

# Uses of Wetlands in the Urban Coastal Meadowlands of New Jersey, USA

Erik Kiviat



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**Cover photograph:** A view from Laurel Hill (Snake Hill) looking west-northwest across the sports fields of Laurel Hill County Park to fragments of altered tidal marsh and a large complex of garbage landfills in the distance. This landscape is a geological and anthropogenic palimpsest that is emblematic of the New Jersey Meadowlands and illustrates the wetland, wetland fill, and (beneath the camera) the natural high ground habitats for human activities. Photograph © Erik Kiviat.

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# Uses of Wetlands in the Urban Coastal Meadowlands of New Jersey, USA

Erik Kiviat<sup>1\*</sup>

**Abstract** - How people use the urban–nature interface has not been broadly documented for an urban–industrial coastal region. I performed a qualitative survey and analyzed historic (<1999) and recent human uses of the “Greater Meadowlands” region of New Jersey, ~150 km<sup>2</sup> dominated by wetlands and wetland fill. I categorized 160 uses, of which 131 were reported before 1999, 98 since then, and 69 in both periods. Uses associated with wetlands numbered 104, wetland fill 73, and natural uplands 82. Only 8 uses were dependent on the estuarine (tidal) environment, 11 were dependent on unique local bedrock or soil, and between 42 and 62 were related to expansive vacant areas. The extensive, low-relief landscape, and sparse human presence in unbuilt areas, encourage certain human activities, many informal and some illegal. Formal uses numbered 69 and informal uses 95. The large number of uses encompasses many possible activities at the urban–nature interface, which can serve as a checklist for other studies. Many urbanizing coastal regions share characteristics of the Meadowlands landscape. Understanding human uses of that landscape informs the management of human activities, biodiversity, ecosystem services, and adaptation to sea level rise.

## Introduction

Human culture, behavior, beliefs, attitudes, feelings, and health are substantially influenced by the environment (Lewis 1979, Sutton and Anderson 2010). People have typically centered activities and built cities along coasts, rivers, floodplains, and wetlands, where those environments were available (Bardach 1964, Carter 1988:356, Niering 1979), because wetlands worldwide provide ecosystem services of disproportionately greater value than the proportion of the landscape occupied by wetland (Costanza et al. 2006). However, human life and culture in and around wetlands face a tradeoff between the provident aspects of the wetland environment (abundant water, food, fiber, and soil resources) and the hazards associated with wetlands (floods, impediments to travel, miring hazards, nuisance and vector insects, and water-related diseases) (Kiviat 2014).

The human–wetland relationship may be viewed under the rubric of services. Ecosystem services have been categorized as provisioning, regulating, and cultural services (Haines-Young and Potschin 2018). Provisioning services provide products (food, construction materials, fodder, etc.), regulating services maintain ecological and geosphere–hydrosphere–atmosphere processes, and cultural services offer subjects for research, education, literature, visual arts, and spirituality. Wetland fill (i.e., soil or other solid material placed in wetland to convert wetland to upland) also provides services (e.g., Mathey et al. 2015), but these services have been less studied and seem fewer than wetland services. Wetlands and wetland fill are ecologically and aesthetically different from other habitats and are used differently. Aside from land development, little is known about direct human uses of unbuilt wetland fill, although both filled and unfilled wetlands are extensive in and around many coastal cities.

Wetlands and wetland fill constitute many urban greenspaces. In general, greenspaces within and bordering cities are critical for recreation and the health of urban populations (e.g., Bell et al. 2003, Bolund and Hunhammar 1999, Manuel 2003, Sullivan 2005). Urban greenspaces can be very productive with regard to services and are highly threatened by pollution, dumping, filling, or other alteration, even in protected areas (Zedler and Leach 1998).

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Manuscript Editor: Sophie Parker

The urban–nature interface lies between the built environment and the wild landscape within or at the edge of the city and is the location of many human activities that are unwelcome in the more developed areas (Lynch 1981:216). At the urban–nature interface, people are also potentially exposed to hazards not present in the urban core, including injury and disease associated with water pollution (Palta et al. 2016). The urban–nature interface may contain some of the worst of both urban and natural hazards as well as many of the best resources. Urban–nature interface environments may be extensive and also supportive of much biodiversity (e.g., Kiviat and MacDonald 2004, Parker 2015), and how the areas are used and managed may have large but poorly-recognized environmental impacts.

Human activities and uses of the environment, and the influences of the environment on the people of a region, must be documented and understood in order for conservation and management of the environment to be effective and sustainable. How people interact with the regional and local environment creates a cultural distinctiveness (Eanes et al. 2018). This interaction influences how people use greenspaces in a wetland and fill-dominated, estuarine delta environment, such as is commonplace along the US Eastern Seaboard, how uses are related to the physiographic and biological characteristics of the region, what environmental impacts are engendered, and how use of the landscape will change with sea level rise.

This paper addresses human interactions with the landscape by means of a broad, qualitative survey. I emphasize those direct human uses of the landscape and biological resources that potentially bear relationships to environmental features, rather than activities that are universally present inside buildings without direct dependence on the external environment. I have found no other comprehensive survey of the direct human uses of an extensive urban–nature interface region (see McDonnell et al. 2009). Use of the landscape and its ecosystem services may have direct and indirect negative impacts on the ecosystem (Kronenberg 2014). In order to understand, measure, reduce, and mitigate impacts, it is necessary to enumerate the uses. Sense-of-place has been considered an ecosystem service in which biodiversity plays a key role (Hausmann et al. 2016), and the outdoor activities (or human uses of a landscape) analyzed here are the connector between sense-of-place and place.

## **Study Area**

The Meadowlands of northeastern New Jersey lie 2 km across the Hudson River from New York City. They are a physiographically distinct region of the New York–New Jersey estuarine delta that is sheltered by the surrounding uplands and has a tortuous and constricted connection to the sea (Fig. 1). Portions of the Meadowlands were formerly called Hackensack Meadows, Bergen Meadows, Elizabeth Meadows, Newark Marshes, and Newark Meadows. In this study, “Greater Meadowlands” refers to the area covering ~150 km<sup>2</sup> of wetlands, wetland fill, upland inclusions, and closely bordering natural uplands, both unbuilt and built, associated with the Hackensack River estuary and Newark Bay in Bergen, Hudson, Essex, and Union counties, New Jersey (Fig. 1), although often a smaller region is defined as the Meadowlands. Unlike many urban fringes in which greenspaces are largely centrifugal to the urban core, the greenspace complex of the Meadowlands is mostly centripetal to surrounding conurbations on higher ground. Physiographic and biological conditions of the region were summarized by Kiviat and Macdonald (2004). The region is highly developed for residential, commercial, industrial, and transportation activities after 3 centuries of alteration of hydrology, soils, vegetation, and fauna but continues to support rich urban biodiversity (Hales et al. 2007; Kiviat and MacDonald 2004, 2021). At the same time, the Meadowlands are “... a museum of dereliction, a collection of forgotten artifacts and relics stuck in an earlier time ... These forgotten, abandoned, empty landscapes are rich with cultural value.” (Sendner 2016:113). This analysis of human outdoor activities documents that cultural value.

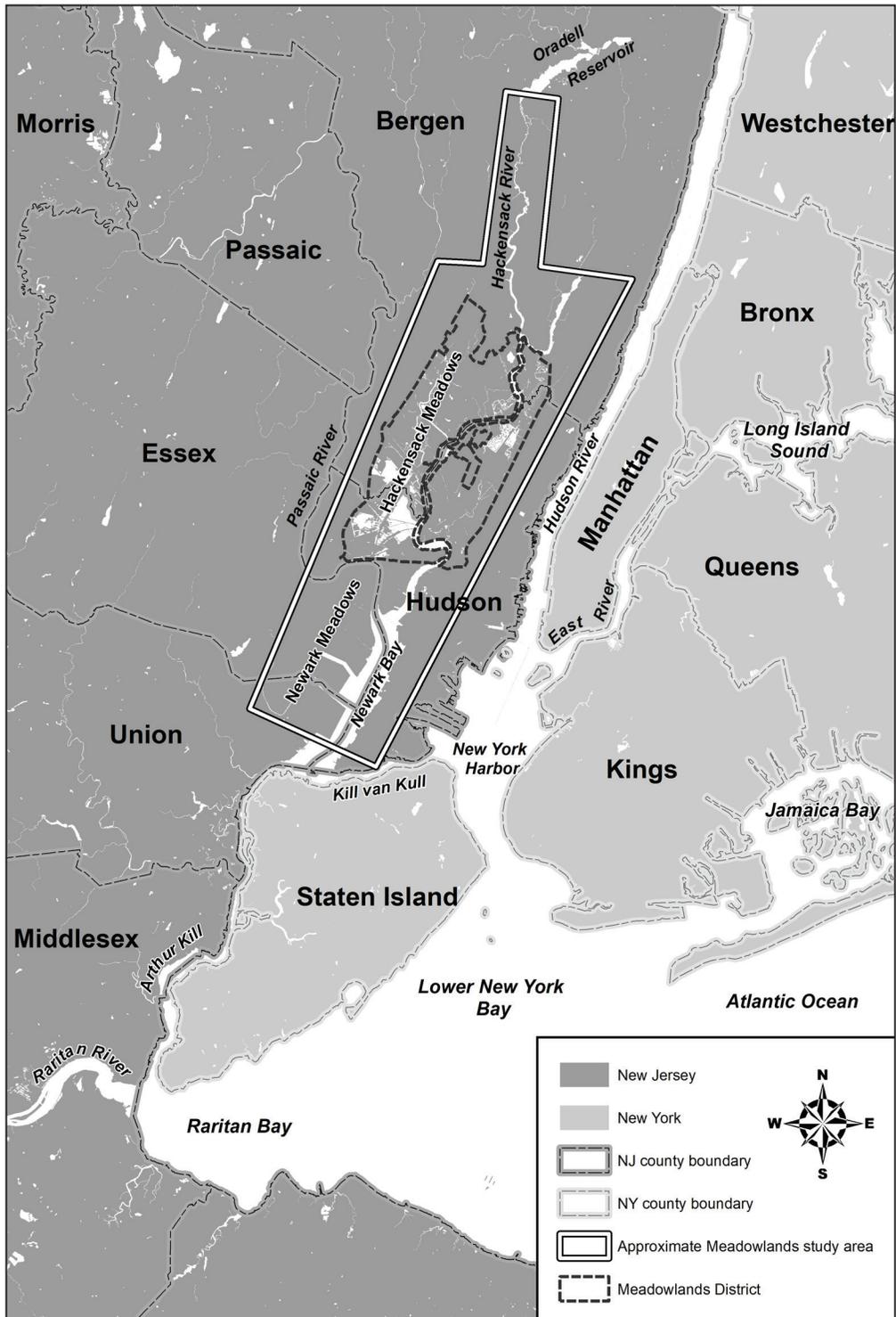


Figure 1. The New York – New Jersey estuarine delta. (Data from NJ bureau of GIS, NJ State Development and Redevelopment Plan, NYS GIS Program Office, and US Geological Survey National Hydrography Dataset.)

## Materials and Methods

I performed a broad survey in the field and literature to capture both rare and common activities in the Meadowlands. Via progressive contextualization (Vayda 1983), I observed the activities present and then analyzed their relationships to the surroundings. This study is a presence survey and may be compared to the compilation of a regional species list, e.g., for birds, based on new observations and extant data. Species lists are incomplete because of temporal change in assemblages and the inability of observers to find all organisms (Palmer et al. 2002). Inconspicuous, taxonomically difficult, rare, or inaccessible species may be missed (Hill et al. 2005:10). Nonetheless, species lists are the first step towards understanding a biota and conducting further research. Lacking a detailed literature on human activities in urban and peri-urban greenspaces, lists of such activities are a useful first step in research. Therefore, I compiled a list of human uses (essentially outdoor activities) in an urban–industrial region with an abundance of unbuilt habitats (Kiviat and MacDonald 2004). Including an area larger than the core of existing and filled wetlands provides context and comparisons for observations in those environments, an opportunity to study the wetland–upland relationships, and the ability to contrast the wet lowlands with the drier and more developed areas.

Analyzing a large collection of anecdotal data, a frequent task in natural history studies, challenges commonly used ecological methodologies. Notwithstanding the potential pitfalls, this type of survey is likely to capture a wide range of human uses and, thus, set the stage for more structured quantitative studies. I identified the types, habitats, time periods, and relative abundances of human uses of the Greater Meadowlands by means of direct observation, photographs, and notes (1999–2019) during ~180 days of biological field work spread widely in space and time. I also extensively reviewed information (formal scientific literature, gray literature, popular literature, news stories, and Web-posted oral history) discovered by means of Google Scholar searches on the keyword “Meadowlands” and retrospective tracing of references in the bibliographies of works such as Quinn (1997) and Sullivan (1998), as well as monitoring local newspapers (e.g., via northjersey.com). Some uses were reported by personnel of government agencies, academic institutions, and non-governmental organizations. I categorized uses as Historic or Recent, Common/Extensive or Scarce/Local, Formal or Informal, and occurring on natural Uplands, Wetland Fill, or Wetlands/Waters. Wetlands/Waters are tidal and nontidal wetlands, the open waters of the Hackensack River estuary, lakes, ponds, and other surface waters. The Historic period was 1665–1998 and the Recent period 1999–2019; Recent was the period of my Meadowlands field work and the time when ecotourism and the Meadowlands environment were promoted as healthy and rewarding by public and private agencies. The much longer Historic period potentially generated more uses but was balanced by my frequent observations and the more abundant literature and media coverage in the Recent period. Nonetheless, comparisons of Historic and Recent numbers should be interpreted cautiously. The great majority of the Historic data are from the 1900s. I categorized uses as Common/Extensive or Scarce/Local subjectively based on the numbers of reports or observations of that activity (akin to abundance ratings often used in species checklists). I also categorized uses as Formal or Informal. Uses are Formal when structured by a company, organization, or agency, whereas Informal uses are originated by the participants individually or in small groups (Chalip et al. 1984, King et al. 2007, Lovelock et al. 2016). I could have classified uses differently (i.e., lumping or splitting them), but the results would only generate a shorter or longer list. Given the variation in classification of uses, use-types, and sources, and the lack of random sampling, my numerical comparisons are hypothetical. Also, uncommon activities, especially if illegal or clandestine, are difficult to detect and document and, thus, may be inconsistently represented or absent in my sample.

## Results

The Appendix (in Supplemental File 1, available online at: <https://eaglehill.us/URNAonline2/suppl-files/urna-173-Kiviat-s1.pdf>) is an annotated checklist of the reported and observed human uses of the Greater Meadowlands. I identified 160 uses that involved direct contact with nature, mostly in unbuilt habitats. Of these uses, 131 were reported historically and 98 recently, including 69 uses that were reported in both periods. The much greater length of the historic period, and the inclusion of reports from various stages of industrialization–urbanization, may account for the larger number of Historic (compared to Recent) uses.

Overall, there were 104 uses of wetlands and waters, 82 uses of natural uplands, and 73 uses of wetland fill. Uses of wetlands were greatest, but uses of natural uplands were surprisingly numerous considering that those habitats constitute relatively small areas of greenspace. Of the 104 wetland/water uses, 42 were not reported from the other habitats. These results are consonant with the general importance of wetland resources to humankind as well as the significance of “dry land” within or adjoining wetlands (Kiviat 2014). Included in the Appendix are a few uses that have occurred mostly or only on the natural uplands at the outer edges of the Meadowlands, such as cemeteries and copper mining. For the Historic period, 96 wetland uses were reported, and, for the Recent period, 60 uses were reported; the smaller number in the Recent period might reflect the extensive filling of wetland post-1900 (Squires 1992). Uses dependent on estuarine resources or unusual environmental conditions were rare (8 and 11 uses, respectively). Between 42 and 62 uses were associated with extensive “vacant” urban-fringe environments with low levels of human activity (this definition is somewhat ambiguous). Informal uses exceeded Formal uses. Eleven uses were restricted to children.

Some of the uses (49 total) in the Appendix involved harvest or collection of products, either wild or agricultural, including energy. Among products, there were 44 historic and 18 recent harvest uses, suggesting a shift away from consumptive uses. Unlike harvests, uses of the Meadowlands for waste disposal or treatment were nearly equal in Historic and Recent periods, with 14 and 11 uses, respectively.

In the Appendix, 69 uses are Formal, 95 are Informal, and 14 are both. The proportions of Formal and Informal uses in each of the 3 habitats (Wetlands/Waters, Wetland Fill, Uplands) seem similar.

## Discussion

For this study of outdoor human activities in a coastal, urban–industrial region, I performed an extensive qualitative survey and classified activities (uses) in several ways. The data (see Appendix) can serve as a checklist of uses that could occur in other urban–nature interface areas as well as rural areas. There has been a large variety of human activities in the Meadowlands, and perhaps most possible activities have been tried. A corollary is that “... all human landscape has cultural meaning ...”, including urban landscapes (Lewis 1979), from which I infer a very broad range of potential cultural uses. Although the Greater Meadowlands (~150 km<sup>2</sup>) are a single region, they encompass an area similar to the total area of New York City parks (~160 km<sup>2</sup> including water bodies), in which human uses were studied by Campbell et al. (2016).

Human uses of the Meadowlands are linked to the environment and its resources. Abundant waterfowl, furbearers, fish, blue crab, mollusks, and reeds promote harvest (now or formerly). Evapotranspiration associated with the extensive wetland vegetation presumably cools the local environment in summer (see Pokorný 2001; Yokohari et al. 1997, 2001), and the presence of other natural resources (e.g., copper, fossils) supports particular uses.

Urbanization generally causes decreases in the species richness of plants and animals (Aronson et al. 2014, Hamer and McDonnell 2008), but urbanization may result in a larger variety of human activities at the urban–nature interface. Some of these activities may seem ecologically or socially inconsequential. Although an activity (e.g., building a treehouse) may be trivial to society, it may not be trivial to the actors, and whether an activity has ecological consequences (e.g., on biodiversity) depends on where, how, and how much an activity is pursued.

### **Categorization of uses**

An overall tally of the uses (see Appendix), categorized by habitat, shows that more uses have been associated with Wetlands/Waters (104) than Wetland Fill (73) or Uplands (82). (Uses were counted without regard to the Historic or Recent periods. Codes with question marks were counted as though they were definite, and a use that occurred in more than 1 habitat was counted multiple times.) Although Wetland/Water uses predominated, many uses occurred on Fill or Upland (natural high ground). The estuarine delta environment has been exploited for 29 uses. However, only 8 uses were estuarine-dependent, although these are among the most important uses of the Meadowlands historically and include tidal water power, salt hay harvest, and the mollusk and crustacean fisheries. Despite the predominance of wetland uses, the large numbers of uses associated with fill or natural upland indicate the importance of non-wetland to people in a wetland-dominated region, and it is noteworthy that the relatively small areas of natural uplands support many activities. Although the proportions of the 3 habitat categories in the region are unknown, all 3 are widespread and include many areas accessible for public use. I have seen no indication that the areas used for, e.g., recreation are saturated with activity; thus, I believe the comparison of numbers of uses is apt.

Eleven uses were based on unique or unusual local conditions of geology or soils. For example, the concentration of cemeteries overlooking the eastern and western edges of the Meadowlands is associated with well-drained, gravelly soils. Mining copper and clay and collecting minerals and fossils depend on the occurrence of these materials.

Some uses reported as only Recent may also have been Historic and vice versa. Some Historic uses listed occurred entirely or largely before urbanization; examples are collecting turtles for food, duck hunting, tidal water mills, and agriculture. Data quality prevents analysis of the relationship of various uses to the spatiotemporal pattern of urbanization, vegetation, or other processes. Shifts in attitudes toward wetlands during the past 50 years (e.g., from hunting and other utilitarian activities, as well as filling and drainage, to conservation of ecosystems and increased nature recreation) help explain the changing human uses of the Meadowlands.

### **Comparison with other regions**

Activities documented in the Meadowlands are similar to, although more diverse than, those reported from other coastal cities (e.g., Manuel 2003, Palmer and Smardon 1988, Zedler and Leach 1998), although a comprehensive survey of another region has apparently not been published. Use of Meadowlands wetlands is also consonant with worldwide patterns outlined by Kiviat (2014). For example, boating uses the corridors provided by wetland channels and the main river; harvest of food (birds, turtles, fish, crabs) and fiber (logs, salt hay, reeds) uses the high productivity of wetlands. No reported use, nor any tool or equipment, is known to be unique to the Meadowlands, although a few uses may be quantitatively distinct. The intensity and extent of disposal of solid waste, including industrial wastes, with the resulting environmental contamination, rank high on the scale of garbage landfilling and industrial contamination worldwide (e.g., Agron 1980, Cardona-Marek et al. 2007, Ceberio and Kase 2015). The disposal of the corpses of murder victims is also reputed to be more common in the Meadowlands than elsewhere (Sullivan 1998) and is an element in negative public perceptions of the region (Sendner 2016). Some uses that have been

observed in other urban–nature interface regions or other wetlands have not been reported for the Meadowlands, such as ice harvesting, iceboating, peat mining, cross-country skiing, snowball fights, playing hide-and-seek, mazes, and paramilitary drill.

Can the Meadowlands results be extrapolated to other “wetland cities” or estuarine deltas? The process of industrialization and urbanization of an estuarine delta in Scotland (Smout 2012) has parallels to the Meadowlands. While Laurel Hill, a large bedrock eminence in the Meadowlands, was being quarried, a prison, poorhouse, hospital, mental hospital, tuberculosis sanitarium, boys’ camp, cemetery, churches, and asphalt plants were built, used, and removed from the hill and adjoining areas (Facciolla 1981, Hudson Institute of Mineralogy 2019, Longo 2007). These historic uses were much like the hill itself—refuges isolated from society by a wetland moat. In the United Kingdom, the fringes of larger cities had a chaotic array of dumps, warehouses, large stores, abandoned industry, business parks, “gypsy encampments”, golf courses, and fragmented farmland (Shoard 2003), a description reminiscent of much of the Meadowlands. Rock musician Keith Richards (Richards and Fox 2010:25–27) grew up at an estuarine wetland complex ~25 km east-southeast (downriver) of London: “My backyard was the Dartford marshes, a no-man’s-land that stretches 3 miles on either side along the Thames ... Everything unwanted by anyone else had been dumped in Dartford since the late nineteenth century—isolation and smallpox hospitals, leper colonies, gunpowder factories, lunatic asylums ...” The last item in a list of urban fringe elements in Gallent and Shaw (2007), “areas of unkempt rough or derelict land awaiting re-use”, describes a large proportion of the Meadowlands.

## **Recreation**

Sixty-nine of the uses I document may be considered recreation for some or all of the actors (i.e., pleasure, relaxation, or exercise activities). At least some of the recreationists using the Meadowlands today seem to recognize the opportunities for close-up aesthetic and intellectual learning from nature, as posited by Manuel (2003) about small urban wetlands in Nova Scotia where residents had impressions of the wetlands that were much more positive than negative. I expect such outdoor or nature recreation to continue increasing in the Meadowlands and perhaps in many other coastal US cities.

The human uses of specific urban and peri-urban parks may be the closest analog to my study of the Meadowlands. The influence of park environment on park use has been analyzed (e.g., McCormack et al. 2014) on a local scale rather than the regional physiographic scale used here. The social functions of parks and their role in coastal resilience have recently been studied in New York City (Campbell et al. 2016). Recreationists in Christchurch and Auckland, New Zealand, used the Styx River corridor (Griffin 1975:87) comparably to use of the Meadowlands, with differences probably due to a less polluted, less industrialized environment and less “refuge” for clandestine or criminal activities in New Zealand.

My secondary data and original observations are not detailed enough to assess the associations of uses with age, gender, social class, or ethnicity of the actors. However, it is my impression that the great majority of uses reported were male activities, that all ages were involved, and that participation by working class males predominated in historic reports, but recent observations included more gender and socioeconomic diversity.

Kesebir and Kesebir (2017) found that the occurrence of nature themes decreased almost monotonically from the 1950s through the 2010s in fiction, song lyrics, and films, with possibly a small increase during the last decade of their data. Based on numbers of park visits, hunting and fishing licenses sold, and camping and hiking activities, nature recreation declined substantially in the United States from the 1980s to the early 2000s (Pergams and Zaradic 2008). However, birdwatching has increased (Cooper et al. 2015) as has use of both state and national parks (Smith

et al. 2019) and nature-based tourism in general (Winter et al. 2019). During the period of my study (1999–2019), outdoor activities burgeoned in the Meadowlands, apparently due to amelioration of the visual, olfactory, and psychological environment and the promotion of ecotourism by government agencies and environmental groups.

### **Vacant lands**

Despite the urban–industrial character of the Meadowlands, the region has been portrayed as “wilderness” in contradistinction to neighboring urban cores (Fast 1958; Hendry 2017; Sendner 2016; Sullivan 1998, 2013). Wetlands often remain wild within an urban matrix (Smardon 1988) and provide users with an experience of wildness otherwise scarce in the city. The scattered individual trees and savanna-like groves of the Meadowlands and many other urban fringes may appeal to people because of our biocultural heritage (e.g., Lohr 2007).

The mostly flat Meadowlands terrain and extensive open spaces with few trees or buildings are conducive to certain uses (e.g., athletic fields, flying model airplanes, *plein air* painting). Rivers, floodplains, and estuaries in 14 cities of Europe and the United States demonstrate the association of both developed and greenspace uses with expansive, flat landscapes and water (Mann 1973) similar to those of the Meadowlands. “Vacant” urban lands with little human presence, typical of most of the wetlands and fill areas, also encourage informal and illicit activities because of reduced risk of detection (e.g., Ceberio and Kase 2015:26).

Problems in governmental administration of urban fringe areas have been described for other countries (e.g., Adesina 2008). Fisher (2015) described, from fiction and historical data, how working-class people used the rural–urban fringes of Chicago and other cities of the Upper Midwest; activities mentioned included many listed here for the Meadowlands. In Sweden, Qvistrom (2007) described elements of the urban fringe as a “disordered” place of ruins, abandoned buildings, squatter huts, temporary gardens, informal playgrounds, places for exploration or prohibited activities, waste dumping, stepping stone places for flora, and shrubland habitats for wildlife. Gouverneur (2016), describing “informal” settlements, said “... land as close as possible to the benefits of the formal city but [in] less desirable locations on the urban fringe... vacant, undesirable land that lacks basic services and that is often vulnerable to such natural disasters as ... flooding ... or such human-made environmental damage as landfills, sewer discharges, or industrial emissions.”

### **Behavior in the urban fringe**

The Meadowlands constitute the fringes of the surrounding cities, including Newark, Jersey City, Secaucus, Carlstadt, and Hackensack, and are also part of the ecological fringe of New York City. Many human uses are fringe activities in the sense of requiring large open spaces or places without formal surveillance as well as often being at the social “fringe” with illegal activities or those perceived as undesirable in residential areas. Fringe areas, including floodplains, woodlands, and waste grounds, are areas of “low control” where people pursue activities outside the mainstream of urban society or which have persisted from earlier times, and where children can play without adult supervision (Bell et al. 2003, Lynch 1981:216–217). Bernard C. Patten’s (University of Georgia, Athens, GA, pers. comm. 12 August 2017) childhood characterization of the Meadowlands greenspaces as the “Weeds” suggests the association with wildness and lack of control. The extensive, undeveloped, low-lying or wet areas, many with dense vegetation and some flooded or with soft soils, near human population centers make law enforcement difficult and invite illegal waste dumping and other disposal. Fragmentation of the environment by transportation corridors, derelict lots, and natural or artificial waterways created isolated unbuilt areas where informal or illegal uses potentially flourish.

Even the existence of under-used spaces can create a perception of crime and danger (Page 1997), and the outdoors itself may be considered dangerous in urban areas (Lovelock et al. 2016). The use of the Meadowlands for waste disposal, crime, and similar activities may still keep many people from using the environment for legitimate purposes, and, thus, possibly provide a refuge for biodiversity from direct human disturbance. Inveterate birdwatcher Robert D. Lamberton (Washington University, St. Louis, MO, pers. comm. 29 December 2007) said of an earlier time in the Meadowlands, "... there was so much trash around, and general sense that these out-of-the-way places were really reserved for activities one would do better not to intrude on". This negative image is less so today than it was a few decades ago because of the cessation of large scale garbage dumping, increased commercial and residential development, a larger human population, and the promotion of ecotourism.

Certain uses can create hazards for other users. Palta et al. (2016) analyzed use of a river and wetlands by homeless people in Phoenix, Arizona, and identified concerns about exposure to pathogens and legal persecution. Human users of the urban–nature interface are also exposed to contaminants and their potential health effects (see maps of contaminant distribution in New Jersey in Ihde et al. 2014). User activities can also affect how other people perceive the environment; Bell et al. (2003) in Scotland documented use of urban fringe woodlands by children and adolescents and the concerns expressed about those activities by land managers and other adults.

### **Impacts and implications**

Research on rural–urban fringe landscapes in diverse regions has addressed urbanization processes, changes in patch composition, interactions between residential and agricultural areas or between urban and suburban zones, greenspace and biodiversity conservation, the role of woodlands in child and adolescent development, and preference for visual landscape elements (Bell et al. 2003, Crossman et al. 2007, Fujihara et al. 2005, López et al. 2001, Malaque and Yokohari 2007, Sullivan 1994, Sullivan et al. 2004, Vaughan et al. 2015). These authors refer to the urban fringe as undergoing rapid land-use change and being the subject of insufficient research. Although the typical process of change at the urban fringe involves conversion of agricultural landscapes to urban ones, the Meadowlands changed from agricultural to waste disposal and industrial to urban (or from agriculture to transportation, in the case of Teterboro Airport), and the development of "vacant" wetland fill and wetlands continues. Many Asian "mega-cities" developed from agricultural land use on deltas (Hara et al. 2005), akin to the New York City metropolitan region including the Meadowlands.

Researchers, including biologists and archaeologists, may use my results to construct hypotheses for testing in other urban areas, depending on the environment. Planners and nature managers should understand that certain uses (e.g., athletic field expansion, fires set by vandals, dumping, wetland mitigation) have environmental impacts, whereas birdwatching and other nature study increase the sense-of-place and stewardship involvement of the actors. Human uses of the urban–nature interface can have adverse, neutral, or beneficial effects on biodiversity (Farmer and Allen 2018, Kronenberg 2014). Negative impacts on nature are often overlooked in the urban environment because many actors and decision-makers do not recognize the value of urban habitats to uncommon and rare species.

Better understanding of how people use urban–nature interface environments, especially those with extensive wetlands and wetland fill, is relevant to the siting and design of buildings, transportation and other infrastructure, recreation facilities, stormwater management, community gardens, wetland mitigation, and biodiversity conservation. In general, the types and diversity of uses of the Meadowlands are similar to those in urban wetland complexes and urban–nature interface areas elsewhere (see, e.g., Kiviat 2009 about East Coast freshwater tidal wetlands).

These environments also are habitat for biodiversity, including many rare native species (Hales et al. 2007, Kiviat and MacDonald 2004).

This analysis of the human uses (reified ecosystem services) supported by the Meadowlands suggests 2 planning concepts: (1) The services currently provided by the Meadowlands, mostly regulating services and cultural services as well as biodiversity support, should be fostered because of their great value to urban society, and (2) urbanizing regions should not be allowed to undergo the environmental degradation that has afflicted the Meadowlands. Urbanization, with the urban sprawl that constitutes both development and dereliction, is a major threat to biodiversity, and conservationists need to pay more attention to managing habitats at the urban fringe (Miller and Hobbs 2002). Coastal regions of the United States are urbanizing faster than the rest of the country, resulting in extensive wetland loss, a greater need for ecological restoration, and different ecological and social conditions for restoration (Ehrenfeld 2000). Undeveloped areas of the Meadowlands are a *de facto* commons for people and biodiversity that is being progressively privatized as it is developed. Daily (1997) advised of the need to identify ecosystem services at various scales so they can be conserved; my analysis of human uses of the Meadowlands indicates the presence of cultural and provisioning services that generally are poorly understood at a medium to large scale in urban regions.

Understanding how people use the outdoor environment also facilitates adaptation to sea level rise and coastal flooding, both prominent in the Meadowlands. Climate change effects on people are mediated through human uses of the local environment. Barnett et al. (2014), studying Lakes Entrance, a barrier beach and estuary region of Australia, characterized the landscape attributes important to the local human community that they wished to preserve via adaptation to climate change, including scenery, a feeling of safety, the “natural environment”, peacefulness, proximity of water, and recreational opportunities. These attributes appear relevant to how people value the Meadowlands environment and, as in Lakes Entrance, can be used to negotiate adaptation to sea level rise, strengthening storms, and increasing surges.

My compilation of human uses of an urban–industrial deltaic region indicates a very broad range of outdoor, formal and informal, activities. This compilation can serve as a checklist for further research. A few lines of inquiry can include the social, economic, and ethnic composition of the actors; the origins and adaptations of the activities; the modes of transmission of skills and interests; the emics (thoughts, feelings, attitudes) of the actors; and the specific environmental features that facilitate various activities and the effects of those activities on the environment. Beliefs and legends associated with urban-fringe wetlands, wetland fill, and uplands would also be worth investigating, such as the legend of the snakes of Snake Hill (Laurel Hill) and the beliefs of the stakeholder groups (e.g., regulators, researchers, practitioners, birdwatchers) involved with wetland restoration or mitigation projects and sites.

### **Acknowledgments**

Many colleagues, student assistants, volunteers, and organizations helped with field work, ideas, or information. Gabrielle Bennett-Meany, A. Brett Bragin, Lindsay K. Campbell, Kristi MacDonald, Stephen Marshall, Bernard C. Patten, and Julianna Zdunich commented on drafts. Lea Stickle assisted with editing. Kristen Bell Travis drafted Figure 1, which was revised by Lauren Bell and Lea Stickle. Meadowlands biodiversity research was supported by: Geraldine R. Dodge Foundation, Meadowlands Environmental Research Institute, Metropolitan Conservation Alliance, Geoffrey C. Hughes Foundation, Hudson River Foundation, Emma Barnsley Foundation, New Jersey Department of Environmental Protection, Conserve Wildlife Foundation New Jersey, the Bay and Paul Foundations, and individual donors. This paper is a Hudsonia–Bard College Field Station contribution.

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