

7-1996

# Rare and endangered plants at Gateway National Recreation Area: a case for protection of urban natural areas

John T. Tanacredi Ph.D.  
Molloy College, [jtanacredi@molloy.edu](mailto:jtanacredi@molloy.edu)

Richard Stalter  
Saint Johns University

Michael D. Byer

Follow this and additional works at: [https://digitalcommons.molloy.edu/cercom\\_fac](https://digitalcommons.molloy.edu/cercom_fac)

 Part of the [Aquaculture and Fisheries Commons](#), [Biodiversity Commons](#), [Biology Commons](#), [Environmental Chemistry Commons](#), [Environmental Health and Protection Commons](#), [Environmental Indicators and Impact Assessment Commons](#), [Environmental Monitoring Commons](#), [Marine Biology Commons](#), [Sustainability Commons](#), and the [Terrestrial and Aquatic Ecology Commons](#)

[DigitalCommons@Molloy Feedback](#)

---

## Recommended Citation

Tanacredi, John T. Ph.D.; Stalter, Richard; and Byer, Michael D., "Rare and endangered plants at Gateway National Recreation Area: a case for protection of urban natural areas" (1996). *Faculty Works: CERCOM*. 8.  
[https://digitalcommons.molloy.edu/cercom\\_fac/8](https://digitalcommons.molloy.edu/cercom_fac/8)

This Peer-Reviewed Article is brought to you for free and open access by the CERCOM at DigitalCommons@Molloy. It has been accepted for inclusion in Faculty Works: CERCOM by an authorized administrator of DigitalCommons@Molloy. For more information, please contact [tochter@molloy.edu](mailto:tochter@molloy.edu), [thasin@molloy.edu](mailto:thasin@molloy.edu).

## Rare and endangered plants at Gateway National Recreation Area: a case for protection of urban natural areas

Richard Stalter  
Michael D. Byer  
John T. Tanacredi

### **Abstract**

The diversity of native plant species in urban environments is usually overlooked when biodiversity levels are considered. Inventories of native plants reveal many to be rare species surviving the harsh conditions encountered in urban ecosystems. Knowledge of their existence and an inventory of their distribution will assist in maintaining these populations. Protection strategies for rare plant species are outlined for urban National Parks.

### **1. Introduction**

#### 1.1. Purpose of the study

Gateway National Recreation Area's annual budget is around \$15.5 million. These funds help to provide the following payoffs: (1) 10 500 ha of woodlands, beaches, fields, historic sites made available to serve over eight million people per year, twice the number that visit the crown jewels of the National Park system (Yellowstone, Yosemite). (2) 30000 of these visitors each year are school children. They come to this park to visit another world that exists right in their backyard, but is totally different from the world they experience daily. It introduces them to a world more physically, visually, and biologically diverse than their urban environment. (3) This recreation area is accessible to people who cannot travel the great distances otherwise necessary to recreate in a similar environment. For these people, this is their only practical access to a natural world.

Gateway and other urban parks have persistently come under political fire to eliminate these non-real parks or to gut their budgets. Yet Gateway's lands provide an opportunity for tens of millions of urban dwellers to experience a biologically diverse, information-rich landscape, which also serves as a laboratory where visitors can observe a continuous experiment taking place in natural successional processes and species dissemination. These lands possess a unique assemblage of plants and animals which are not commonly found within the region due to loss of their habitats to development or inappropriate use. These assemblages are the product of our cultural and natural history. Gateway offers a frontier to explore. As E.O. Wilson puts it in *The Biophilia Hypothesis*, "The true frontier for humanity is life on earth-its exploration and transport of knowledge about it into science, art and practical affairs" (Kellert and Wilson, 1993).

If a park is under the gun politically because its true value to the public is not understood by the decision-makers, as at Gateway, the existence of rare species within the park will bolster arguments for keeping the park and its resource management program afloat financially.

In addition to providing an inventory of rare species at Gateway, the present study offers some fuel for scientific speculation. Rare species, according to theory and some empirical evidence, are thought to often have narrow tolerance ranges (Preston, 1948), and thus remain particularly vulnerable to environmental change. Rare plants might, therefore, be expected to be absent in the face of the relentless pressures to which urban ecosystems are subject. Our survey serves as a test of the hypothesis that rare species can, in fact, occur within highly urbanized, densely populated zones.

### *1.2. Review of floristic work at gateway*

Gateway National Recreation Area (GNRA) included 3388 ha of land area when originally established by Act of Congress in October, 1972 (United States Department of the Interior/National Park Service, 1979). Gateway consists of units at Sandy Hook, Staten Island, and Jamaica Bay. The Jamaica Bay Unit is further divided into the Jamaica Bay, Breezy Point, and Wildlife Refuge Districts (Fig. 1).

Gateway supports a diverse flora reflecting several habitat types, each characterized by different plant associations. Included are a number of ecologically sensitive and regionally unique habitats and plant communities, such as barrier beach dunes, salt marsh, holly and other maritime forests, and grasslands. Venezia and Cook (1991) recorded 652 plant species at Gateway.

Floristic inventories were prepared for Sandy Hook by Chrysler (1930), McKenian (1968) and Stalter (1979), for Fort Tilden (Breezy Point District) by Stalter and Lechthaler (1984), and for Floyd Bennett Field (Jamaica Bay District) by K. Venezia in 1982 and 1983. A. Greller collected extensively at FBF in 1983, and again in grasslands at this location in 1991-1992. R. Stalter and various National Park Service staff made additional collections at this site. Bridges (1976) included a floristic list in his study on the Jamaica Bay Wildlife Refuge. Stalter and Greller (1988) published a floristic inventory of the entire park.

## **2.Methods**

Four Gateway National Recreation Area sites were surveyed for rare and/or endangered species: Sandy Hook, New Jersey; Fort Tilden in the Breezy Point District, Queens, New York; Floyd Bennett Field in the Jamaica Bay District, Brooklyn, New York; and Miller Field/Great Kills in the Staten Island District, New York (Fig. 1). Locations of rare species were mapped. Criteria for rare, threatened, and endangered status in New Jersey and New York State, respectively,

follow Snyder (1992) or Young (1992). Nomenclature follows Gleason and Cronquist (1991). Plants collected at the four sites are housed in the Gateway herbarium at Floyd Bennett Field.

### **3. Site descriptions**

#### *3.1. Sandy Hook*

Sandy Hook is a 10 km long recurved sand spit attached to the mainland of New Jersey. It lies 26 km south of Manhattan, and varies in width from 100 m to 1.5 km. The Hook was formed by the northerly transport of eroded beach sand (Nordstrom et al., 1975); total land area is about 674 ha, of which 599 ha are under NPS jurisdiction (Stalter, 1979).

Much of Sandy Hook supports various types of littoral and dune vegetation. The vegetation also includes American Holly (*Ilex opaca*) forest, red cedar (*Juniperus virginiana*) groves, and patches of mixed hardwoods.

#### *3.2. Floyd Bennett Field*

Floyd Bennett Field (FBF), comprising 565 ha of which about 410 ha is under NPS administration, is located in Brooklyn on the west side of Jamaica Bay. This field occupies the former site of Barren Island and part of surrounding salt marsh that were covered with dredge spoil and urban rubble between 1900 and 1920; an airfield was constructed there in the 1920s. After intermittent use, the field was decommissioned in 1971-1972 and turned over to the National Park Service (see Rogers et al., 1985; Friedberg, 1980; United States National Park Service, 1983; Tanacredi, 1983).

Currently, much of Floyd Bennett Field is grassland maintained by mowing and, since 1992, by prescribed burning. The undeveloped northern portion of this field, known as the North 40, consists of brushlands and successional woodlands, plus Retuma-Gift Pond, a 0.4 ha man-made freshwater pond.

#### *3.3. Fort Tilden*

Fort Tilden (260 ha of NPS land) is situated on the Rockaway Peninsula, the tip of which was approximately 2 km east of the present eastern border of Fort Tilden in 1845. From 1889 to 1980, accretion extended the peninsula roughly 4 km westward, but a rock jetty was constructed to halt this extension (Link, 1981).

The first human habitation of Fort Tilden began after 1917 when the Army Corps of Engineers filled marshlands at the eastern end of the reservation. Fort Tilden was decommissioned in 1967 and remained unoccupied until the National Park Service took it over in 1972 (Link, 1981).

Littoral areas and dunes in various stages of succession, plus patches of wetland, now occupy much of this site.

### 3.4. Staten Island Unit, New York

Two distinct areas, Miller Field and Great Kills, comprise the Staten Island Unit of Gateway.

Great Kills (226 ha) consists of a relatively large, equidimensional northeastern portion; a small, triangular, sandy area, Crooke's Point, to the south, delimiting the entrance to Great Kills Harbor; and a long arm of sand connecting the two (Fig. 1). The large northeastern area was occupied originally by salt marsh, subsequently covered with sanitary landfill topped by a layer of sand dredged from Great Kills Harbor around 1940. It is now mostly covered with dense common reed (*Phragmites australis*), with a strip of disturbed hardwood woodland along Hylan Boulevard, which forms the northwestern border. Dredged sand was also used to form the connecting arm. This arm and Crooke's Point support a variety of littoral plant communities. Recreational beaches occupy the shoreline. Great Kills was a city park from 1949 through 1974 (United States Department of the Interior/National Park Service, 1979; United States Department of the Interior/National Park Service, 1989).

### 3.4. Staten Island Unit, New York

Two distinct areas, Miller Field and Great Kills, comprise the Staten Island Unit of Gateway. Great Kills (226 ha) consists of a relatively large, equidimensional northeastern portion; a small, triangular, sandy area, Crooke's Point, to the south, delimiting the entrance to Great Kills Harbor; and a

Miller Field (84 ha) was constructed just after World War I as a service area for hydroplanes. Much of it is currently utilized for athletic fields and sports facilities. The undeveloped northwestern portion of Miller Field (about 5 ha) is a relict hardwood forest containing several large swamp white oaks (*Quercus bicolor*), which has led to this area being dubbed the Swamp White Oak Forest. The presence of this species is unusual in the eastern seaboard region (Cemiglia, 1982). Other notable plants of this area, although not all rare, include Indian grass (*Sorghastrum nutans*), spice bush (*Lindera benzoin*), yellow flag (*Iris pseuducorus*), and magnolia (*Magnolia virginiana*).

Unfortunately, the drainage pattern in this forest was altered beginning in 1980 by the diversion of Moravian Creek, which sporadically flooded some portions. This resulted in the loss of some unique flora and fauna, and may eventually lead to the disappearance of swamp white oak, which is a floodplain species (Fomino and Oppenheimer, 1982).

#### 4. Results

Tables 1 and 2 list imperiled and rare plants (Natural Heritage Program designations, Young, 1992) for Sandy Hook and the three New York state sites, respectively.

Five plants on the New Jersey state list (Snyder, 1992) were identified at the Sandy Hook Unit. Two of these, *Cyperus polystachyos* var. *texensis* and *Polygonum glaucum*, are critically imperiled (61) in the state; the others are imperiled (62).

*Polygonum glaucum* is the rarest plant encountered at Sandy Hook. It is known there from only two sites, one along the eastern shore and the other actually off National Park property, within the Coast Guard compound at the tip. At both sites, it occurred in sparse, low, herbaceous littoral vegetation near the wrack line. Prior to 1992, this species was known from only two locations in New Jersey (Snyder, personal communication). *Cyperus polystachyos* var. *texensis* and *Panicum oligosanthos*, at Sandy Hook, grow in open, sunny, moist sandy soil at many locations along the roadside rights-of-way. *Artemisia campestris caudata*, although listed as imperiled in the state, is common throughout low, sparse herbaceous littoral vegetation at Sandy Hook (Fig. 2). *Honckenya peploides* grows sporadically along the beaches in open, low littoral vegetation (Fig. 3), often occupying the strand immediately in front of, or at the side of an ocean-facing dune.

Five plants listed in Young (1992) have been identified within the New York units. Two state rarities, *Amaranthus pumilus* (Seabeach Amaranth) and *Polygonum glaucum*, are also globally imperiled, or highly vulnerable to extinction (G2) and very rare and local, or vulnerable to extinction (G3), respectively.

*Amaranthus pumilus* is the rarest plant at Gateway. Since 1950, it had been thought extirpated in New York State, until rediscovered at several locations on Long Island in 1990 (Clements and Mangels, 1990). Because of the recentness of its rediscovery, it is not yet protected in the state.

*A. pumilus*, a brittle annual growing near beaches, may have been decimated over much of its former range by the increasing impacts of beach usage in recent decades. More recently off-road vehicles (ORV) have posed an even greater threat; Van Schoik and Antenen (1993) document instances of amaranth plants crushed by ORV tires.

Clements and Mangels (1990) postulated the sudden reappearance of *A. pumilus* on Long Island in 1990, as follows. Hurricane Hugo, in September of 1989, caused extreme storm tides along the Outer Banks of North Carolina, where the closest populations were found. These unusual tides flooded numerous amaranth plants, perhaps washing their ripe seeds into the ocean. The prevailing

ocean currents, moving northeastward along the coast, presumably then carried these seeds to Long Island beaches.

Gateway's known seabeach amaranth population occurs among open beachgrass (*Ammophila breviligulata*) stands on flat or gently undulating sands at West Beach, Breezy Point. This population has been monitored each year since 1990 and reached a high of 32 individuals in 1992. In 1993, however, only one plant was found, although single plants also were found that year at three new locations on Breezy Point Tip, 2.5-3 km west of the West Beach site, giving a known parkwide total of 4 (M. Hake, pers. comm.). In fact, populations at most Long Island locations were down in 1993 as opposed to previous years. Van Schoik and Antenen (1993) attributed this to beach erosion caused by unusually severe storms (e.g. 11-12 December 1992).

At Gateway and elsewhere on Long Island, fencing that protected piping plover (*Charadrius melodus*) habitat and other shorebird nesting areas has favored seabeach amaranth by reducing access by ORVs and pedestrians.

*Polygonum glaucum* also occurs at Breezy Point, in habitats similar to those favored by *A. pumilus*. At Breezy Point, *P. glaucum* is more widespread than at Sandy Hook, growing all along the south shore and at the tip of the peninsula. In 1993, it was also found inland in loose sand along trails that are barely vegetated, but inland sites are atypical for this plant. The 1993 distribution may have been the result of the unusually violent noreaster the previous December, which could have washed seeds up a long distance from the shore.

The presence of *Quercus phellos* seedlings/saplings at Floyd Bennett Field is also probably a consequence of man's activities, though indirectly. They have been observed in successional woodlands/ shrublands of the northern portion or North 40. These stands are dominated by poplars, birches, and black cherry (*Populus spp.*, *Betula populifolia*, *Prunus serotina*), with an understory of bayberry (*Myrica pensylvanica*) on sandy or gravelly soils. Since *Q. phellos* is widely planted within New York City the seedlings observed here are probably the progeny of planted specimens. *Q. phellos*, however, does not generally reproduce well within New York City. Distribution records reported by Young (1992) show that both *Magnolia virginiana* and *Q. phellos* closely approach the northern limits of their geographical ranges at Gateway.

*Cyperus schweinitzii*, an endangered species in New York State, occurs at several sites within the Jamaica Bay Unit of Gateway and on nearby non-parklands. The more southern of two Floyd Bennett Field populations was intensively sampled and mapped in the summer of 1993. In an area of 1.03 ha, a total of 1661 individual aerial shoots (5% confidence limits between 439 and 2883) was estimated, and 494 (158-829) clumps (n = 24 random plots 10 m X 10 m). Each clump probably represents a single rhizome. This sedge favors sunny, dry,

loose sands with somewhat sparse, graminoid-dominated herbaceous vegetation cover. It abounds also in heavily disturbed, very sparsely vegetated loose sands such as the sides of foot trails and roadsides (Fig. 4) bridal paths, and sandy dooryards. At Breezy Point, it is also found occasionally on older, stable, sparsely vegetated dunes some distance from the shore.

*Magnolia virginiana*, one of New York State's rarest trees, was probably planted at Miller Field, Staten Island, where it grows in light shade along the southeastern border of the Swamp White Oak Forest (Fig. 5) associated with *Clethra alnifolia* and rank weeds such as mugwort (*Artemisia vulgaris*).

Five additional species found at Gateway New York park units are on New York State's Watch List (Zika, 1990). This list "contains taxa that are considered rare, uncommon or declining in numbers, but which need more information or monitoring to decide if they should be actively inventoried" (Young, 1992). The species are *Aster tenuifolius*, *Cenchrus tribuloides*, *Panicum amarum*, *Suaeda linearis* and *Suaeda maritima*. All five are demonstrably secure globally (G5), but have been found at only a limited number of sites and/or in limited acreage within the state (S3).

## 5. Discussion

Our results demonstrate that rare species can survive and persist in a large urban area. Thus, national parks and other protected open spaces within urban areas play an important role in maintaining regional biodiversity, just as they do in more sparsely populated, less-developed regions.

Cities may contain undeveloped areas that do not happen to enjoy the protected status which parks, preserves etc. afford. There are, in fact, several examples in the New York City metropolitan area near Gateway, such as around the north shore of Jamaica Bay (the Vandalia Dunes area, which has been proposed for development) and in Staten Island. Political and economic expediency in the past have often lead to the development of such lands, thus the destruction of the valuable ecosystems and habitats found thereon.

But certainly these parcels, as well as parks, may harbor rare species, rare biological communities, or rare habitats. Indeed, we identified one of the rare species listed for Gateway, *Cyperus schweinitzii*, in two nearby sites outside the park's protective boundary.

Of course, outside-park plant populations and individual plants or the seed stocks of a species close to park borders form part of an effective interbreeding population, together with those individuals growing within the park's borders. It follows that, if these outside-park individuals were eliminated by development of these bordering lands, the now smaller population left within the park would be more prone to extirpation, because of both smaller numbers and reduced genetic



diversity (Gilpin and Soul& 1986). It behoves natural resource managers, as well as environmentally concerned citizens, to work toward the preservation of undeveloped lands in proximity to these protected areas. Two special cooperative reports by the Trust for Public Lands and New York City Audobon Society (1987) and Trust for Public Lands and New York City Audobon Society (1993) urge the purchase of undeveloped parcels bordering Jamaica Bay, where much of Gateway is located, in order to protect the largest possible contiguous areas from development.

Management of rare species populations within national parks should include monitoring, assessment of any conditions that could impact these populations negatively, and attempts to improve or mitigate such conditions, as needed. When there seems to be a reasonable possibility of extirpation, seeds can be stored and/or the plants can be propagated, and stock kept on hand in the protected environment of a greenhouse/nursery complex. Gateway's greenhouse propagates all plants utilized in habitat restoration projects throughout the park. Since its establishment in 1983 more than 15 000 plants (trees, shrubs, etc.) have been planted, and more than 350000 culms of dune grasses.

At Gateway, populations of all the rare species are being informally observed annually, noting any changes in such parameters as abundance, vigor, and area occupied by the population. Any environmental changes that could impact the population are noted as well. Reports are prepared and distributed to interested parties such as unit and district resource managers and superintendents.

An example of how such monitoring combined with alertness can avert a potential disaster and save a valuable biological resource occurred in 1993, when a planned road construction project would have decimated the major population of *Cyperus schweinitzii* at Floyd Bennett Field. The Division of Natural Resources advised the park's administration, and the construction plans were altered to protect the area occupied by the sedge.

A series of permanent plots has been established at Floyd Bennett Field for the monitoring of *Cyperus schweinitzii*. When feasible, monitoring of all rare species should be formalized and quantified. If the nature of the species lends itself to permanent plots and/or marked individuals, (i.e. if the plant is an annual having fairly dense populations in specific areas over the years or a perennial) such measures facilitate accurate and objective monitoring. Similar studies elsewhere are needed to document rare species which occur within intensely urbanized zones in other geographical and climatic regions.

## **Acknowledgements**

We appreciate the assistance of J. McArthur, M. Hake, and comments on the original manuscript by R. Cook. We thank H. Wildman for discovering several new populations of *Cyperus schweinitzii*. This project was supported by NPS, Gateway, Division of Natural Resources funding.

Figure 1

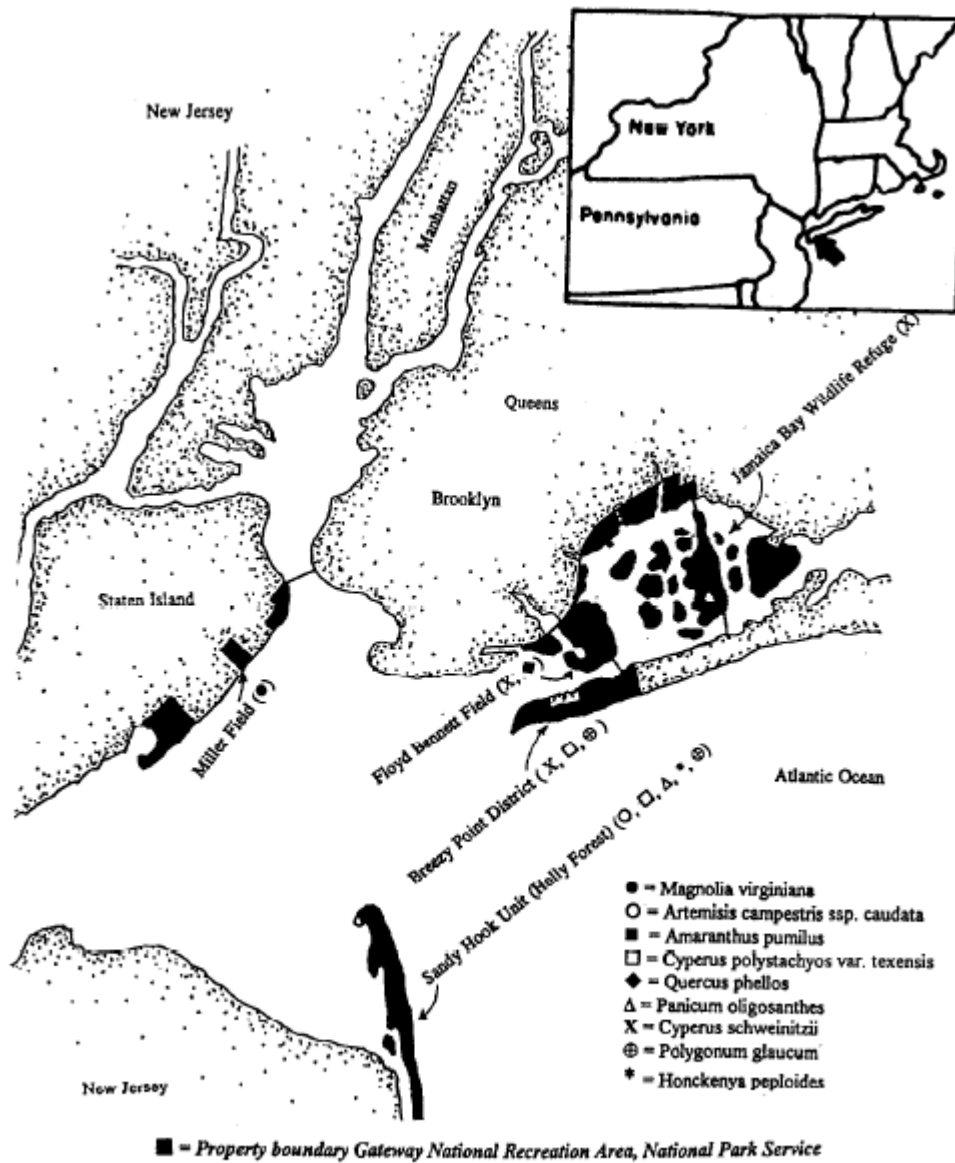


Fig. 1. Map of Gateway National Recreation Area, with locations of the rare plants discussed in this paper indicated.

**Figure 2**



Fig. 2. *Artemisia campestris* ssp. *caudata* (center, indicated by hand) on Gunnison Beach, eastern shore south of Fort Hancock, Sandy Hook.

**Figure 3**



Fig. 3. *Honckenya peploides* (indicated by hand, other clumps seen horizontally across center of photograph) on broad, flat area behind Gunnison Beach, Sandy Hook.

**Figure 4**

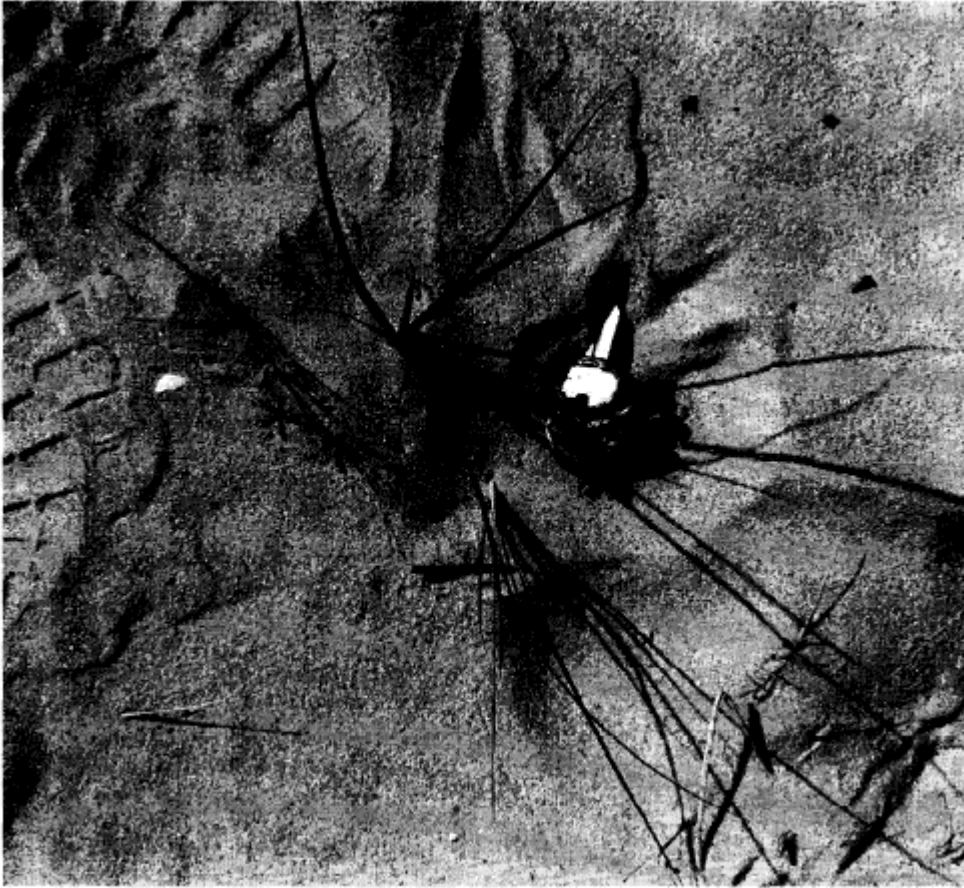


Fig. 4. *Cyperus schweinitzii* (base of shoot just to left of keys) in loose sand at side of vehicle trail, Breezy Point.

**Figure 5**



Fig. 5. *Magnolia virginiana* (center, middle distance, partially hidden by another tree in right foreground) in woodland border vegetation, Swamp White Oak Forest, Miller Field, Staten Island.

## Table 1

Table 1  
Rare plants at Gateway National Recreation Area, Sandy Hook, New Jersey; rarity status according to Snyder (1992)

Scientific name	Common name	Global rank	Federal Rank	State rank	State legal status
<i>Artemisia campestris caudata</i>	Wild Wormwood	G5T4		S2	
<i>Cyperus polystachyos texensis</i>	Coast Flatsedge	G5		S1	E
<i>Honckenya peploides</i>	Seabeach Sandwort	G5		S2	
<i>Panicum oligosanthes</i>	Few-flowered Panic Grass	G5		S2	
<i>Polygonum glaucum</i>	Seabeach Knotweed	G3		S1	E

## Table 2

Table 2  
Rare plants at Gateway National Recreation Area, New York sites; rarity status according to Young (1992)

Scientific name	Common name	Global rank	Federal rank	State rank	State legal status
<i>Amaranthus pumilus</i> <sup>a</sup>	Seabeach Amaranth	G2	C2	SH	U
<i>Cyperus schweinitzii</i>	Schweinitz' Flatsedge	G5		S2	R
<i>Magnolia virginiana</i> <sup>a</sup>	Sweet-bay	G5		S1	U
<i>Polygonum glaucum</i> <sup>a</sup>	Seabeach Knotweed	G3		S3	U
<i>Quercus phellos</i> <sup>a</sup>	Willow Oak	G5		S1	E

<sup>a</sup> Also listed as rare (Y) by Natural Heritage Program



## References

- Bridges, J.T., 1976. Vegetation survey, soils map and estimate of plant health conditions at Jamaica Bay Wildlife Refuge. National Park Service-New York Botanical Garden Cooperative Research Unit, Bronx, NY, 73 + 45 pp.
- Cemiglia, P., 1982. Plant species inventory and tree population survey within the sewer line right-of-way at the Swamp White Oak Forest Staten Island, NY. Gateway Institute for Natural Resource Sciences Gate-N-003- 1, 28 pp.
- Chrysler, M.A., 1930. The origin and development of the vegetation of Sandy Hook, New Jersey. *Torrey Bot. Club Bull.*, 57: 163-176.
- Clements, S. and Mangels, C., 1990. Report on *Amaranthus pumilus* surveys in New York State- 1990. New York Natural Heritage Program, N.Y. State Dept. Environ. Conserv., 10 pp.
- Fomino, R.L. and Oppenheimer, J.R., 1982. Hydrology of the Swamp White Oak Forest at Miller Field, Staten Island. *Environ. Sci. Prog.*, College of Staten Island, NY, iv + 62 pp.
- Friedberg, M.P., 1980. Initial environmental inventory: Gateway National Recreation Area, Floyd Bennett Field. U.S. National Park Service, Denver, CO, 313 pp.
- Gilpin, M.E. and Soul & M.E., 1986. Minimum viable populations: processes of species extinction. In: M.E. Soul & (Editor), *Conservation Biology. The Science of Scarcity and Diversity*. Sinauer Associates, Sunderland, MA, pp. 19-34.
- Gleason, H.A. and Cronquist, A.W., 1991. *Manual of the vascular plants of northeastern United States and adjacent Canada*. Van Nostrand, Boston, 910 pp.
- Kellert, S. R. and Wilson, E.O., 1993. *The Biophilia Hypothesis*. Island Press, 484 pp.
- Link, D.A., 1981. Historic structure report, archaeological data section, Fort Tilden, Gateway National Recreation Area. Denver Service Center, Branch of Historic Preservation, Mid-Atlantic/North Atlantic Team, Natl. Park Serv., U.S. Dept. of the Interior, Denver, CO, 19 pp.
- McKenian, M.R., 1968. An ecological exploration of the flora and fauna in Sandy Hook Park with implications for outdoor recreation. unpublished Master's thesis, Newark State College, Union, NJ, 138 pp.
- Nordstrom, K.F., Allen J.R. and Psuty, N.P., 1975. Beach dynamics and sediment mobility of Sandy Hook, New Jersey. Reprinted from *Proc. Columbia Univ. on Pollution and Water Resources*, Vol. VIII, Special problems on ocean engineering, Columbia University, NY, Reprints 75-76, 26 pp.
- Preston, F.W., 1948. The commonness and rarity of species. *Ecology*, 29: 254-283.

- Rogers, G.F., Robertson, J.M., Solecki W.D. and Flint, M.K., 1985. Rate of *Myrica pensylvanica* (bayberry) expansion in grassland at Gateway National Recreation Area, New York. *Torrey Bot. Club Bull.*, 112: 74-78.
- Snyder, D.B., 1992. *Special Plants of New Jersey*. Office of Natural Lands Management Division, Parks and Forestry, Dept. Environment/Environmental Protection and Energy, CN 404, Trenton, NJ, 21 pp.
- Stalter, R., 1979. The plant communities of Sandy Hook, New Jersey with emphasis on *Ilex opaca*. *Proc. 2nd Conference on Scientific Research on the National Parks*, 11: 26-50.
- Stalter, R. and Greller, A., 1988. A floristic inventory of the Gateway National Recreation Area, New York-New Jersey. *Rhodora*, 90: 21-25.
- Stalter, R. and Lechthaler, D., 1984. A floristic study of Fort Tilden, New York. Abstract in: *Bull. South Carolina Acad. Sci.*, 46: 126.
- Tanacredi, J.T., 1983. Coastal zone management practices at an urban national park. *Environmental Management*, 7: 143- 150.
- Trust for Public Lands and New York City Audobon Society, 1987. *Buffer the Bay: a survey of Jamaica Bay's unprotected open shoreline and uplands*. Trust for Public Lands, New York, NY, 34 pp.
- Trust for Public Lands and New York City Audobon Society, 1993. *Buffer the Bay Revisited: an updated report on Jamaica Bay's open shoreline and uplands*. Trust for Public Lands, New York, NY, 61 pp.
- United States Department of the Interior/National Park Service, 1979. *General Management Plan, Gateway National Recreation Area, New York/New Jersey*. x + 180 pp.
- United States Department of the Interior/National Park Service, 1989. *Amendment to the General Management Plan: Great Kills Park, Staten Island Unit*. 49 pp.
- United States National Park Service, 1983. *Development concept plan and environmental assessment, Floyd Bennett Field, Gateway National Recreation Area*. U.S. Natl. Park Serv., Denver Service Ctr., Denver, CO, 138 pp.
- Van Schoik, D.R. and Antenen, S., 1993. *Final Report, 1993, Amaranthus pumilus, Long Island, New York*. Manuscript, Long Island Chapter, The Nature Conservancy, 13 pp.
- Venzia, K. and Cook. R.. 1991. *Flora of Gateway National Recreation Area*. USDO-I-NPS Gateway National Recreation Area. Unpublished report, 39 pp.
- Young, S.R., 1992. *New York Rare Plant List*. New York Natural Heritage Prog., 700 Troy-Schenectady Road, Latham, NY 12110, 78 pp.. 1 map.

Zika, P.F., 1990. New York Rare Plant Status List. New York Natural Heritage Prog., 700 Troy-Schenectady Road, Latham, NY 12110, 30 pp.