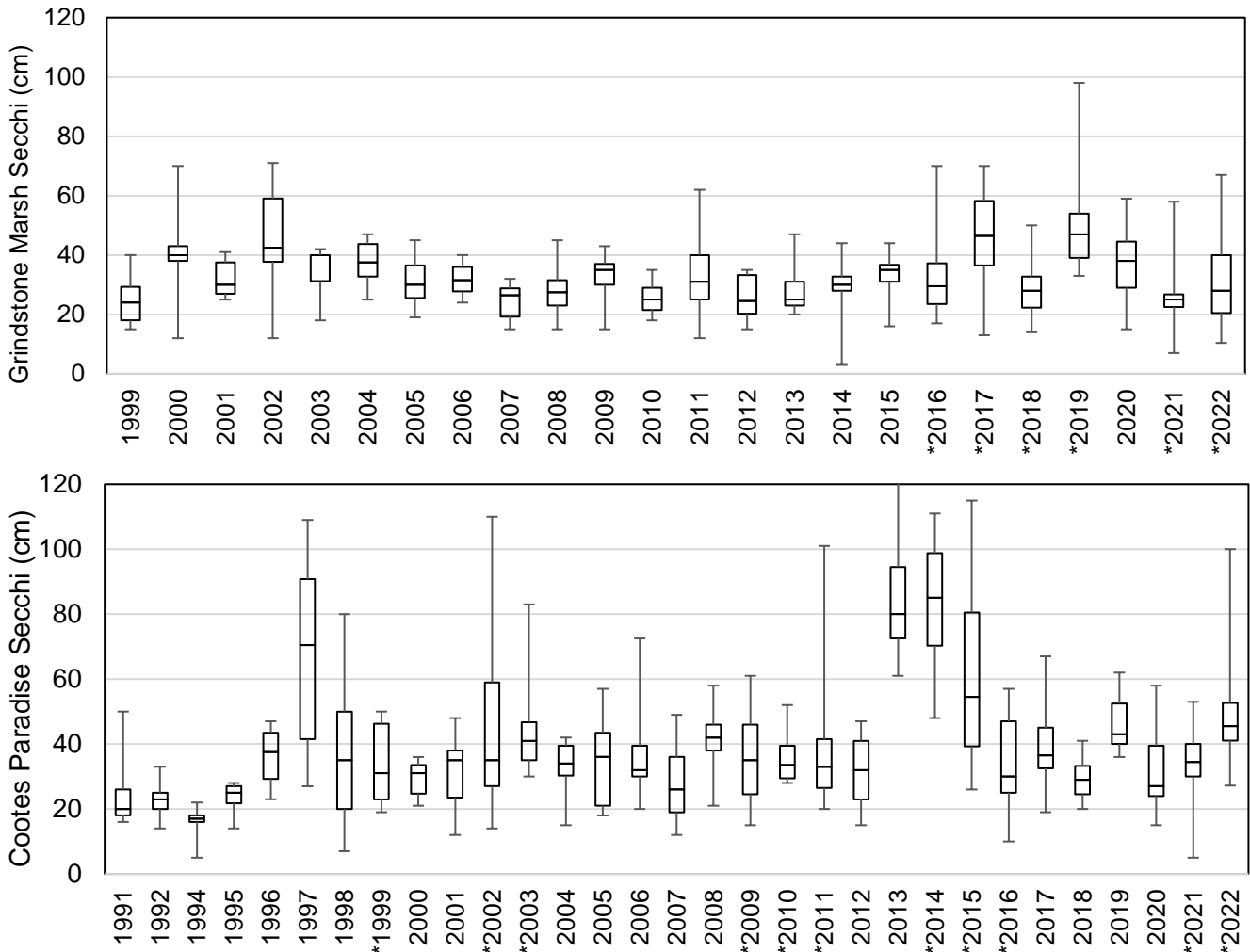


Figure 2 Water clarity (secchi depth) spring and summer samples for Cootes Paradise (above) and Grindstone Marsh (below) delisting stations (CP2, GC1) from 1991 to 2022. *Data include occasion on the bottom result.

Dissolved Oxygen (D.O.) is a water quality parameter which directly impacts quality of habitat for aquatic biota. When DO values fall below 4 mg/L the water becomes less habitable for many fish and other aquatic life. Since 2013 and focus on D.O. at both delisting sites, there have been many

instances where D.O. has been below 4 mg/L throughout the sampling year, most notably in 2018 during the large-scale raw sewage spill from Chedoke Creeks Main-King CSO tank. Large swings in D.O. are also characteristic of impacted eutrophic aquatic systems. Cootes Paradise continues to experience large daily swings in D.O., especially in the most sewage impacted areas of West Pond and Chedoke Creek (Bowman, 2020). Supersaturation is more associated with algal blooms or extremely dense vegetation, and aquatic plant recovery may ameliorate the issue in the nearer term. Some fluctuation in D.O. is characteristic of a healthy marsh.

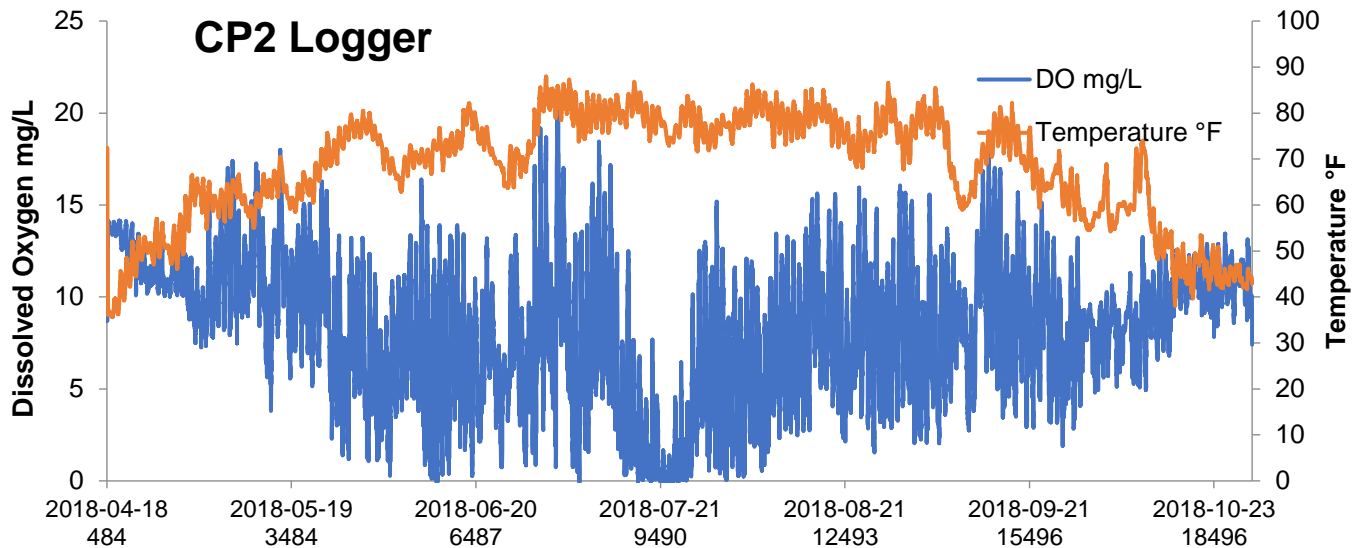


Figure 3. Temperature and Dissolved Oxygen (DO) example from a D.O. Loggers project in 2018 at delisting centre station CP2 of Cootes Paradise Marsh illustrating the fluctuations seen in oxygen.

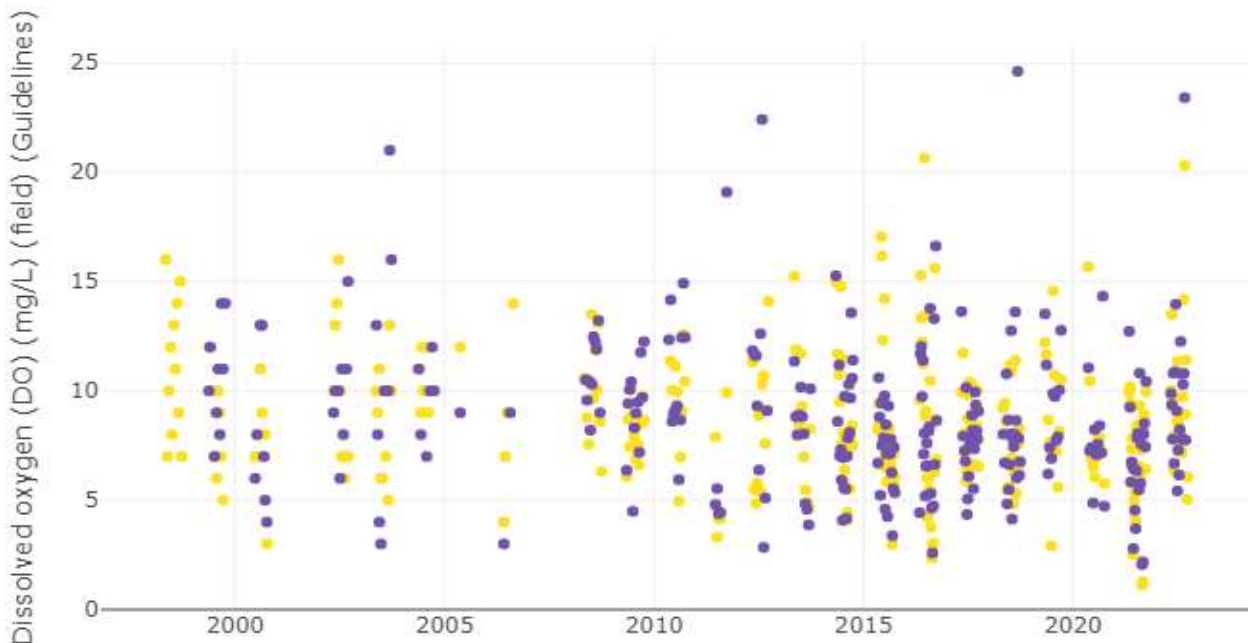


Figure 4 Dissolved Oxygen (DO) values measured in mg/L at HHRAP delisting stations about mid-day between May and October at CP2 (yellow) and GC1 (purple). Plot taken from RBG dataset on Great Lakes Datastream (<https://greatlakesdatastream.ca>)

A water quality index (WQI, by CCME) for both marsh delisting stations summarize the water quality parameters into a single value and indicates improved but marginal water quality conditions on average. The WQI version used incorporates total nitrate as N, inorganic suspended solids, total suspended solids, total phosphorus, *E. coli* and D.O. (Bowman, 2022). Good quality water scores are 90-100 for the index. Water quality conditions rate as marginal with a score in the 50s currently. The WQI indicates an inconsistent, but positive trend in Cootes Paradise, with an improvement from 2021 to 2022 (Figure 5). However, the last three years' values were poor (2021-low water) to marginal (2020 and 2022), meaning that Cootes Paradise is consistently impaired but perhaps close to a tipping point. In Grindstone Marsh, the WQI was slightly better, producing values that were consistently marginal, but perhaps with a slight decline over the past 20 years (Figure 5).

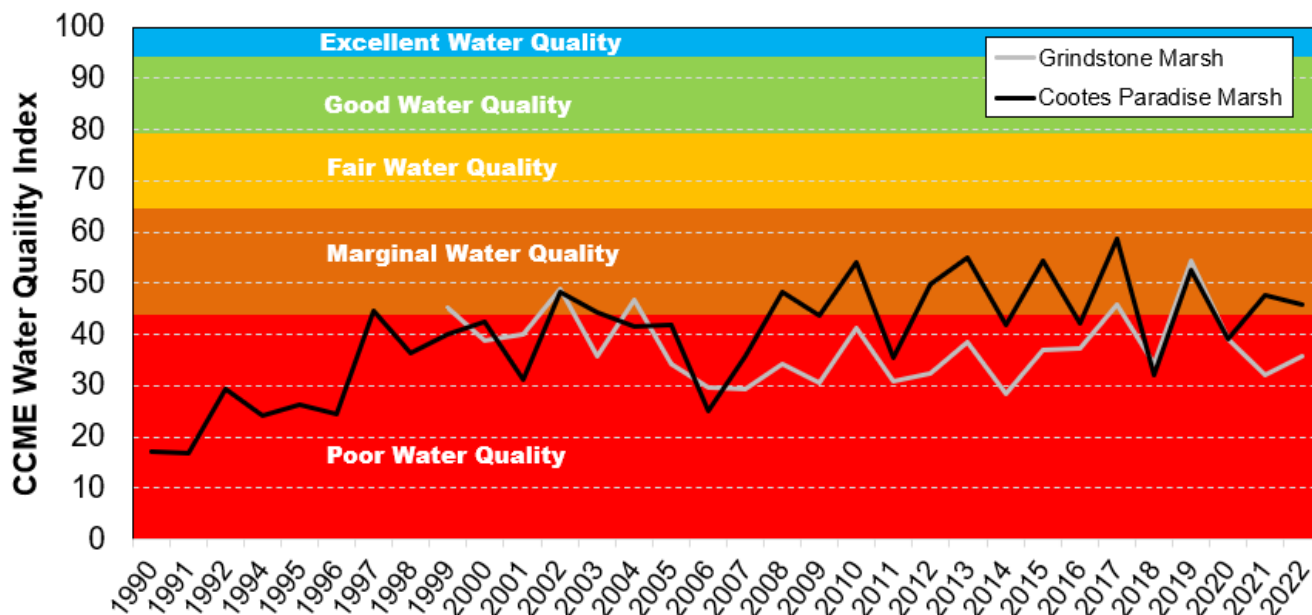


Figure 5. Canadian Council of Ministers of the Environment (CCME) Water Quality Index score coastal marsh centre stations (HHRAP delisting station - GC-1, CP-2 – May to September data) using the subset of parameters of Nitrate-N, Inorganic Suspended Sediment (ISS), Total Suspended Sediment (TSS), Total Phosphorus, *E. coli*, and Dissolved Oxygen. Scores >90 = appropriate clean water.

Plant Community Status

As of the 2022 early-field season in terms of plant area coverage, a total of 75.5 ha of marsh vegetation (aquatic macrophyte, emergent and meadow marsh) was calculated for plant coverage of Cootes Paradise Marsh and 19.1 ha of marsh vegetation in Grindstone Creek (Figure 24). For both marsh areas this is a significant increase in plant coverage (Figure 6) Overall submerged aquatic plant coverage represents 9.5% cover in Cootes Paradise and 20.6% of the cover in Grindstone Marsh (using the later/August aquatic plant results). Consistent with all past years, the later season monitoring in Cootes Paradise, experienced drastic declines in the aquatic macrophyte community coverage. Review of 2022 aquatic plant cover quantified a decreased of almost 12 ha from June to August monitoring (Figure 25). In Grindstone Marsh, there was no significant change between each monitoring season due to abundance of later season white water lily, however, similar drought conditions were experienced resulting in five transects not being sampled. Overall, as of 2022 status monitoring, marsh vegetation covered 31% of the combined coastal marsh areas (Figure 6).

The overall coverage of floating leaf plants has been notably impacted in recent years. White Waterlily (*Nymphaea odorata*) in Cootes Paradise's West Pond area had steadily increased over the years and in 2019 had reached a coverage that exceeded any other area across both marshes at nearly 8 hectares. In 2020 a plant die-off in West Pond essentially erased all aquatic plants from the pond including the waterlilies (save for a few yellow water lily). The cause was likely due to a potential overflow event from the Dundas Wastewater plant during the previous winter (Norris et al. 2021). Since the mass die-off, large filamentous algal blooms have been prevalent, deterring other aquatic plant growth. In 2022 a similar water lily die-off occurred in Long Pond (Grindstone Marsh). Plant coverage in transect LLP2 decreased from 90% to only 25% between early and late season monitoring. It is unclear why this occurred as lilies to the lower east end of the pond were not affected. The Long Pond die off area however is a location of a former sewage outfall (Rebalka et al. 2023).

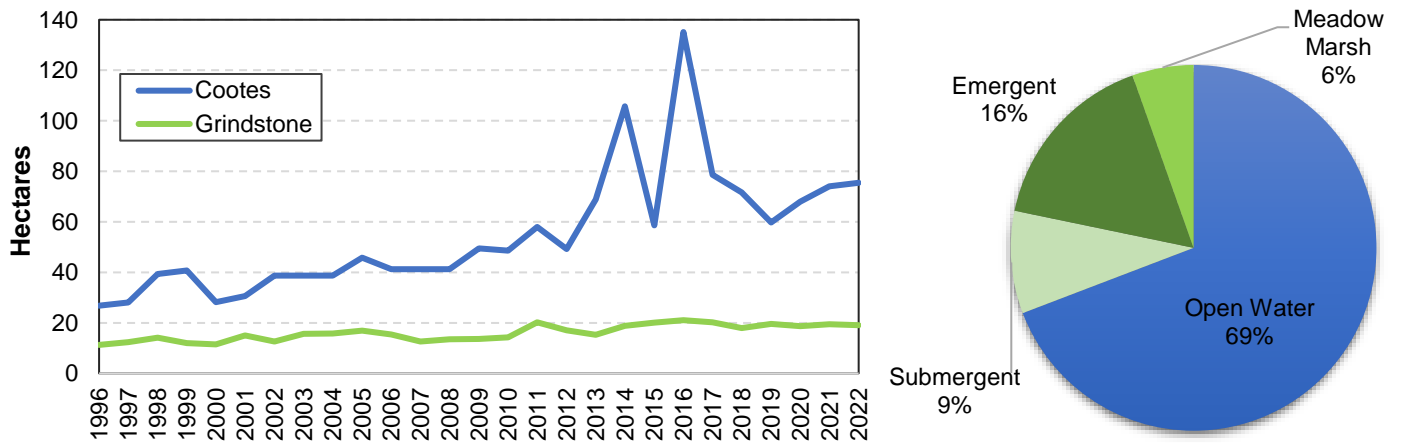


Figure 6a. Total marsh vegetation area trends in Cootes Paradise and Grindstone Marsh. Cootes Paradise Marsh delisting target 230ha., and Grindstone Marsh delisting target is 40ha. Figure 3b. The 2022 Coastal marsh area breakdown between different vegetation types (Cootes Paradise and Grindstone Marsh combined).

For species diversity, aquatic plants were essentially extirpated from the marshes at the outset of the HHRAP save for an area adjacent to Carrolls Bay by Grindstone Marsh. A diverse list of plant species now found with the aquatic species occurring in monitoring sites listed in Table 1. Overall the dominant aquatic plant has become White Water Lily (*Nymphaea odorata tuberosa*), an original native species steadily increasing until recent years, with seasonal and year to year appearances of multiple other aquatic species depending on water level and quality conditions (Figure 25). A total of 23 aquatic plant species have been observed in recent years, a significant increase from almost no species and plants at the outset of the HHRAP (Table 1). Dense areas are found in interior inlets and ponds while areas associated with ongoing stressors are lacking vegetation or are dominated by algae (Figure 41). For the emergent marsh, cattail hybrid (*Typha x glauca*) continues to dominate the area, but now with notable patches of Burreed (*Sparganium americanum*), and River Bulrush (*Bolbuschenoenus fluviatilis*) in localized areas, particularly interior ponds in the meadow marshes. At the same time Water Willow (*Decadon verticillatus*) has been reduced to small remnants due to high water levels and competition with invasive grass species (RBG unpublished). Directed reintroduction of Southern Wild Rice (*Zizania aquatica*), ongoing since 2003, has met with measurable success in recent years with several sites maintaining self-seeding populations in 2022. The full detail species list is found in the RBG Spontaneous Flora of the Nature Sanctuaries Checklist (Smith 2003).

Table 1. Aquatic plant species from index monitoring, species pooled and nonnative species highlighted red.

Cootes Paradise Index Monitoring - August		Grindstone Marsh Index Monitoring - August	
1996-2000	2016-2022	1996-2000	2016-2022
14 Total Species	18 Total Species	11 Total Species	23 Total Species
18% total cover nonnative (mean)	8% total cover nonnative (mean)	10% total cover nonnative (mean)	4% total cover nonnative (mean)
21% nonnative species within plant community	17% nonnative species within plant community	9% nonnative species within plant community	13% nonnative species within plant community
<i>Ceratophyllum demersum</i>	<i>Ceratophyllum demersum</i>	<i>Ceratophyllum demersum</i>	<i>Ceratophyllum demersum</i>
<i>Elodea canadensis</i>	<i>Lemna minor</i>	<i>Lemna minor</i>	<i>Elodea canadensis</i>
<i>Lemna minor</i>	<i>Lemna trisulca</i>	<i>Myriophyllum spicatum</i>	<i>Heteranthera dubia</i>
<i>Lythrum salicaria</i>	<i>Myriophyllum spicatum</i>	<i>Nymphaea odorata</i>	<i>Lemna minor</i>
<i>Myriophyllum spicatum</i>	<i>Najas minor</i>	<i>Polygonum sp.</i>	<i>Lemna trisulca</i>
<i>Nasturtium officinale</i>	<i>Nuphar variagata</i>	<i>Potamogeton amplifolius</i>	<i>Myriophyllum spicatum</i>
<i>Nymphaea odorata</i>	<i>Nymphaea odorata</i>	<i>Potamogeton foliosus</i>	<i>Najas flexilis</i>
<i>Polygonum sp.</i>	<i>Potamogeton crispus</i>	<i>Potamogeton natans</i>	<i>Najas minor</i>
<i>Potamogeton crispus</i>	<i>Potamogeton foliosus</i>	<i>Potamogeton nodosus</i>	<i>Nuphar lutea</i>
<i>Potamogeton foliosus</i>	<i>Potamogeton sp.</i>	<i>Potamogeton richardsonii</i>	<i>Nuphar variagata</i>
<i>Potamogeton sp.</i>	<i>Riccia fluitans</i>	<i>Stuckenia pectinate</i>	<i>Nymphaea odorata</i>
<i>Stuckenia pectinata</i>	<i>RicciaCarpos natans</i>	<i>Filamentous algae species</i>	<i>Persicaria lapathifolia</i>
<i>Vallisneria americana</i>	<i>Spirodela polyrhiza</i>		<i>Potamogeton crispus</i>
<i>Zannichellia palustris</i>	<i>Stuckenia pectinata</i>		<i>Potamogeton foliosus</i>
<i>Filamentous algae species</i>	<i>Utricularia vulgaris</i>		<i>Potamogeton sp.</i>
	<i>Elodea canadensis</i>		<i>Riccia fluitans</i>
	<i>Vallisneria americana</i>		<i>RicciaCarpos natans</i>
	<i>Potamogeton perfoliatus</i>		<i>Rumex verticillatus</i>
	<i>Filamentous algae species</i>		<i>Spirodela polyrhiza</i>
			<i>Stuckenia pectinata</i>
			<i>Utricularia vulgaris</i>
			<i>Vallisneria americana</i>
			<i>Wolffia borealis (sp)</i>

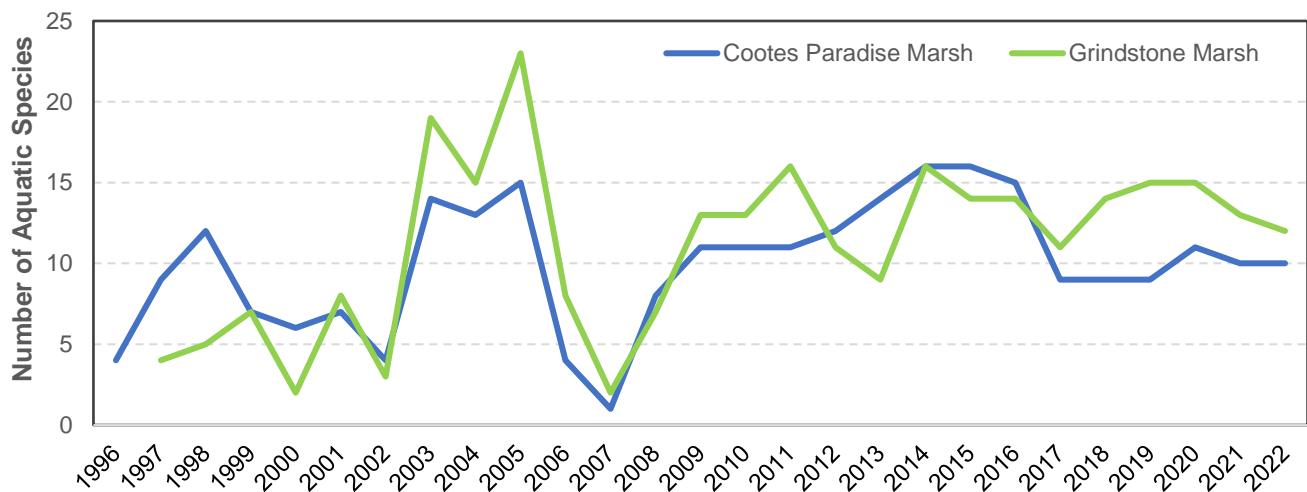


Figure 7. Annual plant species richness from aquatic monitoring quadrates in the marshes (early summer).

Longer Term Plant Community Trend

Both marshes have had increasing vegetation over time, but with periodic setbacks. Cootes Paradise vegetation had been showing consistent increases, but total areas of coverage peaked in early season 2016. This was due to subsequent losses of the submerged aquatic vegetation component (Figure 6, Figure 24). This is directly tied to the Chedoke Creek sewage spill discovered in 2018 (spill determined to be 2014-2018), coupled with record high water in 2017 and 2019. 2018 in particular had a second spill resulting at the same location resulting in large scale raw sewage circulating throughout both marsh areas (Main King CSO tank). This limited light penetration due to intense algae growth, particularly for the submerged aquatic plants (Mataya and Bowman 2019; Theysmeijer 2021). Over the longer term, this also illustrates the continual increase in the number of submerged/floating leaf species since 2007. Almost no species occurred at the outset of the HHRAP. Additionally, in Table 1, species diversity has increased, and percent of non-native aquatic plant cover is decreasing. The native Water Lily (*Nymphaea odorata*) has been the dominant aquatic plant species over the last 7 years (2016–2022) in both marshes. Although dramatically impacted in 2020 and 2021 in Cootes Paradise due to losses noted previously.

Grindstone Marsh has shown mixed results. Areas lacking carp exclusion have lost essentially all vegetation that was formerly present at the outset of the HHRAP. Areas protected from carp as well as other water quality stressors have shown a significant increase in plant coverage, particularly aquatic/floating leave. Several sub areas have remained essentially fully vegetated since carp were excluded, while other areas have had variable results.

Despite the Chedoke sewage spill and record high lake levels of 2019, and the losses of submerged aquatic vegetation, both marshes have shown an increase in emergent area. Within Grindstone Marsh, Osprey Marsh and Pond 1 subareas increased total emergent area from 7.1 to 7.8 ha, currently at the largest extent since the HHRAP began. In Cootes Paradise, 5.7 ha of emergent area was gained over the last 3 years, primarily a result of the successful expansion of the Spencer Creek delta and seedling germination under low water. In 2022 emergent marsh declined again in the early season with notable die offs from the previous year's seedling plants, but showed some recovery aided by low lake levels in the second half of the year. The outcome of status is that as of the end of 2022, area was approximately the total area measured in the previous year (the last year of detailed measurement).

The meadow marsh area, fully vegetated at the outset of the HHRAP, continues to remain vegetated, although is currently in transition from non-native invasive plants to native plants as a result of ongoing management actions. The estimated area of meadow marsh was 11.0 ha for Cootes Paradise and 5.7 ha for Grindstone Marsh as of the last update from the 2019 aerial photos. The area is expected to notably change as a result of both the 2019 record water levels and the ongoing large scale invasive plant elimination.

Plant Community Restoration Through Direct Planting and Management

To expedite vegetation recovery, RBG has reintroduced several historically important and previously occurring plant species as well as undertaken large scale native cattail plantings. The original focus has been on emergent plant species, and a Southern Wild Rice (*Zizania aquatica*) project. This plant continues to be rare and restricted in distribution, however in 2022 a number of plants and locations grew at 11 locations in Grindstone Marsh and at 21 locations in Cootes Paradise (Rebalka et al. 2023). Emergent marsh plant species successfully reintroduced include Three-square/American Bulrush

(*Schoenoplectus americanus*), Hardstem Bulrush (*Schoenoplectus acutus*), Prairie Cordgrass (*Spartina pectinate*), Pickerel Weed (*Pontideria cordata*), Arrow Arum (*Peltandra virginica*), and wild rice as noted. Yellow Waterlily (*Nuphar variegatum*) has also been planted in both marshes, salvaged from outer Grindstone Marsh and adjacent Long Pond, prior to their extirpation from these stressed locations. RBG will continue plant reintroduction for shorelines and as emergent marsh biofilters on inflowing streams, with the intention of accelerating and/ or establishing a large expanse of new aquatic and emergent growth overcoming the of the ongoing stressors for plant seedlings.

In 2013, a *Phragmites* management strategy was established and in 2016 a Manna Grass strategy was established. As of 2022, *Phragmites* has decreased from an initial estimated stem count of six million stems in 2013 to only about 8,000 in both Cootes Paradise and Grindstone Marshes in 2022. The original overall combined area was about 9-ha and continued to form new colonies since that assessment. As of 2022, just over 14-ha of area that once was dominated by *Phragmites* has been treated with herbicide leaving this species at a low level (Figure 29. Example of *Phragmites* population conditions in Cootes Paradise as of 2022). Manna Grass management has also been similarly successful. Herbicide treatments began in the fall of 2016 in several embayment inlets and the main meadow marsh area of Cootes Paradise, with 34-ha having undergone primary treatment since then (Rebalka et al. 2023). Native species have emerged from the seed bank after Manna Grass eradication (Rebalka et al, 2023). See Figure 29 for a map highlighting *Phragmites* stands and respective stem densities. With the success of RBG's management efforts, it is evident that the targeted invasive species are declining, however these species are not yet fully eradicated, as new shoots continues to come up after management including seedlings.

Fish

Fishway Operation (1996 – 2022)

Since the construction of the Fishway in 1996, there has been a noticeable decline in the number of Common Carp trying to enter the marsh. From 1996 – 2000, Common Carp represented most of the fish seen at the Fishway, reaching population numbers of over 20,000 (Figure 8). Common Carp for the last 5 years average about 3,000 carp are caught in the Fishway each year (Figure 8) as compared to numbers of 20,000 at the outset. A number of native species have significantly increased, as well as two invasive species - Rudd and Goldfish. For native species in recent years, Brown Bullhead and White Suckers have been the most prevalent species caught at the Fishway. Channel Catfish, Bowfin, Gizzard Shad and Freshwater Drum have maintained consistent population numbers within recent years, while Rainbow Trout, Northern Pike and Largemouth Bass have experienced (Table 2). Brown Bullhead, Gizzard Shad, and Bowfin have population many times that compared to the outset of the HHRAP, while Northern Pike are nearly extirpated. Species richness overall is also on the decline as measured in all fish monitoring activities (Figure 9).

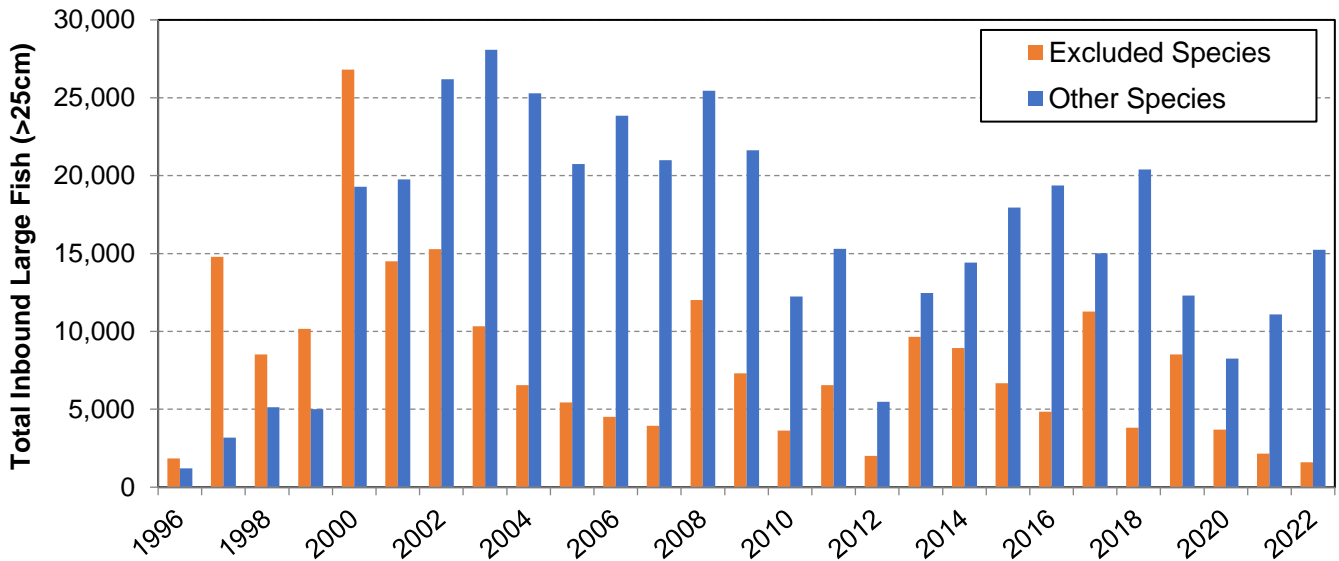


Figure 8. Annual number of inbound invasive species (excluded species) and native fish (other species) at Cootes Paradise Fishway. Excluded species includes Common carp, Goldfish, Carp x Goldfish hybrids, and Rudd.

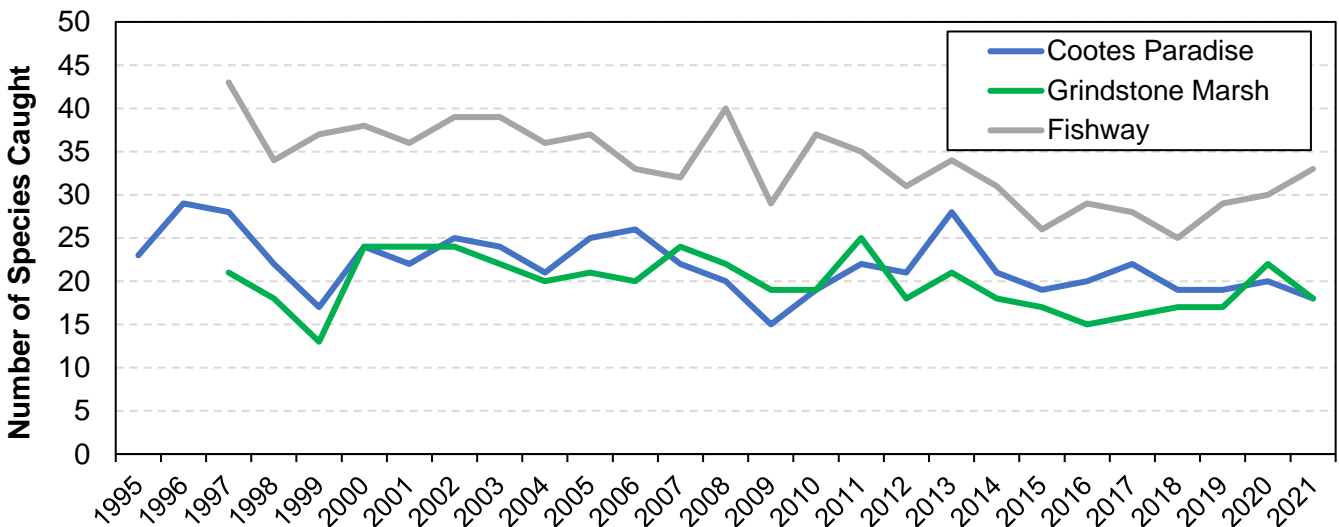


Figure 9. Total fish species found at the Fishway and during August index electrofishing index

Pike Trap Monitoring (2001 – 2022)

The assessment of Northern Pike use of Grindstone Marsh and Cootes Paradise Marsh found mixed results. The overall Pike population remains very low and is now likely lower than it was during the onset of the HHRAP planning in 1991, despite improved spawning and nursery habitat in both marshes and increased spawning success within Cootes Paradise (Theijsmeijer and Court, 2021). In Figure 10, there is a noticeable spike in Common Carp caught from 2018 to 2022, however these did not translate into many YOY later in the season. In the 2022 season (Table 5), 12 traps were set in Grindstone Marsh, catching 856 fish representing 20 species, however only 2 of those were YOY Northern Pike (Rebalka, et al. 2023). Grindstone had an overall catch per unit effort (CPUE) of 1.73 fish/hr. with Ponds 2 and 3 experiencing the highest catch numbers. Only 10 traps were set in Cootes Paradise, catching 1331 fish representing 12 species for a CPUE of 6.08 fish/hr and only 4 YOY Pike were

caught (Rebalka, et al. 2023). It should be noted however, that just over 1,000 of those were from one female Brown Bullhead and her young. In 2020, only 6 traps were set per marsh due to COVID-19 staffing restrictions. Regardless, 13 YOY Northern Pike were caught (4 in Grindstone and 9 in Cootes) (Norris, et al. 2021). In 2019 no YOY Pike were caught in Cootes Paradise, but 9 were caught in Grindstone Marsh. Water levels were much higher in 2019, so it could be possible that the Pike were spawning in other newly accessible areas that weren't monitored (Mataya, et al. 2020).

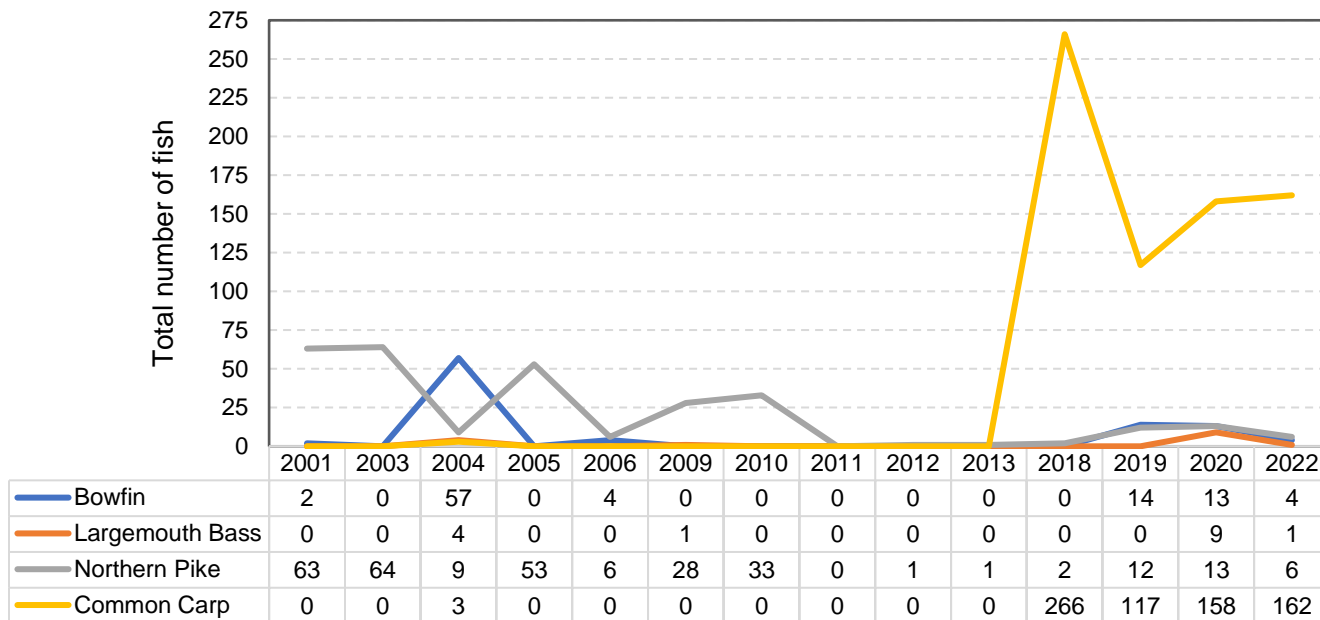


Figure 10. Total number of predatory fish caught each year in the pike trap monitoring, compared against Common Carp. (No monitoring occurred in 2002, 2007, 2008, 2014-2017, 2021)

Index Electrofishing Monitoring (1994 – 2022)

During the electrofishing monitoring, there has been a general decline in the number of fish caught each year, except for 2020, where there was a rise in total catch (Figure 11). Upon further investigation it was concluded that this spike coincided with a large Bluegill and Pumpkinseed YOY success that influenced the numbers (Rebalka et al. 2023). The last big change in catch numbers occurred back in 2011 due to high water levels, allowing for floodplain inundation (Epp & Court, 2012). Mean number of YOY fish caught/ transect has remained relatively low over the last 9 years, not reaching a value of 20 YOY fish/transect since 2013 (Figure 12). Positively, YOY Common carp/transect has remained below 1 fish/transect since 2013, and in 2022, no YOY carp were found in either Marsh system through monitoring (Figure 14, Tables 3 &4).

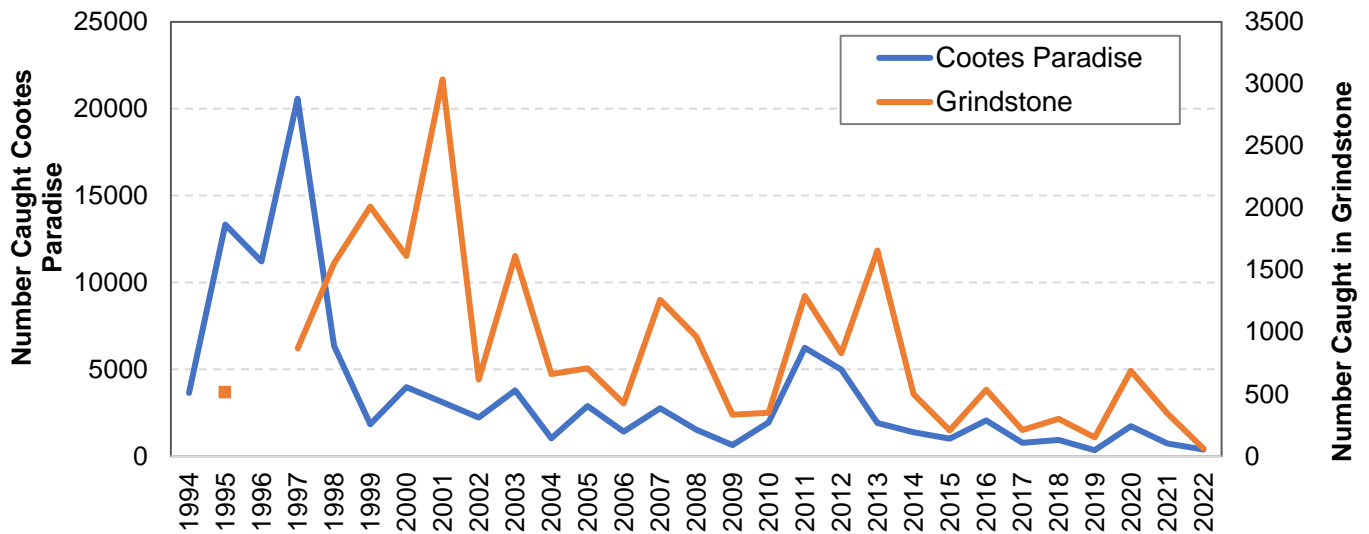


Figure 11. Total number of fish captured in Cootes Paradise and Grindstone marshes during annual electrofishing surveys. (No monitoring took place in Grindstone in 1994 and 1996)

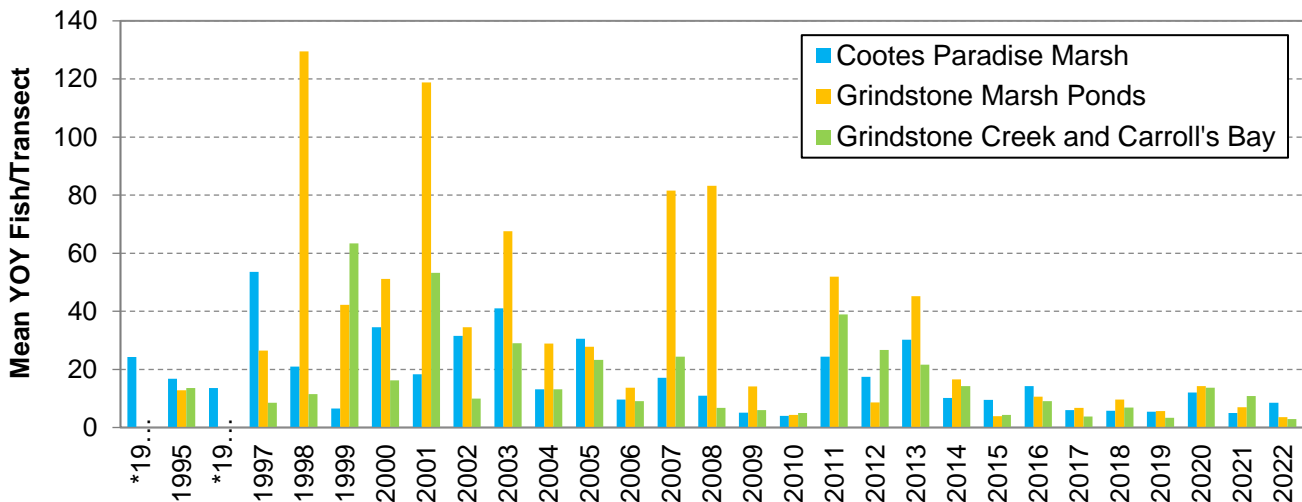


Figure 12. Mean Young of the Year (YOY) fish per transect, by year, for Cootes Paradise Marsh, Grindstone Marsh Ponds, and Grindstone Creek and Carroll's Bay Marsh (Outer Grindstone Marsh).

Common Carp Management

The Cootes Paradise Fishway initiated operation in 1997 significantly lower marsh biomass (Figure 13). Berms were built to exclude carp from a portion of Grindstone Marsh starting in 2000. Current densities are less than 5% of densities at the outset of the HHRAP. To maintain/achieve a low density of carp removal of large carp from these marsh areas has been necessary due to barrier issues as well as the growth of new younger carp. Since 2000, RBG has removed 40,037 large carp (>30cm fork length) from just Cootes Paradise Marsh alone. This doesn't include fish that are prevented from entering at the Fishway or Young of Year found (Figure 15). Additionally, from the protected areas of Grindstone Creek Marsh areas separated from the creek by a berm, another 3,413 have been removed over the last 22 years. Many of these fish were returned to the harbour system directly. Overall, few new carp are being added to the system contributing to the ongoing decline of the carp population (Figure 22).

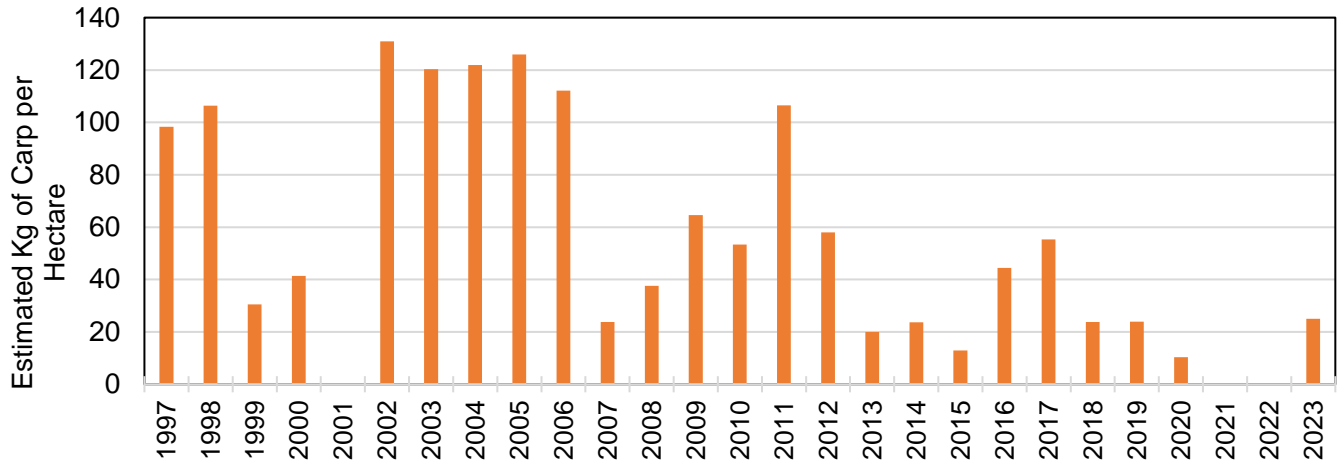


Figure 13. Estimated large carp biomass (fish >30cm fork length) in Cootes Paradise since the carp barrier initiated in 1997. Target is <20kg/ha, with per barrier densities of carp estimated at 800kg/ha. Estimated based on index electrofishing results

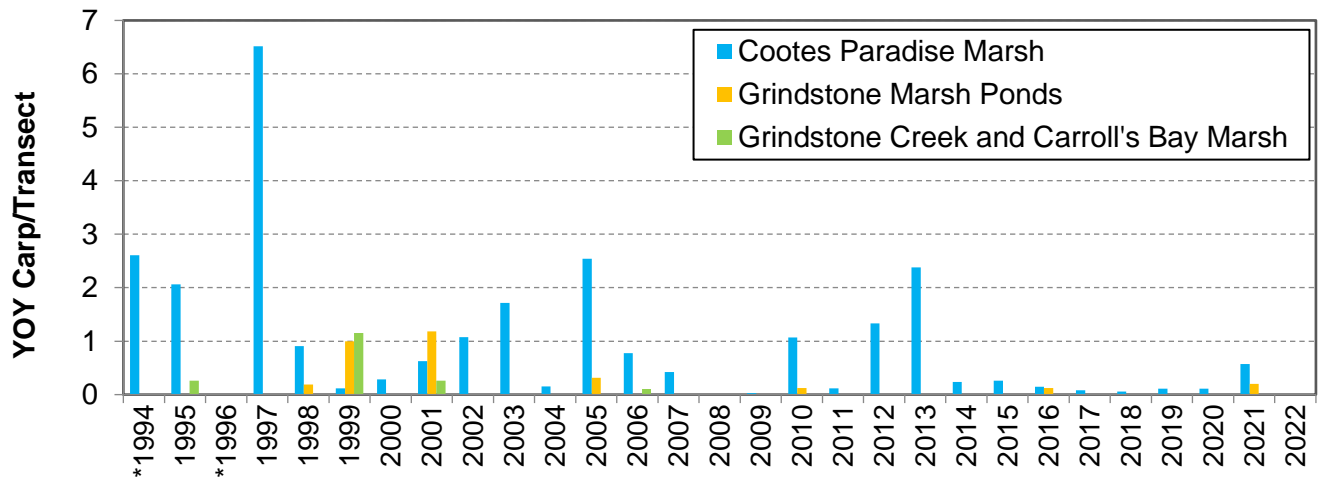


Figure 14. Mean number of YOY Common Carp (and hybrids) caught in August electrofishing transects, by year, for Cootes Paradise Marsh, Grindstone Marsh Ponds, and Grindstone Creek and Carroll's Bay Marsh.

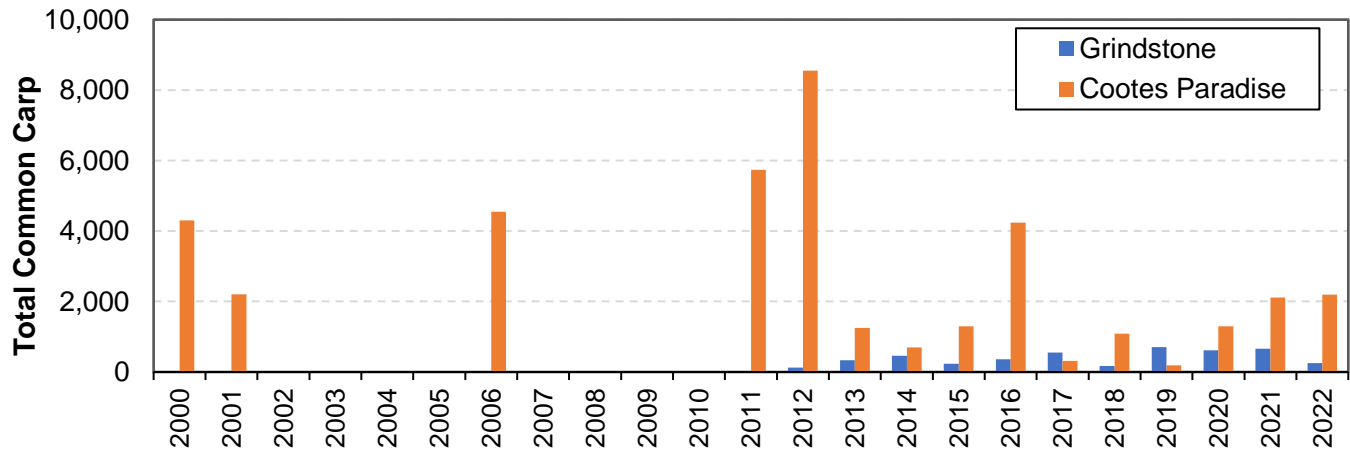


Figure 15. Total number of Common Carp removed from Cootes Paradise and Grindstone Marshes from 2000 - 2022. *The Grindstone Marsh numbers only include carp removed from protected areas.

Amphibian Index Marsh monitoring Program

Monitoring was originally restricted to sites with remnants of habitat with 9 sites surveyed at the outset of the HHRAP (Table 6, Table 7). Since that time and addition 14 sites have been added to track progress of amphibian recolonization across the two marshes (Cootes Paradise 12 sites, Grindstone Creek Marsh 6 sites). The detailed summary is found in the Appendix. A subset of the monitoring stations has been surveyed almost every year since 1995. Large areas continue to lack any suitable habitat and as a result have no survey activity or calling amphibians. Reestablishment of calling amphibians has occurred at many sites where habitat is again found. Amphibians have reestablished in middle zone areas of Grindstone Creek Marsh restoration areas as well as several localized small inlets across Cootes Paradise.

Amphibian abundance is generally low. For Cootes Paradise of the 162 station visits during 2018-2022, 66 visits recorded no amphibians at all. Most of these visits were for the first of the three visits, "Visit 1" typically the first week of April (Table 6, Table 7). A similar scenario has occurred for Grindstone Creek Marsh. No stations achieve a call code of 3, referring to a full chorus (an inestimable number). Only Upper Paradise Pond (ON657A, Figure 16, Table 8) **Error! Reference source not found.** of Cootes Paradise occasion has species achieving a code 2 call level (i.e. difficult to estimate the number of calling amphibians). In 2022 this station had a total of 5 species, and a total of 60 individuals heard, with the most abundant species being Gray Treefrog. Several hundred individuals of 6 species were heard at this station a decade previous, while only a handful of individuals were found at the site at the outset of the HHRAP 25 years previous (Table 6, Table 6. Amphibians of Cootes Paradise Marsh Monitoring Program. Standard annual monitoring includes 3 visits per site.

, Table 7).

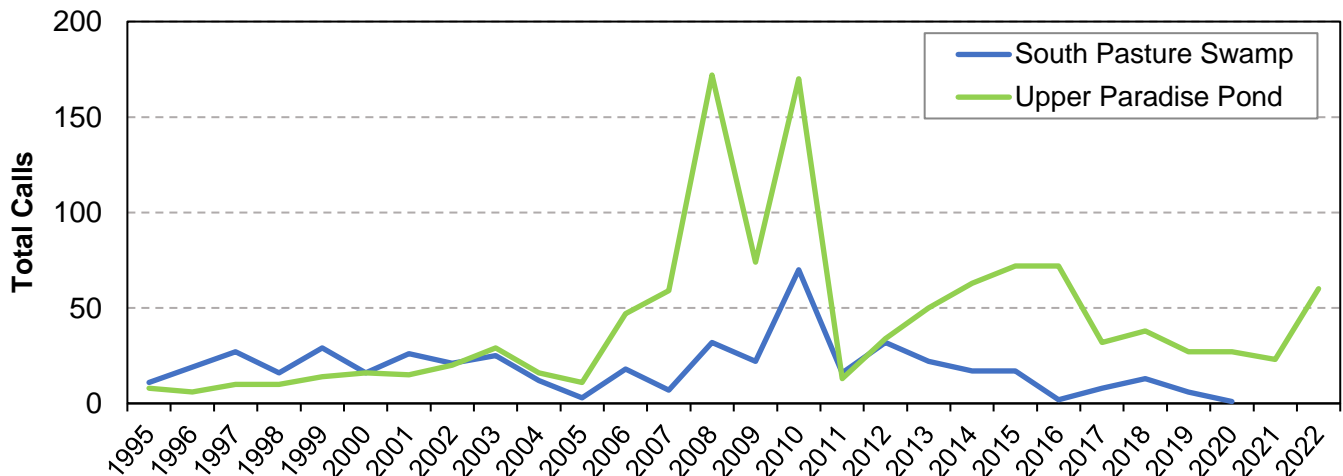


Figure 16. Trend total calls heard annually (3 visits pooled -Marsh Monitoring Program) at the highest quality habitat sites for amphibians (Upper Paradise Pond -Cootes Paradise, South Pasture Swamp -Grindstone Marsh).

Total species richness of the past five years includes 5 species (Table 8, Table 9). As of 2022 a total of 5 species are found at Cootes Paradise Marsh, with Grindstone Marsh reduced to 4 species. In addition, a total of 3 species are extirpated since the outset of the HHRAP including Western Chorus Frog, Pickerel Frog and American Bullfrog. In addition, Wood Frog and Spring Peeper are essentially extirpated from all habitat areas at RBG, with the occasional individuals heard suspected to be washed down from upstream habitats. The last Wood Frog was recorded in 2017. During recent surveys most

species have demonstrated a slight decline in number, except for American Toad at Cootes Paradise Marsh. Cootes Paradise's West Pond (ON657C) is a significantly impacted interior pond habitat location lacking most amphibians in direct contrast to the Upper Paradise Pond site (ON657A). The most commonly heard species across Cootes Paradise Marsh sites is Gray Treefrog, while in Grindstone Marsh and Cootes Paradise Green Frog are also commonly heard with the Green Frog the overall most abundant species of Grindstone Marsh (Figure 17). The Northern Leopard Frog and American Toad are also locally somewhat numerous at a subset of sites and found through most the Grindstone Marsh sites. No locations of large populations exist for any species at any site.

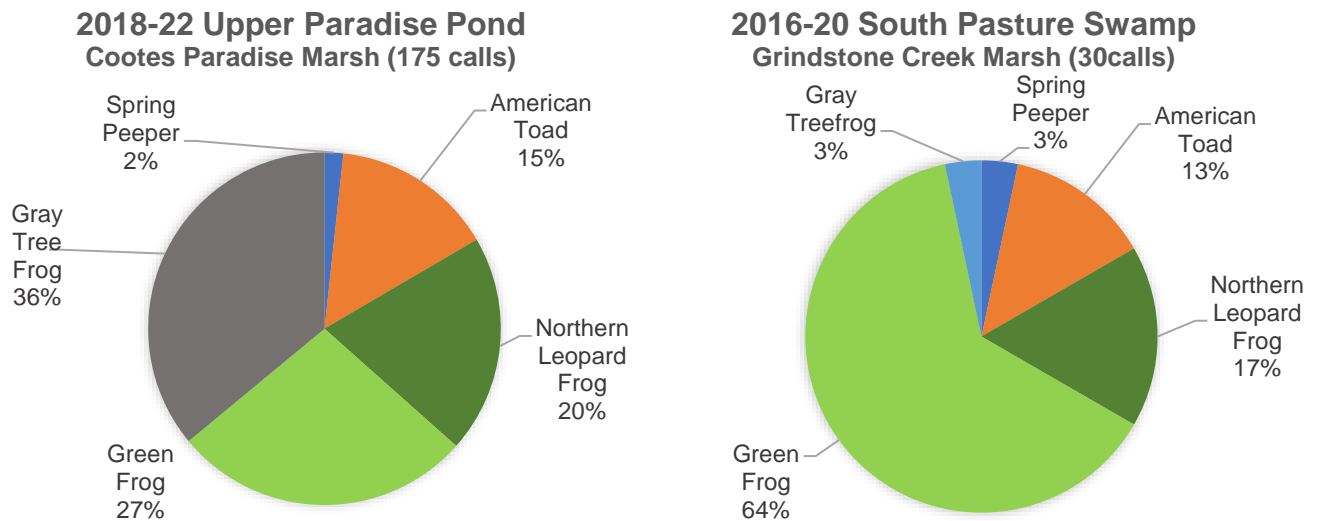


Figure 17. Amphibian species Marsh Monitoring Program at the highest quality habitat stations including Upper Paradise Pond Cootes Paradise (175 total calls) and South Pasture Swamp Grindstone Marsh (30 total calls). Both sites are oxbow ponds supplied by localized spring water and within upstream areas of the coastal marsh.

Bird Index Marsh Monitoring Program

Overall, the diversity of birds encountered is extensive and includes more upland bird species than marsh birds due to nature of the overall RBG site and the adjacent forested areas. During the period of the program 87 bird species have been noted at Cootes Paradise and 61 species at Grindstone Creek Marsh (Table 10, Table 11). The detailed summary is found in the Appendix. As with the same amphibian survey sites, survey data is biased to having sites only where marsh habitat currently exists (particularly emergent marsh). Upwards of half of each marsh area has no survey data consequently due to a lack of marsh habitat. This emergent marsh habitat type bias is tied to the original intent of the program with was to locate emergent marsh specific breeding birds. In total, Grindstone Creek Marsh recorded 30 species in the past five years ranging between 9 and 26 species annually with data consistently coming from five locations (Figure 18). Cootes Paradise recorded 38 species ranging between 16 to 30 species annually. Both locations show an overall trend decline in species richness - about 20% and abundance - about 10% (Table 10, Table 11). Bird abundance per site visit at a station average about 14 birds at Grindstone Creek Marsh and 15 birds at Cootes Paradise Marsh in recent years. In the early years of the monitoring program Grindstone Creek Marsh average 17 birds per station with Cootes Paradise stations averaging 21 birds.

Marsh birds are dominated by Red Winged Blackbirds at about 25-30% of all birds, with Tree Swallows typically foraging throughout the sites as well as multiple other swallow species. In Grindstone Marsh in recent years Barn Swallows have slightly outnumbered Tree Swallow. Waterfowl are uncommon with occasional Wood Duck, Mallard Duck, Canada Goose and European Mute Swan present. Marsh Wrens and Swamp Sparrows are locally numerous at several West Cootes Paradise sites. At Grindstone Marsh Song Sparrows are also common at some monitoring sites.

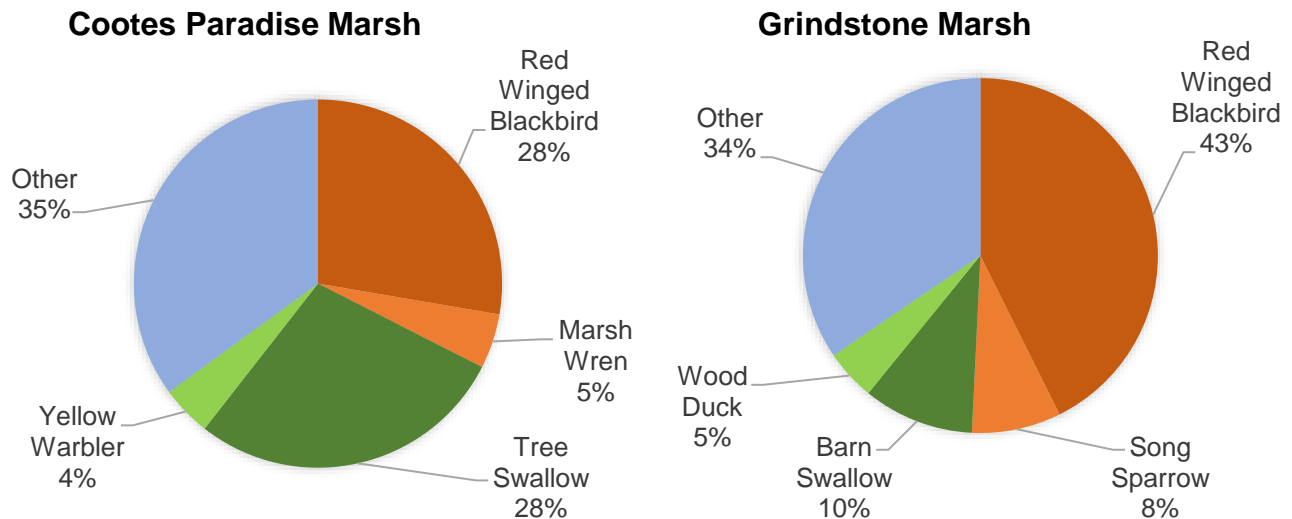


Figure 18. 5-year total for most common bird species for most common birds between 2017-2022, Marsh Monitoring Program (Cootes Paradise 6-14 sites, Grindstone Marsh - 6 sites).

The effect of COVID lockdown and human disturbance was distinctly noted for overall abundance and diversity in 2020 at Grindstone Marsh with the lowest bird numbers recorded for the entire period of the program. During 2020 during lockdown very high visitor numbers on the RBG nature trails created challenging conditions for the species present, with Grindstone Marsh abundance and diversity essentially cut in half (Table 11). Species associated with the Species at Risk list that have been encountered include Wood Thrush, Eastern Wood-Pewee, Prothonotary Warbler, Barn Swallow, Bank Swallow, Chimney Swift, Least Bittern, and Trumpeter Swan.

The emergent marsh focal species are very rare with Least Bittern the most likely species to be encountered, and only at Cootes Paradise Marsh, and with none noted at Grindstone Marsh for more than two decades (Table 10, Table 11). Other focal species found include Common Moorhen, Virginia Rail, Pie-billed Grebe and Sora. The population data indicates population decreases and most distinctly tied to the Sora and Virginia Rail. Within the monitoring sites the Common Moorhen and Pie-billed Grebe are regularly noted in the area of station ON933B (Marsh Boardwalk site), associated with broad area of emergent marsh regeneration in Spencer Creek delta, although the individuals are often beyond the station itself. The historically present King Rail (status Endangered) continues to not be encountered. The Black Tern also has not been present as nesting for decades although independent of the surveys a few individuals have been observed during the summer season in recent years (RBG observations). In addition, Virginia Rail are annually noted during early season amphibian monitoring, presumed to be migrants.

Muskrats

Muskrat populations have grown considerably (Figure 19). Based on current winter lodge counts of 2021 and 2022 (Grindstone Marsh 40, Cootes Paradise 33) it is estimated that both marshes have muskrat populations of between 100-200 animals as of the end of 2022. Lodges concentrate in two locations, the interior oxbow ponds and the banks of the main creek channels of each marsh. The interior ponds are in the upstream portion of each marsh, and during the fall season is where native emergent plants remain flooded during Lake Ontario's typical fall water level decline. In addition to the pond lodges a few muskrats are found in bank tunnels along the lower channels of Spencer and Grindstone Creek where water is flowing. However, the number of dens is unknown as entrances are submerged under rising creek flows. Fall 2021 and 2022 had water levels that precluded muskrats from utilizing other areas of the marsh (Figure 32) and this is not uncommon most years due to reduced extend of emergent vegetation.

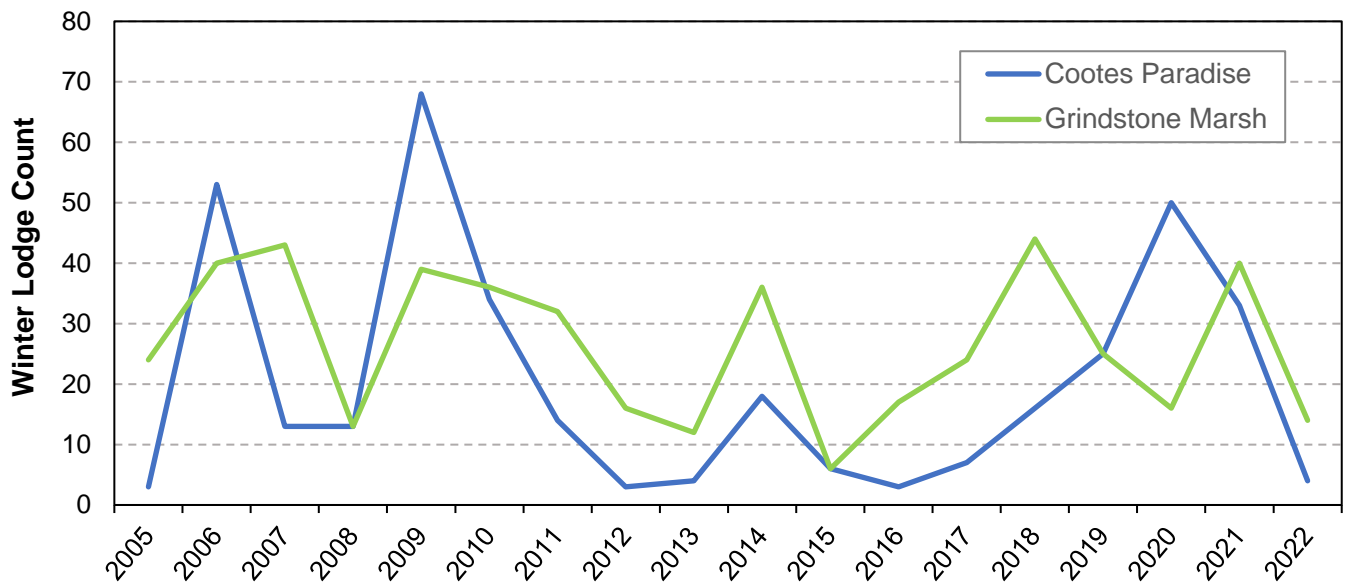


Figure 19. Trends in Muskrat lodge winter count for Cootes Paradise and Grindstone Marsh.

Mink

No formal monitoring program exists for mink, however mink are currently observed across the property and are regularly documented as road kills. Given the extent of mink observations by RBG staff and visitors it is perceived to be a much larger mink population exists now than at the outset of the HHRAP. iNaturalist provides a sense of this with 46 observations submitted between Apr 2020 and March 2023 (Figure 34). An estimated of the mink population for RBG area is likely to be near 50 animals. Many observations are mink reported as roadkill also through iNaturalist (Figure 35), particularly on Old Guelph Rd and Cootes Drive. Cootes Drive is a 2km long causeway/highway through Cootes Paradise Marsh, while Old Guelph Rd crosses the northeast corner.

Beavers

As of the end of 2021 8-10 beaver lodges were active across both marshes (Figure 20). Activity in

Discussion

Overall the habitat and the fish and wildlife populations have changed since the outset of the HHRAP in 1994. The habitat has improved water clarity, excluding out Grindstone Creek Marsh, and marsh plant community are reestablishing but with aquatic plants with highly variable success from year to year. Waters of Cootes Paradise and Grindstone Marsh remain hypereutrophic resulting in algae blooms of various types and impaired dissolved oxygen. Overall habitat recovery could be summarized as 50% of final targets. A diversity of marsh plant species are now found with a number of plant species successfully reintroduced. The recent large scale sewer spill from the operational failure of the Main-King CSO tank had a dramatic negative impact on improving habitat and populations. Fish and wildlife populations remain impaired and not reflective of the improved habitat area available to them, most notable in the amphibian populations with early spring species missing. The most common fish species are now Brown Bullhead and Gizzard Shad (formerly Common Carp), with Goldfish now numerous, while the most common amphibian species are American Toad and Grey Treefrog. Bird populations are overall less dense by monitoring site since monitoring was first initiated, but may be overall larger in number due to the increased habitat area for use. In addition several bird species have returned to the marsh areas. Red Winged Blackbirds remain the most abundant bird species.

Wetland Plant Habitat

The objective of this report was to reassess the HHRAP targets set for Cootes Paradise Marsh and Grindstone Marsh with regards to the Fish and Wildlife Habitat BUI. After assessment of the various monitoring and restoration efforts that have taken place for more than 20 years, these targets have not yet been met. With regards to emergent and submergent plant growth, currently, Cootes Paradise fulfills 33% of the total target area and Grindstone Marsh fulfills 48% of the target area an increase from the 12% and 28% coverage at the outset of the HHRAP. While progress has been made in total vegetation cover, it has been difficult to maintain large area gains year to year due to external stressors. In recent years, drastic Lake Ontario water level changes, sewage leaks into tributaries from CSO tanks and high flow stormwater events from Spencer Creek made up some of those stressors. For example, the seasonal decline exhibited in 2022 was driven by water level changes. Drought conditions in the summer of 2022 caused Lake Ontario water levels to decline. This greatly impacted the number of plants found because 13 out of 29 transects monitored in Cootes Paradise were dry and therefore could not be sampled nor would they have thriving aquatic macrophytes. This dried area in a recovered marsh would be emergent marsh. Furthermore, in 2016 Cootes Paradise reached over 130ha of vegetation cover, making up over half of the 230ha target, but due to high water in 2017 and ongoing hypereutrophic conditions, that dropped significantly (Figure 6a). Plant community area regeneration is largely restricted to sheltered inlets, emergent marsh zones (further aided by direct planting), interior oxbow pond habitat and seasonally flooded meadow marsh habitats. Continuation of the annual aquatic macrophyte monitoring is crucial to demonstrating the impacts external stressors have on the marshes. This is particularly relevant to outer Grindstone Marsh adjacent to Carrolls Bay where no Carp control occurs, and no aquatic plants continue to be found.

Annually seedlings of aquatic and emergent vegetation are noted throughout the Carp exclusion areas, however many are lost by the above noted issues before more permanent establishment. This includes a number of sections of shoreline where emergent marsh has been unable to establish, a direct result of wave action and windblow rafts of filamentous algae. Direct planting of large plants is an ongoing

project to remediate this by RBG. In addition large stormwater events have resulted in large scale established aquatic plant loss in the direct path of the water as illustrated by the July 2015 aerial photo of Cootes Paradise (Figure 26), where a broad swath of established aquatic plants were lost within 2 weeks of the rain event (June 24th 2015). The event highlighted that an unresolved issue that is either toxicity to plants vs direct smothering may exist in stormwater.

To compensate for these losses and expedite plant coverage recovery, RBG has reintroduced several historically important and previously occurring plant species as well as undertaken large scale cattail plantings. This originally focused on emergent plant species and a Southern Wild Rice (*Zizania aquatica*) project. This plant continues to be rare and restricted in distribution, however 2022 found it to be the most successful for number of plants and locations growing, with 11 locations in Grindstone Marsh and 21 locations in Cootes Paradise (Rebalka et. al, 2023). Additional submergent species have been under consideration for reintroduction, particularly the pollution tolerant floating leaf pondweed species. Emergent marsh plant species successfully reintroduced include Three-square/American Bulrush, Hardstem Bulrush, Prairie Cordgrass, Arrow Arum, Pickerel Weed, and Wild Rice. Yellow Waterlily has also been reintroduced in both marshes, salvaged from outer Grindstone Marsh and adjacent Long Pond, prior to extirpation between 2000-2002. RBG will continue plant reintroduction projects as they have proven successful, in with the intention of accelerating and/ or establishing a large expanse of new aquatic and emergent growth.



Figure 21. Southern Wild Rice (*Zizania aquatica*) in an oxbow area of Grindstone Marsh 2022.

Southern Wild Rice, a marsh habitat annual plant, is of particular interest given its typical presence in coastal marshes and dominance in the historical seed core record of Cootes Paradise Marsh. Coastal marsh areas are areas of high-water level fluctuations and thus plant community disturbances, facilitating the success of annual plant species. Two rice species are currently found, northern and southern wild rice (both annual species), and as they regrow from seed each year, they are extremely susceptible to loss at the seedling stage. Of particular interest is Southern Wild Rice (*Zizania aquatica*), a species that is essentially an endangered plant in Canada. The species spontaneously reappeared as a few plants in Grindstone Marsh Pond #3 in 1999. Since then, efforts to curate it within RBG propagation area in holding tanks and re-establish it as a keystone plant in Cootes Paradise has been ongoing. Several times the plant has been extirpated since being reintroduced, and subsequently reintroduced again from the captive population. The seed source for the current population is Rondeau Bay and Point Pelee marshes of Lake Erie. The plant continues to be rare but continues to regenerate well in the stiller, more protected water bodies within the marsh. Two locations over the last two years have really shown promise; Presidents Pond (Cootes Paradise) where in 2021 500+ grew spontaneously and in the Spencer Creek Floodplain (Cootes Paradise) there were another 500+ plants in 2022. In 2022 Wild Rice could be found growing in at least a dozen spots throughout the marshes.

For the meadow marsh habitat, and area once dominated by invasive grass species, in 2022, an interim study was done in the Spencer Creek floodplain. This meadow marsh plant community was one of the largest European Manna Grass-dominated sites in Cootes Paradise, to determine how the plant community has changed following several years of herbicide management (Ford, 2023). It was determined that management efforts were successful as a wide variety of native species were beginning to become abundant. However, transects that exhibited high species richness, had a low species evenness. Therefore, while the meadow marsh areas are starting to be dominated by native species, restoration efforts need to continue to ensure full native coverage. Future detailed monitoring efforts are scheduled for 2023 to fully quantify meadow marsh plant community conditions, with the added metric of percent cover, to better determine the overall quality of meadow marsh habitat in both Cootes Paradise and Grindstone marshes. Overall, many inlets and hectares of invasive grass remain around both marsh areas, with management yet to be completed.

Shoreline Bioengineering Restoration

In recent years (2016-2022) RBG has initiated a program to stabilize collapsing natural shorelines through bioengineering. Within that time period, a total of 3.85km of shoreline (1.2km for Grindstone and 2.7km for Cootes) has been improved upon (Figure 30). This With regards to the improved littoral shoreline designation, the Cootes and Grindstone combined total is 4.4kms (2.3km and 2.1km respectively). This gives Cootes a surplus of 0.4kms and Grindstone falls into a 0.9km deficit. The area showing the most success to date is the South Shore of Cootes Paradise, along Princess Point. That project was a mix of coir log and revegetation with silky dogwoods and sandbar willow. Any visits that have been made post coir log installation have just been to add to the previous year's plantings. The Southwestern Shore of Cootes also has had success in sustaining river bullrush plantings year to year. What should be noted is the consistent need for RBG to re visit many of the same shorelines to replant areas that died/were browsed. Protection is installed yearly to try and stop browsing from Canada Geese and Mute Swans, as well as stop carp from ravaging the areas in times of higher water. Those efforts are quite effective, it's the poor water quality and drastically fluctuating water levels that are detrimental to the shoreline sustainability.

Fish

The HHRAP fish BUI breaks down fish species into three categories and was significantly impaired at the outset of the HHRAP. Eutrophic Species (White perch, Bullheads, Carp), Top Predators (Northern Pike, Bowfin, Largemouth Bass), and Other Natives. (Suckers, Yellow Perch, sunfishes). The index measure of the population is completed within Hamilton Harbour by DFO Science of the Great Lakes Lab for Fisheries and Aquatic Science (GLFASS). The detailed inventory of the marsh fish community prior to HHRAP actions was completed by Theysmeyer (Tys Theysmeyer 1999). The fish community was dominated by Common Carp, but with a diverse collection of species at very low populations and with an abundance of Gizzard Shad, White Perch, and a short seasonal appearance of Alewife. The goal is to have a low biomass of eutrophic species and instead a high biomass of predators and other native species for delisting criteria to be met. When separating catch numbers at the Fishway each year, eutrophic species still outnumber predators and natives. This is slowly shifting. Gizzard Shad and Brown Bullhead dominate with a rapidly rising number of Goldfish and Rudd. Several native species are also become very rare and overall species diversity in all monitoring types is lower.

While decreasing in recent years, Brown Bullhead and Common carp still make up majority of the population seen at the Cootes Paradise Fishway. For the carp the primary target of management, there has been a dramatic decline both the total number of fish present in the marsh as well as in Hamilton Harbour attempting to enter the marsh demonstrated by the Fishway catches and index monitoring information. The 2022 carp biomass of 55.5kg/ha is a 93% decrease from the initial estimated 800kg/ha in the early 1990s (Theysmeyer 1999). However, it is more than double the 20kg/ha goal needed to render the marsh essentially unaffected by carp and with population rise and falls based on removal efforts, floods, and new carp recruitment to the population. During the past 20 years nearly 40,000 large carp have been removed from Cootes Paradise Marsh. The total elimination of the Common carp population in the coastal marsh system is not imminent and conditions remain favourable for it to dominate (hypereutrophic water). While the Fishway is effective at preventing movement of larger fish and providing status information, the 5cm grating allows for incidental non-breeding size carp to enter. This grating issue also exists in the Grindstone marsh system, with our manual fish barriers. In addition, the Grindstone ponds are also more susceptible to carp introduction through other means. Flooding is a primary concern as the berms, while built up to about a meter above the water level, can only hold back so much water. Secondly, there is a growing beaver and muskrat population in the Grindstone marsh system, which occasionally burrow through the berms creating holes that are difficult to detect and repair (Rebalka et al. 2023).

The installation of a Grindstone Marsh Fishway barrier at the mouth of the creek as originally intended (Appendix 4), would greatly benefit the health of the marsh area and remove ongoing berm repairs. By preventing Common Carp from accessing the Grindstone Marsh watershed, the ponds would have more opportunity to regenerate vegetation, improving habitat conditions. Furthermore, it would help determine how frequently top predators utilize the ponds for spawning. RBG Pike trap and electrofishing monitoring, and DFO telemetry data are helpful in determining successful spawning efforts. While it is currently known that pike, walleye and gar prefer Grindstone marsh to Cootes Paradise, a Grindstone Fishway would be the most effective way of further tracking their population.

While populations of many fish species are decreasing, there are some promising trends that suggest an overall change in fish community, while at the same time new diseases are a factor limiting populations. Species such as Bluegill and Bowfin are successful and Yellow Perch have variable but

improved success from year to year. Brown Bullheads while abundant and initially dramatically increased in number have suffered issues with virus/disease impacting the population. This is also notable for other species and assumed to be a primary cause of the lack of adult Northern Pike with rarely more than 30 adult fish passing through the Fishway during the spring spawning period. Generally notable is that since about 2009 monitoring in spring season for young fish (Pike) with Fyke nets generally finds an abundance of young fish of many species, however much fewer young are found by end of August period during electrofishing index monitoring. Also, among the noteworthy items is that Walleye have been subject to an intensive reintroduction program by OMNR for a decade. To date no walleye have been found at either Grindstone Marsh or Cootes Paradise Marsh, with Grindstone Creek and Spencer Creek prime spawning habitats. As a positive note, Northern Pike have been found to be spawning in regenerated habitat areas within both marshes (Theijsmeijer & Court 2021). Overall, a diversity of diseases are present with the most notable effect occurring about 2007 with the arrival of Viral Hemorrhagic Septicemia (VHS). A thorough inventory of diseases present in the aquatic system of Hamilton is currently not available to currently be able to quantify the effects. Fish populations continue as significantly impaired and may potentially measure up as in poorer condition than at the outset of the HHRAP.

Wildlife Overview

Wildlife population inventories through various monitoring programs have found both expansion of wildlife into newly restored habitat areas as well as the extirpation of several herpetile species. Only three of the remaining amphibian species are increasing in abundance, with overall populations remaining low to absent generally. Mammal populations have increased, however are variable and recent history has found a significant decline. In the case of herpetiles and looming broader species extirpation, specific separate work has been initiated to change the trajectory of this trend. This has been aided by several species listed in the Species at Risk Act (first established in 2003), a post HHRAP initiated approach to providing resources to stop the decline of specific remnant species. The addition programs at RBG include wildlife barriers along roads and captive breeding programs (Harrison & Theijsmeijer 2014). In addition a directed project by ECCO with insitu leopard frog reproduction, a species used separately for contaminant monitoring at Cootes Paradise Marsh, found large scale reproductive failure at most sites, with only the interior pond locations providing showing notable frogs reproduction (Hughes et al 2021).

The HHRAP objective for wildlife is “healthy, self-sustaining resident and non-resident wildlife populations, that should be enhanced on a Harbour wide basis and through water quality improvements and habitat rehabilitation and protection” (HHRAP stage 2). The IJC Delisting Guideline (1991) states “When environmental conditions support healthy, self-sustaining communities of desired fish and wildlife at predetermined levels of abundance that would be expected from the amount and quality of suitable physical, chemical and biological habitat present. An effort must be made to ensure that fish and wildlife objectives for Areas of Concern are consistent with Great Lakes ecosystem objectives and Great Lakes Fishery Commission fish community goals”. Further, in the absence of community structure data, this use will be considered restored when fish and wildlife bioassays confirm no significant toxicity from water column or sediment contaminants. In the case of wildlife populations at Cootes Paradise and Grindstone Marsh extensive monitoring and updates have been ongoing throughout the HHRAP period. Progress on some species has been noted in specific locations.

Amphibians

The status as summarize in HHRAP Stage 1 Report (1992) is as follows; Cootes Paradise - Significant concentrations of frogs and turtle species in many localized wetlands within Cootes Paradise. Frogs were abundant where vegetation remains flooded throughout the spring and fall. The Northern Leopard Frog and American Toad are the most common species and well distributed but are especially abundant in the old Spencer Creek bed. The Green Frog also occurs here. The Western Chorus Frog is uncommon and found in small patches of marsh vegetation. Today this location is known as Upper Paradise and Presidents Pond and associated oxbow channels, grouped within the Spencer Creek Delta Special Protection Area. For Grindstone Marsh status in 1992 Grindstone Marsh (Hendrie Valley/Carrolls Point), the area is characterized by regionally rare species. Bull Frog and Pickerel Frog occur in backwater ponds of Hendrie Valley in restricted numbers.

As of the end of 2022 populations and distributions have changed both positively and negatively for frogs and toads. The distribution of several species of amphibians has expanded with associated with increases in habitat in both marsh systems. Areas without habitat continue to lack amphibians. The overall abundance of several species has also increased, particularly the Gray Treefrog at Cootes Paradise. Green Frog, Northern Leopard Frog, and American Toad are regularly encountered at low numbers, and at higher numbers than at the outset of the HHRAP. However, amphibian populations continue to be very low with a particular season issue demonstrated for early season breeding species. Long-standing high-quality habitat locations in both marshes hold only moderate to very low populations of all species as measured at spring breeding season through the Marsh Monitoring Program. Three species are now extirpated including Western Chorus Frog, American Bullfrog and Pickerel Frog. In addition, Wood Frog and Spring Peeper are essentially extirpated from all habitat areas at RBG. Adjacent upstream populations of these continue to exist upstream from both marsh (unpublished Marsh Monitoring Program data). The most striking situation is the lack of amphibians at a long-standing restored habitat location in Grindstone Creek Marsh were in the past 5 years only 30 individual frogs have been heard representing predominantly 2 species. Roadkill's have been a theory for lack of population increases and as a result an ongoing project to establish roadside barriers was initiated in 2016. The longest standing roadside barrier is adjacent to monitoring site ON657E (Presidents Pond) with populations at the site remaining extremely low. The most distinctly impacted site is West Pond in Cootes Paradise (site ON657C) where habitat exists, but most amphibians are absent. The conditions of the site are summarized in more detail in the West Desjardin Canal Area Conditions Report (Theijsmeijer & Bowman 2017), with the water in this area essentially 100% wastewater effluent from the Dundas Wastewater Plant with very high levels of nitrates as well as many other compounds found in the water (Hughes et al. 2020).

Due to ongoing concerns with frog abundance and distribution and potential issues with reproduction, Environment and Canada and Climate Change undertook a specific study at Cootes Paradise Marsh, focusing on Northern Leopard Frog with a multiyear project undertaken between 2014 & 2016 (Hughes et al.2020). This involved insitu growth from egg to frog to determine survivability at multiple sites across the marsh. Only one site did not show severely impaired survivability, Upper Paradise Pond (an interior pond), where results were like the control site. Several sites had total loss of all individuals before transformation to frog. The potential issues and compounds were so numerous in the supporting water quality monitoring information that determining the specific limiting issues was not possible.

Birds

The most challenging of wildlife measures identified in the HHRAP Stage 1 and 2 is migratory waterfowl. Information tied to migratory birds is generalized in the HHRAP reports for the Coastal Marsh habitats of RBG area. The ability to describe current conditions and abundances of spring and fall migratory species is beyond the scope of this report. Populations of migratory birds are also significantly influenced by habitat conditions in breeding and overwintering areas beyond the HHRAP area. For local breeding birds, the colonial nesting species are separately summarized in a HHRAP report (2022) and includes an abundance of Doublecrested Cormorants on Hickory Island in Cootes Paradise Marsh.

Onsite spring/summer breeding and foraging bird species are captured through a broad cross section of stations utilizing the Marsh Monitoring Program. Through this monitoring declines are noted for the majority of species at the longest monitored sites, many of which have with the best onsite habitat conditions. This includes the focal bird species specific of the know much more extensive emergent marsh habitat. Several areas of marsh habitat have been regenerated and now support measurable and somewhat diverse populations of various birds, dominated by Red-Winged Blackbirds. The impact of the much larger vegetated habitat has spread the birds out, and means that the total birds breeding and foraging during the season has increased overall despite the site specific density decreases. This situation was demonstrated for a Threatened status focal birds species, Least Bittern, with Bird Studies Canada locating 17 individuals throughout western Cootes Paradise in 2018 (Touzer 2019), while index monitoring sites had few to no bitterns. Human disturbance of habitat is noted for Grindstone Marsh's highest quality habitat sites in particular with the COVID constraints year of 2020 bringing large numbers of visitors to this constrained habitat area via the RBG nature trail system. A rebound in population diversity was noted in the most recent year of monitoring for this area.

Waterfowl present with breeding populations currently include Wood Duck, Mallard Duck, Canada Geese and European Mute Swans, with the later two species having targeted management activities for several decades. The large Canada Goose populations has potentially stabilized due to a mixture of onsite habitat modifications and active management activities limiting recruitment. This is demonstrated in the low numbers present in the Marsh Monitoring Program with only 2 individuals noted in 2022 surveys. The history of the species is largely summarized in a 2014 RBG Summary report that recommended current management strategy approach. Mute Swans have benefitted dramatically from the habitat improvements in both marshes with populations rising dramatically, and subsequently creating challenges for some native birds species to find territories. At nesting time Mute Swans now occupy most areas of habitat, with the Marsh Monitoring Program recording 3 pairs in the stations. Management activities to prevent any further population increase located 5 nests in 2022 between the two marshes and had a peak of 14 nests in 2015. Up to 50 birds have been noted in mid summer, gathering in the open waters (RBG observations 2022). Trumpeter Swans are the most impacted with this species with only a single nest successful in recent years, located in Grindstone Marsh. Broader Great Lakes wide population data that includes the RBG sites is summarized at periodic intervals by Bird Studies Canada Breeding bird assessments and are available for review.

Turtles

Turtles have no population status measures for the HHRAP although Snapping turtles are used as an index of contaminants through hatching success and deformity rate. Status as summarize in HHRAP

Stage 1 Report (1992) is as follows. Cootes Paradise Marsh turtle populations and diversity are high in abundance. Their preferred areas of concentration are the old Spencer Creek channel. Westdale Inlet and backwater ponds in the extreme western end. One of the ponds rivals other sites in North American as the highest density of Midland Painted Turtle. Snapping turtle's densities in the western end are considered very high compared to other sites. Small populations of Blanding's Turtles are restricted to the old Spencer Creek channel area (current name: Spencer Creek Delta Special Protection Area), while the Northern Map turtle occurs in Westdale Inlet in fair numbers (20-30). Grindstone Creek Marsh (Hendrie Valley/Carrolls Point) – A large population of Map Turtles present and an Eastern Spiney Softshell sighted on two occasions in 1994, with one specimen caught in 1982. In addition, the Snapping turtle was in the past used as an indicator species of Great Lakes health providing a few quantitative estimates of the Cootes Paradise population over time. The Cootes Paradise population is showing steep decline (Figure 22) with overall turtle population information and issues summarized in an RBG Turtle Site Specific Recovery Plan (Harrison & Theysmeyer 2014). This report provided a combined total turtle population of about 1,500 individuals with 2/3 of the turtles located in Grinstone Creek Marsh and dominated by Midland Painted Turtle representing a little more than half of all turtles, with populations declining.

The RBG Turtle Site Specific Recovery Plan put a special focus on issues of populatin decline, extirpation, habitat quality, road mortality and nest predation, and defined the need for an immediated need for a special program to prevent the extirpation of the Blanding's Turtle (status Endangered). No specific surveys tied overall turtle populations have been undertaken in recent years save for Blandings Turtle, with the last significant inventory of all species about a decade ago (Harrison & Theysmeyer 2014). The Blanding's Turtle population is currently estimated at 3 turtles for Cootes Paradise and about 20 turtles for Grindstone Creek Marsh. In addition several dozen hatchlings have been released from controlled incubation of protected nests, and in 2022 four 2 year old "head-started" turtles were released (Coots Paradise-1, Grindstone Marsh-3). It remains to be determined if these will survive. Formerly released other hatchlings were observed in 2022 providing some optimism (RBG observ), and some interior pond areas in both marshes provide ideal habitat conditions for young turtles.

Overall it is thought that due to the extensive ongoing stresses turtle populations are moderately or substantially reduced from the latest 2014 population summary and continuing to decline based on nest monitoring each year (Richer 2019). Populations of most turtle species remain, with only the Eastern Spiney Softshell extirpated in recent decades, the last known Lake Ontario based population. Softshell turtle species have been observed and even caught at the Cootes Paradise Fishway, however on all occasions they have been confirmed as pet releases, often the Texas Spiney softshell. There is still a confirmed population of Midland Painted, Map, Snapping and Blanding's turtles in RBG's Coastal marsh area. In 2022 an Eastern Musk Turtle was caught at the Fishway in May changing the idea that this species was extirpated as well. A radio tracker tag was placed on it and may result in identification of a small remnant population. It was also encountered on RBG property 12 years previous, with these the only other observation of the past 25 years. The previously caught turtle was caught at the Fishway, and by markings was a different individual.

Locations of Midland Painted Turtle concentration in Cootes Paradises remain in Westdale Inlet were upwards of 100 were observed basking in 2022 during Blanding's Turtle surveys. During the similar surveys across the marsh, the extensive population noted in west Cootes in the HHRAP Stage 1 appears to be reduced to about 40 individuals (basking surveys). In Grindstone Marsh in the upper half

of the Marsh continues to have an abundance of Midland Painted Turtles, while the lower half of the marsh area with degraded habitat has very few (by Carrolls Bay). This now degraded marsh area was the area of a large remnant population of Northern Map Turtles, among the largest in Canada thought to be more than 400 individuals in the 1990s. Recent observations indicate this population is greatly reduced although does still exceed 100 individuals currently by the number of nests encountered (RBG unpublished 2022). Nesting conditions have been greatly improved in this area through the closure of Valley Inn Rd and the complete rebuild of an adjacent section of shoreline to renaturalize it. This shoreline rebuild is highlighted in the BUI FH2- Improved Shoreline Habitat Appendix 2023. At Cootes Paradise Northern Map turtle continue to exist in low numbers and remain centred at Westdale Inlet where upwards of 20 are observed basking in the summer (RBG observations 2022). Both Northern Map Turtles and Midland Painted Turtles are observed as scattered individuals throughout the remainder of Cootes Paradise Marsh.

Turtle species have benefited from the Blanding’s Turtle and nest protection projects, and have resulted in extensive casual observations connected with the focused effort to stop the extirpation of turtle populations. In recent years hundreds of turtle nests as well as rescued nests have resulted in the release of well over 1,000 turtle hatchlings (RBG unpublished), dominated by Snapping Turtle. Extensive sections of temporary wildlife barriers have been established along Cootes Drive a road passing through West Cootes Paradise Marsh and are initiated along Plains Rd West in Burlington adjacent to Grindstone Creek Marsh. Road mortality is greatly reduced so far with Cootes Drive observations (unpublished) down to less than 10 turtles per year in recent years and none in the section adjacent to the former concentration area of painted turtles noted in the HHRAP stage 1. Considerable work remains to complete the temporary roadside barrier systems at both marshes, and to date no wildlife protection programs have been established by City of Hamilton or Burlington.

Cootes Paradise Snapping Turtle Population Trend

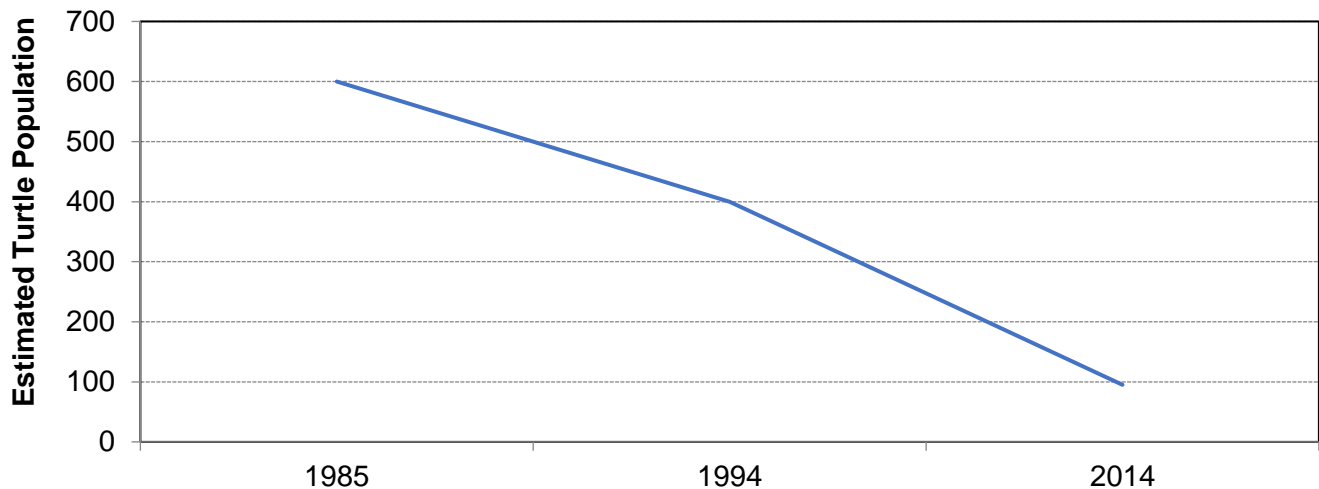


Figure 22. Trend of Snapping Turtle population in Cootes Paradise (Harrison & Theysmeyer 2014)

Mammals

Total muskrat’s population assessed in 1984 was estimated at less than 100 for Cootes Paradise and at 30 individuals for Grindstone Marshes, generally noted as living in bank tunnels due to the lack of emergent vegetation to build lodges out off (HHRAP Stage 1 1992). In an assessment of Muskrats in 1944 the Cootes Paradise population was large and typical of coastal marshes (Dept of Lands and Forest 1947). *“Mr Beattie, game overseer, and other naturalists estimate the muskrat population in*

1944 to have been at least 5,000. In large areas houses were too numerous to count and in places it was possible to jump from house to house” The following year in 1945 the population was estimated at less than 100, the decline thought to be related to a large-scale application of DDT in 1945. In 1984 Muskrats were noted as focused to the lower creek channels and West Pond area of Cootes Paradise. Muskrat populations have since grown substantially and appear to vary based on water level and available habitat for overwintering. Secondly mink will also affect the population of muskrat. Based on current winter lodge counts it is estimated that both marshes have muskrat populations of between 100-200 animals as of the end of 2021. Lodges concentrate in the interior ponds where water and native emergent plants exist (Figure 32), and in creek delta areas where vegetation has regenerated and is flooded by fall/winter lake level. In addition to the lodges a few muskrats continue to be found in bank tunnels along the lower channels of Spencer and Grindstone Creek.



Mink numbers were not quantified but noted as present in 1984 (HHRAP Stage 2 1992). No formal monitoring program exists for mink, however Mink is currently observed across the property and are regularly documented as road kills. Given the extent of mink it is perceived to be a much larger mink population exists now than at the outset of the HHRAP. An estimated of the mink population for RBG area is likely to be near 50 animals. Mink is regularly reported as roadkill also through iNaturalist, particularly on Old Guelph Rd and Cootes Drive. Cootes Drive is a 2km long causeway/highway through Cootes Paradise Marsh, while Old Guelph Rd crosses the northeast corner (Figure 31).

In the HHRAP Stage 1 report, 1 beaver lodge was noted, located in lower Spencer Creek. As of 2021 8-10 beaver lodges are active. This however follows a substantial die off of beavers during 2019-2020. A review of the marsh at the end of 2020 noted a dozen beaver lodges as abandoned and many dead beavers located across the marshes during the year. The cause for the deaths is unknown. This then included an addition 3 more dead during spring 2021 in Grindstone Marsh, which is likely attributable to the fact that a berm and lodge on the east side of Spring Garden Rd (Blackbird Marsh) were set fire by vandals. Overall, the beavers tend to be in every habitat area if permanent water as is present including occasionally in the most polluted water areas of Lower Chedoke Creek and the Desjardin Canal (Figure 20).

Recommendation 2022 Beneficial Use Status of HHRAP Area

Overall notable progress has been made during the past 25 years, with some notable successes however conditions and populations remain impaired.

Habitat

- All components of water quality – status impaired
- All components of marsh plant communities – status impaired

Fish and Wildlife

- Fish Community – status impaired
- Wildlife “Other” Populations – status impaired

APPENDIX 1: Marsh Specific Overviews and Data

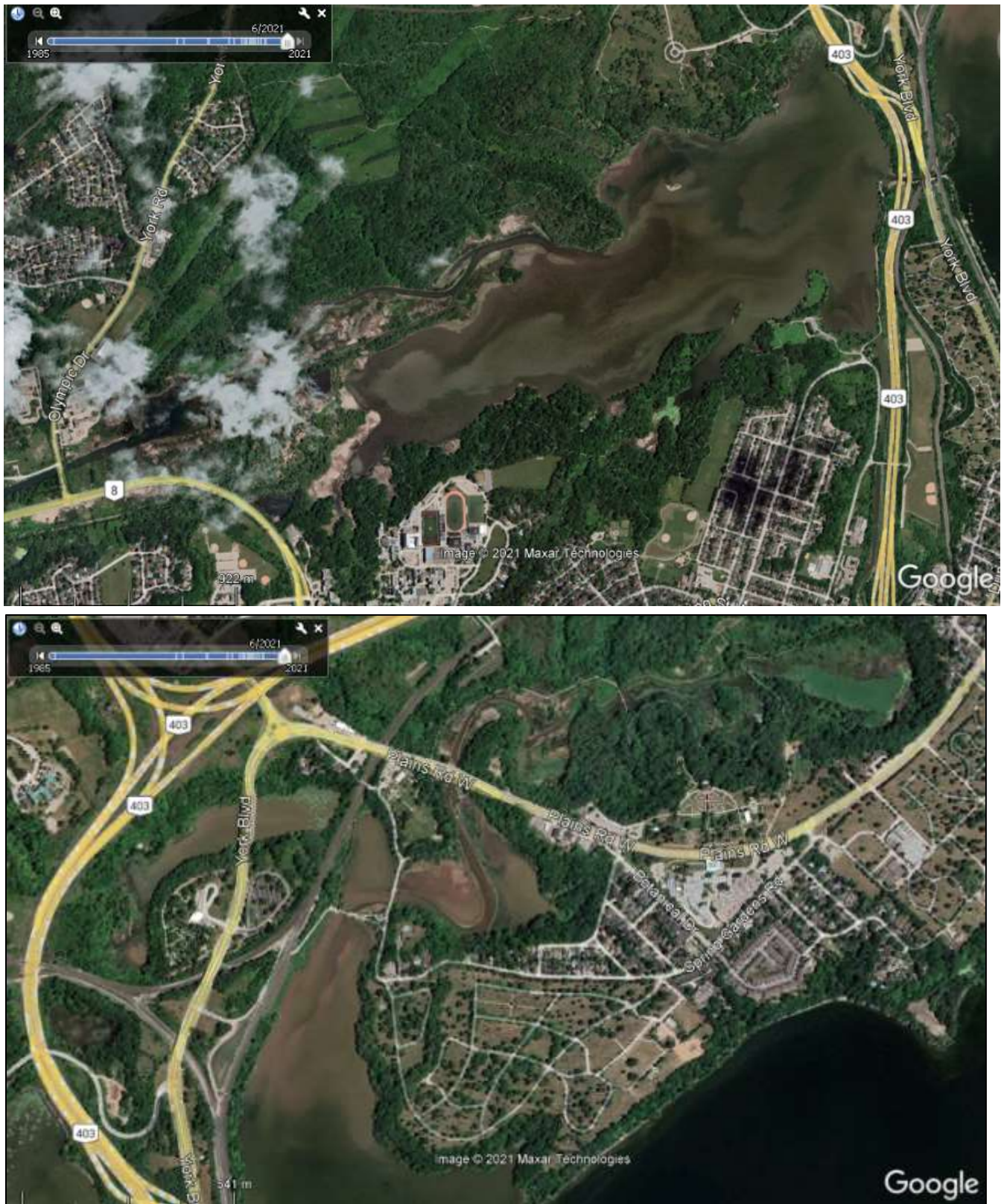
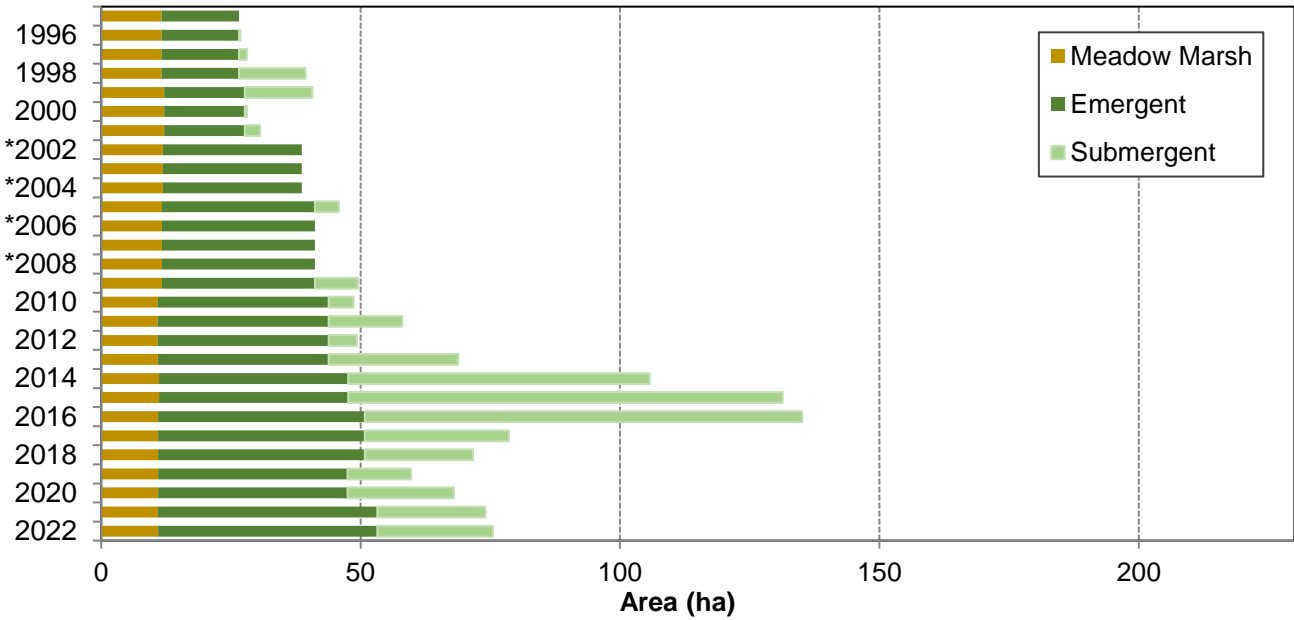


Figure 23. June 2021 Aerial Photo of Cootes Paradise Marsh (above) and Grindstone Marsh (below)

Cootes Paradise Marsh Vegetation Changes



Grindstone Marsh Vegetation Changes

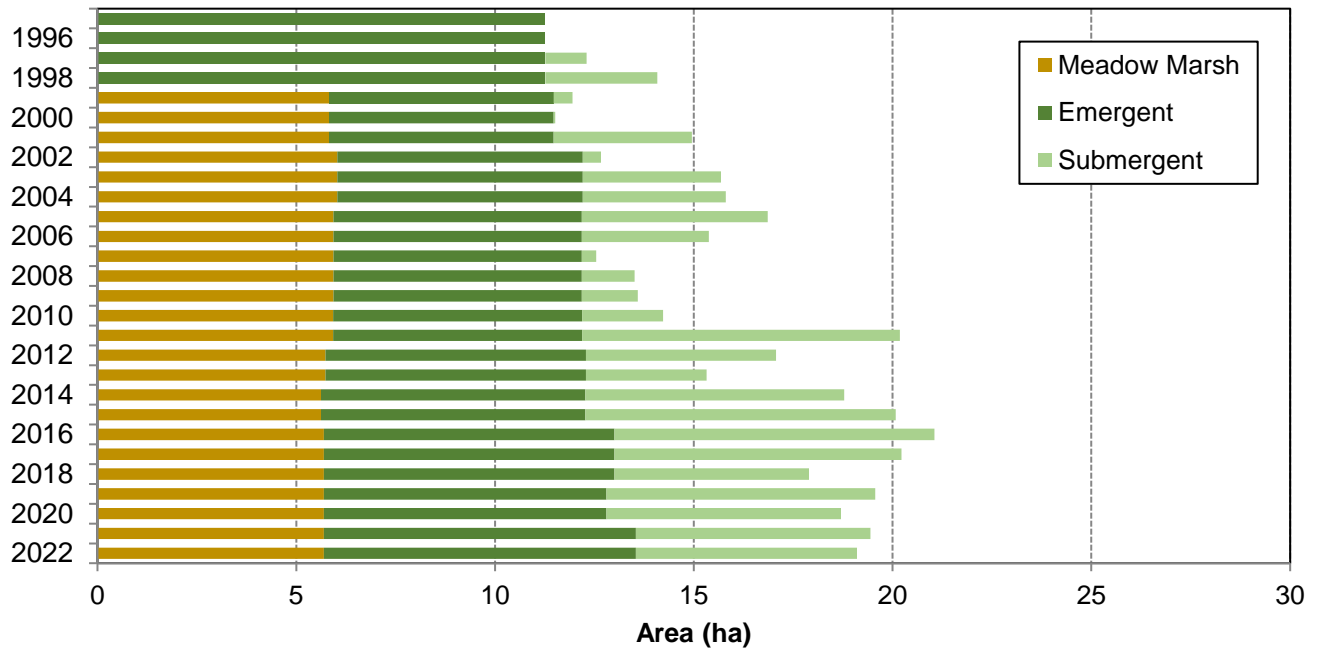
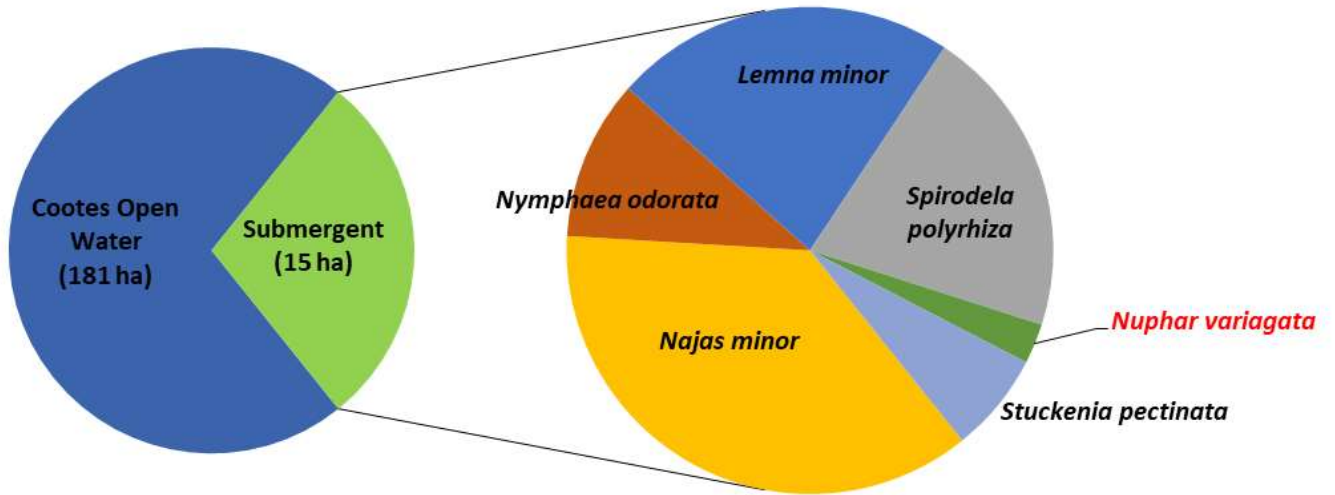


Figure 24 Total marsh vegetation in Cootes Paradise Marsh (above) and Grindstone Marsh (below), including meadow marsh, emergent, and submerged vegetation as measured in early July (submergent/floating leaf area). * Indicates that submergent wasn't measured that year.

Cootes Paradise Marsh Late Season Monitoring



Grindstone Marsh Late Season Monitoring

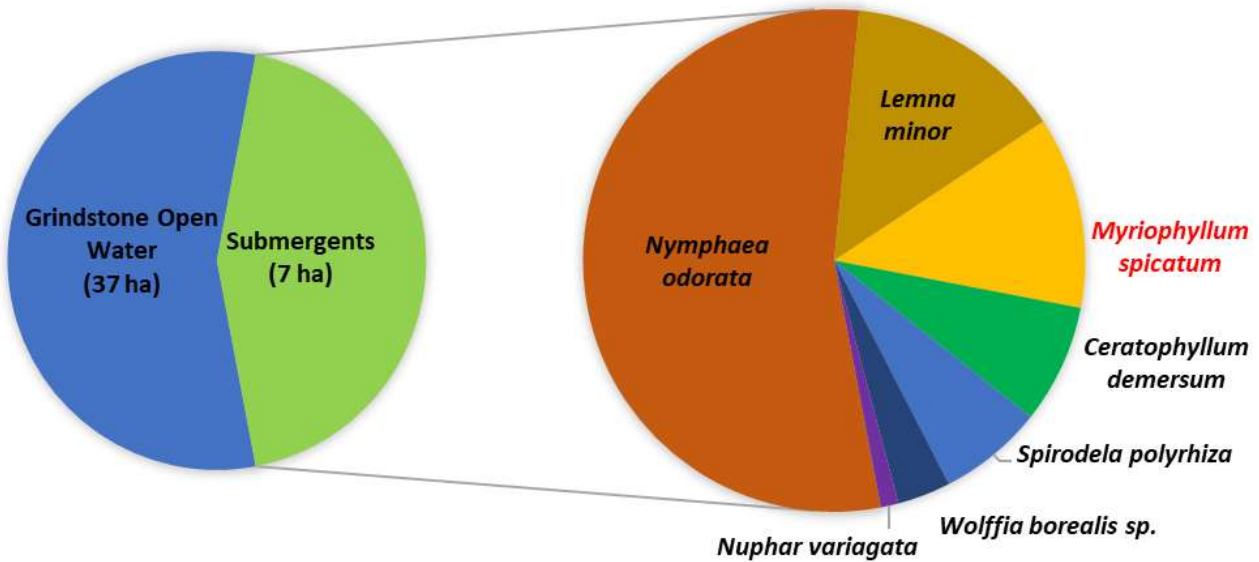


Figure 25. Aquatic plant community composition. Upper chart Cootes Paradise Marsh, lower chart Grindstone Marsh.

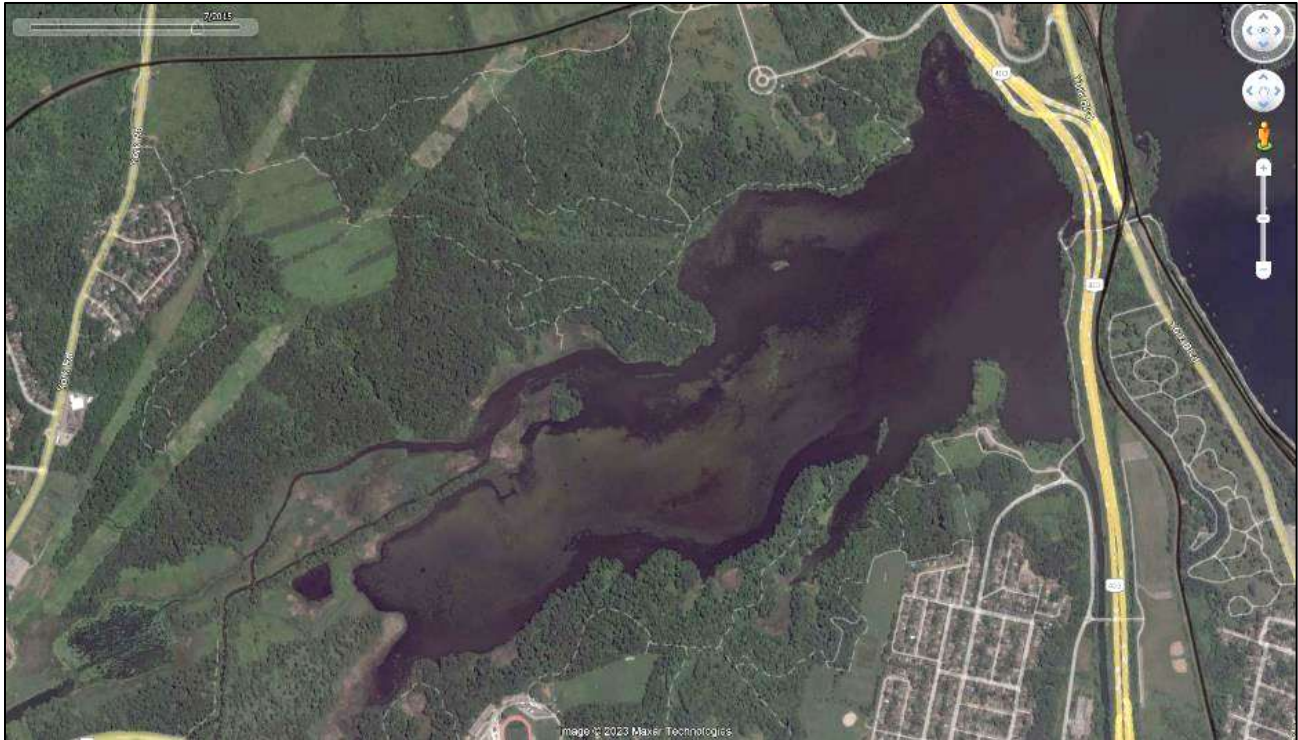


Figure 26. Aerial imagery of Cootes Paradise in July 2015, showing the area dense aquatic vegetation as well as the missing vegetation in the flow of Spencer Creek. Vegetation present prior to a late June rainstorm.



Figure 27. Aerial imagery of Cootes Paradise in October 2022, showing the area that dried out in the marsh, and scattered aquatic plant patches in the remaining water areas. Water level was low at about 74.6masl.



Figure 28. Maps of emergent vegetation cover gained in Cootes Paradise (top) and Grindstone Marsh (below) during 2021 low water as of 2022.



Figure 29. Example of Phragmites population conditions in Cootes Paradise as of 2022



Figure 30. Shoreline Bioengineering and planting sites for Cootes Paradise and Grindstone Marsh as of 2022.

Table 2 Annual comparison of large fish caught entering the marsh at Cootes Paradise Fishway.

Species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
American eel																													
Atlantic salmon																													
Brown bullhead																													
Black bullhead																													
Black bullhead x Brown bullhead																													
Black crappie																													
Bowfin																													
Brown bullhead																													
Brown trout																													
Channel catfish																													
Chinook salmon																													
Freshwater drum																													
Grass carp																													
Golden redbreast																													
Greater redbreast																													
Lake trout																													
Langemuth bass																													
Longnose gar																													
Longnose sucker																													
Northern pike																													
Rainbow trout																													
Rock bass																													
Sea lamprey																													
Shorthead redbreast																													
Silver lamprey																													
Silver redbreast																													
Smoothmouth bass																													
Spotted gar																													
Striped bass																													
White bass																													
White perch																													
White sucker																													
Yellow perch																													
Subtotal	1,201	3,477	5,133	5,017	19,288	19,756	26,188	28,076	25,282	20,754	23,840	20,995	25,459	21,627	12,251	15,307	5,485	12,466	14,426	18,961	19,787	15,007	20,398	12,175	8,135	14,096	15,249		
Common carp x Goldfish	1,739	14,667	8,517	10,158	26,681	14,443	14,974	10,068	6,176	4,971	3,920	3,379	10,422	5,946	2,967	5,658	1,603	8,695	7,161	4,091	2,684	9,249	1,836	4,528	1,986	1,082	1,176		
Goldfish	58	95			8	1	3	11	13	118	91	116	307	413	65	101	18	162	59	124	130	292	280	1,322	303	37	75		
Goldfish	53	22	9	1	116	65	296	250	354	346	503	440	1,289	958	587	789	388	765	1,706	2,446	2,019	1,682	1,690	2,651	1,240	999	268		
Rudd																													
Total	3,051	17,961	13,659	15,176	46,085	34,255	41,461	38,405	31,625	26,089	28,355	24,931	37,478	28,945	15,691	21,657	7,485	22,109	23,355	24,627	24,201	26,274	24,220	20,697	11,689	13,252	16,947		

Table 3. August Electrofishing transect (50m length) fish catch for Cootes Paradise Marsh

Species	Scientific Name	1994	1995	1996	1997	1998	Sub total	2018	2019	2020	2021	2022	Sub total	Grand Total
Common Carp	<i>Cyprinus carpio</i>	29	34	145	68	8	284	6	5	3	2	3	19	303
Large Common Carp		153	307	10	0	1368	1838	1	5	6	31	0	43	1881
Young of Year														
Alewife	<i>Alosa pseudoharengus</i>	1	4	1		1	7		1				1	8
Black Crappie	<i>Pomoxis nigromaculatus</i>	1		8	33	1	43							43
Bluegill	<i>Lepomis macrochirus</i>		7	254	5	857	1123	78	40	604	56	49	827	1950
Bluntnose Minnow	<i>Pimephales notatus</i>	37	147	69	209	193	655		3	67	19	10	99	754
Brook Silverside	<i>Culaea inconstans</i>			3	1	6	10		1	2		2	5	15
Brown Bullhead	<i>Ameiurus nebulosus</i>	131	47	49	426	15	668	37	42	94	3	37	213	881
Central Mudminnow	<i>Umbra limi</i>	1					1							1
Channel Catfish	<i>Ictalurus punctatus</i>	6	1				7							7
Common Shiner	<i>Luxilus cornutus</i>	1	2				3	1					1	4
Creek Chub	<i>Semotilus atromaculatus</i>			1	2		3							3
Emerald Shiner	<i>Notropis atherinoides</i>		1	1	4	2	8							8
Fathead Minnow	<i>Pimephales promelas</i>	23	3		265	48	339		4		5		9	348
Freshwater Drum	<i>Aplodinotus grunniens</i>		2	4			6							6
Gizzard Shad	<i>Dorosoma cepedianum</i>	9	204	52	99	13	377	34	55	45	82	12	228	605
Golden Shiner	<i>Notemigonus crysoleucas</i>						0			11			11	11
Goldfish	<i>Carassius auratus</i>	8	2	9	11	3	33	47	49	18	17	9	140	173
Green Sunfish	<i>Lepomis cyanellus</i>	3	3	2	4	8	20	2	6	16	9	2	35	55
Johnny Darter	<i>Etheostoma nigrum</i>	2	10	12	59	6	89	6			19	17	42	131
Largemouth Bass	<i>Micropterus salmoides</i>	14	65	11	8	2	100	28	22	33	10	2	95	195
Lepomis sp.	<i>Lepomis sp.</i>				2		2	5	2	16	5	1	29	31
Logperch	<i>Percina caprodes</i>	39	46	87	32	14	218	2	4	22	105	9	142	360
Northern Pike	<i>Esox lucius</i>			2	1	1	4	1		1			2	6
Pumpkinseed	<i>Lepomis gibbosus</i>	1091	889	419	3337	543	6279	103	16	496	102	28	745	7024
Rock Bass	<i>Amphoblites rupestris</i>						0	1	2	3			6	6
Round Goby	<i>Neogobius melanostomus</i>						0	2	1	14	2	11	30	30
Rudd	<i>Scardinius erythrophthalmus</i>						0	3	70	14		2	89	89
Spottail Shiner	<i>Notropis hudsonius</i>	17	5	56	24	28	130	47	4	13	5	22	91	221
Tadpole Madtom	<i>Noturus gyrinus</i>					2	2							2
Trout Perch	<i>Percopsis omiscomaycus</i>			2	35		37							37
Walleye	<i>Sander vitreus</i>					1	1							1
White Bass	<i>Morone chrysops</i>						0		1				1	1
White Perch	<i>Morone americana</i>	44	1080	25	591	110	1850	63		66	145	35	309	2159
White Sucker	<i>Catostomus commersoni</i>	2	9	5	43	21	80	8		2	54	3	67	147
Yellow Perch	<i>Perca flavescens</i>	2	4	17	432	9	464	39	3	8	23	17	90	554
Grand Total		1614	2872	1157	6999	1936	14681	514	336	1558	696	271	3375	18050
#Species		20	22	24	23	23	37	20	20	22	19	19	27	37
# Transects		14	22	24	24	21	105	23	20	23	23	14	103	208

Note: Transects summarized: B1,B2,B3,B4,C1,C2,E2,E4,M1,M3,M4,M5,N3,N4,O1,O2,O3,O4,P2,P3,R1-R6

Table 4. August Electrofishing transect (50m length) fish catch for Grindstone Creek Marsh

Species	Scientific Name	1994	1997	1998	1999	2000	Sub total	2018	2019	2020	2021	2022	Sub total	Grand Total
Common Carp Large	<i>Cyprinus carpio</i>	35	3	22	6	13	79	0	2	0	0	0	2	102
Common Carp Young of Year		5	0	4	10	0	19	0	0	0	2	0	2	21
Black Crappie	<i>Pomoxis nigromaculatus</i>	7		3		1	11	4	1	2			7	18
Bluegill	<i>Lepomis macrochirus</i>	25	9	267	47	672	1020	103	47	389	92	17	648	1668
Bluntnose Minnow	<i>Pimephales notatus</i>	113	192	448	1541	326	2620			48	20		68	2688
Bowfin	<i>Amia calva</i>		2				2							2
Brook Silverside	<i>Culaea inconstans</i>				1		1	1	2	4	5	1	13	14
Brown Bullhead	<i>Ameiurus nebulosus</i>	94	22	1	8	20	145	9	1	6	5		21	166
Central Mudminnow	<i>Ubra limi</i>	1	1			3	5	1	1	5			7	12
Common Shiner	<i>Luxilus cornutus</i>	1	1				2							2
Cyprinid sp.	<i>Notripis sp</i>										4	1	5	5
Emerald Shiner	<i>Notropis atherinoides</i>		8	3	3	1	15							15
Fathead Minnow	<i>Pimephales promelas</i>	3	6	1	2	3	15				1		1	16
Gizzard Shad	<i>Dorosoma cepedianum</i>	16	7		9	18	50	45	13	5	48	1	112	162
Golden Shiner	<i>Notemigonus crysoleucas</i>	1					1		1	1			2	3
Goldfish	<i>Carassius auratus</i>						0	1	1		12		14	14
Green Sunfish	<i>Lepomis cyanellus</i>			13		11	24	1	1	10	4	4	20	44
Johnny Darter	<i>Etheostoma nigrum</i>	19	32	14	1	3	69							69
Largemouth Bass	<i>Micropterus salmoides</i>	33	34	45	18	28	158	36	43	36	34	1	150	308
Lepomis sp.	<i>Lepomis sp.</i>									9	24	6	39	39
Logperch	<i>Percina caprodes</i>	10	163	18		23	214	4	1	1	10		16	230
Mimic Shiner	<i>Notropis volucellus</i>					6	6			4			4	10
Northern Pike	<i>Esox lucius</i>	1		2		7	10			1			1	11
Pumpkinseed	<i>Lepomis gibbosus</i>	81	357	689	363	267	1757	40	2	92	22	5	161	1918
Rock Bass	<i>Amphoblites rupestris</i>		1	4	2	2	9	2		9	3		14	23
Round Goby	<i>Neogobius melanostomus</i>					32	32	11	11	42	36	6	106	138
Rudd	<i>Scardinius erythrophthalmus</i>								7	1			8	8
Spottail Shiner	<i>Notropis hudsonius</i>		2				2	16		5	1	14	36	38
Tadpole Madtom	<i>Noturus gyrinus</i>	18	1	8		5	32			6			6	38
Trout Perch	<i>Percopsis omiscomaycus</i>		9				9							9
White Perch	<i>Morone chrysops</i>	2	4	4		155	165	12		7	11	5	35	200
White Sucker	<i>Catostomus commersoni</i>	48	3	7		2	60	7	1	3	9	1	21	81
Yellow Perch	<i>Perca flavescens</i>	1	12	1	1	13	28	7	17	2	2		28	56
White Crappie	<i>Pomoxis annularis</i>					2	2							2
Grand Total		514	869	1554	2012	1613	6562	300	152	688	345	62	1547	8109
#Species		19	21	18	13	24	31	17	17	23	20	12	27	34
# Transects		7	13	10	8	13	51	13	13	13	13	11	63	114

Note: Transects Summarized -G1,G2, G3 G4, G5, G6, G7, G8, G9, G10,G11,G12,G13,G14,G15, G16

Table 5. Fyke Net Catch for end of May 2022 from Cootes Paradise and Grindstone Marsh.

Species	Grindstone Creek Marsh						Cootes Paradise Marsh					Species Totals
	Pond 1	Pond 2	Pond 3	SouthP Swamp	Blackbird Marsh	Osprey Marsh	Inner Bay	Mac Landing	Old Channel	West Pond	Westdale Outflow	
Black Crappie			1	3								4
Bluegill	29				1	3					1	34
Bowfin	1					1				2		4
Brook Silverside					3	2						5
Brook Stickleback				2								2
Brown Bullhead						1	116			1026		1143
Central Mudminnow		5	26	5								36
Common Carp				1			72	88			1	162
Crayfish Sp.		5										5
Fathead Minnow		308	242								1	551
Golden Shiner			2	3		1						6
Goldfish	1											1
Green Sunfish	5				2	16					3	26
Largemouth Bass											1	1
Minnow Sp.	1	1										2
Northern Pike	1				1				2		2	6
Painted Turtle		2				1		1				4
Pumpkinseed	27	3		7	45	98	6				3	189
Round Goby	2											2
Rudd			3							1	1	5
Rusty Crayfish									4			4
Salmonid Sp.	1											1
Spottail Shiner	1											1
Tadpole (Large)	5	82	44					2			4	137
Tadpole (Small)		11	7									18
White Perch					1					1		2
Yellow Perch							1	3				4
Species Richness	11	8	7	6	6	8	4	4	2	4	9	
Grand Total	74	417	325	21	53	123	195	94	6	1030	17	2355

Table 6. Amphibians of Cootes Paradise Marsh Monitoring Program. Standard annual monitoring includes 3 visits per site.

Species	1992*	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
No Calling Amphibians	-	2	6	2		3	3	8	1	5	2	1	5	10	5	5	1	11	9	6	7	17	9	11	20	17	6	17	6	195
Wood frog <i>Lithobates sylvaticus</i>	P				2	6		1	1						1					2	2	3	1	6						25
Spring Peeper <i>Pseudacris crucifer</i>	P			6	4	2	7	1	5	1	3		4				157	3	1		1			2	1			1	1	200
Western Chorus Frog <i>Pseudacris triseriata</i>	P																2													2
Northern Leopard Frog <i>Lithobates pipiens</i>	P	1	2	25	13	11	14	5	12	13	12	6	37	92	93	18	59	7	15	9	10	26	12	8	8	13	26	6	27	580
American Toad <i>Anaxyrus americanus</i>	P	7	3	5	15	35	20	16	8	39	21	15	73	97	132	106	151		30	28	44	16	27	57	28	18	77	50	46	1,164
Gray Treefrog <i>Dryophytes versicolor</i>	P					3	11	4		12			24	7	86	1	8	8	14	28	12	12	40	63	25	107	36	13	25	539
Green Frog <i>Lithobates clamitans</i>	P	16	20	34	21	8	10	15	30	24			42	39	33	170	90	43	41	45	51	63	74	53	50	51	52	15	34	1,124
American Bullfrog <i>Lithobates catesbeianus</i>	P																													0
Total Heard	-	24	25	70	55	65	62	42	56	89	36	21	180	235	345	295	467	61	101	112	120	120	154	189	112	189	191	85	133	3,634
Total Species	8	3	3	4	5	6	5	6	5	5	3	2	5	4	5	4	6	4	5	5	6	5	5	6	5	4	4	5	5	7
Total Sites Visited	-	8	18	18	12	18	18	18	13	18	7	6	31	30	21	21	17	25	25	21	21	35	26	33	39	41	26	33	23	622
Stations Active	-	6	6	6	6	6	6	6	6	6	4	3	13	10	7	7	7	11	9	7	7	12	9	11	14	14	11	11	8	22
Sites Dry	-																				1						1			2

Notes: *As listed in the HHRAP stage 1. Observations are by volunteer in West Cootes Paradise sites 2010 and the Spring Peeper calls at a minimum are thought to be incorrect based on pattern of other years. Many areas have no monitoring due to lack of habitat.

Table 7. Amphibians of Grindstone Marsh Monitoring Program. Standard annual monitoring includes 3 visits per site.

Species	1992*	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
No Calling Amphibians	-	4	1	1		1		1					7	6	1	2			6		3	4	6			7		50
Wood frog <i>Lithobates sylvaticus</i>	P												2		1		1											4
Spring Peeper <i>Pseudacris crucifer</i>	P					4				6	2	3	1		1	3	50		3	4			1		1	2		81
Western Chorus Frog <i>Pseudacris triseriata</i>	P																											2
Copes Gray Tree Frog Dryophytes <i>chrysoscelis</i>											1																	0
Northern Leopard Frog <i>Lithobates pipiens</i>	P		16	17	10	8	14	15	35	11	13	26		7	88	22	20	35	25	25	5	21	31	11	5	1	5	466
Pickerel Frog <i>Lithobates palustris</i>	P																											0
American Toad <i>Anaxyrus americanus</i>	P		2	1	4	2	6	1	16	27	10	12	50		22	15	3	5	19	16	7	14	9	2	6	2	4	255
Gray Treefrog <i>Dryophytes versicolor</i>	P														5					4		1		8				18
Green Frog <i>Lithobates clamitans</i>	P	24	18	39	18	36	29	49	21	54			1	29	55	30	48		59	30	68	41	8	14	21	11		703
Total Heard	-	24	36	57	32	50	49	65	72	98	26	41	54	36	172	70	122	40	106	79	80	77	49	35	33	16	9	1,528
Total Species	8	1	3	3	3	4	3	3	3	4	4	3	4	2	6	4	5	2	4	5	3	4	4	4	4	4	2	7
Total Sites Visited	-	9	9	9	6	9	9	9	12	12	6	7	15	15	15	15	9	6	17	12	12	15	17	8	9	14	3	279
Stations Active		3	3	3	3	3	3	3	4	4	3	4	5	5	5	5	3	3	6	4	4	6	6	3	3	5	3	7
Sites Dry	-																											0

Notes. *As listed in the HHRAP stage 1. Observations of Copes Gray Tree Frog thought to be tied to a captive escaped individual.

Table 8. Amphibians totals of Cootes Paradise Marsh Monitoring Program stations. Standard annual monitoring includes 3 visits per site.

Station Summary	1995	1996	1997	1998	1999	2000		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	
Visit 1	1	2	12	34	10	25		2	22	20	10	5	81	189	214	84	357	6	30	12	6	28	11	63	7	0	26	27	20	1,304	
ON656A		0	2	8	2	3		0	1	0			0	6	0																22
ON656B													0	0	0				1			0									7
ON656C		1	2	4	0	4		0	2	6			0	2	8																29
ON657A		0	0	1	0	2		0	3	0	4	4	22	40	81	25	150		14	9	3	21	1	3	4	0	5	2	7	395	
ON657B		1	2	7	6	6		2	14	2		0	4	80	80	40	103		6	3	0	2	1	2	0	0	0	0	7	368	
ON657C		0	2	8	1	1		0	1	5	0	1	12	8					6	0	0	1	0	0	0	0	0	0	0	46	
ON657D											6		24	42	45	1	104													222	
ON657E																								2	1	0	3	0	3	9	
ON658A													8	5	0	0		0	0			0	0			0				8	
ON791A													4	3		6		3				4		27	0	0		0		47	
ON791B														3		12		3						28	0	0		0		46	
ON791C																0		0					0	0	0	0		0		0	
ON933A													3						0	0	0	0	0	0	0	0		8	0	11	
ON933B	1	0	4	6	1	9		0	1	7			1						3	0	3	0	4	0	0			10	3	53	
ON933C													3						0	0	0	0	5	0	0	0		5	0	13	
ON933D													0						0	0	0	0	0	1	2	0		2	0	5	
SC14																									0	0	0			0	
SC2																									0	0	18			18	
SC6																									0		0			0	
Visit 2	23	16	22	21	43	27		20	4	37	26	16	46	14	57	156	74	14	34	47	45	24	47	63	43	55	83	34	56	1147	
ON656A	0	2	2	1	1	4		2		4				1	2															19	
ON656B	1	1	0	1	6	1		1		0				0	0		2	0				0								13	
ON656C	3	7	6	7	9	8		6		9				1	3		1													60	
ON656F																		0												0	
ON657A	8	3	3	3	7	7		5		14	12	7	12	5	43	41	12		11	16	22	14	11	8	13	4	6	5	26	268	
ON657B											6	3	1	2	4	80	1		9	7	0	0	0	0	0	0	6	0	5	14	188
ON657C	5	1	7	3	9	7		6		1	0	6	11	0					7	1	8	3	14	0	1	6	3	0	7	106	
ON657D											8		6	4	0	30	50													98	
ON657E																							4	0	6	4	6	7	7	34	
ON658A													8	0	5	1		5	5			0	0			1				19	
ON791A														0		0	7	2				4		6	4	1		7		31	
ON791B														1		4	1	4				2		26	4	4		3		49	
ON791C																0		0				0		0		0		2		2	
ON933A													2						0	0	4	0	6	4	5	0	13	0	1	35	

ON933B	6	2	4	6	11	0		0	4	9			2					0	15	7	0	2	9	10	12	31	0		130		
ON933C													1					1	7	3	0	9	9	0	11	18	1	0	60		
ON933D													3					1	1	1	1	1	1	0	4	0	4	1	18		
SC14																									1	2			3		
SC2																									0	1	2		3		
SC6																										2			2		
Station Summary	1995	1996	1997	1998	1999	2000		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	
Visit 3	0	7	36	-	12	10		20	30	32	-	-	53	32	74	55	36	41	37	53	69	68	96	63	62	134	82	24	57	1183	
ON656A		1	6		1	0		0	0	0				0	4															12	
ON656B		0	1		0	1		0	2	0				0	2		7	5				0								18	
ON656C		3	7		2	5		4	9	8				0	2		7													47	
ON656F																		0												0	
ON657A		2	5		1	3		8	6	13			13	14	48	8	8	13	9	25	38	37	60	21	21	23	16	16	27	397	
ON657B													8	4	8	1	2	12	0	2	0	0	0	0	0	0	6	0	0	4	85
ON657C		0	5		2	1		2	8	6			6	0					7	2	8	7	11	4	4	12	8	1	8	102	
ON657D													6	6	6	30	7	6												61	
ON657E																							9	3	3	8	7	7	4	41	
ON658A													8	0	4	4		0	3			0	0			4				15	
ON791A														3		6	5	1				5		5	0	26		0		51	
ON791B														5		6	0	1				5		4	0	27		0		48	
ON791C																0		0				1		0	0	0		0		1	
ON933A													0						0	3	6	4	4	4	4	2	1	1	0	0	25
ON933B	0	1	12		6	0		6	5	5			1						2	7	7	4	10	9	7	10	23	0	5	120	
ON933C													4						4	12	10	4	2	10	7	7	8	0	3	71	
ON933D													7						12	2	0	1	0	3	5	9	19	0	6	64	
SC14																										2	1			3	
SC2																										6	0			6	
SC6																										5				5	
Grand Total	24	25	70	55	65	62		42	56	89	36	21	180	235	345	295	467	61	101	112	120	120	154	189	112	189	191	85	133	3,634	

Table 9. Amphibians totals of Grindstone Marsh Monitoring Program by station. Standard annual monitoring includes 3 visits per site.

Station Summary	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	
Visit 1	0	16	17	14	8	19	15	35	28	11	22	13	23	92	23	72	34	47	25	1	25	36	11	5	3	9	604	
ON658B												0	5	2	0			0			0	0			0			7
ON658C								6	8	2	7	0	0	5	2			6			11	25			0			72
ON867A	0	8	7	4	5	6	6	10	7	6	2	6	5	7	6	56	14	9	3	0		0	3	1	2	1		174
ON867B	0	3	0	3	1	6	3	6	6		6	1	2	18	5	10	5	8	5	0	7	6	3	2	1	3		110
ON867C	0	5	10	7	2	7	6	13	7	3	7	6	11	60	12	6	15	12	7	1	7	3	5	2	0	5		219
ON867D																		12	10	0		2						24
Visit 2	21	14	9	18	9	21	11	17	27	15	19	40	2	22	33	32	6	32	27	16	28	9	4	15	2		449	
ON658B												0	0	5	1			0			0	1			0			7
ON658C								3	8	8	8	10	0	5	1			0			10	0			0			53
ON867A	10	9	7	12	8	9	5	5	4	6	1	12	0	5	11	12	2	12	4	1	9	2		5	2			153
ON867B	2	1	1	3	1	4	0	5	7			10	2	1	4	9	1	9	8	3	5	5	2	4	0			87
ON867C	9	4	1	3	0	8	6	4	8	1	10	8	0	5	16	11	3	11	6	3	4	1	2	6				130
ON867D																		0	9	9								18
Visit 3	3	6	31		33	9	39	20	43			1	11	58	14	18		27	27	63	24	4	20	13	11		475	
ON658B												0	0	3	1		1	0			0	0			0			6
ON658C								3	8			1	3	0	1		2	0			0	0			1			21
ON867A	1	2	13		16	1	15	6	14			0	2	20	5	2		11	15	16	8	0	5	7	2			161
ON867B	0	0	6		7	5	8	2	9			0	3	5	2	8		4	2	14	5	1	7	4	1			93
ON867C	2	4	12		10	3	16	9	12			0	3	30	3	8		12	7	26	9	2	8	2	7			185
ON867D																			3	7	2	1						13
Grand Total	24	36	57	32	50	49	65	72	98	26	41	54	36	172	70	122	40	106	79	80	77	49	35	33	16	9	1,528	

Table 10. Birds of Cootes Paradise Marsh Monitoring Program. Standard annual monitoring includes 2 visits per site. Does not include recent categories of Flythroughs. Shaded rows are focal marsh species.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2006	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	
American Coot																						2	2	
American Crow	5	5	9	7	3	6	4	6	6				5											56
American Goldfinch	1	6	1	3	3		2		4	5	3	14	6	1	4	10	1	1	1					66
American Redstart											1													1
American Robin	3	4	8	8	4	4	10	8	10	7	0	7	11	6	10	3	1	3	6	1	2	5		121
American White Pelican		1																						1
Bald Eagle								1																1
Baltimore Oriole	2	5	3	8	1	8	9	10	10	6	1	4	10	5	4	5	6	5	1			1		104
Bank Swallow	11	3	4						2	2														22
Barn Swallow		1		1				5	1	2	32	2	8		1	1	2	4	7			6		73
Belted Kingfisher		3	1			2			1	1	0		2											10
Black-capped Chickadee	5	3	4	3	3	4	2	4	2	8	0	2			2	2			2					46
Black-crowned Night-Heron	2		1	1		2		1			3	1	2	1										14
Blue Jay		1	4	2	1	1	1	2	3	6	0	1			1			1	1					25
Blue-Grey Gnatcatcher	1	3	3				3	4	3	1														18
Blue-winged Teal											0													0
Brown-headed Cowbird						4	1			4	0		2		1									12
Canada Goose	4		4	5	37	7	6	25	10	6	9	2	5		2		4		6		1			133
Carolina Wren									1		4		2					2				1		10
Caspian Tern	11	2	3	2	9	3	1	4	6	5	8		2		2	1		2						61
Cedar Waxwing	8	2		1		34	3	6	11	5		1	5		8	2		2	1	1				90
Chimney Swift		2			1		1	3		2	5					2					5			21
Chipping Sparrow						1						1						1						3
Common Grackle			2	5	3	3	5	1	4	5	0	1	28	4										61
Common Moorhen					1	1	3	1		1			5			1	2	1						16
Common Nighthawk														1										1
Common Tern				1					2							1								4
Common Yellowthroat	2	1	1	1	1	9	5	3	7	7	6	7	14	3	6	8	6	3	2	2	1	5		100
Cooper's Hawk										1														1
Double-crested Cormorant	2	2		1	2		3	1	3	1	0		12											27
Downy Woodpecker	1	2		3	1	2	3	2		2	0		4				1	1				1		23
Eastern Kingbird	2					3		1	3		1	1	3	4	2	2	2	5	9		1	3		42
Eastern Phoebe											1													1
Eastern Wood-Pewee	2	3	1	3	2	1	1		3	1	1				2		1							21
European Starling	6	2	3	5	5	8	12	13	9	6														69

Species cont.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2006	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total	
Gadwall								1		1													2	
Gray Catbird	2	2	1	1	1	2	1	3	1	1	2	3	3	1	3	2	1	2	1					33
Great Blue Heron	5	4	7	4	4	7	7	6	4	5	4	1	3				1	1	4	1		1	69	
Great Crested Flycatcher	3	3	1	3	3	3	1	4	4	5		1	2		1		3		1	2	1	1	42	
Great Egret						1		1				1	2										5	
Great Horned Owl	1																						1	
Green Heron					1						1	2	2										1	7
Green-winged Teal											1													1
Hairy Woodpecker								1	2	1		1												5
Herring Gull	1	1			2	2	2		4	1	0													13
House Finch			1								1		1											3
House Sparrow													1											1
House Wren	6	7	3	1	1	7	3		4	5	0		1			1	2							41
Indigo Bunting												2	2	1			1					1		7
Killdeer		2		2	2	4	1		1											2	1			15
Least Bittern			1	1	1	3	2										2		0					10
Mallard	3	2	4	10	3	6	2	7	4	8	0	1	2	1					9	1		4		67
Marsh Wren	5		4	6	6	1	5	4	8	7	10	5	21	9	7	6	7	7	8	11	9	3		149
Mourning Dove	1	1	4	1	2	5	1	2	7	7	0		1	1	1	1						1		36
Mute Swan		2	4	5	3	5	7	4	7	8	9	1	18	2	3	1	6	3	2	2	2	2		96
Nashville Warbler													3											3
Northern Cardinal	4	2	3	5	3	5	2	5	2	6	0		12	2	5	2	1	2				2		63
Northern Flicker	7	5	2	3	1	5	2	5	4	3	0	1												38
Northern Rough-winged Swallow											6	1	2		7	12		3	2			3		36
Osprey			1				1		1						1		1		2					7
Pied-billed Grebe																5			0	1				6
Pileated Woodpecker								1		3														4
Prothonotary Warbler													1											1
Purple Finch		1																						1
Red-bellied Woodpecker													1			1	2							4
Red-eyed Vireo							1					3	1		1		1		1					8
Red-tailed Hawk		2			1		2	1		3														9
Red-winged Blackbird	103	37	51	62	56	64	55	52	49	53	73	32	108	59	98	64	49	63	55	19	16	66		1,284
Ring-billed Gull	67	11	9	9	7	9	9	7	5	9	0		12											154
Rock Dove	1	1			1					1														4
Rose-breasted Grosbeak				1		1			1		2	2	1		1	1	1		1					12

Species cont.	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2006	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Scarlet Tanager												1							1				2
Song Sparrow	11	17	16	14	11	14	16	19	14	11	12	9	34	6	8	14	4	9	4	6	1	11	261
Sora	1	1		6	2		1		1											1			13
Spotted Sandpiper	3					2		1														3	9
Swamp Sparrow	1	2			1	1			3	3	11	9	32	7	15	18	10	16	11	10	6	9	165
Tree Swallow	26	11	19	14	11	31	17	11	25	17	123	19	45	30	45	44	9	119	33	10	6	54	719
Trumpeter Swan						1		1	1		2												5
Turkey Vulture		2			1	3	1	1	6	6	1												21
Virginia Rail	4	1	1	6	14	1	11		3	4			4							2	1	2	54
Warbling Vireo	3	1	3	10	4	6	4	11	4	3		6	7	5	5	5		6	3		1	1	88
White-breasted Nuthatch					1	2		1		2													6
Willow Flycatcher							1						2				2						5
Wood Duck	1	1	3	2	3	18	4	3	3	4		2	11		1						2	2	60
Wood Thrush		2	3		3	2	1	1		1	0							1					14
Yellow Warbler	12	12	13	13	15	21	8	9	18	16	18	13	34	17	16	10	5	10	10	2	2	11	285
Yellow-billed Cuckoo																	1						1
Grand Total	339	184	206	239	241	335	243	263	287	278	351	160	495	166	263	225	135	273	184	79	53	202	5,201
Total Species	40	45	38	40	45	48	47	46	48	50	46	35	48	21	30	28	30	26	29	18	16	27	87
Total Site Visits	12	12	12	12	12	12	12	12	12	12	21	11	26	9	12	12	8	12	12	6	6	14	269
Stations Surveyed	6	6	6	6	6	6	6	6	6	6	13	7	13	6	6	6	5	6	6	3	3	7	18

Table 11. Birds of Grindstone Marsh Monitoring Program. Standard annual monitoring includes 2 visits per site. Does not include recent categories of Flythroughs. Shaded rows are focal marsh species.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2006	2008	2012	2015	2017	2018	2019	2021	2022	Total
American Crow	1	1	3	1	5	1	1	4	6			2								25
American Goldfinch	3	4	1	4	5		2	2	4	2				2	4					33
American Robin	3	3	3	7	9	6	5	5	5	3			3	6	4	3	1		2	68
Baltimore Oriole	3	2	3	2	3		2	2	4	2		3		4	4	1			4	39
Bank Swallow			1	7			3	6	1	2										20
Barn Swallow			2					3	1				2		4	8	14	10	10	54
Belted Kingfisher	4	2		3	1	3		2	3	3		2	2	6	3	1	1	2	4	42
Black-Billed Cuckoo							1													1
Black-capped Chickadee	5	2	2		3		3		1	4				8	1	2			2	33
Black-crowned Night-Heron		2	1	1	1	5		2		3										15
Blue Jay		3	2			2			2	1						1				11
Blue-Grey Gnatcatcher	3	2						1	2											8
Brown-headed Cowbird		1	1			2														4
Canada Goose			1		4		2	25	28	14	4			2		19	7		2	108
Carolina Wren									1											1
Caspian Tern	1							1	3	2	1						6			14
Cedar Waxwing	2	5	6	2		1	3		4				3							26
Chimney Swift		1		2		2			5	2										12
Common Grackle	4	2	3	2	3		5	1	12	5					3	2	1		2	45
Common Nighthawk									1											1
Common Tern									3				3	2						8
Common Yellowthroat	1				3	3	1									2				10
Double-crested Cormorant								1								1				2
Downy Woodpecker		1	1	1		3			2	1				8	1	2	1			21
Eastern Kingbird			2					1			0	1			1	1	2		1	9
Eastern Phoebe									1					4						5
Eastern Wood-Pewee	1	5	1	3	1	1			2	1				2						17
European Starling	8	5	3	3	3	4	12	7	8	6			5	6						65
Gray Catbird	3	2			2	3	2	2	1	2				2	1	1			1	22
Great Blue Heron	2	3	1	1	4	2	4	8	5	5						1	3	2		41
Great Crested Flycatcher	4	1	3	2		1		2		1				2	2		0			18
Green Heron	1			3		1			1	2		1		2		1				12
Hairy Woodpecker						1		1		1										3
Herring Gull			1		2		3		4	2	0									12
House Sparrow									1	4										5

House Wren		2	1	1			3								1				8	
Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2006	2008	2012	2015	2017	2018	2019	2021	2022	Total
Indigo Bunting					1											1				2
Killdeer	2	2							1											5
Least Bittern			1						1											2
Mallard	1	2	1		1	4	3	15	8	10				6		3	3		1	58
Marsh Wren											1									1
Mourning Dove		1	4	5		5	3	2	5	10										35
Mute Swan				2				1	4	4	4	1	3			1	3		1	24
Northern Cardinal	5	6	2	4	6	4	6	3	4	4		5		4	3	2	4		2	64
Northern Flicker	6	2	4	4	1	1	1	2	1	2		1		2			1			28
Northern Rough-Winged Swallow						1	2	2	5	1										11
Osprey																1	2			3
Red-bellied Woodpecker							1							4		1				6
Red-winged Blackbird	26	15	21	23	22	24	20	32	30	40	16	42	15	62	48	45	51	18	32	582
Ring-billed Gull	19	5	6	4	2	6	6	7	7	7		1								70
Rock Dove			1	1				2		1										5
Rose-breasted Grosbeak	1																			1
Song Sparrow	9	11	4	9	12	3	6	9	11	7			4	14	5	9	9		14	136
Sora		1						3	2											6
Spotted Sandpiper		1	1	1				2												5
Swamp Sparrow				1										2	2	2	2	1	4	14
Tree Swallow	7	7	3	8	12	8	8	16	12	4		1	4	8	4	7	4	2	3	118
Trumpeter Swan																6	2	2	1	11
Turkey Vulture										1										1
Virginia Rail										1								1		2
Warbling Vireo	3		3	7	4	4	1	5	4	3							2			36
White-breasted Nuthatch			2	2													2		1	7
Wood Duck	1		3	3	4	6	4	5	8	5	2				1	9	3	1	7	62
Wood Thrush								3		3		2								8
Yellow Warbler	3	4	5	8	9	8	5	4	7	8				14	3	5	6		1	90
Grand Total	96	98	96	110	111	104	105	161	190	167	27	61	44	168	84	123	114	39	95	2,216
Total Species	27	30	33	29	25	26	26	31	35	33	7	12	10	23	15	26	24	9	20	61
Total Site Visits	6	6	6	6	6	6	6	8	8	8	2	3	6	6	6	9	8	6	6	118
Stations Surveyed	3	3	3	3	3	3	3	4	4	4	2	3	3	3	3	4	4	3	3	6

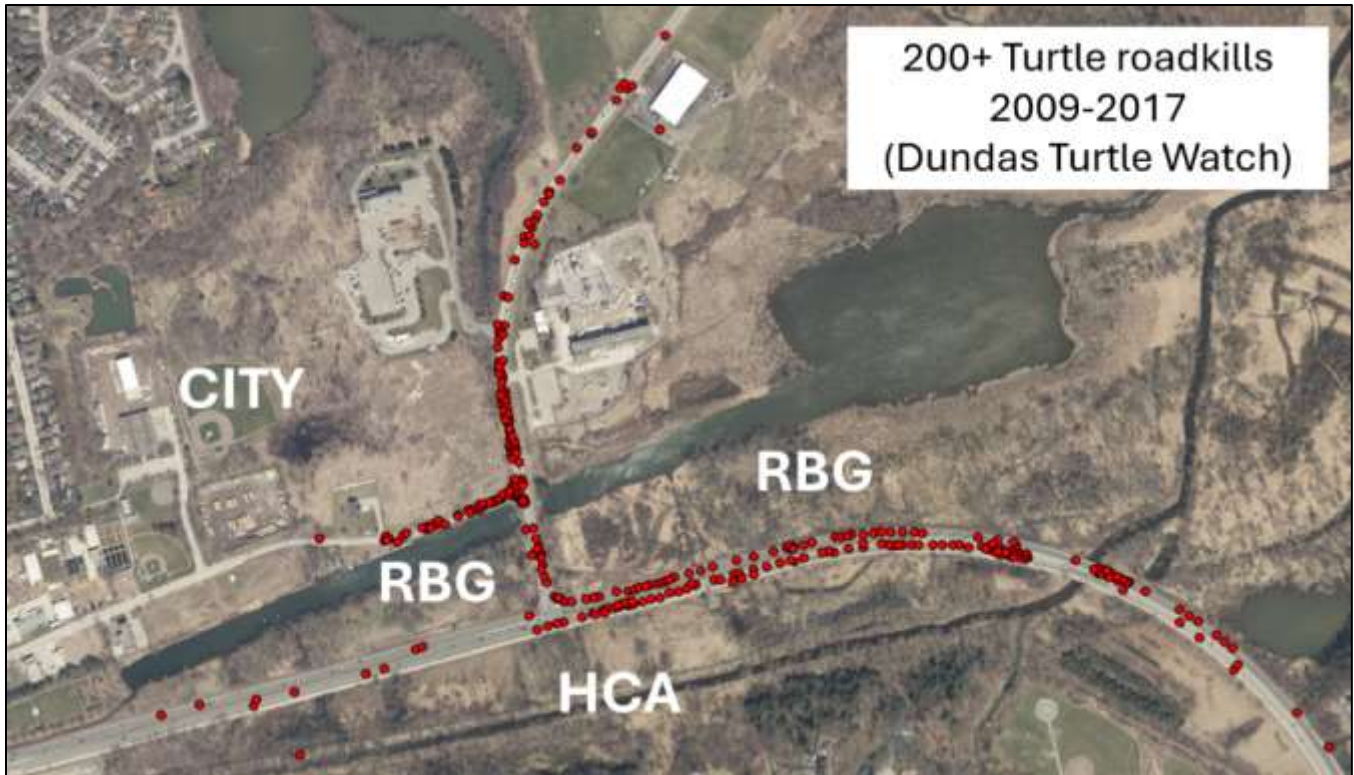


Figure 31. Map of Turtle Roadkill and property owners at Cootes Dr/Olympic Dr, West Cootes Paradise Marsh. Data provided by Dundas Turtle Watch for the years 2009 to 2017 and mapped by RBG.



Figure 32. Aerial photo of Cootes Paradise Marsh's West Pond outflow area in fall 2022 drought, illustrating muskrat trails to lodges during extremely low water. The water level refloded once adjacent Spencer Creek returned to average water flows. West Pond is the largest oxbow pond of the marsh.



Figure 33. Example of dead beavers in lower Spencer Creek Channel Cootes Paradise Marsh. Theijsmeijer 2021.

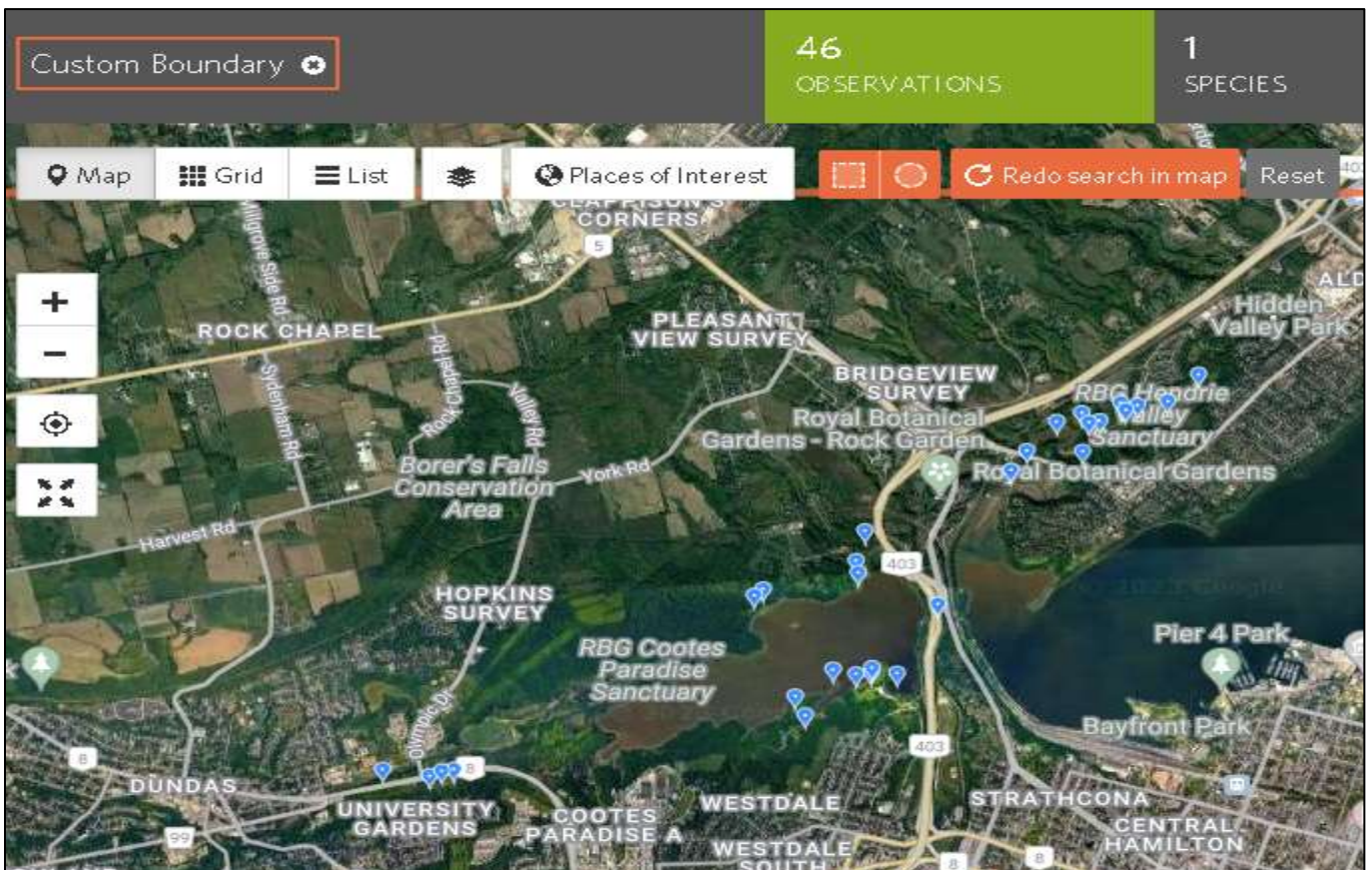


Figure 34. iNaturalist Mink observations April 2020 to end of March 2023. A number of the sightings are tied to road kills on roads adjacent to the two wetland systems.



Figure 35. August 2021 iNaturalist Mink provided by account user “Inegratz” of a road killed mink on Old Guelph Road by Cootes Paradise Marsh.



Figure 36. Roadkill issues, turtles and amphibians above pictures,



Figure 37 Roadkill mitigation small animal fence, ongoing installation at Cootes Paradise and Grindstone Marsh.

APPENDIX 2: Feature Coastal Marsh Areas

Spencer Creek Delta

Restoration of the main delta channel of Cootes Paradise Marsh has been a primary focus of restoration work. The combination of historical ditching of the watershed into the old Desjardins Canal, combined with total loss of emergent and submergent vegetation destroyed the original feature. The channel as it restores serves the function of a pollution shunt for a kilometer of the western marsh and is the largest of these features in western Lake Ontario. The channel edge adjacent emergent vegetation acts as biofilter as water passes through it. As of 2021 the redeveloping creek delta has a defined meandering channel of about 1.6 km in length with two pond features gradually forming as creek bank levees newly establish. To facilitate the regeneration more than 100,000 cattails have been planted and temporarily fenced from geese, combined with natural regeneration on exposed mudflats under low water conditions in 1999 and 2021. This corridor is also a focal area of *Phragmites* growth from inflowing seed and plant fragments and has had hectares of this invasive plant removed with ongoing work to control newly forming populations. Appendix 1 contains GIS maps of this feature.



Figure 38. Cootes Paradise Spencer Creek delta, plant community change images. Top November 2021, where the natural flow pattern at the mouth of Spencer Creek is seen, lower photo sequence from the marsh boardwalk lookout 2016, 2019 and 2022 comparison.

Interior Ponds – Upper Paradise Pond

Upper Paradise Pond in Cootes Paradise is a spring feed 1.5-hectare semi- isolated oxbow pond tied to a pre canal construction Spencer Creek. The pond has undergone dramatic plant recovery transformation in recent years to among the most diverse wetland area of Cootes Paradise.

Emergent plants now include a diverse mix of Cattails, Softstem and River Bulrush, and Giant Burreed. Aquatic plants include a various Potamogeton species and White Waterlily. Emergent I at reestablishment is illustrated in the Appendix maps.



Figure 39. Upper Paradise Pond plant community change images. Top July 2021, lower Google Earth Aerial photo sequence 2009 and fall 2022 under low water.

Interior Ponds – Presidents Pond

Presidents Pond in Cootes Paradise is a spring feed 3 hectares semi- isolated oxbow pond tied to a pre canal construction Spencer Creek. The pond has undergone a dramatic transformation in recent years from a plant less pond rimmed by invasive Eurasian Manna Grass and patches of Phragmites, to the most diverse wetland area of Cootes Paradise. The area naturally regenerated more than 500 Southern Wild Rice plants. Emergent plants now include a diverse mix of Cattails, Softstem and River Bulrush, Swamp Loosestrife and Giant Burreed. Aquatic plants include a various Potamogeton species and Yellow Waterlily. Emergent establishment is illustrated in the Appendix maps.



Figure 40. Presidents Pond plant community change images. Top July 2021, lower Google Earth Aerial photo sequence 2015, 2018 and 2021 comparison.

Interior Ponds – West Pond

West Pond is the largest interior pond of Cootes Paradise at about 9 hectares. The principal water supply is the Dundas Wastewater plant. During the summer of 2020 nearly all of the white water lilies died off and disappeared over a short period of time and for an unknown reason. As the 2021 growing season progressed, the lilies were not observed beyond a few along the edges of the marsh. During the summer of 2021 a wooden boom was put in place at the outfall of the pond by RBG staff to hold back the floating filamentous algae mats from drifting out of west pond and into the rest of Cootes Paradise. These mats have been observed in past years to smother marsh vegetation which can cause widespread vegetation loss in the marsh. (Water Quality Report 2021)



Figure 41. West Pond plant community change images. Top July 2021, middle Google Earth Aerial photo sequence, bottom 2019 and 2021 comparison.

Interior Ponds – Long Pond

Long Pond is the largest interior pond of Grindstone Marsh at about 6 hectares. The pond is the historical outflow channel of Cootes Paradise prior to isolation and outflow relocation by railway construction in the 1850s. A diverse mix of emergent plant species is recolonizing around the rim. The aquatic plants are challenged but White-Waterlily continue to increase in number year of year until 2022 when die offs began. More fragile submergent plant species are sparse, and the pond continues as hypereutrophic and dominated by phytoplankton. Due to the pond's depth elimination of the remnants of common carp population continue to be a challenge.



Figure 42. An image of long pond in 2021 showing lily growth and an aerial image (Google Earth)

Interior Ponds South Pasture Swamp

South Pasture Swamp is the last pond in the RBG Grindstone system. It proves to be one of our most prolific areas in terms of biodiversity. It maintains a stable white waterlily population that can populate very quickly year to year as seen in the aerial imagery. In terms of emergent plants, cattails and burred fill in the northern side of the pond and in Grindstone, it is also among the most successful Southern Wild Rice reestablishment sites.



Figure 43. Aerial images taken of South Pasture swamp (Pond 4) within the same year to illustrate vegetation growth during the season (early spring to mid summer)

Outer Grindstone Marsh and Chedoke Delta

Outer Grindstone Marsh is characterized by three redefined floodplain areas; Sunfish Pond, Blackbird, and Osprey Marsh, all of which are highly dependent on Lake Ontario water levels. At the downstream end of each berm is a carp exclusion structure which is designed similarly to the Fishway in that large fish can not enter unless we allow them too. Since native fish (Northern Pike, Bowfin, etc.) rely in these wetlands to spawn, the structures are opened in early April to allow for their movement (Grindstone Estuary Rehab). Due to high lake levels in 2019, flooding occurred inundating these wetlands with Common carp, negating any previous efforts made.



Figure 44. Berm realignment changes shown between 2009 and 2021 of Blackbird and Osprey marshes. The berm was realigned to better match the natural sinuosity of Grindstone Creek.

Chedoke Creek River Delta Berm

Like Grindstone Marsh, a Christmas tree berm was installed in Chedoke Bay to act as a breakwater and filtration system for the bay and to help better define the mouth of Chedoke Creek. The largest change has been the movement of water in the bay, the stillness of the water has in theory helped facilitate more plant growth and fish habitat.



Figure 45. Pre (right) and post (left) berm construction at the mouth of Chedoke Creek

APPENDIX 3 – Wetland Plant Species

Table 12. Wetland Plant Species Present in Cootes Paradise and Grindstone Marsh (excluding tree species)

Common Name	Scientific Name	Category	Non Native	Common Name	Scientific Name	Category	Non Native
Sweet flag	<i>Acorus americanus</i>	emergent		Flat-Stalked Pondweed	<i>Potamogeton friesii</i>	submergent	
Water Plantain	<i>Alisma plantago-aquatica</i>	emergent		Narrowleaf Pondweed	<i>Potamogeton natans</i>	Floating leaf	
Swamp Milkweed	<i>Asclepias incarnata</i>	meadow marsh		Floating Pondweed	<i>Potamogeton natans</i>	submergent	
Mosquito fern	<i>Azolla caroliniana</i>	Floating leaf	Eurasian	Long-Leaf Pondweed	<i>Potamogeton nodosus</i>	submergent	
Devil's Beggar-tick	<i>Bidens frondosa</i>	meadow marsh		Small Pondweed	<i>Potamogeton pusillus</i>	submergent	
Nodding Beggar-tick	<i>Bidens cernua</i>	meadow marsh		Richardson's Pondweed	<i>Potamogeton richardsonii</i>	submergent	
River Bulrush	<i>Bolboschoenus fluviatilis</i>	emergent		Tall Buttercup	<i>Ranunculus acris</i>	meadow marsh	
Flowering Rush	<i>Butomus umbellatus</i>	emergent	Eurasian	Multiflora Rose	<i>Rosa multiflora</i>	Shrub	Eurasian
Canada Bluejoint	<i>Calamagrostis canadensis</i>	meadow marsh		Swamp Rose	<i>Rosa palustris</i>	shrub	
Wild Calla	<i>Calla palustris</i>	emergent		Curly Dock	<i>Rumex crispis</i>	meadow marsh	Eurasian
Marsh Marigold	<i>Caltha palustris</i>	Meadow marsh		Golden Dock	<i>Rumex maritimus</i>	meadow marsh	
Bebbs Sedge	<i>Carex bebbii</i>	meadow marsh		Swamp Dock	<i>Rumex verticillatus</i>	meadow marsh	
Bristly Sedge	<i>Carex comosa</i>	emergent		Greater Water Dock	<i>Rumex orbiculatus</i>	emergent	
Lake Bank Sedge	<i>Carex lacustris</i>	meadow marsh		Broad-leaved Arrowhead	<i>Sagittaria latifolia</i>	emergent	
Tussock Sedge	<i>Carex stricta</i>	meadow marsh		Narrow leaf Arrowhead	<i>Sagittaria subulata</i>	emergent	
Fox Sedge	<i>Carex vulpinodea</i>	meadow marsh		Sandbar Willow	<i>Salix exigua</i>	Shrub	
Common Buttonbush	<i>Cephalanthus occidentalis</i>	Shrub		Hardstem Bulrush	<i>Schoenoplectus acutus</i>	emergent	
Coontail	<i>Ceratophyllum demersum</i>	submergent		Common three-square Bulrush	<i>Schoenoplectus pungens</i>	emergent	
Turtlehead	<i>Chelone glabra</i>	meadow marsh		Soft-stem Bulrush	<i>Schoenoplectus tabernaemontani</i>	emergent	
Bulb-bearing Water-hemlock	<i>Cicuta bulbifera</i>	emergent		Black Bulrush	<i>Scirpus atroviridis</i>	meadow marsh	
Field Bindweed	<i>Convolvulus arvensis</i>	meadow marsh		Common Skullcap	<i>Scutellaria galericulata</i>	meadow marsh	
Siberian Dogwood	<i>Cornus alba.</i>	Shrub	Eurasian	Bittersweet Nightshade	<i>Solanum dulcamara</i>	meadow marsh	Eurasian
Silky Dogwood	<i>Cornus amomum</i>	Shrub		Giant Burreed	<i>Sparganium eurycarpum</i>	emergent	
Red-osier Dogwood	<i>Cornus sericea</i>	shrub		Prairie Cordgrass	<i>Spartina pectinata</i>	meadow marsh	
Umbrella Sedge	<i>Cyperaceae sp.</i>	Meadow Marsh		Greater Duckweed	<i>Spirodela polyrhiza</i>	Floating leaf	
Swamp Loostrife	<i>Decodon verticillatus</i>	emergent		Sago Pondweed	<i>Stuckenia pectinatus</i>	submergent	
Water Hyacinth	<i>Eichhornia sp.</i>	Floating leaf	Eurasian	Lanceleaf Aster	<i>Symphyotrichum lanceolatum</i>	meadow marsh	
Needle spikerush	<i>Eleocharis acicularis</i>	meadow marsh		New York Aster	<i>Symphyotrichum novi-belgii</i>	meadow marsh	
Canada Waterweed	<i>Elodea canadensis</i>	submergent		Skunk Cabbqge	<i>Symplocarpus foetidus</i>	meadow marsh	
Virginia Rye	<i>Elymus virginicus</i>	Meadow Marsh		Narrow leaf Cattail	<i>Typha angustifolia</i>	emergent	
Riverbank Rye	<i>Elymus riparius</i>	meadow marsh		Broad-leaved Cattail	<i>Typha latifolia</i>	emergent	
American Burnweed	<i>Erechtites Hieraciifolius</i>	meadow marsh		Cattail Hybrid	<i>Typha x glauca</i>	emergent	

Common Name	Scientific Name	Category	Non Native	Common Name	Scientific Name	Category	Non Native
Joe Pye-weed	<i>Eupatorium maculatum</i>	meadow marsh		Common Bladderwort	<i>Utricularia vulgaris</i>	submergent	
Boneset	<i>Eupatorium perfoliatum</i>	emergent		Blue Vervain	<i>Verbena hastata</i>	meadow marsh	
European Manna Grass	<i>Glyceria maxima</i>	meadow marsh	Eurasian	Riverbank Grape	<i>Vitis riparia</i>	vine	
Dames Rocket	<i>Hesperis matronalis</i>	meadow marsh	Eurasian	Northern Watermeal	<i>Wolffia borealis</i>	Floating leaf	
Orange Jewelweed	<i>Impatiens capensis</i>	meadow marsh		Columbian Watermeal	<i>Wolffia columbiana</i>	Floating leaf	
Himalayan balsam	<i>Impatiens glandulifera</i>	meadow marsh	Eurasian	Horned Pondweed	<i>Zannichellia palustris</i>	submergent	
Yellow Iris	<i>Iris pseudacorus</i>	emergent	Eurasian	Southern Wild Rice	<i>Zizania aquatica</i>	emergent	
Blue Flag	<i>Iris versicolor</i>	emergent		Northern Wild Rice	<i>Zizania palustris</i>	emergent	
Virginia Iris	<i>Iris virginica</i>	emergent					
Canada Rush	<i>Juncus canadensis</i>	meadow marsh					
Soft Rush	<i>Juncus effusus</i>	meadow marsh					
Rice Cut Grass	<i>Leersia oryzoides</i>	meadow marsh					
Lesser Duckweed	<i>Lemna minor</i>	Floating leaf					
Star Duckweed	<i>Lemna trisulca</i>	Floating leaf					
Cardinal Flower	<i>Lobelia cardinalis</i>	meadow marsh					
Blue Lobelia	<i>Lobelia siphilitica</i>	meadow marsh					
Purple Loosestrife	<i>Lythrum salicaria</i>	meadow marsh	Eurasian				
Forget-me-not species	<i>Myosotis sp.</i>	meadow marsh	Eurasian				
Northern Watermilfoil	<i>Myriophyllum sibiricum</i>	submergent					
Eurasian Watermilfoil	<i>Myriophyllum spicatum</i>	submergent	Eurasian				
Slender Naiad	<i>Najas flexilis</i>	submergent					
Smaller Naiad	<i>Najas minor</i>	submergent	Eurasian				
Watercress	<i>Nasturtium microphyllum</i>	emergent	Eurasian				
Yellow Waterlily	<i>Nuphar variegata</i>	Floating leaf					
White Waterlily	<i>Nymphaea odorata</i>	Floating leaf					
Ladies Thumb	<i>Persicaria maculosa</i>	meadow marsh					
Arrow Arum	<i>Petrandra virginica</i>	emergent					
Reed Canary Grass	<i>Phalaris arundinacea</i>	meadow marsh	Eurasian				
Common Reed (Phragmites)	<i>Phragmites australis</i>	emergent	Eurasian				
Clearweed	<i>Pilea pumila</i>	meadow marsh					
Water Smartweed	<i>Polygonum amphibium</i>	emergent					
Pennsylvania Smartweed	<i>Polygonum pennsylvanicum</i>	meadow marsh					
Pickerelweed	<i>Pontederia cordata</i>	emergent					
Largeleaf Pondweed	<i>Potamogeton amplifolius</i>	submergent					
Berchtold's Pondweed	<i>Potamogeton berchtoldii</i>	submergent					
Narrow-Leaved Pondweed	<i>Potamogeton cf. strictifolius</i>	submergent					
Curly-Leaved Pondweed	<i>Potamogeton crispus</i>	submergent	Eurasian				
Leafy Pondweed	<i>Potamogeton foliosus</i>	submergent					

Appendix 4 - Habitat Creation Objectives 1990-1994 HHRAP

Source HHRAP Stage 2

Table 1. Habitat creation at each site

Location	Fish Habitat (ha)	Wildlife Habitat (ha)	Littoral Edge (m)	Trails (m)
Cootes Paradise	250.0	250.0	0	2000
Grindstone Creek	20.0	20.0	0	1000
Pier 27	3.8	0.1	500	0
Northeastern Shoreline	18.4	0.3	2,920	500
LaSalle Park	11.9	0.2	2,340	1,170
North Shore	18.0	0.6	2,550	0
Waterfront Park and Pier 4	22.1	0.4	2,600	1,300
Total	344.20	271.60	10,910.00	5,970.00

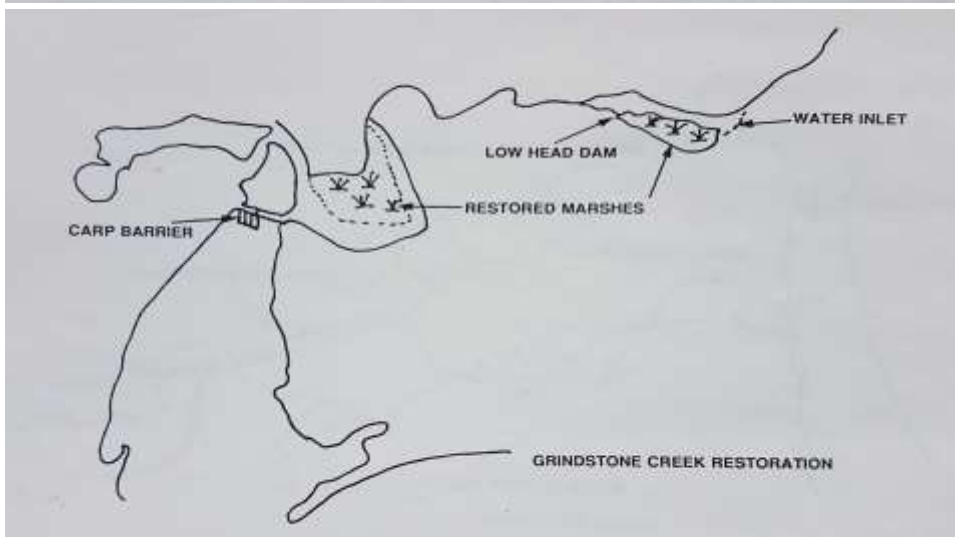
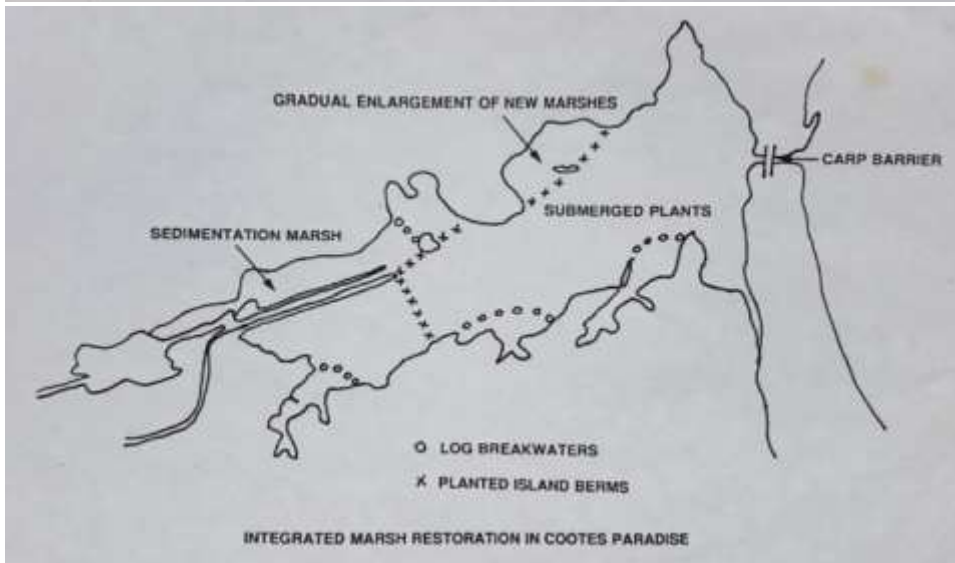
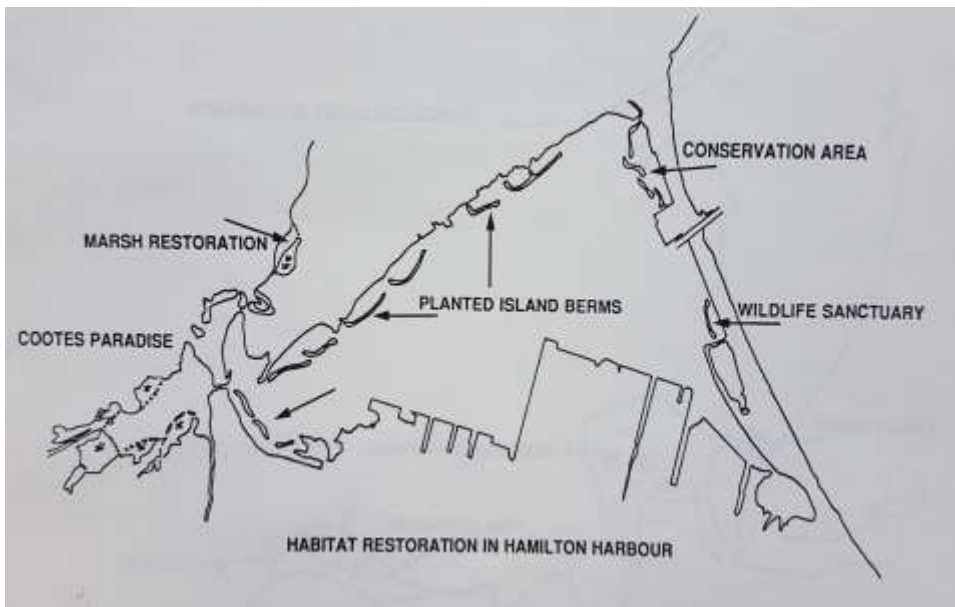
Habitat Loss:

- Shoreline loss Burlington Bay south shore = 45km of shoreline length lost (65km to 20km)
- Shoreline loss Burlington Bay total = total distance?
- Shoreline loss Cootes Paradise = undetermined – Chedoke Area inlet focused?
- Shoreline hardened = total distance?
- Area of land filled = ? (Bay south, Bay east, Cootes Paradise)
- Cootes wetland/aquatic plants = 85% of area missing plants (25ha of 190ha)
- Grindstone Marsh wetland/aquatic plants = ?% of area (?ha of ?ha)
- Burlington Bay wetland/aquatic plants = ??
- Gravel and cobble extraction from the bed of the bay = amount unknown

Report highlights concerns over potential further infilling from; proposed Redhill Expressway, CDFs, GO transit, Hwy 403/QEW expansion, waterfront access expansion.

HHHRAP Recommended Fish and Wildlife Projects (Dec 1990), from: A Plan for Restoration of Fish and Wildlife Habitat in Hamilton Harbour and Cootes Paradise (Prepared by CWS & GLLFAS 1990).

- Grindstone Marsh
 - Carp Barrier Grindstone Valley in Rd Bridge area
 - Water level control – cherry hill marsh (RBG Ponds 2,3,4)
 - Emergent Vegetation planting
 - Upper Carrolls Bay – TBD – carp & aquatic plants
- Cootes Paradise
 - Carp Barrier Cootes Paradise
 - Turbidity barriers (berms/islands?)
 - Pollution abatement – inflowing waters
 - Emergent vegetation replanting
 - Recontour for submergent vegetation
- East Port & Windermere Basin
 - Pier 27 designated a wildlife area
 - F&W projects – TBD based on toxic sediment information
 - Inflowing pollution to great for habitat use (Sewage)
 - Nesting islands for birds displaced as infill proceeds (CDFs)
 - Van Wagners Pond = ?
- Waterfront Park (Bay front Park)
 - CSOs mitigated (x2)
 - Habitat improvements TBD
 - Nature trail/fishing piers
 - Fish & Wildlife Conservation Area – NE Harbour Area
 - Islands
 - Public access/viewing platform
 - Harbour NS Habitat Improvements
 - LaSalle Park Islands
 - Lasalle groynes and fishing piers
 - Islands along north shore
 - Window to the Bay Park (groynes/fishing piers – sheltered shorelines)



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