An Update on the Disappearing Salt Marshes of Jamaica Bay, New York

Prepared by:

Gateway National Recreation Area,
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Jamaica Bay Watershed Protection Plan Advisory Committee

August 2, 2007

Photo Credit:
M. Kathryn Mellander. 2002, July. National Park Service, Gateway National Recreation Area.
Section of Black Wall Marsh.

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Executive Summary

For at least a decade, it has been recognized that Jamaica Bay's tidal wetlands are rapidly disappearing. In 2001, mapping analysis conducted by the New York State Department of Environmental Conservation (DEC) showed that between 1924 and 1999, half of the bay's vegetated marsh islands disappeared.[1] Even more alarmingly, DEC determined that the rate of loss had been increasing over time.[2] Between 1994 and 1999, for example, the rate of loss had nearly doubled from that of 1974-1994; assuming that rate of loss continued baywide into the future, it was calculated that the marsh islands would completely vanish by 2024.[3]

The Jamaica Bay Watershed Protection Plan Advisory Committee (Advisory Committee or Committee), created by New York City municipal law in 2005, and the Gateway National Recreation Area (GNRA), which encompasses more than half of the bay within its Jamaica Bay Unit, conducted this study to obtain a current understanding of the marsh loss problem, and specifically to determine whether the rate of loss had continued to accelerate since DEC released its 1999 results. For this report, the Committee and GNRA relied upon comprehensive (baywide) analysis of 2003 satellite imagery and aerial photography previously conducted by GNRA. The Committee and GNRA also obtained 2005 aerial photography of representative marshes from DEC, which was then analyzed and extrapolated to the bay as a whole, for the purpose of updating the 2003 analysis. Like the DEC analysis, this analysis focused only on the salt marsh islands where loss is known to be the most severe, and did not encompass fringe marshes or the upper reaches of the bay beyond John F. Kennedy International Airport. It is assumed that the bay's fringe marshes, the bay's upper salt marsh, and the margins of the dredge-spoil islands will degrade at a slower pace.

The analysis of the 2003 satellite imagery and aerial photography and 2005 aerial photography, and comparisons to earlier aerial photography using the protocols described *infra*, indicate that the rate of tidal wetlands loss in Jamaica Bay continues to accelerate. Field observations support this conclusion. From 1989-2003, the calculated average rate of loss was 33 acres per year, compared to a fairly consistent rate of approximately 18 acres per year from 1951-1989. This supports DEC's earlier conclusion that the marsh loss rate started to rapidly accelerate in the 1990s. By 2003, just 37 percent of the salt marsh islands that had been present in Jamaica Bay in 1951 were calculated to be left. Analysis of the 2005 aerial photography for five selected marshes representing different areas in the bay, and comparisons to the 2003 baywide map, yielded startling results. From 2003-2005, just a two-year period, it was calculated that four of the five marshes lost 54 acres, or almost 30 percent of the extent in 2003 (187 acres) (the fifth marsh, Elders Point, which had already lost more than 90 percent of its wetlands, remained approximately the same). The analysis indicated that a marsh in the south of the bay, Black Wall, which had been relatively stable, lost more than half of its remaining tidal wetlands over the two-year period. At a landscape scale, what is generally happening on the marsh islands is that tidal creeks are expanding and vegetated areas are transforming into mud flats, then to sand flats as they disappear.

Because the rate of marsh island loss appears to have continued to increase, prior projections that the marsh islands will disappear by 2024 are also likely too optimistic, probably by a significant margin. In a manner similar to prior projections, if the 2003-2005 observed loss for the five representative marshes is extrapolated to the entire bay, the bay's marsh islands would be projected to all disappear by 2012, just five years from now. Because this projection is based on a short time period and marsh loss rates vary between individual marsh islands, some islands may persist for longer and some for shorter. It should also be noted that only two years of data to represent current trends, as well as adequate aerial photography for only five marshes, was available. It will be important to collect and analyze additional years of data, including for additional marshes, to check for possible bias in this dataset. Also, if loss rates slow when only elevated vestiges of marsh island remain, then these projections will be overly pessimistic, while a continued trend towards accelerating loss rates would have the opposite effect. Finally, intervention to successfully reverse these trends will obviously affect the future scenario.

Jamaica Bay remains one of the largest and most productive coastal ecosystems in the northeastern United States, and includes the largest tidal wetland complex in the New York metropolitan area.[4] The bay's waters and marshes are considered a critical stopover point for migrating birds – estimated to be visited annually by nearly twenty percent of the continent's different bird species – and home for more than eighty fish species, as well as many threatened and endangered species.[5] Jamaica Bay's tidal marshes also provide flood protection for nearby businesses and residences, and serve as, together with the wildlife that depend on them, a unique recreational, aesthetic, and cultural resource for New York City.

Although the exact causes of the accelerating marsh loss remain unknown, the gravity of the problem warrants immediate action. Where possible contributing causes and how to address them have been identified, action should taken immediately. Poor water quality in the bay, and specifically significant nitrogen pollution from the city's wastewater treatment plants, falls into this category. In other words, as the Advisory Committee has previously recommended, steps to dramatically reduce nitrogen discharges into the bay should be undertaken immediately. In addition, marsh island restoration should be continued and expanded in order to help balance out marsh island loss until its underlying causes are addressed. Finally, the scientific and engineering effort to pinpoint the causes of the marsh loss and how to effectively address them *(e.g.*, determine how to address possible causes other than excess nitrogen) should be immediately and significantly scaled up.

Background

In the late 1990s, DEC began analyzing aerial photography of Jamaica Bay dating back to 1924 in collaboration with concerned local groups, such as the Jamaica Bay Eco Watchers. In 2001, the agency produced the first official report on the extent of the bay's tidal wetlands loss. It would be an underestimate to say that this report confirmed concerns that the bay's wetlands had been disappearing – indeed, DEC calculations show that between 1924 and 1999 the bay had lost fully half of its tidal wetlands.[6] Even more alarming, the analysis showed that the rate of loss had been accelerating over time. From 1924 to 1974, DEC calculated that 780 acres of marsh islands were lost because of direct dredge and fill activities (which were more strictly regulated after the 1970s) and 510 acres were lost due to other reasons at roughly 10 acres a year.[7] More than 500 acres were again lost between 1974 and 1994 – approximately the same loss of land in half the time. And between 1994 and 1999, the rate increased again, with DEC calculating an additional 220 acres of loss.[8] DEC roughly estimated that if the loss were to continue at the rate of 44 acres per year, it was predicted that – 100 years after the first aerial mapping of the bay in 1924 – all of the marsh islands in Jamaica Bay could be gone.[9]

While restoration efforts in the bay had been ongoing for a number of years, DEC's report triggered an intensified effort to protect and restore salt marsh and to determine the cause of the wetlands loss and possible solutions. In 1999, the Jamaica Bay Ecosystem Research and Restoration Team (JABERRT) investigated twelve potential salt marsh restoration sites within Jamaica Bay, and several of these sites (*e.g.*, Gerritsen Bay and Spring Creek) have been partially restored.[10] In 2001, GNRA convened a "blue ribbon" panel of national experts to examine the possible causes of the bay's marsh loss, focusing mainly on reduced sediment supply and suspension problems. The panel recommended a number of additional studies and restoration projects, such as the Big Egg Marsh thin layer sediment spraying, to add sediment to areas, which are then planted to help restore healthy marsh elevations.[11]

In 2005, New York City responded to the marsh loss crisis, as well as other problems besetting Jamaica Bay, by enacting Local Law 71. The law required the New York City Department of Environmental Protection (DEP) to develop a comprehensive *Jamaica Bay Watershed Protection Plan* (Plan) to "restore and maintain the water quality and ecological integrity of Jamaica bay."[12] (See Appendix A.) The new law also established the Advisory Committee; its seven members are charged with assisting DEP in Plan development. (See Appendix B.)[♦]

Not surprisingly, Jamaica Bay's marsh loss became one of the Advisory Committee's priority concerns. The Committee was surprised to find, despite the recognized gravity of the problem and the attention it has received, the current extent of the marsh loss was unknown, and specifically that it was unknown whether the rate of loss was continuing to increase. DEC has not updated its analysis with post-1999 data. Although GNRA staff had

[♦] The original timeline in the law called for submission of the final Plan by September 1, 2006; this timeline was extended to October 1, 2007 by Introduction 376 (See Appendix C). Local Law 71, as amended, provided an iterative process for the Plan's development, with several opportunities for the Advisory Committee to provide formal input to DEP. Pursuant to this process, on June 29, 2006, the Advisory Committee provided *Planning for Jamaica Bay's Future: Preliminary Recommendations on the Jamaica Bay Watershed Protection Plan*, on September 1, 2006, DEP submitted an *Interim Report on the Jamaica Bay Watershed Protection Plan*, and on March 1, 2007 DEP submitted its *Draft Jamaica Bay Watershed Protection Plan* (Draft Plan). On June 1, 2007, the Advisory Committee provided its *Final Recommendations on the Jamaica Bay Watershed Protection Plan*; however, because the Committee believes that the DEP's Draft Plan did not contain the level of detail called for by the legislation, the Committee intends to supplement their recommendations following the submission of DEP's final Plan on October 1, 2007.

The Value of Jamaica Bay's Wetlands

Made of glacial till left behind during the last ice age and shaped by erosion and wave action, the open water and wetlands portion of Jamaica Bay is approximately eight miles long, four miles wide and covers 26,645 acres, more than half of which is part of Gateway National Recreation Area's Jamaica Bay Unit.[13] Wetlands, also known as marshes, are land areas intermittently covered with shallow water or have soil saturated with moisture.[14] Saltwater marshes, such as those found in Jamaica Bay, are a type of tidal wetland, which become flooded periodically by tidal action.[15]

Jamaica Bay comprises one of the largest and most productive coastal ecosystems in the northeastern United States, and includes the largest tidal wetland complex in the New York metropolitan area.[16] These wetlands play a vital role in the city's ecological and economic health:

- Jamaica Bay's marshes provide critical wildlife habitat for more than eighty fish species and for nearly twenty percent of the continent's species of birds that visit the bay every year as they traverse the Eastern Flyway migration route to their breeding grounds further north. Saltwater marshes not only serve as nursery sites for finfish and shellfish, but also for feeding, spawning, and refuge from predators;[17] edge marshes are used by transient and resident fish and crustacean species, while interior marshes provide an important food sources for adult transient fishes.[18] Endangered and threatened species like peregrine falcons, piping plovers, and the Atlantic Ridley sea turtle reside in or visit the bay, along with more than 325 kinds of waterfowl and shorebirds (sixty-two of which are confirmed to breed in the bay).[19] The bay's wildlife depends on the wetlands for survival.

- Jamaica Bay's wetlands mitigate flooding and provide shoreline erosion control for homes and businesses in Brooklyn and Queens. The neighborhoods surrounding Jamaica Bay are home to more than five hundred thousand New Yorkers and the marshes serve as coastline buffers from waves, tides, winds, and floods, and can help reduce coastline erosion and property damage during storm events.[20] Marsh grass can decrease wave energy 10-fold and, due to its unique properties, even trap sediment instead of eroding during storm events.[21] With intense "hundred-year flood" storms predicted to become twice or even four times more frequent from global warming, natural barriers like wetlands are more important than ever.[22]

- The bay's wetlands act as the ecosystem's kidneys to filter out pollutants in the water. Wetlands act as nutrient buffers for coastal waters, capable of transforming large quantities of organic pollutants, suspended solids, and metals from runoff and wastewater effluent into organic matter, and thus act as sinks as organic matter is buried through marsh accretion and as bacterial denitrification releases nitrogen gas into the air.[23] This cycling is important because overabundance of nitrogen and organic matter spurs the growth of algae blooms that turn the bay's waters murky. As the algae die, sink to the bottom, and decompose, the water's oxygen levels drop, killing any aquatic life unable to swim away.[24] Salt marshes' roles as nutrient buffers are amplified in cases where there is anthropogenic nutrient enrichment in coastal waters (*e.g.*, sewage effluent and agriculture), but the efficiency by which they do so is hampered by excessive nutrient loadings.[25] It should be noted that, in the case of Jamaica Bay, the four city sewage treatment plants that surround the bay discharge more than 250 million gallons of treated wastewater containing thirty to forty thousand pounds of nitrogen into the bay every day.[26] This is far too much nitrogen for the bay's current wetlands to assimilate – one estimate puts the removal capacity of existing marshes somewhere between a tenth and a fifth of the total nitrogen inputs.[27]

- Salt marshes have the highest primary productivity of any floral community; moreover, the algal and phytoplankton communities they support significantly contribute to overall rates of carbon fixation, which helps reduce carbon dioxide in the atmosphere.[28] Each acre of Spartina grass produces ten tons of organic matter annually, which then enters the food chain to provide fuel for higher orders of organisms.[29] In order to reach Mayor Bloomberg's PlaNYC goal of reducing the city's greenhouse gas emissions 30 percent by 2030, we will need to protect all of the city's green space – especially the bay's wetlands.[30]

- The marshes serve as a recreational haven and living laboratory with education, research, and recreational opportunities. Groups like the American Littoral Society provide educational programs about the bay's resources to schools and civic groups, and the New York/New Jersey Harbor Estuary Program has broadcast education programs for high school students live from the bay.[31] Accessible to America's most populated city by subway and bus, millions of people who visit the area each year consider the waters, parks, and open space surrounding the bay "a sanctuary or haven from the stress of the city."[32]

conducted some additional and, in certain respects, enhanced, mapping of the bay, including using 2003 aerial photography, this information required further updating and analysis.

The Advisory Committee and GNRA decided that they would attempt to update the picture of the bay's wetlands loss problems, as such updated information was almost certain to be relevant to the significant decisions that need to be made with respect to the bay, including as part of the development and implementation of the Plan. As explained in greater detail *infra* (Methodology), working with mapping analysts at GNRA, the Committee has updated the 1999 report findings with a comprehensive look at the bay in 2003 obtained from satellite imagery and aerial photography and, for select marshes, from 2005 aerial photography.

As detailed *infra* (Results and Discussion), the dramatic increase in the rate of marsh loss we found is shocking. The Advisory Committee and GNRA present this updated look at Jamaica Bay's marsh island loss in the hopes that this analysis will further underscore the emergency in what is, figuratively, the backyard of millions of New Yorkers, a unit of the National Park system, and a resource of enormous ecological value, and – most importantly – in order to galvanize us to the necessary action. Given the short time that appears to be remaining for the marsh islands, this may be our last chance to save Jamaica Bay.

Methodology

This report relies upon a salt marsh mapping study conducted by GNRA. The purpose of GNRA's mapping study was to document salt marsh habitats and their status over time in Jamaica Bay. Unlike previous studies, such as that conducted by DEC, GNRA GIS office mapped not only vegetated areas of marsh, but also internal marsh structures such as tidal creeks, mud flat, and areas of degrading vegetation at a fine scale. This highly specific mapping has allowed analysis of change in the amount and distribution of vegetation. It has also enabled analysis of change from vegetation to mud flat, expansion of tidal creeks, and other changes made evident in a more robust analysis of the interior of the marshes over time. Among other things, it is hoped that this type of record of the marshes at various times over the modern history of the bay will aid in identifying factors influencing marsh loss and how the marshes react to these stressors. For this report, analysis was conducted for the salt marsh islands including JoCo marsh; fringe marshes are excluded from the analysis, as well as the upper reaches of the bay beyond John F. Kennedy International Airport.

GNRA utilized the following aerial interpretation and mapping methodology:

Scanned aerial photography of Jamaica Bay was obtained from DEC for the years 1951, 1974, 1989, 2003, and – for selected marshes – 2005. The photography ranged from digital photos of blown-up black and white mosaics (1951), to high resolution natural color and color-infrared aerials, flown at a ground resolution of well under a meter (1974, 1989, 2003, 2005). Care was taken to ensure that the images matched in terms of season and tidal cycle. With a reference panel that included wetlands scientists, GIS specialists, and remote sensing experts, a wetlands classification scheme was developed that included several levels of vegetation densities, tidal creeks, pools, mud flats, and sand. (See Appendix D). Mapping staff worked together to calibrate interpretation of the aerials for a comparable and consistent result.

The 2005 aerial photography was obtained and analyzed for five marshes: East High, Yellow Bar, Black Wall, Elders Point, and Pumpkin Patch. The purpose of analyzing the 2005 photography was to gain an understanding of the most recent marsh loss trends in the bay. Consultations with National Park Service (NPS) staff and others who conduct field work in the bay was done to verify that the five marshes are considered representative for their sections of the bay and can serve to provide an understanding of trends within these areas of the bay, and in the bay as a whole.

The individual aerial scans were geo-rectified at GNRA GIS Office to the New York City land base aerials from 1996, and checked for accuracy against the New York City aerials, as well as a more recent set of NPS aerials.

Marsh polygons were digitized on-screen over an aerial backdrop using specialized vector editing software. The high resolution of the scans for most of the photography involved allowed large scale mapping at around 1:600 scale, with a minimum mapping unit of approximately 20 square meters. The resulting time series of maps for each marsh island were overlaid after checking for attribute accuracy, and corrected for spatial variation that resulted from geo-rectification of aerials in an undeveloped natural area with few ground control points available. Tidal creek intersections, spatially very stable, functioned as control points and as points of comparison when overlaying and adjusting the various temporal data layers. Field ground-truthing from 2003 and 2005 mapping has been and is being performed to verify interpretive and spatial accuracy. In addition, 2003 results have been compared to an automated marsh mapping protocol developed for the NPS, and specifically GNRA, using high resolution satellite imagery and automated image processing techniques and the same class scheme as for the photo-based project. In this comparison, results were very similar.

Mapping the study area from 1951 aerials using the same NPS protocol as for the other aerial layers in the time series was a challenge. In all of the other sets of aerials, mapping was done from high resolution scanned images of high quality aerial photography flown at low altitudes (4,000–7,000 feet) with a ground resolution of 1–1.5 feet. These images were all flown by contract within an hour of low tide at times of peak biomass (late summer). The 1951 aerials, however, were digital pictures of poster-sized blow-ups of hand-mosaicked 9 x 9 inches black and white aerial photos. The same mapping protocols were used, but it is challenging to distinguish the complex interiors of the marshes. Tidal creeks, vegetated areas, and some of the mud flat areas were sufficiently clear; however, the relative clarity of the water in 1951 makes it difficult to distinguish low marsh from submerged areas.

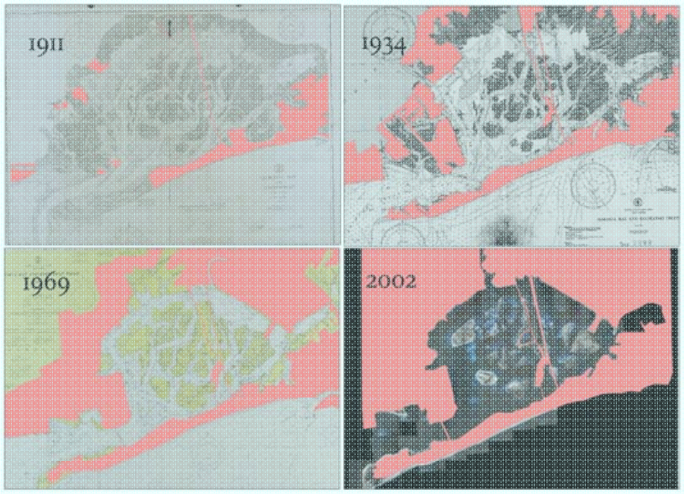
In the summary maps showing marsh loss from 1951 to 2003, and in selected cases, to 2005, only fully and partially vegetated classes are displayed. The category of sparsely vegetated was excluded from these maps because it only represented severely fragmented areas that contained less than 10 percent vegetation or areas that had any remnants of vegetation. (See Appendix E.)

Statistical analyses performed on the resulting marsh maps range from simple area calculations to cross-tabulation algorithms resulting in a “what changed to what” analysis to evaluation of where losses of each type have occurred within the individual marshes and within Jamaica Bay overall. Results have been reported in GNRA “loss” maps, statistical reports, and other forms of presentation media. The project reference panel was consulted at all stages of mapping and analytical planning.

The results of this study have also been compared with DEC ongoing salt marsh mapping projects, with general agreement in rates of loss and overall marsh status between the two studies. The differences in acreage within individual marsh areas are due to the different mapping scales and the difference in classification schemes used by DEC and NPS. When NPS mapped Yellow Bar, for example, there were many polygon areas within the marsh that were not mapped as vegetated areas, such as mud flats and tidal creeks; DEC mapped only the perimeter of marshes using their regulatory tidal wetlands classification, including two vegetative categories, HM (high marsh) and IM (inter-tidal marsh). Within these perimeter polygons, DEC did not differentiate between solid and fragmenting vegetation, nor did it map interior mud flats as a separate category. In addition, NPS mapped at a scale of 1:600, except for the 1951 imagery, which was completed at approximately 1:1000. DEC mapped at a scale of 1:12,000. DEC's estimate of vegetated marsh extent therefore was probably consistently higher than GNRA figures, which subtracted areas of mud flat and even small tidal creeks from the vegetated area estimates. In several meetings, discussions, and email/phone conversations, DEC and NPS have compared results and methodologies, and believe that, despite the slight differences in results, the data support the underlying primary results of both studies: marsh loss is occurring at a fast rate, and that rate is increasing.

Why Are Jamaica Bay's Wetlands Disappearing?

The exact cause or causes of Jamaica Bay's wetlands degradation are still unknown. Increasingly, marsh loss is occurring within the interior of marsh islands. When tidal pools expand, marsh areas become fragmented as the vegetation, largely salt marsh cordgrass, *Spartina alterniflora*, becomes waterlogged and drowns, loosening the root structures that hold the salt marsh substrate in place and turning into unvegetated mud flats.[33] On some islands, more than 75 percent of the vegetation has disappeared in the past three decades.[34]

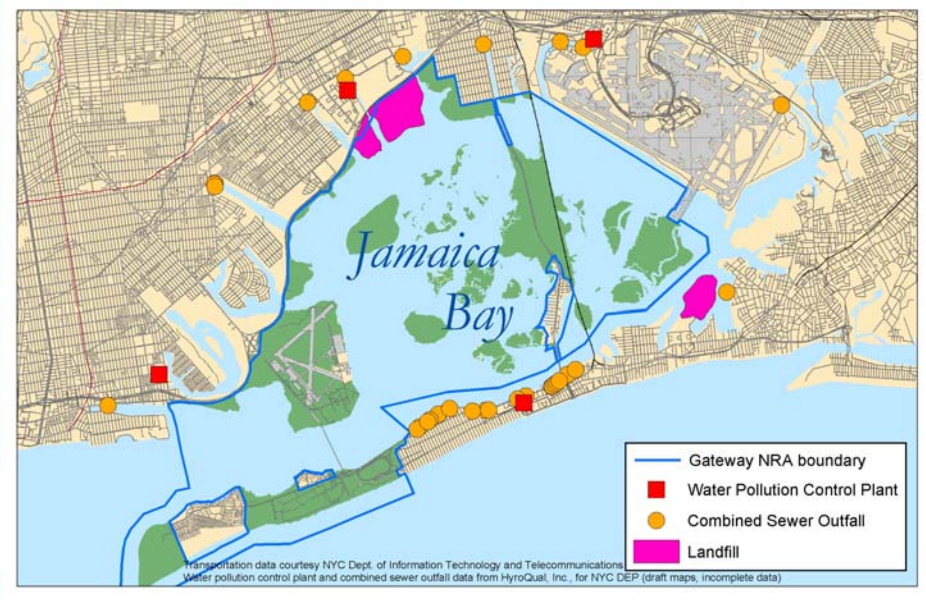


Pink shading shows increased development around Jamaica Bay.

Changes in sediment deposition to the bay continues to attract considerable scientific attention as a possible culprit. A hardening of the bay's perimeter from increased residential and commercial development and the channeling of overland flow through storm sewers and combined sewer overflows (CSOs) has reduced and redistributed the overall sediment load to the bay and, hence, to the marshes.[35] Without new sediment washing over the marsh islands, they may be eroding and disappearing. Changes in the bay's physical contours by westward progression of the Rockaway Peninsula, the dredging of navigational channels, the stabilization of Rockaway Inlet, landfills, and the construction of John F. Kennedy International Airport (JFK) and its runway into the bay have altered sediment transport and affected water circulation. Jamaica Bay's tributaries, basins creeks and canals have also been highly altered over the years and tend to have little or no freshwater flow other than that conveyed by the sewage treatment or water pollution control plants (WPCPs) and/or storm sewers.[36] Hardened shorelines and dredging have also removed the natural graded edge between habitats, which is often the most productive strip. Borrow pits and other areas from which sandy sediment was dredged to construct JFK and other areas around the bay and establish navigation channels may be acting as sediment sinks, and the increased wave energy and sediment flushing time caused by a deeper average depth may affect sediment accretion.[37] It also may be that the physical alterations made over time to the bay's waterways may have resulted in changed tidal hydrodynamics – actual increases in water levels over the wetlands may be greater than that due to sea level rise alone.[38] Changes in hydrology also affect the bay's salinity and, if significant enough, can make the bay unsuitable for many of its native species of flora and fauna.

Recent research has brought attention to another potential cause: water pollution. Every day, the four city WPCPs (26th Ward, Coney Island, Jamaica, and Rockaway plants) that encircle the bay discharge more than 250 million gallons of treated wastewater containing thirty to forty thousand pounds of nitrogen into the bay every day – far too much nitrogen for the remaining marshes to use up or assimilate.[39] In addition, rainfall intensity as low as 0.15 centimeters per hour for 6.7 hours will exceed the city's limited sewer and plant storage capacity, causing overflow of untreated sewage high in organic pollutants combined with stormwater through numerous outfalls ringing the bay's waters.[40] Although system upgrades continue to be made to combat the CSO problem, according to city records and based on a 40-year average rainfall, only about 32 percent of the bay's CSO is being captured.[41] Stormwater from places such as the Belt Parkway and JFK also flows directly into the bay without treatment. The DEC has included Jamaica Bay on its Section 303(d) impaired water list since 1998 because of violations of water quality standards relating to pathogens, nitrogen, and oxygen demand, and lists CSOs and wastewater as the primary causes of the impairment.[42] In fact, DEP's modeling discussed in the *Draft Jamaica Bay Watershed Protection Plan* "… clearly show[s] that the WPCPs are the major contributors to the phosphorus, nitrogen, silica, and carbon loadings to Jamaica Bay. CSOs are just as clearly the major contributor to the pathogen loadings to the Bay."[43] Finally, although playing no known role in the marsh loss problem, there is increasing concern about the ecological impacts of hormone disrupting chemicals in the wastewater and stormwater discharged into the bay.*[44]

Some research indicates that the high amounts of organic content from wastewater and CSOs in the bay are contributing to high concentrations of sulfide; longer periods of flooding also lead to a gradual build up of hydrogen sulfide in sediments. *S. alterniflora* has limited ability to oxygenate its roots and detoxify sulfide. At high sulfide concentrations, it cannot recover; its roots degrade, marsh grass loss occurs and the marsh begins to lose its physical integrity and fragments.[45]



Other factors are likely exacerbating and/or contributing to the marsh loss. The bay's remaining natural uplands serve as important buffers in maintaining the bay's wetlands, reducing stormwater flow, and providing habitat corridors. But these uplands continue to be lost to development, and those that remain are frequently in degraded condition.[46] Additionally, certain species of geese graze on *S. alterniflora* and/or eat the roots. When marshes were more plentiful this did not pose a serious problem, but as the wetlands disappear, the geese's impacts increase.[47] Mussel banks block the natural drainage channels of the marshes, allowing ponds to form on marshlands and immersing *S. alterniflora* for longer periods each year.[48] Tides bring wrack (sea lettuce, straw, dried seaweed, and floatable debris) into the bay to cover the marshes and smother the remaining *S. alterniflora*.[49] There is also the possibility that nitrogen-enriched water is causing an excessive growth of *Ulva sp*. (sea lettuce), which is carpeting the bay's bottom and preventing sediments from being resuspended into the water for redistribution onto the marsh surfaces.[50]

The bay's sediment accretion rate has historically kept pace with relative sea level rise.[51] However, global climate models predict an increase in sea level rise, which would exceed the historical accretion rate of the bay, leading to more frequent inundation of the marshes, marsh erosion, and greater wave action, thereby potentially transforming them to mud flats.[52] Additionally, inundation of the marshes leads to a chemical reaction whereby the salt marsh produces phytotoxin hydrogen sulfide, and this also contributes to their demise.[53] In research conducted for the U.S. Global Climate Change Research Program, a number of sea level rise projections were compared with plausible rates of marsh growth; analysis suggests that if enough sediment were available to marshes, the wetlands could survive all but the most extreme cases of future sea level rise.[54] However, with increased sea level rise predictions, additional marsh elevation is needed to offset global warming impacts. The addition of mineral sediment to the marshes, which supplies iron and manganese to precipitate hydrogen sulfide, can lead to further plant growth and organic matter production.[55] As little as 2-8 centimeters of artificially supplied sediment can stimulate plant growth and productivity in *S. alterniflora*.[56] Using the experience from the Big Egg Marsh Restoration Project, proper amounts of sediment could be determined and applied to other marsh islands in need.

* Current treatment plant technologies do not screen out hormone disrupting chemicals from wastewater. Recent studies have revealed that trace substances with hormone-like properties from prescription and over-the-counter drugs, and chemicals from soaps and other products exist in treatment plant effluent, and could be accumulating in the sediments of receiving waterbodies. For example, estrogen from pharmaceuticals and industrial detergents that break down into products that mimic the hormone estrogen can contribute to higher levels of estrogen-like materials in treatment plant effluent. These chemicals can build up in the sediments and affect development of marine life by depressing the male to female ratio, causing delayed development and reduced hatch and survival rates, such as that observed by scientists in the bay's winter flounder populations.

Photo credit: Previous page, Gateway National Recreation Area, GIS Staff. This page, Gateway National Recreation Area Staff, from information supplied by New York City Department of Environmental Protection through HydroQual, Inc.

Results and Discussion

Using the method discussed *supra*, it was calculated that, in 2003, Jamaica Bay's salt marsh islands encompassed 876 acres (*see* Table 1).[*] This represents an approximately 63 percent decline in the bay's vegetated salt marsh islands since 1951, for which 2,347 acres were mapped (*see* Figure 2). (As noted previously, analysis was only conducted for the bay's salt marsh islands; fringe marshes and the upper reaches of the bay beyond John F. Kennedy International Airport were not included in this report.) From 1989-2003, the average rate of loss was calculated to be 33 acres/year (*see* Table 2).[†] In the two preceding time periods, 1974-1989 and 1951-1974, the calculated average rate of loss was 18 acres/year and 17 acres/year (after accounting for dredge and fill activities) respectively.[‡] In other words, the 1989-2003 calculated average rate of loss was almost double the 1951-1974 and 1974-1989 rates, consistent with what the 1999 DEC analysis had shown.[§]

Table 1

JAMAICA BAY MARSH ISLANDS: Total Vegetated Marsh				
	Time Period			
	1951	**1974**	**1989**	**2003**
Vegetated Marsh (Acres)	2347	1610	1333	876

Table 2

JAMAICA BAY MARSH ISLANDS: Rate of Marsh Loss			
	Time Period		
	1951 - 1974	**1974 – 1989**	**1989 - 2003**
Average Rate of Loss (Acres/Year)	17	18	33

[*] Please note that all calculations in the text and tables have been rounded to the nearest whole number

[†] Even JoCo marsh, which is adjacent to East High in the northeast of the bay and which had seemed immune to the bay's marsh loss issue, has begun to show significant rates of loss, losing marsh at a calculated average rate of 5 acres/year from 1989-2003, comparable to the rate elsewhere in the bay and five times higher than the average rate it had shown for the prior period, 1974-1989 (1 acre/year), and eighteen times the average rate of loss for the period 1951-1974 (< 1 acre/year). JoCo's total vegetated marsh was calculated to be 387 acres in 1951, 381 acres in 1974, 367 acres in 1989, and 299 acres in 2003.

[‡] From 1951 to 1974, 57 marsh acres were calculated as lost due to the construction of West Pond and 283 acres lost as a result of the Broad Creek and Goose Pond marsh impoundments. Other factors accounted for the loss of the remaining 398 acres.

§ As explained in the Methodology section *supra*, because GNRA and DEC utilized different mapping methodologies and generally examined different time periods, specific wetlands loss rates from this study and the 1999 DEC analysis cannot be readily compared. Generally, the wetlands loss rates calculated are similar across the two studies and the two studies strongly support similar trends, including specifically an accelerating rate of tidal wetlands loss in the bay starting in the 1990s.

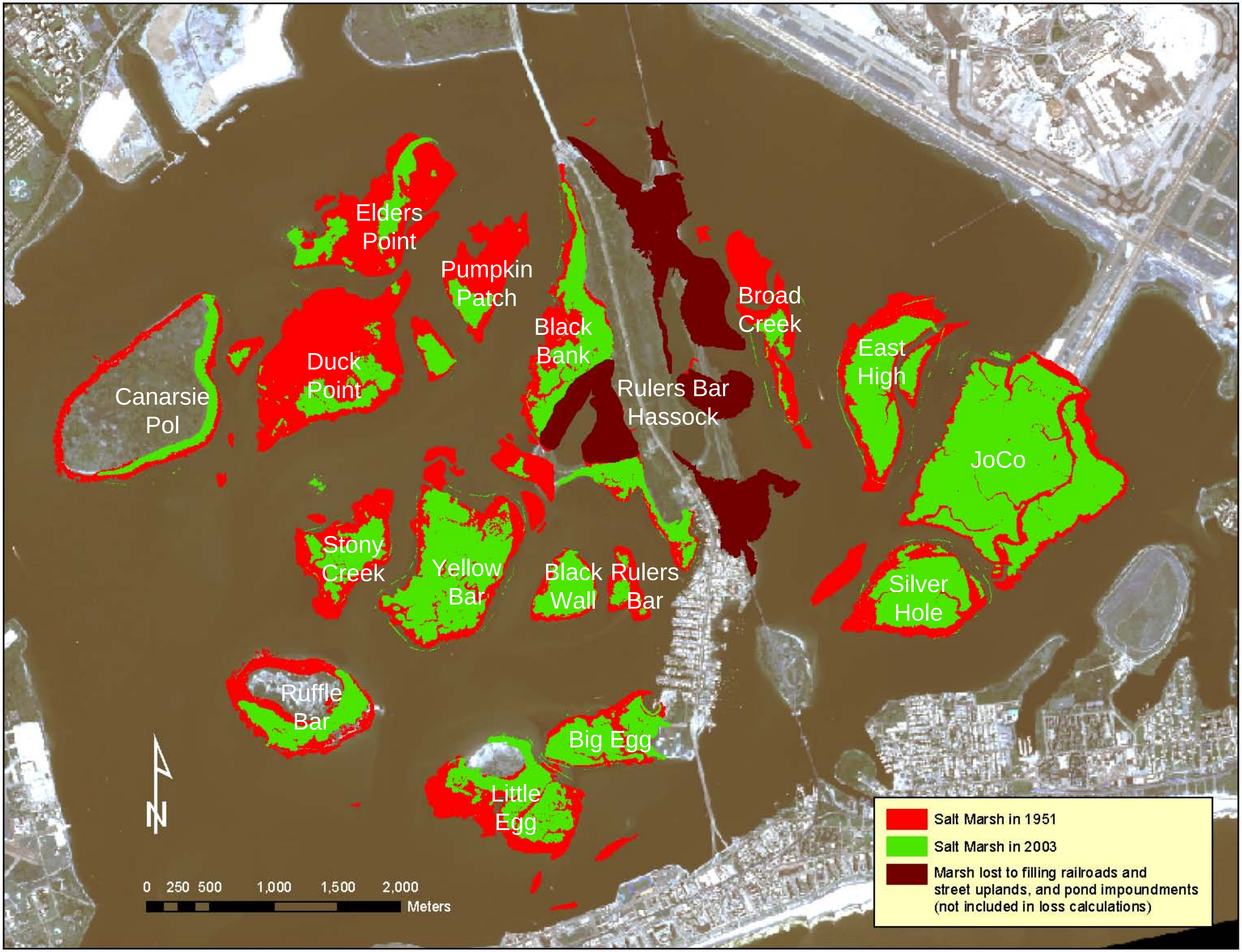
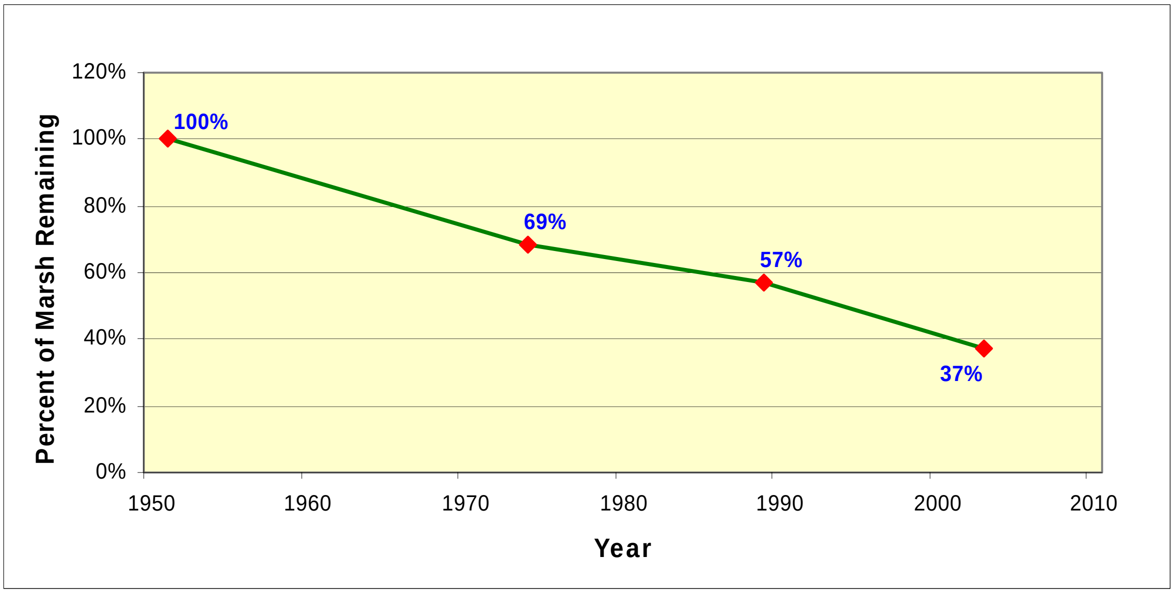


Figure 1. Jamaica Bay's salt marsh islands in 1951 and 2003.

Figure 2

JAMAICA BAY MARSH ISLANDS:
Vegetated Marsh as a Estimated Percentage of 1951 Marsh Extent



Analysis of the 2005 aerial photography for the five representative marshes generated more surprising – and alarming – results. By 2003, these specific five marshes had already lost significant tidal wetlands – what was calculated to be a total of 415 acres, or 68 percent of their acreage in 1951 (*see* Tables 3 and 4, Figures 3 and 4). However, from 2003-2005, just a two-year period, four of the five marshes were calculated to have lost 54 acres, or almost 30 percent of their tidal wetlands extent in 2003 (187 acres); Elders Point, which had already lost more than 90 percent of its wetlands, was calculated to have remained approximately the same. While it is important to note that the uncertainty of rate calculations is greater when the time is shorter (*i.e.*, 2 years compared to 50 years), there is no data to suggest that the rate has not increased significantly in the last several years. Field observations support this conclusion as well.

The last several years have been particularly hard on Yellow Bar and Black Wall marshes located in the south of the bay. According to the analysis, these marshes had been generally losing wetlands at a steady, but not significantly increasing, rate over the three time periods (spanning 1951-2003). But between the time periods 1989-2003 and 2003-2005, Yellow Bar's average calculated rate of loss jumped from 2 acres/year to 6 acres/year. The situation on Black Wall marsh was even worse, with the calculated rate of wetlands loss increasing from < 1 acre/year in the period 1989-2003 to 7 acres/year in the years 2003-2005, an increase of more than 7 times. It was calculated that Black Wall lost fully 30 percent of the tidal wetlands that existed in 1951 over just the two year-period; at this rate, Black Wall is losing more than 27 percent of its wetlands each year.

The status of marshes in the northeast of the bay is similarly dismal. These marshes, like those in the south, had been relatively healthy, although there were some indications of an accelerating rate of loss. One of the most significant marshes in that area, East High marsh, had been losing marsh at an average calculated rate of 1 acre/year from 1951-1974, 2 acres/year from 1974-1989, and 2 acres/year from 1989-2003. In 2003-2005, East High's average calculated rate of wetlands loss greatly accelerated to 12 acres/year. This means that, at this rate, East High marsh is losing more than 20 percent of its wetlands every year.

In the northwestern part of the bay, the news is more mixed. Pumpkin Patch marsh continues to rapidly disappear, and its tidal marshes are calculated to now be just 9 percent of their 1951 extent. But the status of Elders Point marsh is less clear. Of all the Jamaica Bay marsh islands, Elders Point was hit the hardest and earliest by marsh loss. Between 1951 and 1974, the analysis indicated that Elders Point lost 65 percent of its salt marshes. By 1989, only 14 percent of the 1951 acreage was calculated to be left. Since then, however, the rate has slowed significantly, at least on an average acres lost per year basis. And, between 2003 and 2005, no significant difference in tidal wetlands extent was found.

Table 3

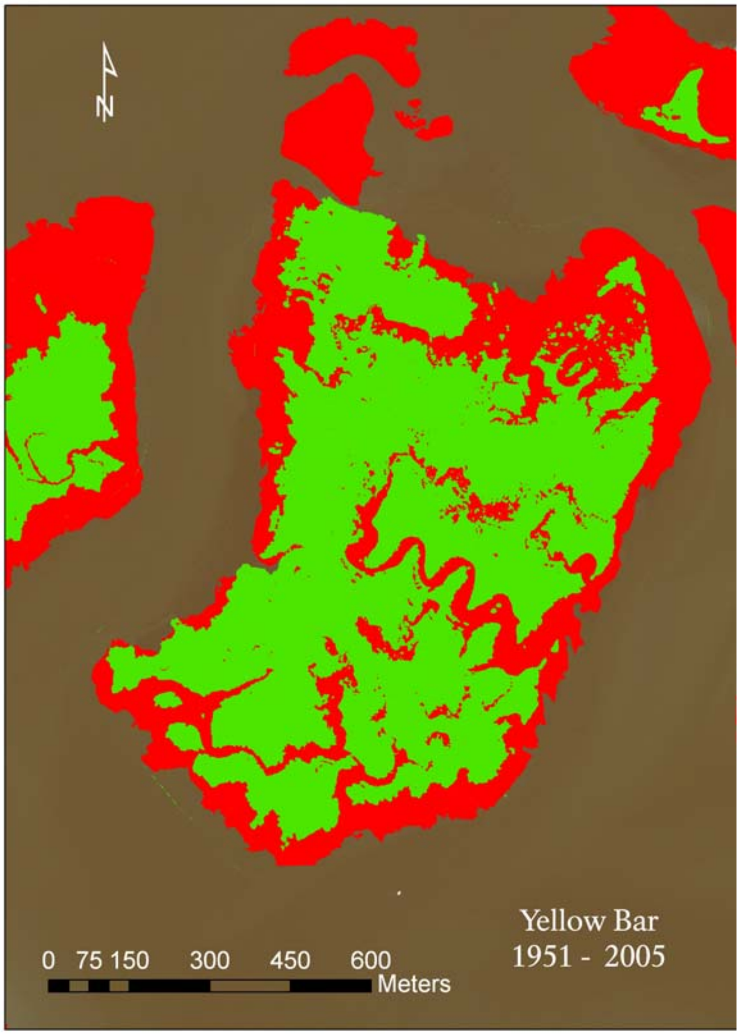
CALCULATED VEGETATED MARSH SIZE 1951 TO 2005						
		East High	**Yellow Bar**	**Black Wall**	**Elders Point**	**Pumpkin Patch**
1951	**Acres**	155	184	46	142	88
1974	**Acres**	125	131	37	50	24
	Remaining Marsh as Percentage of 1951 Extent	81%	71%	81%	35%	27%
1989	**Acres**	90	117	29	20	19
	Remaining Marsh as Percentage of 1951 Extent	58%	63%	63%	14%	22%
2003	**Acres**	57	93	25	11	12
	Remaining Marsh as Percentage of 1951 Extent	37%	50%	55%	8%	13%
2005	**Acres**	34	80	12	11	7
	Remaining Marsh as Percentage of 1951 Extent	22%	43%	25%	8%	9%

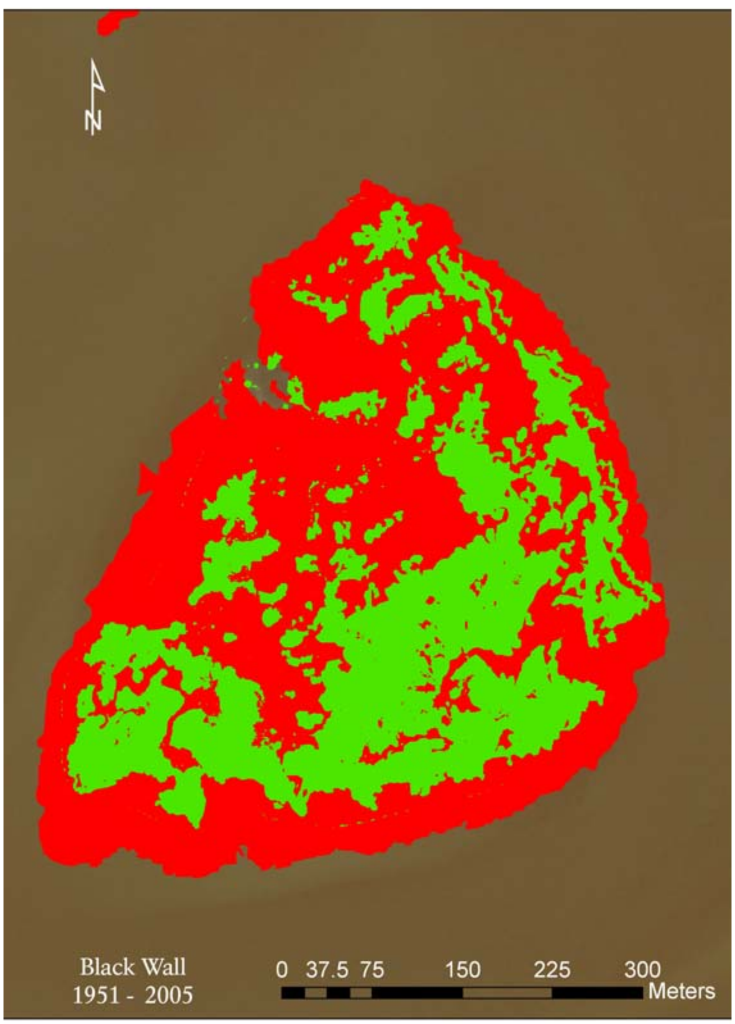
Table 4

CALCULATED MARSH LOSS FROM 1951 TO 2005						
		East High	**Yellow Bar**	**Black Wall**	**Elders Point**	**Pumpkin Patch**
1951 to 1974	**Average Acres Lost Per Year**	1	2	0	4	3
	Percent of Marsh Lost Each Year	1%	1%	1%	3%	3%
1974 to 1989	**Average Acres Lost Per Year**	2	1	1	2	0
	Percent of Marsh Lost Each Year	2%	1%	1%	4%	1%
1989 to 2003	**Average Acres Lost Per Year**	2	2	0	1	1
	Percent of Marsh Lost Each Year	3%	1%	1%	3%	3%
2003 to 2005	**Average Acres Lost Per Year**	12	6	7	0	2
	Percent of Marsh Lost Each Year	20%	7%	27%	0%	18%

In sum, it appears that areas of the bay with significant and previously relatively healthy marshes, *i.e.*, the northeast and the south, are now seeing the same rapid decline that the northwest has experienced. It is possible that more elevated remaining tufts of marsh islands may be able to persist for some period of time. However, wetland loss for these decimated marshes will likely still occur over time (in this regard, there is no sign that marsh loss at Pumpkin Patch, adjacent to Elders Point, is slowing), in part because the remaining marsh vestiges are more vulnerable to disturbance, such as severe weather events.

Figure 3a. Yellow Bar, Black Wall and East High marshes in 1951 and 2005.

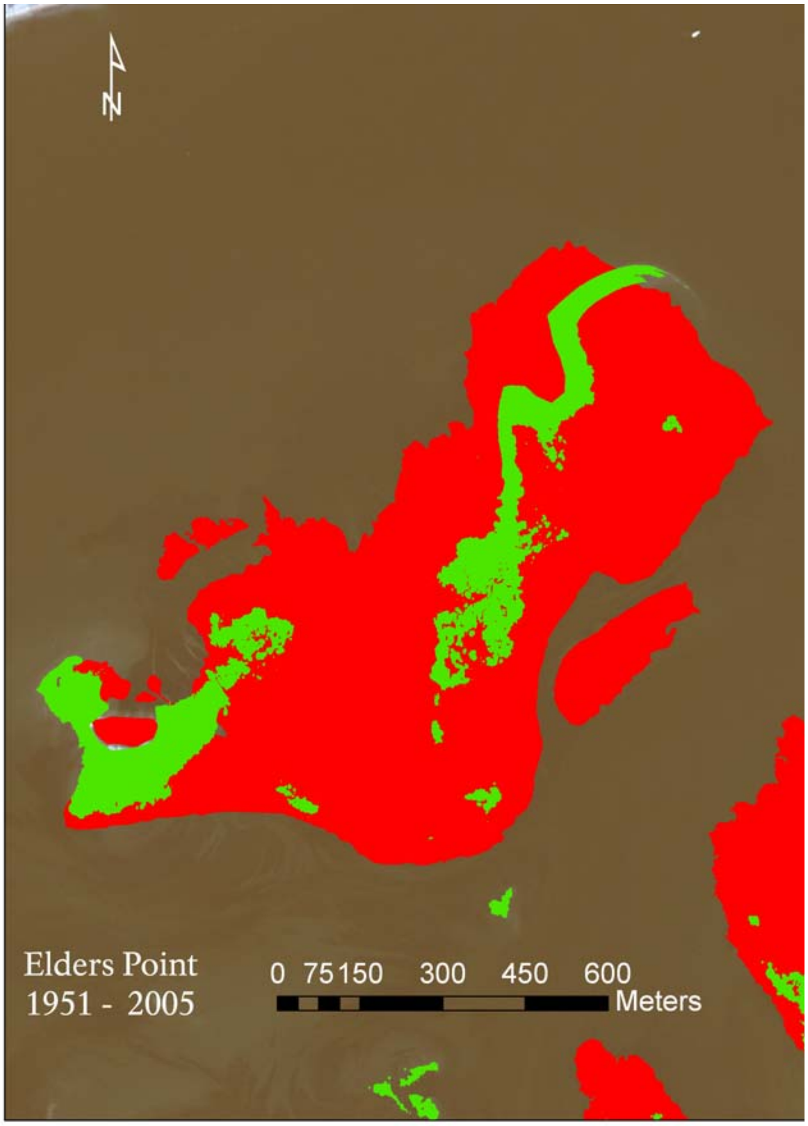




Total Vegetated Marsh

	Acres		
	Yellow Bar	Black Wall	East High
1951	184	46	155
2005	80	12	34

Figure 3b. Elders Point and Pumpkin Patch marshes in 1951 and 2005.



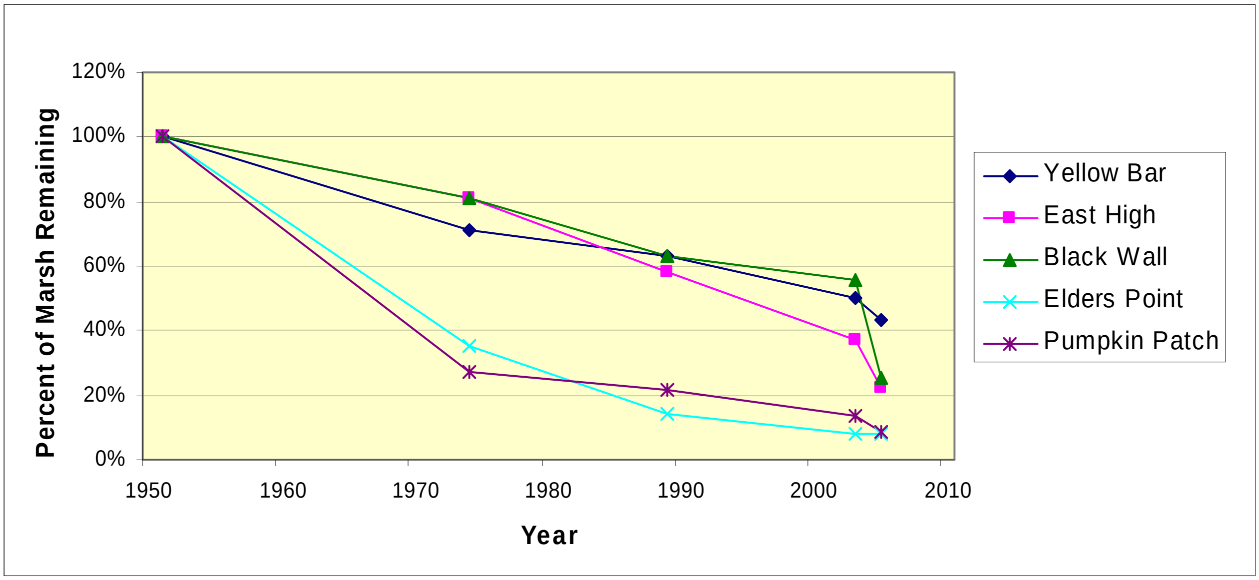
Total Vegetated Marsh		
	Acres	
	Elders Point	Pumpkin Patch
1951	142	88
2005	11	7

Salt Marsh in 1951

Salt Marsh in 2005

Figure 4

CASE STUDY MARSHES: Vegetated Marsh as a Percentage of 1951 Marsh Extent



If the vegetated tidal wetlands on the bay's marsh islands disappear at the rate most recently demonstrated at five of its marsh islands, they will be gone significantly sooner than the 2024 date previously calculated by the DEC 1999 analysis (*see* Table 5 for individual marsh loss projections). For example, for purposes of updating the prior DEC projection, the combined mapped acreage of these vegetated marshes in 2003 was 199 acres, or 23 percent of the 2003 baywide acreage. The five representative marshes were calculated to have lost a total of 54 acres in two years (2003-2005); if the same percentage loss (27 percent) is assumed for the rest of the bay, the bay as a whole can be projected to have lost 237 acres in the same two year time period. Assuming an average yearly loss of 119 acres, the bay's remaining total vegetated acreage would be projected to be gone in as little as 7 years, or 2012 (counting from 2005), just five years from now. Because this projection is based on a short time period and marsh loss rates vary between individual marsh islands, some islands may persist for longer and some for shorter. We also note that such projections should be interpreted cautiously, as they assume the 2003-2005 rate of marsh loss for the five marsh islands is representative of both conditions in the future and the bay as a whole; inter-annual variability, in particular, in rates of marsh loss may be significant, making it important to collect and analyze additional years of aerial photography or satellite imagery in order to minimize any anomalies associated with the 2003-2005 time frame. Also, if marsh loss slows only when a few remaining vestiges are left, as might occur, then the projection would be excessively pessimistic; however, if the rate of loss continues to accelerate, consistent with past trends, it might be too optimistic. Such a projection also assumes there is no intervention to reverse the marsh loss.

Table 5

Projected Number of Years Until Vegetated Marsh Disappears (as of 2005), Based on 2003-2005 Trends

East High	Yellow Bar	Black Wall	Elders Point	Pumpkin Patch
3	12	2	18	4

Projections based on 2003-2005 average rate of loss, except for Elders Point, which is based on a 1989-2003 average rate of loss.

While the exact mechanism and cause(s) of the wetlands loss is unclear, GNRA's technical analysis shows that vegetated intertidal marsh is being converted to nonvegetated lands. In 2001, DEC staff observed that "… the interior portions of the marsh appear to be at a lower elevation and water logged, soft and compressed rather than 'spongy' like healthy marshes."[57] GNRA's more detailed mapping confirms this intertidal wetlands loss, and also shows that much of the vegetated area is changing to mud flat and, over time, to sand. (See Appendix F.) For example, Black Wall over time has lost much of its perimeter, and a significant section of its northern area has transformed into mud flat and sand; its tidal creeks, like other marshes in Jamaica Bay, have widened and mud flat and sand can be found on their embankments. The smaller crescent-shaped marsh found to the east of the East High's main marsh in 1951 has lost its upper range over time and has almost completely transformed into sandbar and mud flat. While mud flat does have some habitat value, it does not provide the same set of ecological values that the area's wildlife has grown to rely on – intertidal marsh is the most productive of all tidal wetlands – and does not provide equivalent flood mitigation for surrounding neighborhoods and businesses.[58]

Conclusion

Based on the mapping analysis and field observations, the signature salt marsh islands of Jamaica Bay are disappearing much more rapidly than previously anticipated. Without a concerted effort to counteract this loss, these marshes, and the benefits they provide to the bay's wildlife and the regional ecosystem, and to the surrounding communities, can be anticipated to be lost in the near future.

There must be an immediate and aggressive effort to address this emergency. Generally, a stepped-up science effort for the bay is needed, including specifically additional investigation of the factors contributing to marsh loss in the bay and how to address them. GNRA has replaced the original "blue ribbon" panel with a science advisory committee, with many of the same members – this group should be reconvened for a public update on their individual and joint efforts to further understand the bay's wetlands loss and to determine necessary next steps. To keep pace with the problem as much as possible there should be a significantly expanded effort to restore and expand marsh habitat on existing islands, as well as to protect and restore fringe tidal marshes around the bay.[**] In addition, all levels of government – federal, state, and city – should convene a task force to ensure the necessary actions to address the marsh loss crisis are taken, including providing adequate funding and to ensure that agencies are coordinated in their work within the bay.

Also, as the Advisory Committee previously recommended, in its *Planning for Jamaica Bay's Future: Final Recommendations on the Jamaica Bay Watershed Protection Plan*, dated June 1, 2007 ("Final Recommendations"), a Jamaica Bay nitrogen control strategy at least equal, *i.e.*, a 55% reduction from current levels by 2015, to that of Long Island Sound should be put in place. Not only is nitrogen pollution possibly linked to the marsh loss directly, but it is responsible for other significant problems in the bay, including low dissolved oxygen levels, algal blooms, and poor water clarity (improvements in each of these areas will provide the necessary ecological support to help reduce further marsh losses and improve success in current and future marsh restorations.) The recommended reduction in nitrogen loadings needs to be initiated now, considering the time it will take to fund and construct the necessary improvements.

The city is truly fortunate to have a unit of the National Park Service within its borders, including the only wildlife refuge accessible by subway. The bay's waters and marshes are home to a diversity of wildlife, and a haven for millions of people who fish, boat and enjoy a view of Manhattan from within this urban oasis.[59] The bay's wetlands serve as a nursery for fishes and the other marine life that swim our waterways and are caught by the city's fishermen. And the wetlands mitigate flooding and provide shoreline erosion control for surrounding homes and businesses in Brooklyn and Queens. As the Advisory Committee noted in its Final Recommendations: "If the bay's wetlands are lost, the bay's resources as a general matter will not be far behind, and the city will be a much poorer place."

[**] While salt marsh restoration at Big Egg Marsh has been implemented, and numerous *Buffer the Bay* recommended sites, including Vernam-Barbados Peninsula, Paerdegat Basin and Fresh Creek Basin, have been wholly or partially acquired and larger salt marsh restoration efforts funded by the Army Corps of Engineers and Port Authority of NY/NJ and implemented through an extensive partnership with others, including NPS, DEC, and DEP, have been undertaken at Elders Point and Yellow Bar, more must be done to keep pace with rising sea levels and accelerating marsh loss.

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Appendix A

LOCAL LAWS
OF
THE CITY OF NEW YORK
FOR THE YEAR 2005

No. 71

Introduced by Council Members Gennaro, Avella, Barron, Brewer, Clarke, Comrie, Fidler, Gonzalez, Jennings, Koppell, Liu, Nelson, Palma, Quinn, Recchia, Sanders, Vallone Jr. and Weprin.

A LOCAL LAW

To amend the administrative code of the city of New York, in relation to developing a watershed protection plan for the watershed/sewershed of Jamaica Bay.

Be it enacted by the Council as follows:

Section 1. Legislative findings and intent. In October of 1972, the United States Congress established the Gateway National Recreation Area ("Gateway") as part of an effort to bring the National Park System and its ethic of preserving and protecting outstanding resources closer to major urban areas.

Gateway encompasses the largest collection of natural systems, wildlife habitats, historic resources, and recreational opportunities in the New York City/New Jersey metropolitan area. It also encompasses numerous sites of critical natural and cultural importance to the health of local ecosystems, to the life of migratory and native species and to the military, navigational and aviation history of the region and the nation, especially in the context of attendant defenses of New York Harbor.

According to the National Park Service (NPS), Gateway is the only extensive public natural area in the New York City region. The Jamaica Bay Unit is one of several units, consisting of lands, waters, marshes and submerged lands, comprising Gateway. The Jamaica Bay Wildlife Refuge ("Refuge"), established by the City of New York in 1948, is located within the Jamaica Bay Unit. The Refuge, a State and nationally recognized important bird area, encompasses 2,500 acres within the boroughs of Brooklyn and Queens. The only wildlife refuge in the National Park System, it provides a shelter for rare and endangered birds and a variety of habitats for more than 325 kinds of waterfront and shorebirds. It is also a critical stop-over area along the Eastern Flyway migration route and is one of the best and world renowned bird-watching locations in the western hemisphere.

Jamaica Bay is one of the largest and most productive coastal ecosystems in the State of New York, as well as within the Northeastern United States, and is an important recreational destination for local, national and international visitors. It contains approximately 13,000 acres of surface waters, including the largest tidal wetland complex in New York State. These wetlands provide benefits such as natural water quality improvement, flood protection and shoreline erosion control for the commercial and residential areas in and around the Bay in Brooklyn and Queens. Unfortunately, construction and development within the Jamaica Bay watershed has often been conducted without consideration of potential adverse impacts on the Bay and sometimes without notice to all interested governmental agencies, civic groups and other interested parties. One such governmental agency is the NPS, which is the primary steward of the Bay, itself, and with whom, among many other agencies, it is critical for the City to collaborate in order to protect the Bay.

Jamaica Bay's future as an oasis of great ecological importance is in severe jeopardy due to the fact that thousands of acres of the Bay's marshy islands, which serve as nesting and feeding areas for an abundance of birds and other wildlife, are rapidly and mysteriously vanishing. Scientists predict that the Jamaica Bay marshlands will completely vanish in less than twenty years if the cause of their deterioration and a solution to their preservation are not found.

This legislation would require the New York City Department of Environmental Protection to create a watershed protection plan for the watershed/sewershed of Jamaica Bay, and would create a Jamaica Bay watershed protection plan advisory committee. The Council finds that such watershed planning is vital to the future of Jamaica Bay. This legislation establishes the initial pathway towards restoring and maintaining the water quality and ecological integrity of the Bay by comprehensively assessing threats to the Bay and coordinating environmental remediation and protection efforts in a focused and cost-effective manner. Watershed protection planning for Jamaica Bay is an efficient and effective means of promoting the sustainability of the Bay's environment, the economy associated with the Bay, and the linkages between the two.

§2. Chapter five of title 24 of the administrative code of the city of New York is hereby amended by adding thereto a new section 24-527 to read as follows:

§24-527 Watershed protection plan for the watershed/sewershed of Jamaica bay. a. No later than September 1, 2006, the commissioner shall complete a watershed protection plan for the watershed/sewershed of Jamaica bay, which shall, among other things, include measures the city can implement to help protect Jamaica bay. The overall goal of such plan shall be to restore and maintain the water quality and ecological integrity of Jamaica bay.

b. The commissioner shall assess the technical, legal, environmental and economical feasibility of including the following measures, at minimum, in the plan prepared pursuant to subdivision a of this section:

(1) best management practices for the minimization and control of soil erosion and stormwater runoff and reduction of both point and non-point source pollution, including, but not limited to, the promotion of development practices such as the on-site detention and infiltration of stormwater runoff, the minimization of impervious surfaces and the creation of natural systems to control and minimize stormwater runoff;

(2) measures to address threats to aquatic habitat, including, but not limited to, stabilizing and restoring salt marshes, wetlands, soils and other natural areas, strengthening ecological buffers, restoring natural features to the Jamaica bay watershed/sewershed shoreline, and reestablishing water flows;

(3) land acquisition and land use planning practices and opportunities, including, but not limited to, incentives, such as expedited permitting and property tax relief, for infill, brownfield redevelopment and other environmentally beneficial development, and

disincentives, such as stricter development guidelines, for development that may adversely impact Jamaica bay;

(4) a protocol for coordination with appropriate federal, state and city governmental entities that have jurisdiction over the Jamaica bay area, with respect to, but not limited to, efforts to restore and maintain the water quality and ecological integrity of Jamaica bay and notification regarding proposed development projects within the Jamaica bay watershed/sewershed that may adversely impact Jamaica bay;

(5) a protocol for coordination with the office of environmental coordination that ensures that environmental assessments and reviews of projects within the Jamaica bay watershed/sewershed address potential impacts to Jamaica bay and are conducted pursuant to all applicable federal, state and city environmental quality review laws and regulations;

(6) a public education program, including, but not limited to, programs for schools, developers, commercial facilities, civic groups and other local organizations and entities to increase awareness about the ecological significance and degradation of Jamaica bay; potential threats to Jamaica bay; restoration and watershed stewardship activities undertaken by the department and others involving Jamaica bay; and methods and practices to reduce pollution in Jamaica bay; and

(7) a program to target enforcement efforts that will help reduce polluting behaviors and operations that may adversely impact Jamaica bay.

c. The watershed protection plan prepared pursuant to subdivision a of this section, as it may be revised pursuant to subdivision f of this section, shall contain the following:

(1) specific goals related to restoring and maintaining the water quality and ecological integrity of Jamaica bay;

(2) the geographic boundaries of the watershed/sewershed of Jamaica bay for the purpose of achieving the goals of such plan and an explanation for the selection of such boundaries;

(3) the assessments the commissioner completed for each measure considered for inclusion in such plan;

(4) for any final recommendation of the Jamaica bay watershed protection plan advisory committee established pursuant to subdivision h of this section that was not assessed for inclusion or incorporated in such plan, an explanation for such omission; and

(5) a schedule, including interim and final milestones, for implementing the measures and achieving the specific goals included in such plan and methods of monitoring progress towards achieving such milestones and goals.

d. The commissioner shall implement the plan prepared pursuant to subdivision a of this section, as it may from time to time be revised pursuant to subdivision f of this section, in accordance with its provisions.

e. The commissioner shall submit to the mayor and the speaker of the council the watershed protection plan prepared pursuant to subdivision a of this section, or any revised plan prepared pursuant to subdivision f of this section, no later than five business days after its completion.

f. The watershed protection plan prepared pursuant to subdivision a of this section shall be reviewed and revised as necessary to achieve its goals, but in no event shall such review occur less often than once every two years.

g. No later than October 1, 2007, and no later than October 1 every two years thereafter, the commissioner shall submit a report to the mayor and the speaker of the council, which shall include, but not be limited to:

(1) the implementation status of the measures included in the watershed protection plan prepared pursuant to subdivision a of this section, as it may have been revised pursuant to subdivision f of this section; and

(2) where the plan has been reviewed in accordance with subdivision f of this section and the commissioner determines that no revisions are required, such determination and the reasons for it.

h. (1) A Jamaica bay watershed protection plan advisory committee shall be established, which shall provide advice to the commissioner for the duration of its term and provide final recommendations to the commissioner and the speaker of the council on the watershed protection plan prepared pursuant to subdivision a of this section regarding:

i. the specific goals of such plan related to restoring and maintaining the water quality and ecological integrity of Jamaica bay;

ii. the geographic boundaries of the watershed/sewershed of Jamaica bay to be included in such plan;

iii. any measures that should be assessed by the commissioner for inclusion in such plan, in addition to those listed in subdivision b of this section;

iv. the assessment of the technical, legal, environmental and economical feasibility of including in such plan the measures listed in subdivision b of this section and any additional measures; and

v. a schedule, including interim and final milestones, for implementing the measures and achieving the specific goals to be included in such plan and methods of monitoring progress towards achieving such milestones and goals.

(2) Such advisory committee shall be comprised of seven members, three of whom shall be appointed by the speaker of the council and four by the mayor. The members shall be appointed within forty-five days after the effective date of this section and shall serve without compensation. The chairperson shall be elected from amongst the members. Any vacancy shall be filled in the same manner as the original appointment for the remainder of the unexpired term. The commissioner may provide staff to assist the advisory committee.

(3) Such members of the advisory committee shall serve until three months after the date upon which the commissioner completes the watershed protection plan prepared pursuant to subdivision a of this section, after which time the committee shall cease to exist.

(4) No later than July 1, 2006, the chairperson of such committee shall submit a report containing its final recommendations to the commissioner and the speaker of the council.

§3. This local law shall take effect immediately.

THE CITY OF NEW YORK, OFFICE OF THE CITY CLERK, s.s.:

I hereby certify that the foregoing is a true copy of a local law of the City of New York, passed by the Council on June 30, 2005, and approved by the Mayor on July 20, 2005.

VICTOR L. ROBLES, City Clerk of the Council

CERTIFICATION PURSUANT TO MUNICIPAL HOME RULE LAW §27

Pursuant to the provisions of Municipal Home Rule Law §27, I hereby certify that the enclosed Local Law (Local Law 71 of 2005, Council Int. No. 565-A) contains the correct text and:

Received the following vote at the meeting of the New York City Council on June 30, 2005: 50 for, 0 against, 0 not voting.

Was signed by the Mayor on July 20, 2005.

Was returned to the City Clerk on July 21, 2005.

JEFFREY D. FRIEDLANDER, Acting Corporation Counsel

Appendix B

LIST OF COMMITTEE MEMBERS INCLUDING AFFILIATIONS AND BIOGRAPHIES

Doug Adamo

Since his appointment as Chief of the Division of Natural Resources at Gateway National Recreation Area in March, 2003, Doug Adamo has worked in coordination with Park natural resource staff on a variety of issues/efforts focusing on Jamaica Bay Resources. The largest effort was the Big Egg Marsh Experimental Saltmarsh Restoration Project, for which Mr. Adamo provided administrative assistance and began shortly after he reported to Gateway. In a multi-agency effort over the past 13 months, Mr. Adamo worked on compliance, alternative, and monitoring issues for the proposed Elder's Point – Yellow Bar Saltmarsh Restoration Project sponsored by the U.S. Army Corps of Engineers, New York City Department of Environmental Protection, and the Port Authority of NY/NJ.

Mr. Adamo also serves on the Harbor Estuary Program's Management Committee and the Long-Term Control Planning Government Steering Committee, both of which involve considerable efforts toward improving water quality in Jamaica Bay. In addition, he has coordinated development of and sought funding for several National Park Service project proposals to restore ecosystem health to Jamaica Bay. In April 2005, he hosted the first symposium on oysters and eelgrass in Jamaica Bay and plans to hold a second symposium in the spring of 2006.

Mr. Adamo has a B.S. in Wildlife Biology and M.S. in Soil Science from West Virginia University. He previously worked as a biologist for the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the U.S. Forest Service.

Manny Caughman

A community and environmental activist, Manuel Caughman is an active member of the community, whose contributions in helping to resolve the environmental issues facing the residents of Southeast Queens has been evident for over almost a decade. As Chairman of the Community Board #12 Environmental Committee, the 29th Assembly District Environmental Committee, and a member of the Brooklyn-Queens Aquifer Feasibility Study, he has been instrumental in bringing attention to and resolving the issues currently facing the residents of Southeast Queens.

Having received numerous awards for his dedication to environmental issues pertaining to water quality, soil contamination and protection of aquifers, Mr. Caughman is recognized in the community by residents and elected officials on every level of government as a respected authority on issues facing the environment. The remediation of the West Side Hazardous Waste Site was paramount in improving environmental issues by removing petrochemicals from the soil that could possibly contaminate the aquifers. Mr. Caughman is currently working along with city and elected officials to address the rising water table affecting Southeastern Queens.

Len Houston

Len Houston is Chief of the Environmental Analysis Branch for the U.S. Army Corps of Engineers, New York District. He holds a B.S. in Biology from Brooklyn College and a M.S. in Marine Biology from Long Island University.

Mr. Houston authored the Reconnaissance Report (1999) recommending that the Federal government undertake (with the New York City Department of Environmental Protection as partner) preparation of a Feasibility Study for Environmental Improvements to Jamaica Bay. He was the Team Leader who developed the Jamaica Bay Environmental Survey that identified 50+ potential improvement options, and developed a scope of work and funding transfers for extensive field studies to investigate and assess many of those sites as part of the Jamaica Bay Ecosystem Restoration Program field study undertaken by AREAC (under oversight and guidance of the Gateway National Recreation Area). As Chief of the Special Studies Section, Mr. Houston worked with the New York City Parks and Recreation Department to initiate and complete studies for environmental restoration projects at Gerritsen Beach and Spring Creek; the former of which was completed and lead to the signing of a Project Cooperation Agreement with City Parks Department to construct the recommended marsh restoration project upon appropriation of Federal studies. As Branch Chief, he worked with Gateway, the New York State Department of Environmental Conservation, Port Authority of NY/NJ and the New York City Department of Environmental Protection to initiate a study for a pilot project at Elders Point and Yellow Bar to address marsh island losses in Jamaica Bay. The Elders Point project has been funded and a contract to restore the mostly eroded marsh using stockpiled sand from the maintenance of Rockaway Inlet was awarded and is scheduled for completion in summer 2006.

Mr. Houston is the author of several presentations on restoration needs/options in Jamaica Bay for conferences sponsored by Gateway and AREAC. He is the Corps representative to the Jamaica Bay Task Force.

Dan Mundy

Dan Mundy is a retired Fire Captain and a lifelong resident of Broad Channel, Queens. In 1995 he was the first to notice the disappearance of the marshes in Jamaica Bay and in 1996 founded the Jamaica Bay Eco Watchers, an environmental group advocating for the restoration and funding to protect this great resource. He is the environmental chairperson of Community Board #14 and also serves on citizens advisory committees for the Harbor Estuary Program and Pollution Control. Mr. Mundy has been active in the planning, construction, and monitoring of the Big Egg Marsh Restoration project as well as the next restoration project with the U.S. Army Corps of Engineers, New York State Department of Environmental Conservation and New York City Department of Environmental Protection.

Eco Watchers also conducts water quality monitoring and works closely with other scientists working in Jamaica Bay. For the past four years Mr. Mundy has led Operation Clean Sweep, a cooperative effort with National Park Service, New York Department of Environmental Conservation, New York Department of State, Port Authority of NY/NJ, and the New York Police Department, and the Jamaica Bay Guardian in removing hundreds of derelict boats and debris from the water and marshes of Jamaica Bay.

Bradford H. Sewell

Bradford H. Sewell is a senior attorney with the Natural Resources Defense Council, Inc. (NRDC), a public interest organization specializing in environmental protection. He is Director of the NRDC NY/NJ Harbor Bight Project, which focuses on NY/NJ marine environmental issues, including marine water quality and fisheries. Since 1998, Mr. Sewell has also served as Director of the NRDC Everglades Project.

NRDC has been working to reduce the impacts on Jamaica Bay of combined sewer overflows and nitrogen pollution from New York City's wastewater treatment facilities. NRDC also provided legal assistance in the creation of Gateway National Recreation Area. Other relevant areas of NRDC's ongoing work include the clean-up of contaminated sediments in Newark Bay (including minimizing impacts of navigational dredging projects), cleanup of Hudson River PCBs, preserving the Hackensack Meadowlands, coastal habitat preservation around New York City, and green building design in the City. NRDC annually publishes "Testing the Waters," which details the problem of beach closings as a result of water pollution; also, in 2002, NRDC published a report entitled “Cape May to Montauk: A Coastal Protection Report Card.”

Mr. Sewell has a bachelor's degree from Stanford University, a law degree from Columbia University, and a master's in public health from the Division of Environmental Sciences at Columbia's School of Public Health. He is an adjunct faculty member at Columbia University School of Public Health, Division of Environmental Sciences. From 1992-1998, Mr. Sewell was an attorney at the New York law firm of Paul, Weiss, Rifkind, Wharton and Garrison, where he litigated and counseled clients concerning environmental matters.

Dr. R. Lawrence Swanson

Dr. R. Lawrence Swanson received his Ph.D. in Physical Oceanography from Oregon State University in 1971. Since 1987, he has been the director of the Waste Reduction and Management Institute (WRMI), and since 2003 also the Associate Dean of the Marine Sciences Research Center, Stony Brook University (SBU). Prior to his appointment at SBU, he was with the National Oceanic and Atmospheric Administration and served in a variety of capacities including Project Manager of the Marine Ecosystems Analysis Program for the New York Bight; Director of the Office of Marine Pollution Assessment; and the Executive Director of the Office of Oceanic and Atmospheric Research.

Dr. Swanson plays an active role in New York City’s marine policy, often testifying at public hearings and producing government reports and policy recommendations. He has conducted research on water quality, ocean dumping, marine debris and medical wastes, hypoxia, marine pollution issues, and waterfront uses in and around New York City. Dr. Swanson serves as the principal investigator on the New York State component of the National Coastal Assessment Program, where he coordinates sampling of water quality, sediment toxicity and biological health of New York waters, including specific sites in Jamaica Bay. He also served as co-editor of a National Oceanic and Atmospheric Administration book concerning hypoxia and mass mortalities in the New York Bight. Dr. Swanson’s work contributed to passage of federal legislation and also led to the national emphasis on regulating combined sewer overflows.

More recently, he synthesized large data sets for the New York City Department of Environmental Protection in order to expand the utility of the City’s annual water quality monitoring program. This past year, he, along with other members of his research team, published a monitoring plan for the Hudson River for the New York State Department of Environmental Conservation. Swanson and a colleague, R.E. Wilson, have also prepared a paper for publication synthesizing historical data sets as they pertain to hypoxia in Western Long Island Sound.

Christopher R. Zeppie

Christopher R. Zeppie is Director of the Office of Environmental Policy, Programs and Compliance at the Port Authority of New York and New Jersey. Since coming to the Port Authority in 1979, Mr. Zeppie has held positions of increasing responsibility as Environmental Compliance Specialist; Manager, Permits and Governmental Approvals; Attorney, Environmental Law Division; Assistant Director, Office of Environmental Management; and Chief Environmental Policy Officer.

Mr. Zeppie serves on the Transportation Research Board’s “Committee on Climate Change and U.S. Transportation” as well as the Steering Committee of the Environmental Division of the New York Academy of Sciences, the Advisory Committee to New York State Sea Grant, and the NYS Implementation Plan Coordinating Council for the Federal Clean Air Act.

He holds a B.S. degree in biology and ecology from Manhattan College, a M.S. degree in marine environmental science from the Marine Sciences Research Center at Stony Brook, and a J.D. degree from St. John's University School of Law. His Master Thesis is entitled "Vertical Profiles and Sedimentation Rates of Cd, Cr, Cu, Ni and Pb in the Sediments of Jamaica Bay, New York", and entailed extensive research in and around Jamaica Bay.

Prior to coming to the Port Authority, Mr. Zeppie worked as an Oceanographer at the New York District Corps of Engineers, Water Quality Compliance Branch and he has also held the position of environmental engineer at the New York Power Authority. He has been an adjunct faculty member at Stony Brook and the New York Institute of Technology.

Mr. Zeppie lives on Long Island in Rockville Centre and has three children and one grandchild**.**

Appendix C

Int. No. 376

By Council Members Gennaro, Addabbo Jr., Brewer, Clarke, Fidler, Gerson, James, Koppell, Liu, Mark-Viverito, Monserrate, Nelson, Sanders Jr., Sears and Weprin

A Local Law to amend the administrative code of the city of New York, in relation to the watershed protection plan for the watershed/sewershed of Jamaica Bay.

Be it enacted by the Council as follows:

Section 1. Section 24-527 of the administrative code of the city of New York is amended to read as follows:

§24-527 Watershed protection plan for the watershed/sewershed of Jamaica bay. a. No later than September 1, [2006]2007, the commissioner shall complete a watershed protection plan for the watershed/sewershed of Jamaica bay, which shall, among other things, include measures the city can implement to help protect Jamaica bay. The overall goal of such plan shall be to restore and maintain the water quality and ecological integrity of Jamaica bay.

b. The commissioner shall assess the technical, legal, environmental and economical feasibility of including the following measures, at minimum, in the plan prepared pursuant to subdivision a of this section:

(1) (1) best management practices for the minimization and control of soil erosion and stormwater runoff and reduction of both point and non-point source pollution, including, but not limited to, the promotion of development practices such as the on-site detention and infiltration of stormwater runoff, the minimization of impervious surfaces and the creation of natural systems to control and minimize stormwater runoff;

(2) (2) measures to address threats to aquatic habitat, including, but not limited to, stabilizing

and restoring salt marshes, wetlands, soils and other natural areas, strengthening ecological buffers, restoring natural features to the Jamaica bay watershed/sewershed shoreline, and reestablishing water flows;

(3) land acquisition and land use planning practices and opportunities, including, but not limited to, incentives, such as expedited permitting and property tax relief, for infill, brownfield redevelopment and other environmentally beneficial development, and disincentives, such as stricter development guidelines, for development that may adversely impact Jamaica bay;

(4) (4) a protocol for coordination with appropriate federal, state and city governmental entities

that have jurisdiction over the Jamaica bay area, with respect to, but not limited to, efforts to restore and maintain the water quality and ecological integrity of Jamaica bay and notification regarding proposed development projects within the Jamaica bay watershed/sewershed that may adversely impact Jamaica bay;

(5) (5) a protocol for coordination with the office of environmental coordination that ensures

that environmental assessments and reviews of projects within the Jamaica bay watershed/sewershed address potential impacts to Jamaica bay and are conducted pursuant to all applicable federal, state and city environmental quality review laws and regulations;

(6) a public education program, including, but not limited to, programs for schools, developers, commercial facilities, civic groups and other local organizations and entities to increase awareness about the ecological significance and degradation of Jamaica bay; potential threats to Jamaica bay; restoration and watershed stewardship activities undertaken by the

department and others involving Jamaica bay; and methods and practices to reduce pollution in Jamaica bay; and

(7) a program to target enforcement efforts that will help reduce polluting behaviors and operations that may adversely impact Jamaica bay.

c. The watershed protection plan prepared pursuant to subdivision a of this section, as it may be revised pursuant to subdivision [f]h of this section, shall contain the following:

(1) (1) specific goals related to restoring and maintaining the water quality and ecological

integrity of Jamaica bay;

(2) (2) the geographic boundaries of the watershed/sewershed of Jamaica bay for the purpose

of achieving the goals of such plan and an explanation for the selection of such boundaries;

(3) (3) the assessments the commissioner completed for each measure considered for inclusion

in such plan;

(4) for any final recommendation of the Jamaica bay watershed protection plan advisory committee established pursuant to subdivision [h]j of this section that was not assessed for inclusion or incorporated in such plan, an explanation for such omission; and

(5) a schedule, including interim and final milestones, for implementing the measures and achieving the specific goals included in such plan and methods of monitoring progress towards achieving such milestones and goals.

d. No later than September 1, 2006, the commissioner shall complete an interim report on the preparation of the watershed protection plan required pursuant to subdivision a of this section, which shall include, at minimum, the following elements:

(1) a description of the current status of the plan preparation, including, but not limited to, the status of all feasibility assessments of measures conducted pursuant to subdivision b of this section; and

(2) for each preliminary recommendation of the Jamaica bay watershed protection plan advisory committee provided to the commissioner pursuant to paragraph four of subdivision j of this section, the commissioner shall state whether:

i. i. the recommendation will be incorporated into the plan required pursuant to subdivision a of this section;

ii. ii. the recommendation will not be incorporated into such plan, in which case the commissioner shall provide a detailed explanation of the basis for any such omission; or

iii. iii. the recommendation will be further assessed for inclusion in such plan, in which case the commissioner shall provide a detailed explanation of the reason for such further assessment, including a timeline for such assessment's completion.

e. No later than March 1, 2007, the commissioner shall complete a draft of the watershed protection plan for the watershed/sewershed of Jamaica bay required pursuant to subdivision a of this section.

f. The commissioner shall implement the plan prepared pursuant to subdivision a of this section, as it may from time to time be revised pursuant to subdivision [f]h of this section, in accordance with its provisions.

[e]g. The commissioner shall submit to the mayor and the speaker of the council the watershed protection plan, draft of such plan and interim report prepared pursuant to subdivisions a, d and e of this section, or any revised plan prepared pursuant to subdivision [f]h of this section, no later than five business days after its completion.

[f]h. The watershed protection plan prepared pursuant to subdivision a of this section shall be reviewed and revised as necessary to achieve its goals, but in no event shall such review occur less often than once every two years.

[g]i. No later than October 1, [2007]2008, and no later than October 1 of every [two]second year[s] thereafter, the commissioner shall submit a report to the mayor and the speaker of the council, which shall include, but not be limited to:

(1) (1) the implementation status of the measures included in the watershed protection plan

prepared pursuant to subdivision a of this section, as it may have been revised pursuant to subdivision [f]h of this section; and

(2) where the plan has been reviewed in accordance with subdivision [f]h of this section and the commissioner determines that no revisions are required, such determination and the reasons for it.

[h]j. (1) A Jamaica bay watershed protection plan advisory committee shall be established, which shall provide advice to the commissioner for the duration of its term and provide preliminary and final recommendations to the commissioner and the speaker of the

council on the watershed protection plan prepared pursuant to subdivision a of this section regarding:

i. the specific goals of such plan related to restoring and maintaining the water quality and ecological integrity of Jamaica bay;

ii. the geographic boundaries of the watershed/sewershed of Jamaica bay to be included in

such plan;

iii. any measures that should be assessed by the commissioner for inclusion in such plan, in addition to those listed in subdivision b of this section;

iv. the assessment of the technical, legal, environmental and economical feasibility of including in such plan the measures listed in subdivision b of this section and any additional measures; and

v. a schedule, including interim and final milestones, for implementing the measures and achieving the specific goals to be included in such plan and methods of monitoring progress towards achieving such milestones and goals.

(2) Such advisory committee shall be comprised of seven members, three of whom shall be appointed by the speaker of the council and four by the mayor. The members shall be appointed within forty-five days after the effective date of this section and shall serve without compensation. The chairperson(s) shall be elected from amongst the members. Any vacancy shall be filled in the same manner as the original appointment for the remainder of the unexpired term. The commissioner may provide staff to assist the advisory committee.

(3) Such members of the advisory committee shall serve until three months after the date upon which the commissioner completes the watershed protection plan prepared pursuant to subdivision a of this section, after which time the committee shall cease to exist.

(4) No later than July 1, 2006, the chairperson(s) of such committee shall submit a report containing the committee's preliminary recommendations regarding the watershed protection plan prepared pursuant to subdivision a of this section to the commissioner and the speaker of the council.

(5) No later than [July 1, 2006]June 1, 2007, the chairperson(s) of such committee shall submit a report containing [its]the committee's final recommendations regarding the watershed protection plan prepared pursuant to subdivision a of this section to the commissioner and the speaker of the council.

§2. This local law shall take effect immediately.

PCW 6/7/06
LS #1173

Appendix D

MAPPING REFERENCE PANEL

Kathryn Mellander, *GIS Specialist*, National Park Service, Gateway National Recreation Area, Division of Natural Resources

Patrick Kiprotich, *Student Conservation Association Intern*, National Park Service, Gateway National Recreation Area, Division of Natural Resources

George W. Frame, Ph.D., *Biologist (Natural Resources)*, National Park Service, Gateway National Recreation Area, Division of Natural Resources

Doug Adamo, *Chief of Division of Natural Resources*, National Park Service, Gateway National Recreation Area

Megan Lew, *New York/New Jersey Harbor-Bight Project Assistant*, Natural Resources Defense Council

Fred Mushacke, *Marine Biologist*, New York State Department of Environmental Conservation, Bureau of Marine Resources

Appendix E

MAPPING CLASSIFICATION DESCRIPTIONS

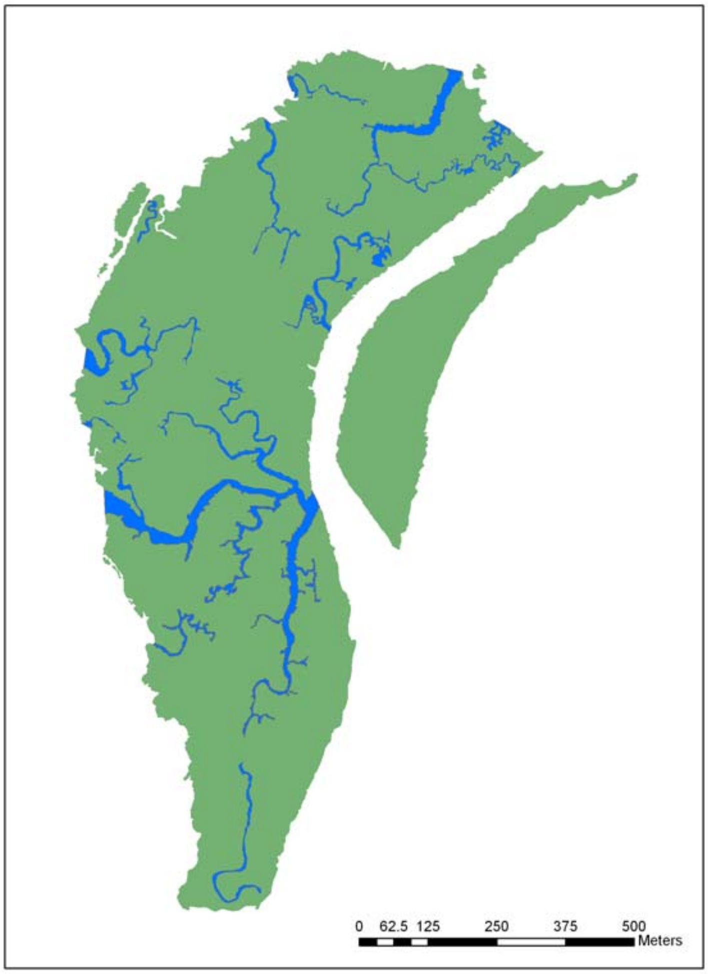
Name	Description/definition
Spartina >50%	Vegetation (*altern.* and *patens*) covers > 50% of area - contiguous; (non-fragmented salt marsh vegetation)
Spartina 10-50%	Vegetation covers 10-50% of area (fragmenting marsh).
Spartina <10%	Severely fragmented vegetation, usually in marsh interior. Use if unsure whether area is mud flat or peat, or has vegetation remnants.
mud flat/mucky peat	Mud flat (no vegetation) with no defined channel. Can be connected to tidal creek or marsh exterior, but is surrounded by marsh vegetation and not exposed to exterior forces.
tidal creek	Channel area of tidal creeks: areas with visible channel only
tidal pool	Interior areas inundated at low tide. If area partially water-filled and partially mud flat, use mud flat category
sand	Visible areas on marsh exterior. Exterior support of salt marsh, submerged sand at low tide.

Appendix F

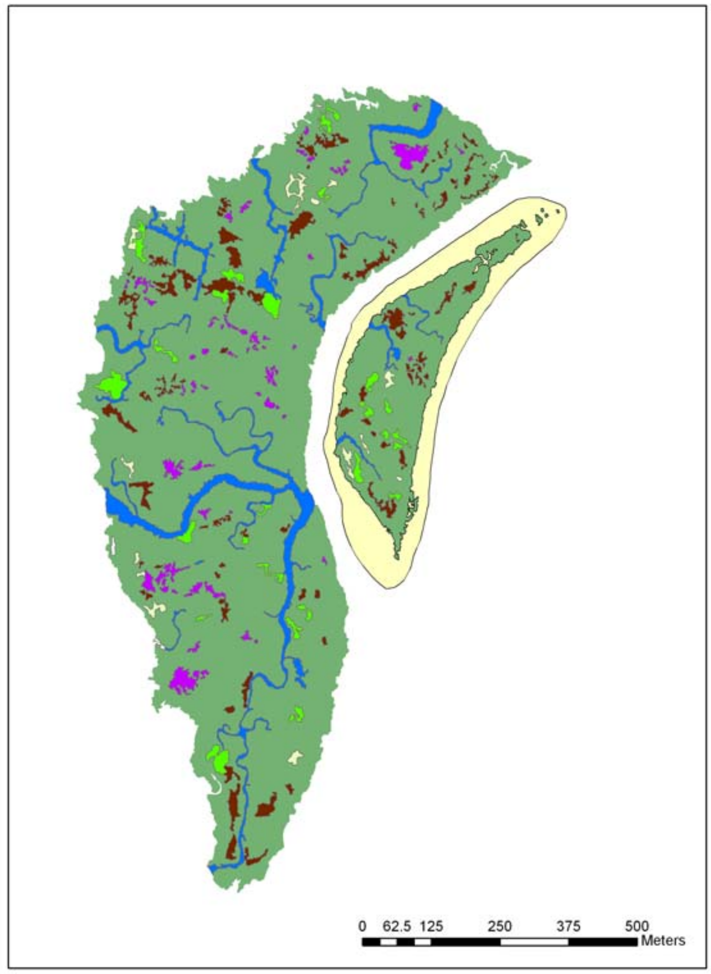
Vegetated Marsh Maps for East High, Yellow Bar, Black Wall, Elders Point, and Pumpkin Patch Marshes

East High

1951

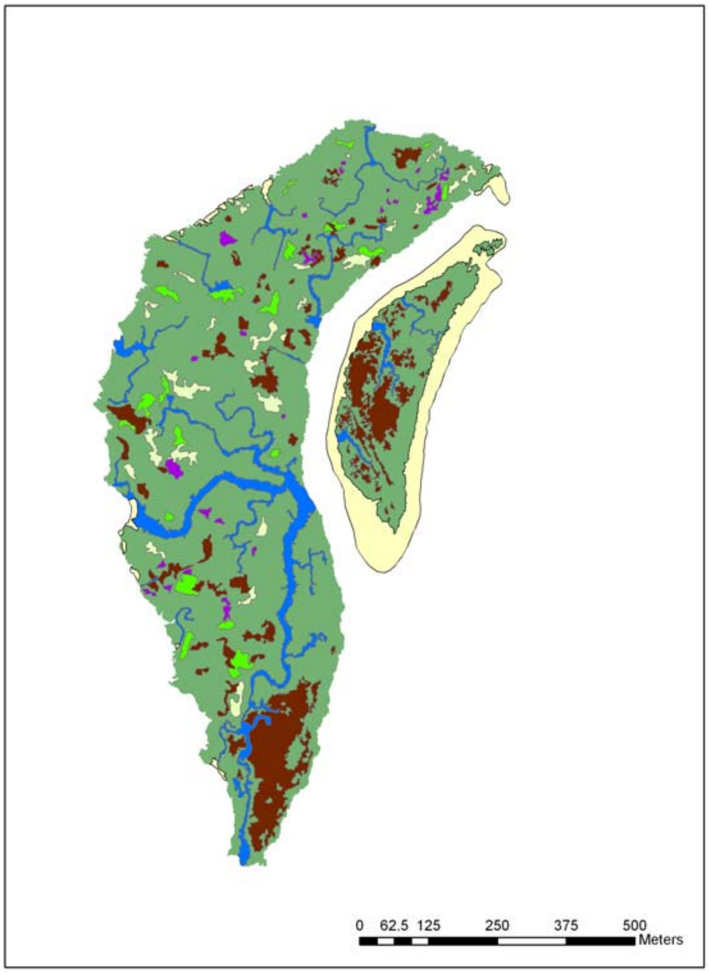


1974

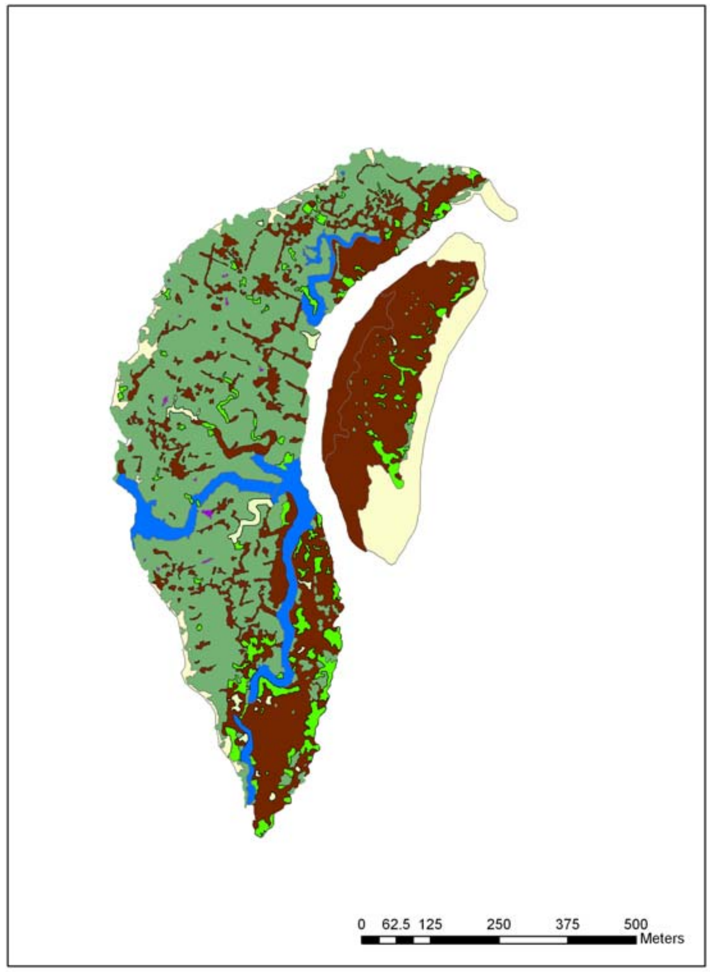


East High

1989

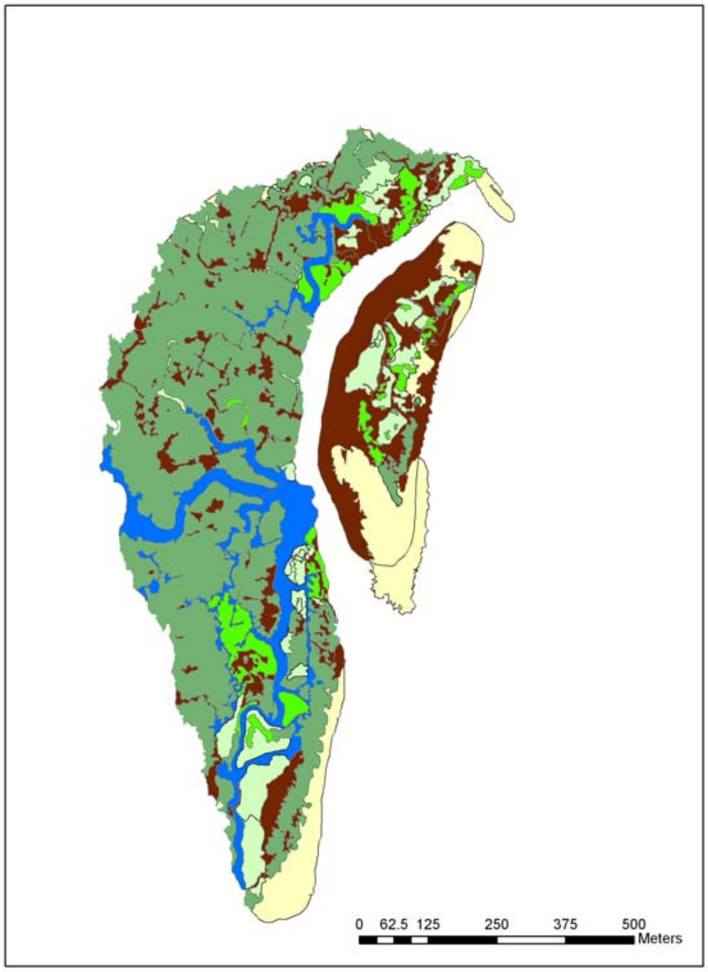


2003



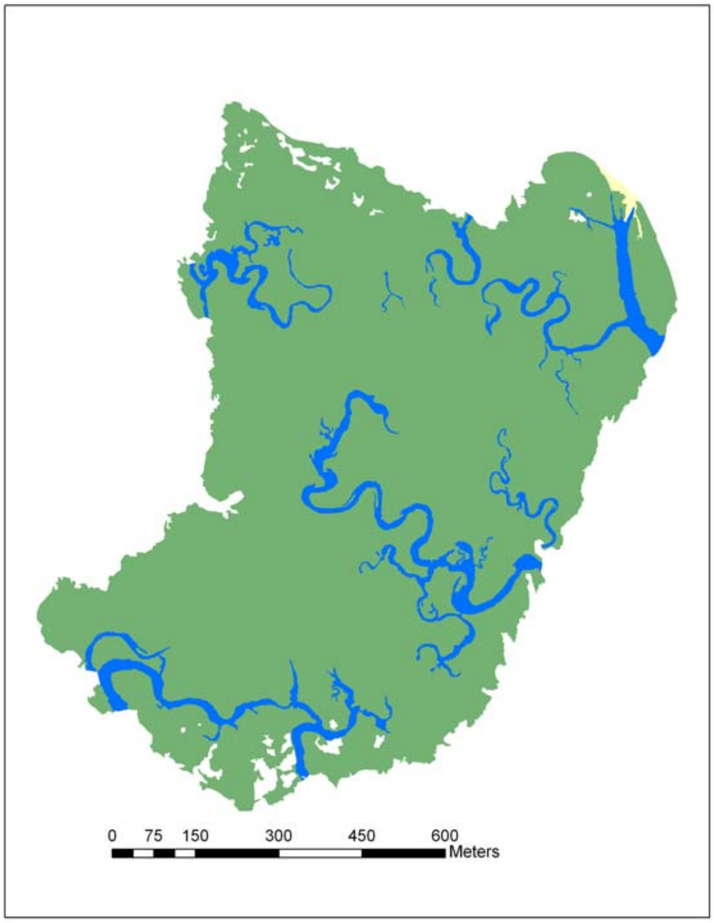
East High

2005

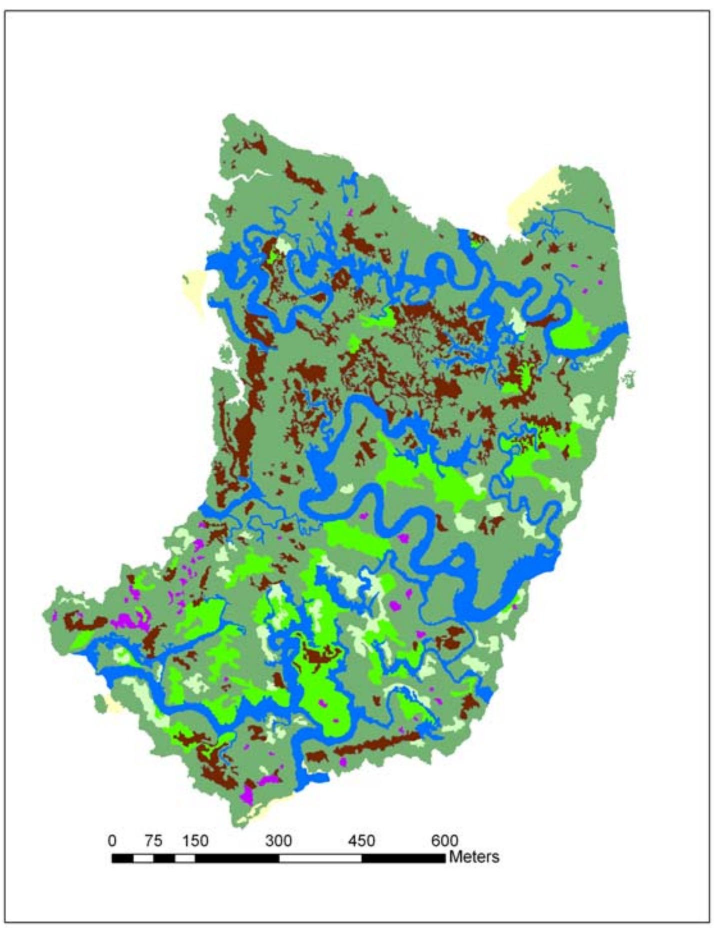


Yellow Bar

1951

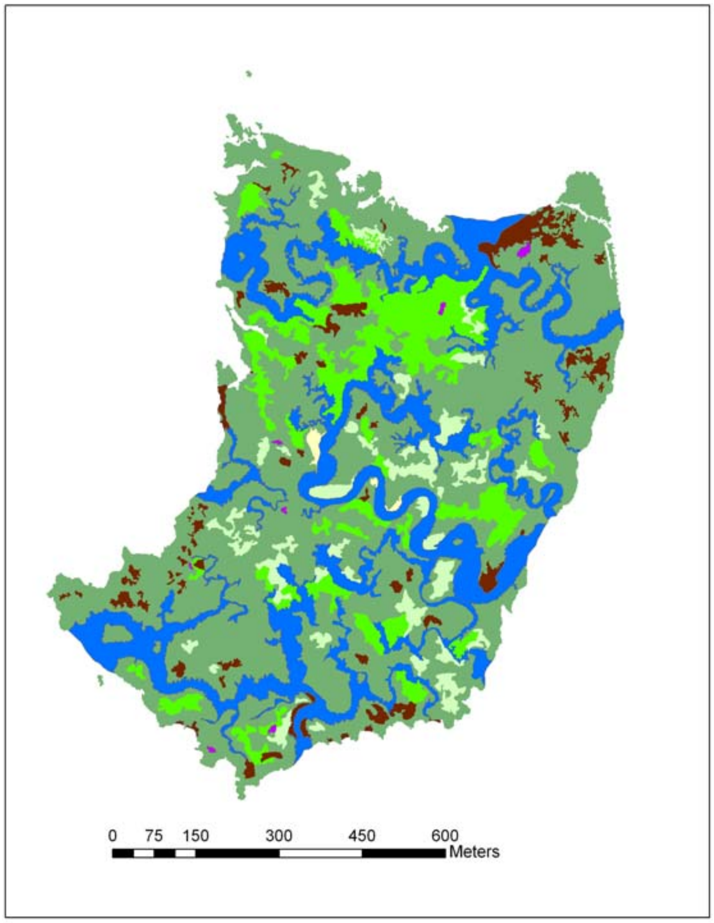


1974

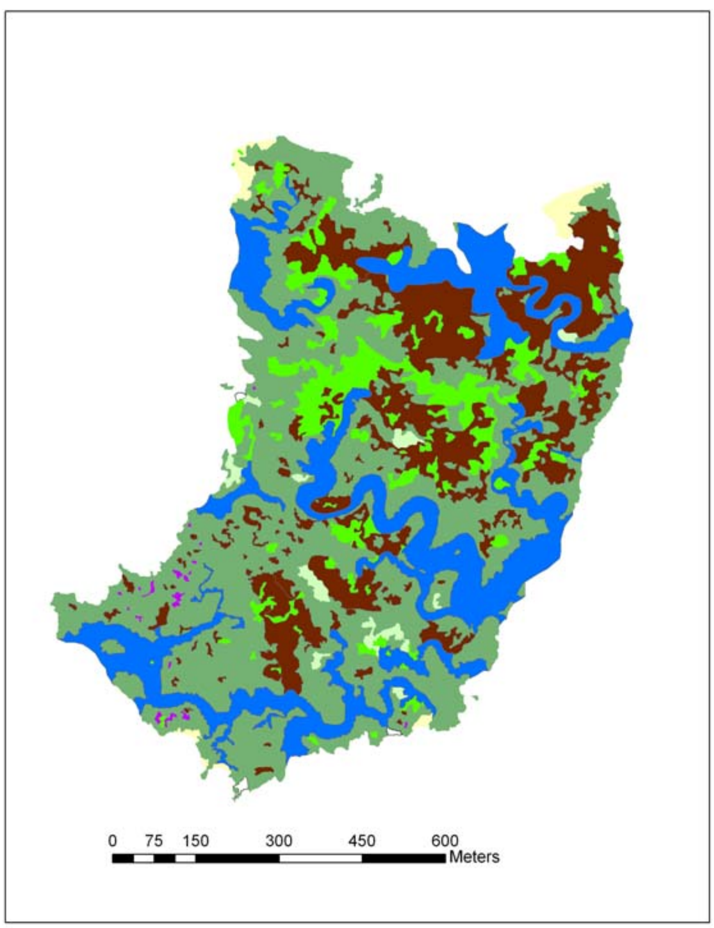


Yellow Bar

1989

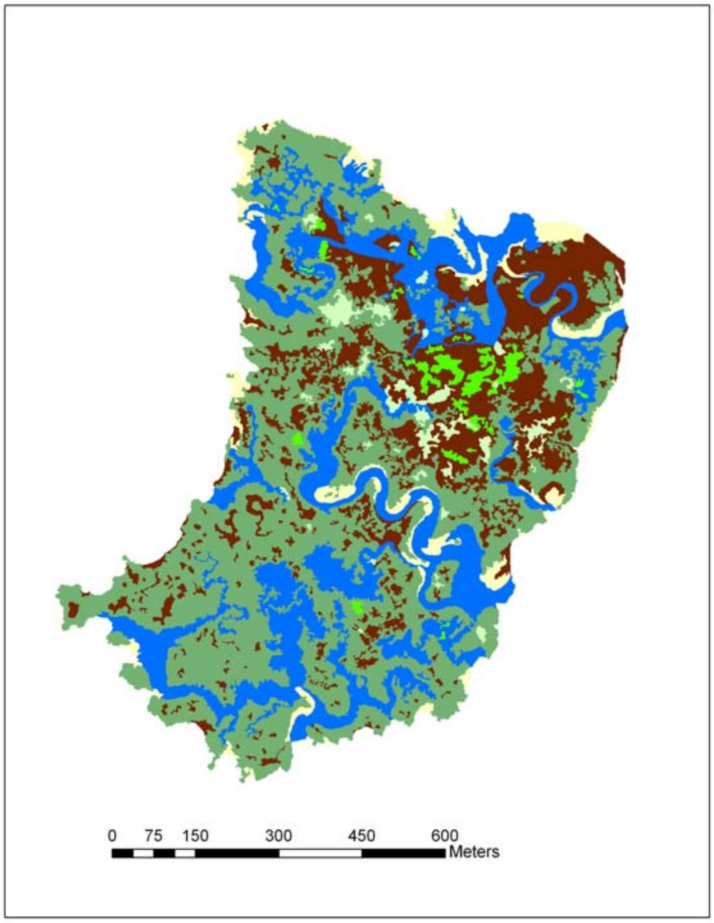


2003



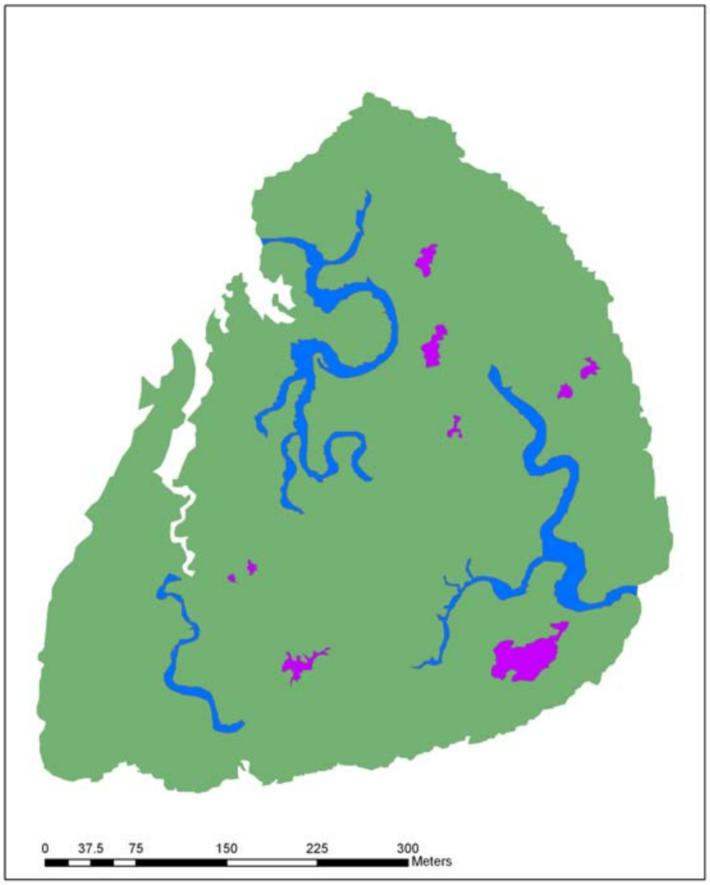
Yellow Bar

2005



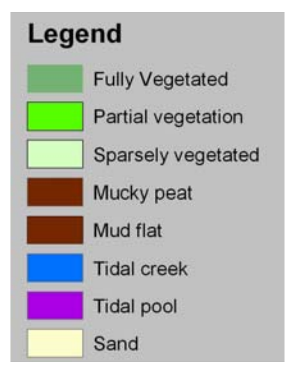
Black Wall

1951



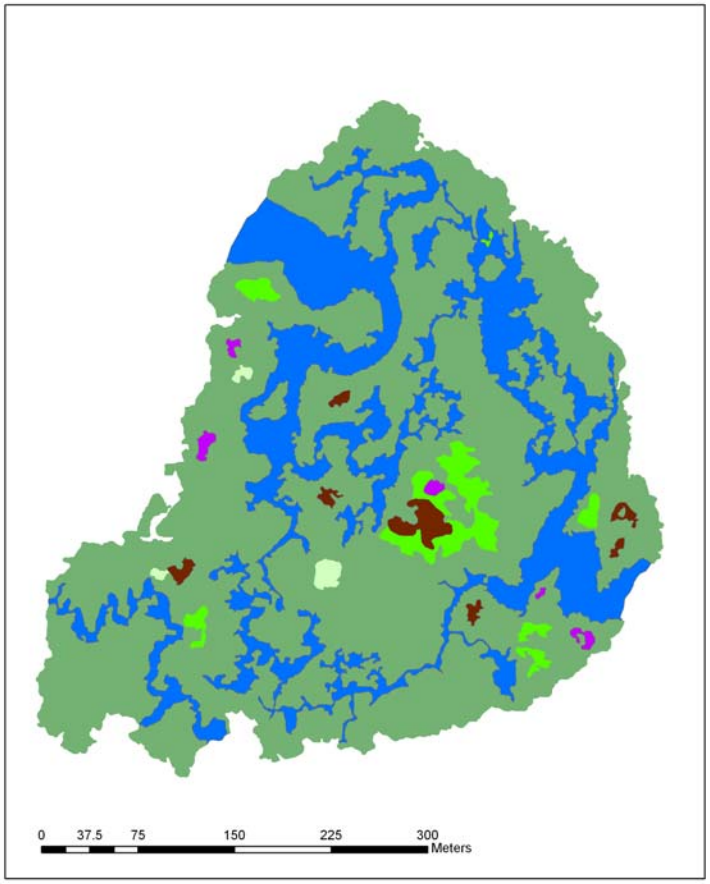
1974

Tidal creeks were not mapped for Black Wall in 1974.

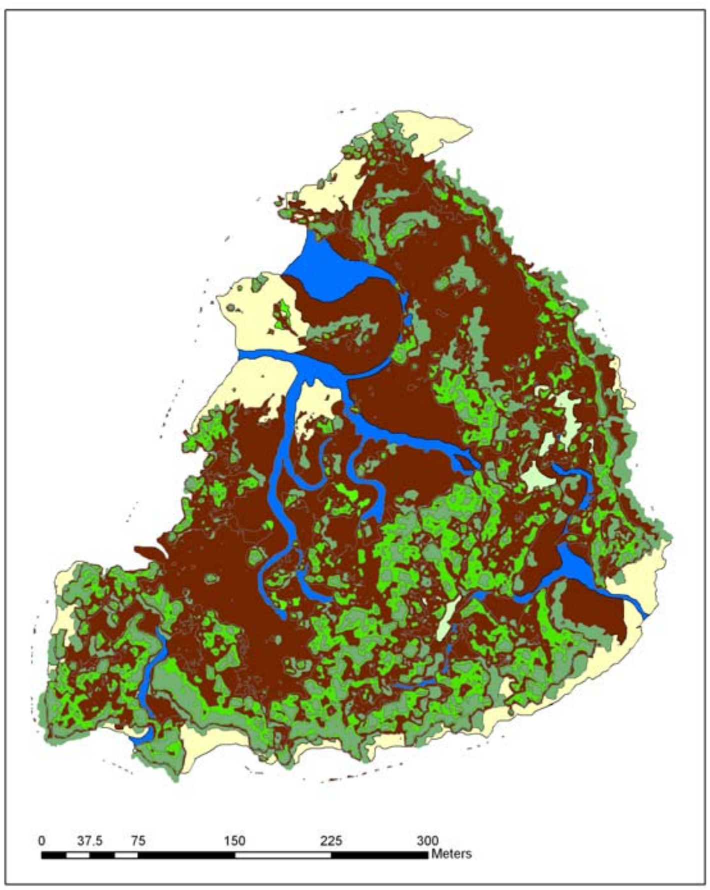


Black Wall

1989



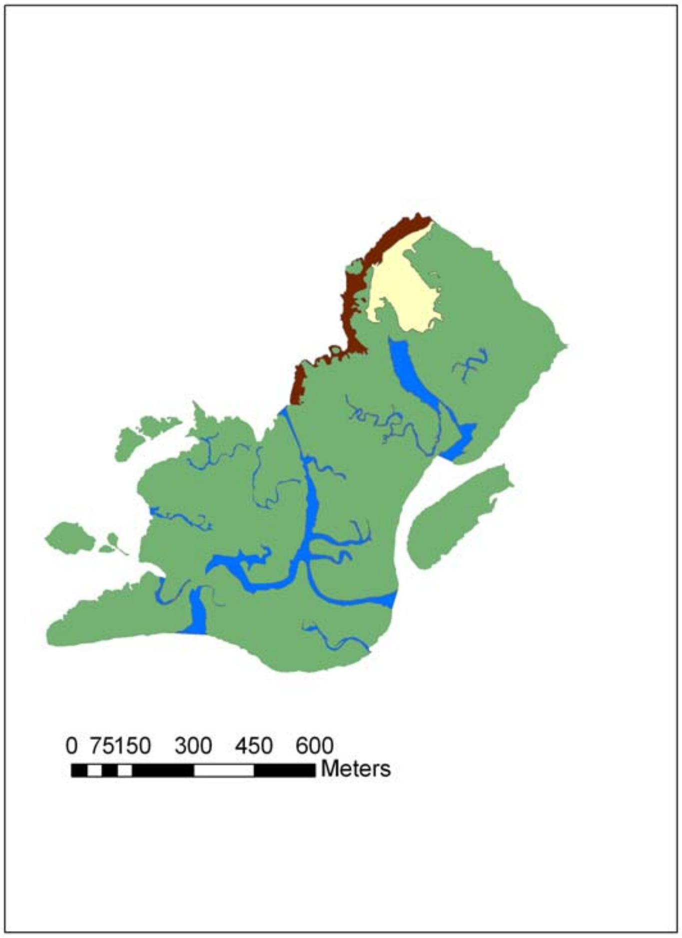
2005



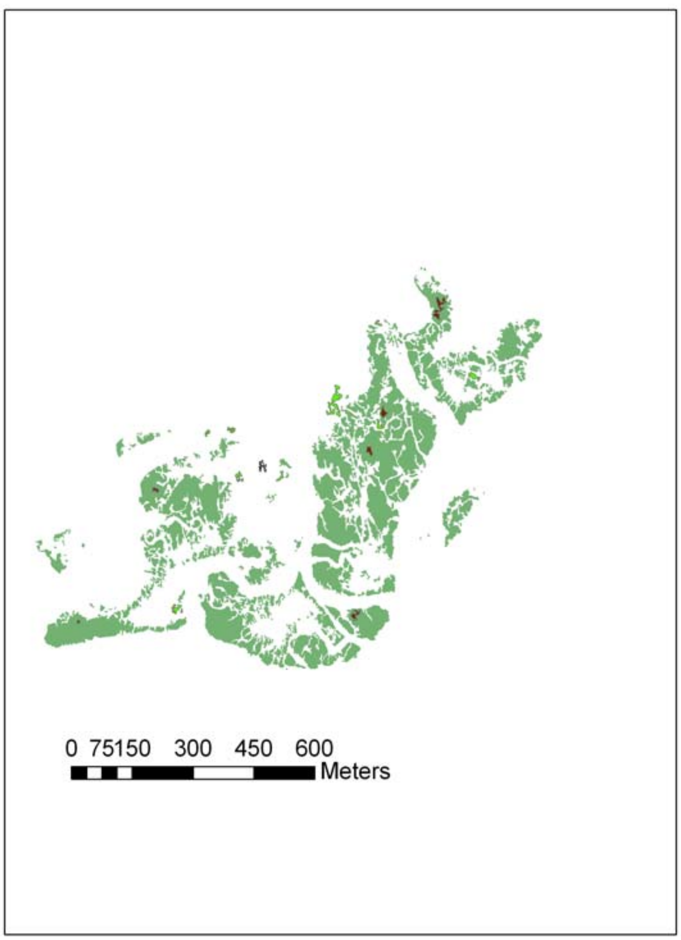
The vegetation map for Black Wall in 2003 has been omitted because the classification was based on satellite imagery, and not an aerial photograph. The classification using the satellite image is not visually compatible with the aerial photographs, and thus, is omitted here.

Elders Point

1951

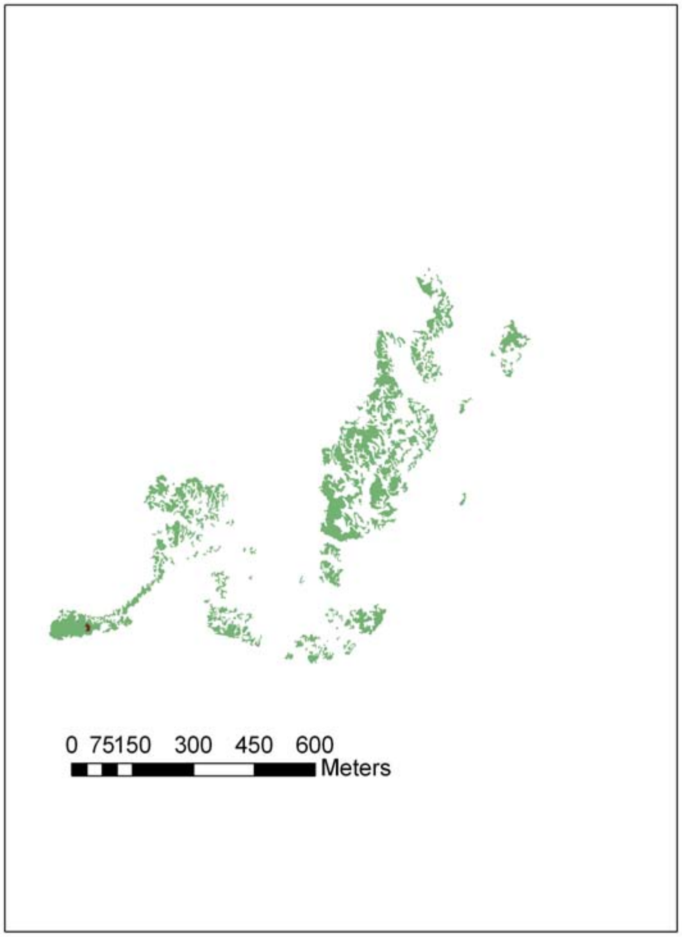


1974

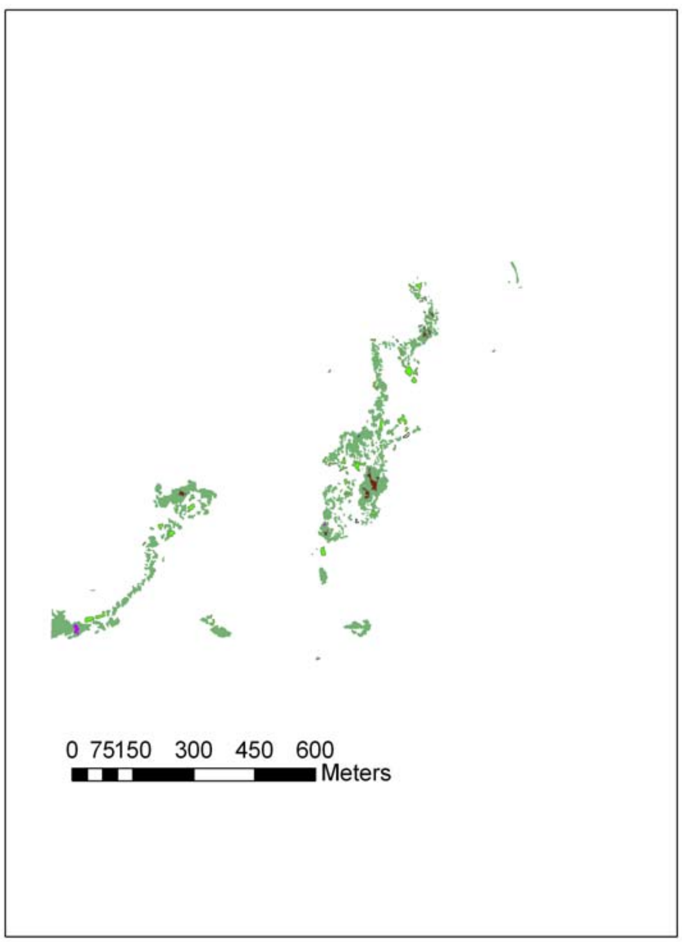


Elders Point

1989

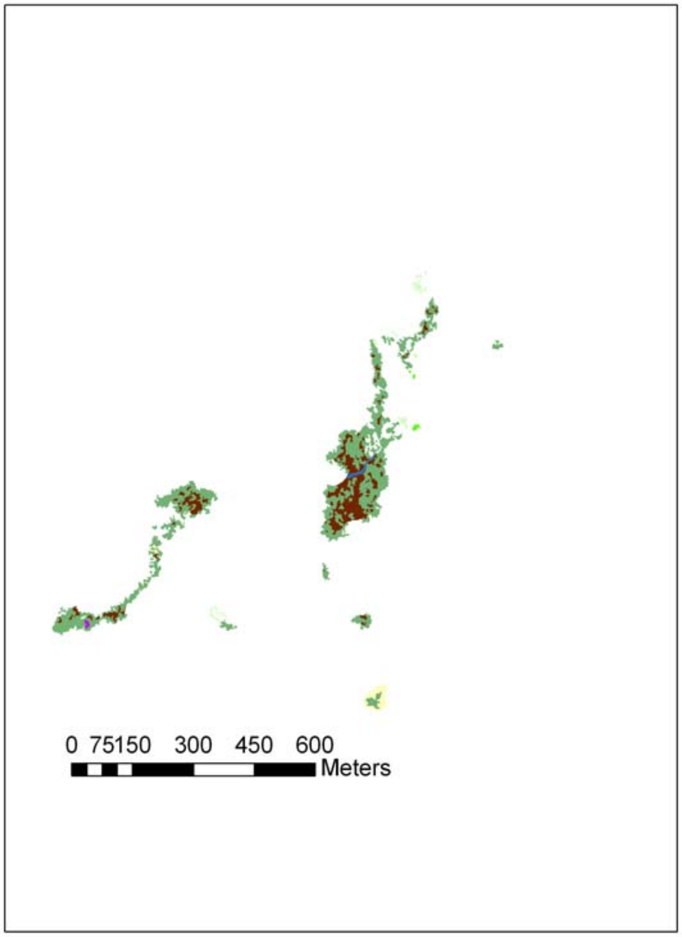


2003



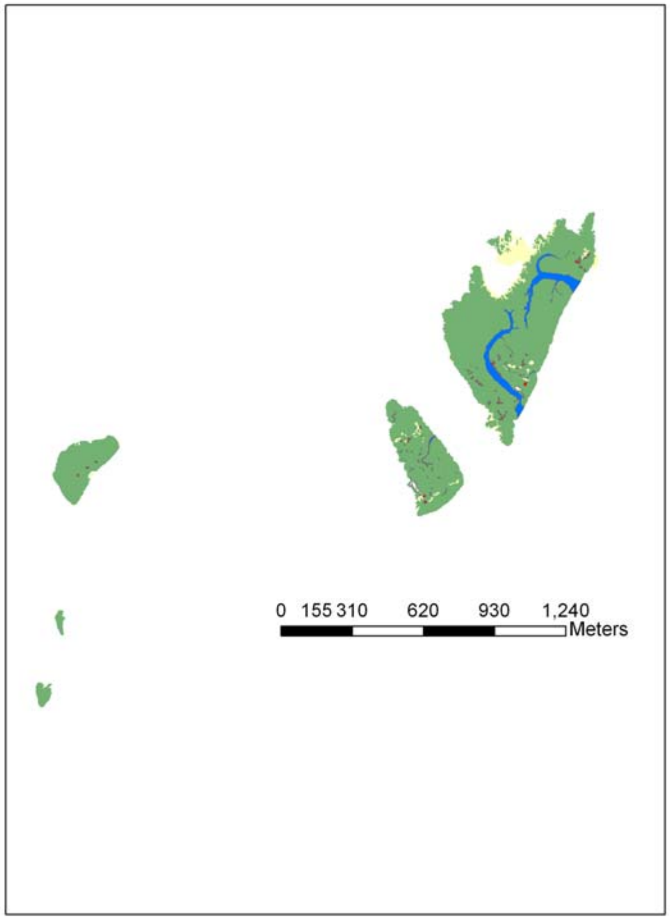
Elders Point

2005

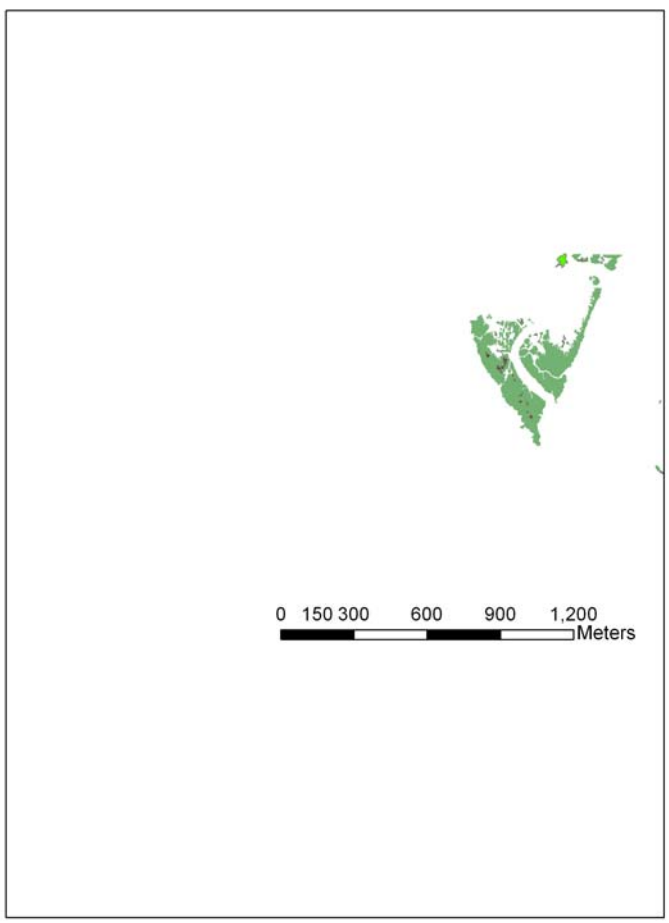


Pumpkin Patch

1951

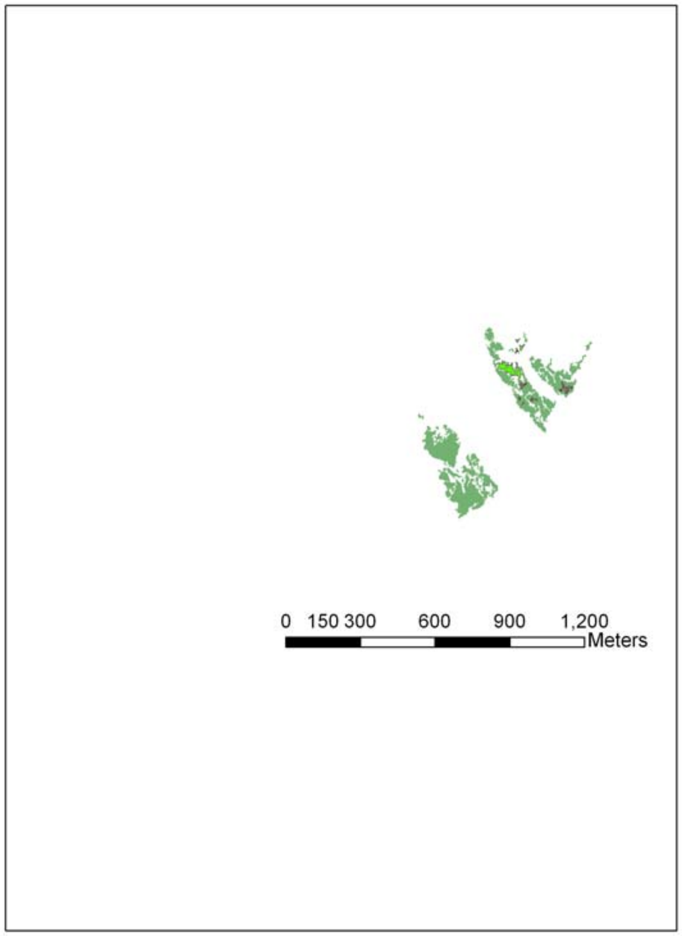


1974

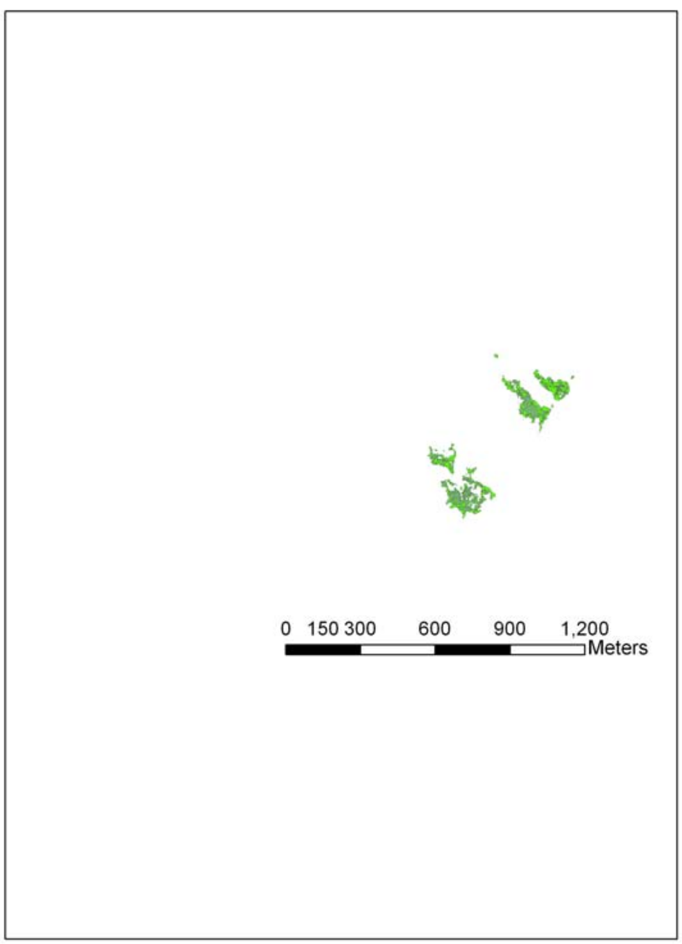


Pumpkin Patch

1989

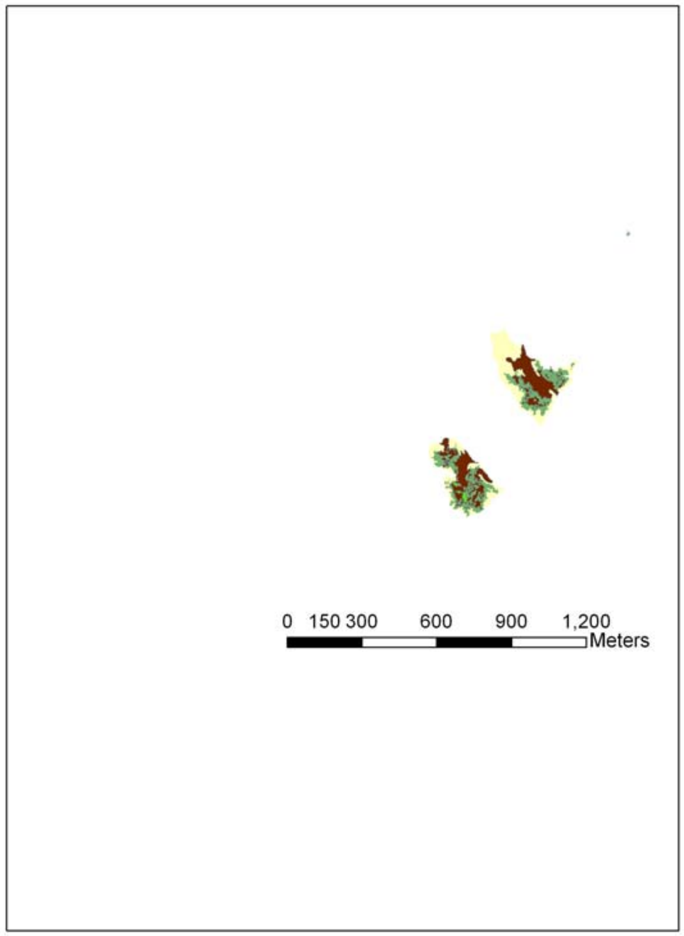


2003



Pumpkin Patch

2005



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