HUDSONIA
a nonprofit institute

PO Box 5000, Annandale, NY 12504
Phone: (845) 758-7053
www.hudsonia.org

Biodiversity Assessment and Biological Surveys of the Future Parkland Site, Village of Highland Falls, Orange County, New York

by **Erik Kiviat** PhD, **Christopher Graham** MS, and **Lea Stickle** BS

Hudsonia

Report to the Village of Highland Falls and Scenic Hudson

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Introduction

At the request of the Village of Highland Falls and Scenic Hudson, Hudsonia conducted a preliminary biodiversity assessment and biological surveys of the Future Parkland in the Village of Highland Falls, NY. The purpose of this assessment is to analyze the habitats and biodiversity of the site and recommend conservation measures consistent with future recreation use of the property. Hudsonia is a nonprofit institute for research and education in the environmental sciences. We do not take advocacy positions for or against land use development or park planning proposals; rather, we make observations, collect data, review existing information and relevant documents, assess potential impacts of proposed land use on wildlife, plants, and their habitats, and make recommendations for avoidance and reduction of impacts.

Biological diversity, or biodiversity, is the variety of life in nature, ranging from genes through species and up to landscapes and regions. Most ecosystem services (the work of nature that supports human life and quality of life) depend on biodiversity, and in turn, biodiversity support is an ecosystem service. The general approach of Hudsonia's biodiversity assessments was presented by Kiviat and Stevens (2001).

Study area

The study site consists of 31 acres (ac) owned by Scenic Hudson in the Village of Highland Falls, Orange County. It is a long and narrow (from ca. 70 to 230 m wide east to west) tract, oriented north-south along the Hudson River, and separated from the river only by the West Shore Railroad. It is bounded by Havens Road to the north and by commercial and residential development off Main Street (Regina Road, Ondaora Parkway, and other local streets) to the west; in the northwest, there is a boundary cut-out around Peregrine Hall, a historic house that now contains apartments. South of the property is undeveloped land under conservation easements held by the Scenic Hudson Land Trust and the Hudson Highlands Land Trust. The terrain slopes broadly down from west to east, sometimes steeply, to bluffs and cliffs overlooking the railroad tracks and river, and the slopes are broken by numerous flat areas and low, rocky ridges.

A narrow rocky ridge (the "railroad sliver"), approximately 800 feet long and 3-13 feet high borders the east side of the railroad in the northern portion of the site. Very steep, artificial talus-covered slopes (rock rubble dumps) separate the mostly level, younger forests around Peregrine Hall from the rest of the site, giving most of the land an isolated feeling. This "talus" comprises boulder-size and smaller rocks (some with drill holes) and debris, evidently dumped down the slope, perhaps originating from highway or other construction many years ago. There is also refuse that has been dumped among the rocks and elsewhere at the western and northern edges of the site. Dry, rocky, exposed areas are often fire-prone, and past fires are indicated by charred wood (Kiviat 2001); we saw charred wood in two places on the Future Parkland site in circumstances indicating the source was not campfires.

The site is underlain by bedrock described as "Garnet-bearing gneiss and interlayered quartzite; contains varying amounts of biotite, garnet, sillimanite; minor marble, amphibolite, rusty

paragneiss" (Fisher et al. 1970). The marble, if present, could contribute calcium to the Future Parkland soils, and amphibolite and possibly paragneiss could also be sources of calcium. Soil calcium may facilitate the local presence of calcicolous plants such as the herb-Robert, hackberry, and basswood that we found onsite. We do not know the source of the rock rubble dumped into the western edge of the site but the material, along with glacial drift from other rock formations, likely adds more geochemical diversity. Bedrock geology west of the site is complex.

Surficial geology of the site is glacial till (Cadwell 1989). The soils of the site are mapped as Hollis gravelly loam and Hollis – rock outcrop complex. The Hollis soil is described as "Shallow Dry Till Uplands" (U.S. Department of Agriculture Web Soil Survey https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx).

The Hudson Valley Natural Resource Mapper (https://gisservices.dec.ny.gov/gis/hvnrm/) shows state-regulated wetland mapped at East Gable, the point projecting into the Hudson River east of the railroad off the southeastern corner of the Future Parkland. The Mapper also shows a small "Freshwater Forested/Shrub Wetland" at the southwestern corner of the site, and an extensive "State Regulated Wetland Checkzone" that may contain additional wetlands across the southern end of the site. Portions of the site are mapped as "Known Important Areas for Rare Aquatic Animals," "Known Important Areas for Rare Plants," "Known Important Areas for Rare Terrestrial Animals," "Important Bat Foraging Areas," and "Significant Biodiversity Areas in the Hudson River Valley" (https://gisservices.dec.ny.gov/gis/hvnrm/). Most of these designations likely pertain to the estuary itself, although Bat Foraging Areas and Rare Terrestrial Animals may be pertinent to the Future Parkland. It is also worth considering that the Hudson Highlands overall are considered important for biodiversity, and this is reflected in the Significant Biodiversity Area.

Methods

We used the methods of Kiviat and Stevens (2001) to map habitats (communities) on the site. First we used aerial orthophoto imagery (2021, 2017, 2014), topographic maps, geology and soils maps, and wetland maps to create a map of predicted habitats. We then used this preliminary map during field work to verify and correct habitat (community) boundaries while describing the flora, vegetation, and other habitat characteristics. We intentionally omitted from our study the "river sliver" of the Future Parkland site that falls in the Hudson River estuary just east of the railroad (east of the railroad sliver), because this habitat supports an entirely different assemblage of animals and plants than the rest of the site, and has a different management and conservation framework than the mainland areas. We did, however, survey the railroad sliver, which is a small area of upland habitat between the river and the railroad (Figure 1).

We recorded all identifiable plant species observed, stratified by community, and ranked abundance for each species as abundant, common, occasional, or rare (Appendix 1). A clumped or patchy distribution was denoted by a p in the species abundance, as in Cp (common-patchy). Plants that we could not identify in the field were photographed or collected for laboratory identification. A few specimens of interesting or challenging species will be deposited in the

Bard College Field Station – Hudsonia Herbarium. Tree diameters (diameters-at-breast-height, dbh) were estimated using a Biltmore stick or by eye. GPS coordinates were recorded for habitat mapping purposes and at locations of particular interest.

Graham conducted a morning bird survey on 28 June. Kiviat and Stickle surveyed butterflies and moths in June and September. Kiviat conducted a bird and herpetofauna (amphibians and reptiles) survey on 22 October during warm weather following September and October rains. All three authors noted birds and butterflies opportunistically during all field work. Amphibians and reptiles were also searched for during all field work, visually, acoustically, and by turning rocks and logs under which animals often hide. Graham visited the site on 24 and 28 June, 30 July, and 24 August 2022; Kiviat on 14, 24 and 29 June, and 14 September 2022; and Stickle on 29 June and 14 September 2022. We avoided most field work during the intense summer drought.

We recorded butterflies on all site visits, and conducted moth surveys on the evenings of 29 June and 14 September. Butterflies were observed with binoculars and naked eye; one species (harvester) was netted for identification and released. Our nighttime moth surveys used two techniques: ultraviolet light in "night collecting tents," and sugaring. Sugaring comprises painting on small areas of tree or log bark or rocks a mixture of beer, molasses, brown sugar, and overripe fruit. The tents were manufactured by Bugdorm (item BT3001; https://shop.bugdorm.com/), with UV light provided by the Bioquip #2805 DC night collecting light powered by the Power PS Sonic 12V battery PS12140 F2. Many species of moths are attracted to the UV light and land on the white fabric of the tent where they are visible. The evening-nighttime surveys began before dusk and extended for at least two hours after dark at two locations, one in the disturbed hardwood forest north of Peregrine Hall, and the other in the northern pine barrens (Figure 2). Most of the moths we observed came to the UV lights in the tents.

We photographed live moths in the field without handling them, and identified them using the Beadle and Leckie (2012) field guide, iNaturalist (https://www.inaturalist.org/), Moth Photographers' Group (https://mothphotographersgroup.msstate.edu/), Mass Moths (https://massmoths.org/), and BAMONA (https://www.butterfliesandmoths.org/). We posted photos of selected species on iNaturalist for identification or verification, and consulted moth expert Dylan Cipkowski for identification or verification of most of the species we found. These nocturnal surveys were supplemented by observations of a few species either flying by day to visit flowers (e.g., basswood), or flushed from ground layer vegetation as we walked around the site. Abigail Higgins assisted Stickle and Kiviat in the moth surveys. The moths are a species-rich group, only about half of the northeastern species are shown in Beadle and Leckie (*ibid*.), and some of our species await identification or are unidentifiable from photographs. Some photographs were indeterminable, especially for small species, because of photo quality or the inability to examine certain diagnostic characters that are not visible in life (e.g., hind wing patterns). Little information is available about moth rarity. The list of moths in Appendix 2 includes the "Common" and "Uncommon" categories of Beadle and Leckie (2012) that pertain to the entire northeastern region.

We did not conduct surveys for mammals, fishes, or invertebrates other than butterflies and moths, nor for mosses, liverworts, lichens, or fungi. A few miscellaneous observations on mosses, lichens, and invertebrates are included in this report.

We refer to New York State Department of Environmental Conservation (DEC) rarity ranks (2015a) and New York Natural Heritage Program (NYNHP) ranks (Schlesinger 2017, Young 2021), where appropriate. DEC ranks are, in order of decreasing rarity: Endangered (E), Threatened (T), Special Concern (SC) (animals)/Rare (R) (plants). The DEC also maintains a list of animal Species of Greatest Conservation Need (SGCN), developed for the New York State Wildlife Action Plan (NYSDEC 2015b). Some species on this list are ranked as High Priority SGCN (SGCNHP); these species need conservation actions within the next 10 years or are at risk of extirpation in New York State.

NYNHP ranks are, in order of decreasing rarity: S1 (Critically Imperiled), S2 (Imperiled), S3 (Vulnerable), S4 (apparently secure). For birds, the presence of B in a rank (e.g. S2B) indicates that the rank applies to breeding individuals only, while N references non-breeding individuals (e.g. S3N). In double ranks (e.g. S1S2, S2S3), the first rank indicates rarity based upon current documentation. The second rank indicates the probable rarity after all historical records and likely habitat have been checked. We denote regionally rare species with the letters RR, but only when a species is not ranked by the DEC or NYNHP.

Scientific names of plants are in the flora list (this report, Appendix 1). Scientific names follow the New York Flora Atlas (https://newyork.plantatlas.usf.edu/). In order to avoid common names of plants that selectively refer to geographic or ethnic entities (e.g., "Japanese knotweed," "Indian pipes"), we use neutral common names from the compilation in Kiviat and MacDonald (2022:Appendix 1).

Regarding categorization of the risk level to native biodiversity posed by nonnative species, the Lower Hudson Partnership in Regional Invasive Species Management (LHPRISM) posted:

> *The Lower Hudson PRISM's Focal Species Working Group has categorized many of the invasive species found within the PRISM region into 5 Tiers: Tier 1 - threat, Tier 2 - emerging, Tier 3 - established, Tier 4 - widespread, and Tier 5 - watch species. The tier categorization was created as a way to standardize categories throughout New York State. This is a working list and should not be considered a finalized list.* [See https://www.lhprism.org/document/species-categorization-priorities for the lists of species in each Tier.]

We searched several online resources for biological information about the site, and at our request Tom Lake searched the *Hudson River Almanac*. *eBird, iNaturalist, Hudson River Almanac,* and searches of the open Web and of Google Scholar did not yield any local records specifically from the Future Parkland. The *Hudson River Almanac* contains records of a black bear and a timber rattlesnake in the Highland Falls area, and these two species could occur at the Future Parkland. Google Scholar mainly yielded citations to the publications of the late 1800s – early 1900s naturalist Edgar A. Mearns who documented biodiversity in the vicinity of Highland Falls (see discussion of birds, below).

The habitat descriptions below, in addition to summarizing our observations at the Future Parkland, present information about selected species of conservation concern likely to occur in those habitat types although not necessarily found in our current study.

Results

Natural communities and flora

Virtually the entire site was undeveloped and in natural or seminatural habitats. We mapped 18 habitat (community) types, including 12 upland and 6 wetland types. Nearly the entire site was upland, with < 1% (0.1 ac) in wetlands. The site was mostly forested, with 86% percent (27 ac) forest cover (including upland forest, hardwood swamp, and pine barrens), and harlequin maple (*Acer platanoides*) forest was the most extensive habitat at 13 ac (44%) (Figure 1).

Despite its narrow width, the site can be roughly divided into western and eastern sections or "halves." The western half comprised mostly highly disturbed seminatural communities dominated by nonnative species, yet offered considerable habitat value for native plants and animals. The eastern half consisted mostly of less disturbed and more native-dominated plant communities, and was much rockier and drier (Figure 1).

Flora summary

We found 203 taxa (mostly identified to the species level) of vascular plants. Of those, 71% (145 species) are native to New York, and 28% (56 species) are nonnative. Ambiguous taxa, because of unknown native status or incomplete identifications, comprised 1% (2 species) of the flora.

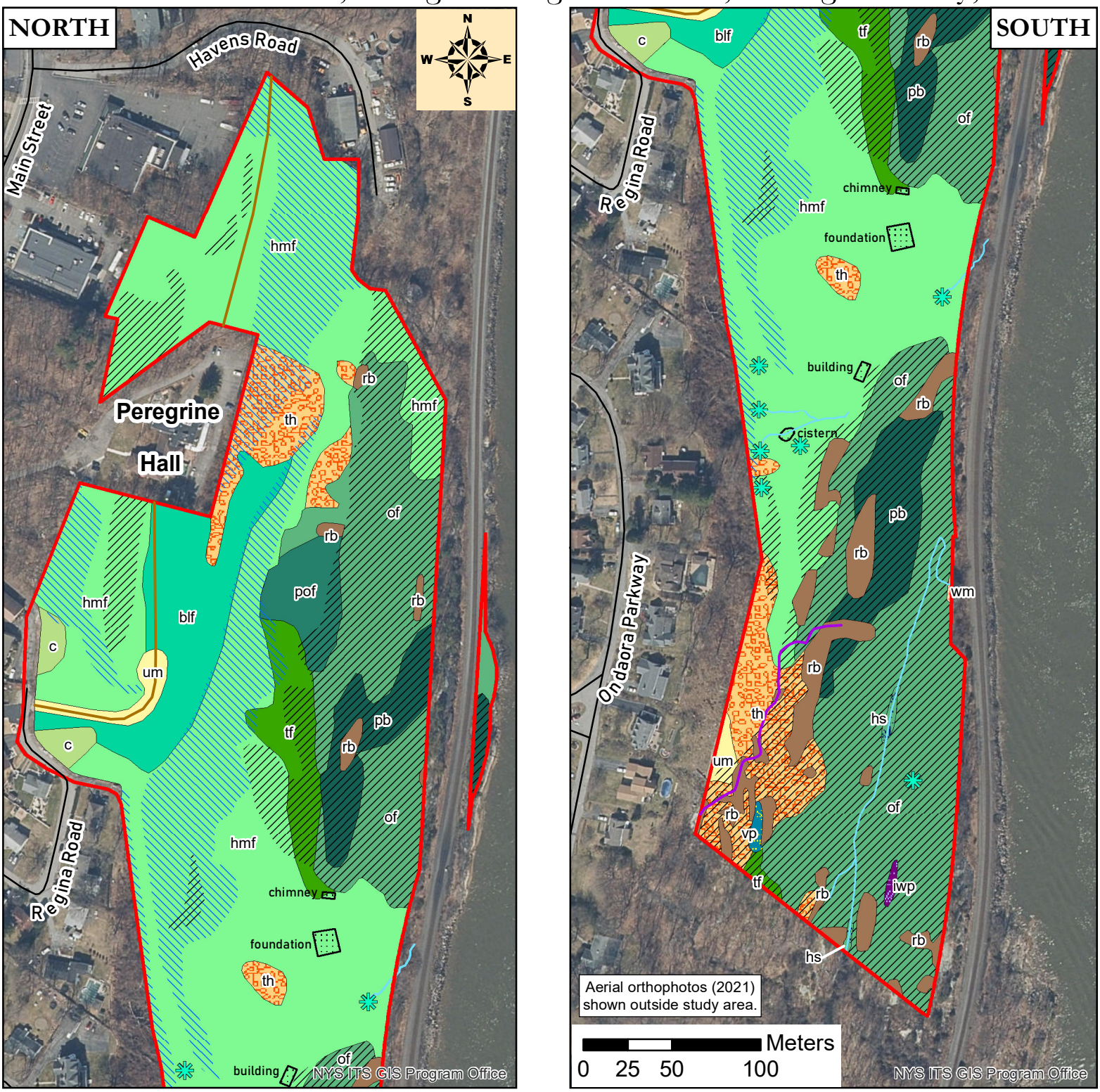
The flora was especially rich in trees—after forbs (broad-leaved herbs), trees were the most species-rich growth form with 45 species observed. Most tree species were native, but a few nonnatives were invasive and prominent on the site. Harlequin maple (native to Europe) was the most abundant tree on the property, dominating the harlequin maple forest canopy. Black locust (native southward in the U.S.) was locally common in that forest and princess-tree locally abundant, and tree-of-heaven occurred here and there. Sycamore maple is a Tier-3 established species in the Lower Hudson PRISM, but is still an uncommon tree in the Hudson Valley as far as we know (see https://www.lhprism.org/species-information regarding the ranking system).

We documented 32 native tree species, of which red oak was the most common. Numerous large (18-48+ in. dbh) specimens of several native tree species (e.g., red oak, chestnut oak, black oak, basswood, sugar maple, white pine) occurred across the property's forests. Single individuals of three regionally rare tree species were encountered: cucumber magnolia (20 in. dbh), sweetgum (3 in.), and butternut (17 in.) The first two species are at or near the northern limit of their native range but are also sometimes cultivated, so it is unknown whether the specimens found are naturally occurring or were planted or spread from plantings. Butternut is regionally rare in part because of the butternut canker, a fungal disease that may have reduced the population of this species. The single butternut observed was next to one of the ruins

Figure 1

Ecologically Significant Habitats

Future Parkland, Village of Highland Falls, Orange County, NY



- Road
- Woods road
- Social trail
- Study area
- Ruins

Upland habitats

- Crest/ledge
- Artificial talus
- Cultural (c)
- Upland meadow (um)
- Thicket (th)
- Black locust forest (blf)
- Harlequin maple forest (hmf)
- Transitional forest (tf)
- Oak forest (of)
- Pine-oak forest (pof)
- Pine barrens (pb)
- Rocky barrens (rb)

Wetland habitats

- Spring
- Stream
- Wet meadow (wm)
- Hardwood & shrub swamp (hs)
- Intermittent woodland pool (iwp)
- Vernal pool (vp)

of the site, so it too may have been planted; nevertheless, it is an important find given the dearth of butternuts in our region. Figure 2 shows the locations of these trees.

Grasses had high cover in the rocky barrens, pine barrens, and oak forest, and true sedges (*Carex*) were common in the harlequin maple forest. Ferns were uncommon at the site, and aside from Appalachian rock polypody and marginal wood fern growing on ledges, only five other fern species were observed, all rare. Forest forbs were also not diverse, with only 50 species observed. Moreover, most of these species were rare on the site. *Spring ephemeral* wildflowers, that bloom in spring before the canopy trees leaf out, were very few. Possibly a combination of competition from garlic-mustard and shrubs, excessive deer herbivory, and the probably acidic soils of the oak forests and pine barrens is responsible for this low diversity. Besides the trees mentioned above, we encountered a few other species that we consider regionally rare: fern-leaved false foxglove (a single plant), sweet goldenrod, and downy arrowwood (a few small copses) (Figure 2).

Mosses and lichens covered large areas of exposed rock in the rocky barrens, pine barrens, and oak forest. While identifying these was beyond the scope of our work, we observed large areas of pincushion moss (*Leucobryum*), haircap moss (*Polytrichum*), and reindeer lichens (*Cladonia*), as well as many others. All of these are vulnerable to trampling by recreationists, and the *Cladonia* lichens, which are brittle when dry, are especially easy to destroy. We therefore mapped several *Cladonia* concentration areas, locations of large patches, that should be avoided by trails (Figure 2).

Invasive plants were abundant on the property, especially in the thicket, upland meadow, harlequin maple forest, and black locust forest communities, mostly of the western half of the property. Most of the invasive plants were of the Lower Hudson PRISM Tier 3 and 4 categories, both of which contain species that are so widespread and abundant in the Lower Hudson region as to be beyond control except at very small scale. These included (Tier 4) harlequin maple, tree-of-heaven, black locust, multiflora rose, wineberry, Thunberg barberry, winged euonymus, round-leaved bittersweet, stiltgrass, mugwort, and garlic-mustard; and (Tier 3) sycamore maple, angelica tree, black swallowwort, autumn clematis, and porcelain-berry. At least three species found on the property are classified as Tier 5 Watch species: false-indigo, mimosa, and common periwinkle.

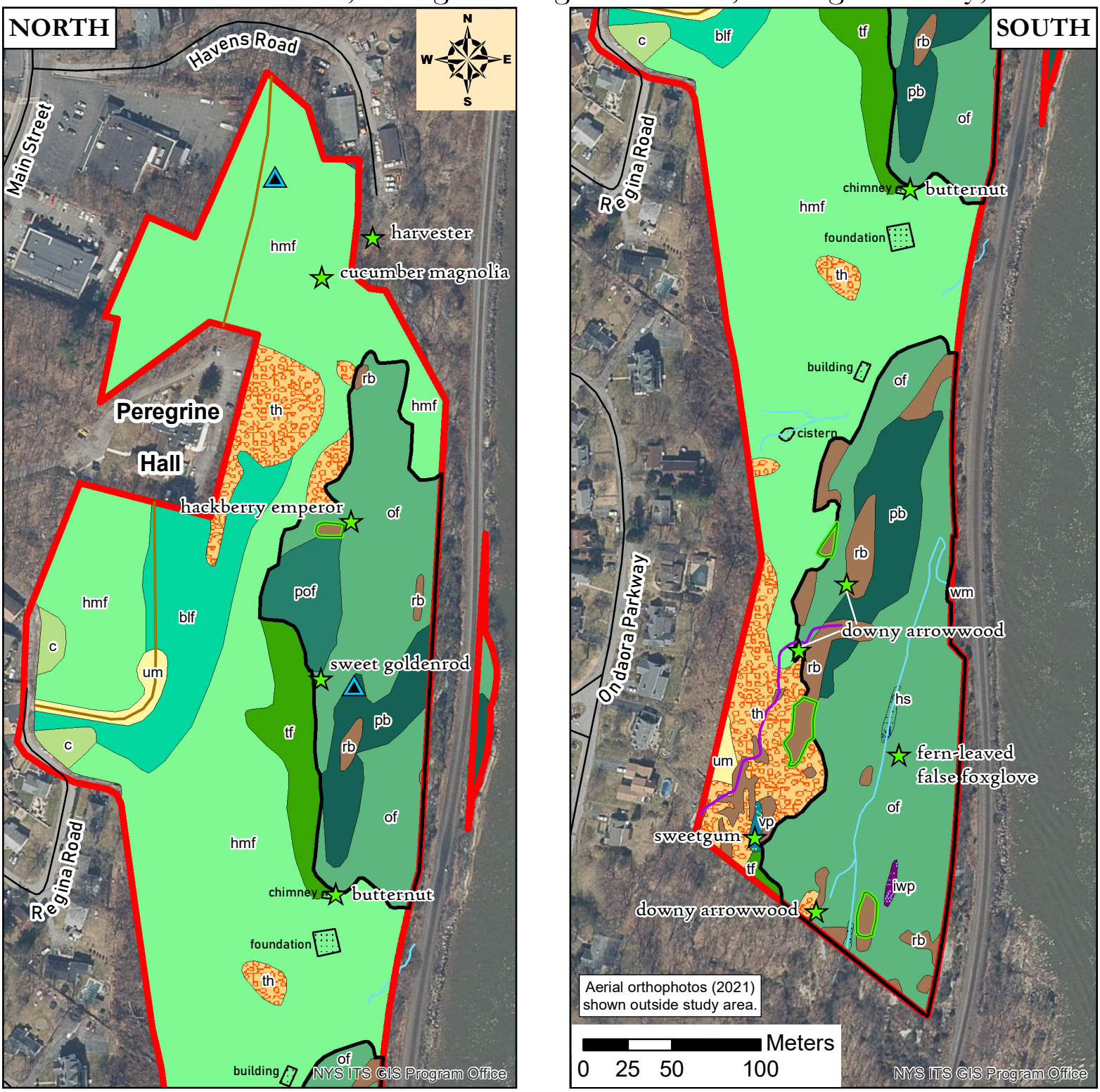
Upland habitats

Crest/ledge and artificial talus

This is a rocky site, with 18 ac (58%) mapped as either naturally occurring crest and ledge or artificial talus. In general, crest and ledge habitats occur where soils are very shallow and bedrock is partially exposed at the ground surface, typically either at the summit or shoulder of a hill or knoll (crest), or elsewhere (ledge). Rocky crests, boulders, slabs, and cliffs up to 20 feet high (though usually lower) characterize the eastern part of the site, an area of 13 ac in total. These were often unvegetated, but sometimes supported sparse vegetation such as Appalachian

Figure 2 Species and Habitats of Conservation Concern

Future Parkland, Village of Highland Falls, Orange County, NY



- Road
- Woods road
- Social trail
- Study area
- Ruins
- Moth tent
- Species of concern
- Lichen concentration

Upland habitats

- Oak-pine habitat complex
- Cultural (c)
- Upland meadow (um)
- Thicket (th)
- Black locust forest (blf)
- Harlequin maple forest (hmf)
- Transitional forest (tf)
- Oak forest (of)
- Pine-oak forest (pof)
- Pine barrens (pb)
- Rocky barrens (rb)

Wetland habitats

- Stream
- Wet meadow (wm)
- Hardwood & shrub swamp (hs)
- Intermittent woodland pool (iwp)
- Vernal pool (vp)

rock polypody, marginal wood fern, and deertongue grass. Level or nearly level ledge with little to no canopy cover was mapped as rocky barrens. There are many ledges and small cliffs (road cuts, essentially) bordering the railroad; probably some are on the Future Parkland and some on the railroad (ConRail) ownership.

Artificial talus (5 ac) occurs on the band of very steep slopes separating Peregrine Hall and the "upper" areas from the rest of the property, and consists of materials dumped down the slopes historically: small to large boulders, cobbles, gravel scree, bricks, and chunks of concrete and asphalt. This area likely has some of the same wildlife habitat values as naturally occurring talus despite the composition of artificial materials. For example, the cave cricket and five-lined skink we found onsite could use this habitat for refuge.

Cultural
Cultural habitats are areas that are significantly altered and intensively managed (e.g., regularly mowed) but not otherwise developed with pavement or structures. There were two small lawn areas, evidently maintained by neighbors, on the western edge of the property.

Upland meadow
We mapped two small meadow areas on the property. One was just a wide woods road (sewer line right-of-way?) that had grown in with lush mugwort, south of Peregrine Hall. The other small meadow, along the southwestern edge, was also dominated by mugwort, with autumn clematis common, porcelain-berry occasional, and a few common milkweed mixed in.

Thicket
Most of these areas were dominated by dense tangles of lianas (woody vines). In the southwestern thicket, the largest at nearly 1 ac, autumn clematis and catbrier were abundant, forming dense tangled mats ranging from ground-level to shrub-level (3-10 feet). Poison-ivy (locally abundant), multiflora rose (common), and Virginia creeper (locally common) also contributed to these mats. Saplings and pole-size young trees (i.e., < 12 inches dbh; northern catalpa, harlequin maple, tree-of-heaven, black cherry, white and red oaks) were scattered about. Mugwort was abundant, and there were patches of reed canary-grass, wood nettle, and rough goldenrod.

The large thicket next to Peregrine Hall was an exuberant mass of summer grape, with occasional autumn clematis, round-leaved bittersweet, and young tree-of-heaven. A small, steep gash in the forest, mapped as thicket along the western edge of the site, was evidently created by an upslope landowner's cutting large trees (on the Future Parkland property) to create a view, and was filling in with shrubs and vines.

Black locust forest
This small (1.7-ac) forest south of Peregrine Hall was very young, with abundant, small, closely spaced black locust. Maximum locust size was circa 6 in. dbh. Other trees included harlequin maple, eastern cottonwood, black cherry, and eastern sycamore. Multiflora rose and wineberry were common in the understory.

*Harlequin maple (*Acer platanoides*) forest*
This habitat, the most extensive on site, covered most of the western half of the site and extended all the way to the eastern boundary in two locations. Harlequin maple was abundant and dominant in this mature forest, commonly reaching diameters at breast height (dbh) of 15 inches (in.), and occasionally of 24 in. or more. Many of the largest harlequin maple occurred in the eastern section of forest that separates the two oak forest complexes. In this moist section of forest, black locust also attained great diameters (up to 30 in.), spicebush formed an understory thicket, and stinging nettles carpeted the ground. A large, dense thicket of knotweed occurred next to the railroad here. Impressively large harlequin maples were scattered around the site, as well as an occasional American basswood, sugar maple, or oak of 25-48 in. dbh. Basswood, sugar maple, red oak, black cherry, black locust, and tree-of-heaven were occasional, and summer grape festooned the canopy here and there. Princess-tree, an invasive near the northern limit of its range, was locally abundant in an area along the central-western edge of the site, reaching 24 in. dbh. We found one individual each of two regionally rare trees: butternut (17 in.) and cucumber magnolia (20 in.). Sycamore maple, an uncommon non-native tree, was scattered about, probably remaining and reproducing from historical landscaping around several former buildings; mock-orange (*Philadelphus* sp.), wych elm saplings, and an as yet unidentified shrub likely had the same provenance.

Multiflora rose and wineberry were common throughout, sometimes forming small thickets along with summer grape and round-leaved bittersweet. Spicebush was locally abundant. Thunberg barberry was occasional, and catbriar formed small to large ground-level tangles.

Herbaceous plant diversity was low. Garlic-mustard was common to abundant, and two sedges (Swan's sedge, common woodland sedge) were common. The nonnative woodland bluegrass was locally abundant north of Peregrine Hall. Other species were occasional—including stiltgrass, several other sedges, black swallowwort, white wood aster, white snakeroot, nipplewort, false Solomon's seal, Jack-in-the-pulpit, jumpseed, enchanter's-nightshade, northern dewberry, and knotweed—or rare. Ferns were quite rare. We found no horsetails or clubmosses, which are generally urban-sensitive and rare in post-industrial areas (Kiviat and MacDonald 2022). Course woody debris (decaying fallen logs and branches) was common, and large snags, i.e. standing dead trees, occasional. Woody debris provides important microhabitats for many small animals, mosses, lichens, and fungi.

Transitional forest
Transitional between oak and harlequin maple forests, this small area was dominated by mature red oak and harlequin maple, with pignut hickory also common. The lower strata were similar to those of the harlequin maple forest, dominated by nonnatives. Wineberry was common. A small patch of angelica tree was the only occurrence of this Lower Hudson PRISM Tier 3 species we found on the site. Black swallowwort and garlic-mustard were common and flat-stemmed bluegrass locally common.

Oak forest
Mature oak forest occurred in two discrete complexes of native habitats—along with pine barrens and rocky barrens—on the eastern side of the site. Lightly vegetated crests and ledges were numerous in these complexes, producing exposed, sunny conditions and dry, shallow soils.

The oak forests were dominated by red oak and chestnut oak commonly up to 14 in. dbh, and occasionally as large as 24 in.; rarely a massive oak stood at 30-42 in. dbh. Many of the oaks growing on crests appeared stunted—shorter (15-40 feet) and of lesser diameter (mostly ≤ 10 in.)—and in places spaced farther apart, than those growing in deeper soils. Pitch pine, eastern white pine, pignut hickory, and red maple were occasional. Black tupelo, black oak, white oak, northern hackberry, and several other tree species were rare. The shrub and sapling layer was sparse, with downy shadbush, blackhaw, and common greenbrier occasional and several other species rare. Downy arrowwood, a regionally-rare shrub, occurred in a few small copses. Hillside blueberry was common in small patches, and deerberry and black huckleberry occasional. Herbaceous plant diversity was low. Small patches of Appalachian rock polypody (a fern) occurred here and there on outcrops. Hair grass was common, and several other grasses and sedges occasional. Marginal wood fern, false Solomon's seal, cow-wheat, and mugwort were occasional. Pincushion moss was common. In a narrow, shallow gully between two rocky barrens was an interesting tupelo-blackhaw "pocket," an unusual community dominated by black tupelo and pignut hickory in the canopy and blackhaw in the understory.

Pine-oak forest
This was a small stand dominated by large, tall white pine and mature red oak, with some pitch pine mixed in.

Pine barrens
The pine barrens earned their name by being very species poor with low herbaceous cover. Soils are shallow, droughty, presumably acidic, and mostly covered with brown pine needles. Pitch pines dominated the canopy, with occasional red oaks mixed in, and the ground layer was characterized by grasses and mosses. An understory (shrub) layer was absent. Hair grass and pincushion moss were abundant, sweet vernal grass common, and poverty grass, woolly rosette grass, sessile-leaved bellwort, hillside blueberry, and catbriar occasional.

Rocky barrens
Areas dominated by exposed bedrock with sparse vascular vegetation, not steeply sloping, were mapped as rocky barrens. Rocky barrens were scattered across the oak-pitch pine complexes and in the southwestern thicket. All were very small, the largest being 0.27 ac, and they totaled only 1.3 ac. Soils of rocky barrens, if any, are extremely shallow, excessively well drained, probably nutrient poor, and susceptible to drought. Plants and animals that live there are adapted to exposed, dry conditions, which likely produce warmer microclimates in summer, and colder conditions in winter, than surrounding forest.

Some rocky barrens on the property had scattered trees, mainly pitch pine and red oak, especially around the edges. Multiflora rose and common blackberry were occasional, and other shrubs, including staghorn and winged sumac, rare. Catbriar patches were here and there. The dominant vascular plants were hair grass (abundant) and sweet vernal grass (common), though even these were often patchy, leaving large areas of bedrock without vascular plants. Little bluestem and pink corydalis, which often inhabit such places in our region, were rare. Some barrens, especially the most western barrens and the southwestern barrens that were adjacent to nonnative plant communities, had little native vegetation and were being invaded by nonnative plants including common chickweed, low smartweed, Asiatic dayflower,

and stringy stonecrop. In addition to exposed bedrock, mosses and lichens were a prominent component of many rocky barrens. *Cladonia* lichens formed sizeable patches in a few barrens and were otherwise scattered about in small amounts. Mosses including pincushion moss (*Leucobryum*), and haircap moss (*Polytrichum*) were common, sometimes forming extensive carpets.

Wetland habitats

Wetlands were few and small, amounting to circa 0.5% of the study site. However, the vernal pools and riparian wetlands almost certainly have substantial habitat value for amphibians, invertebrates, and other animals.

Wet meadow
Only a sliver of a small wet meadow was on the property, on the eastern edge adjacent to the railroad tracks where the intermittent stream fell from the escarpment. Dotted smartweed filled the wet meadow, with occasional false-nettle.

Hardwood and shrub swamp
We mapped two small swamps along the intermittent stream that flowed across the southeastern corner of the property. The offsite portion of the southern swamp was substantially larger (ca. 1 ac).

The northern swamp had a red maple canopy (trees 2-20 in. dbh) with an occasional northern catalpa. Even at the end of July in a dry year, there were small, shallow pools along the stream bed, surrounded by herbaceous vegetation including abundant rice cut-grass, stout woodreed (common), stiltgrass (occasional), orange jewelweed, a violet, mugwort, false-nettle, and turtlehead. Numerous ebony jewelwing damselflies were flying. The southern unit was a shrub swamp with buttonbush, common elderberry, and meadowsweet, a good deal of purple loosestrife, as well as beggar's ticks, stout woodreed, and a dodder. One common and several rare dodder (*Cuscuta*) species occur in the Hudson Valley. Just south of the property boundary was a deepish open pool of approximately 22 x 32 feet, bordered by lush herbaceous vegetation on three sides and a low bedrock wall on the fourth.

Intermittent woodland pool and vernal pool
Vernal pools are small temporary pools usually with little or no vegetation within the pool itself. Typically these pools have no surface water inlet or outlet and contain standing water during fall, winter, and spring that dries up by mid- to late summer during a typical year. Intermittent woodland pools are a type of vernal pool partially or entirely surrounded by forest.

There was one long, narrow intermittent woodland pool (ca. 80 x 20 feet) in the southeastern corner of the property, east of the stream. It was dry in June and July and lacked vegetation except around the edges, where small sweet pepperbush, swamp azalea, and highbush blueberry, as well as several black tupelo trees, grew.

The vernal pool was of similar dimensions but surrounded by rocky barrens and thickets rather than forest. It had shallow standing water in late June. There were a few small red maples and a

single sweetgum (3 in. dbh) on a low hummock. The latter is a regionally rare tree that is sometimes planted. Common duckweed covered the water, and hop sedge, blunt broom sedge, water-purslane, purple loosestrife, beggar's ticks, and common elderberry were present.
Due to their seasonal drying and lack of a stream connection, vernal pools lack fish predators of amphibian eggs and larvae. Thus they provide crucial breeding and nursery habitat for several pool-breeding amphibian species that have difficulty reproducing in other wetlands that contain fish, namely Jefferson salamander (RR), marbled salamander (SC; S3; SGCN), spotted salamander, and wood frog. Because these amphibians require access to surrounding forest for non-breeding season habitat, intermittent woodland pools are preferred, but high-quality non-woodland pools may support some breeding activity as well.

Reptiles such as spotted turtle (SC; S3; SGCN HP) and ribbon snake (SGCN) also use vernal pools for foraging, rehydrating, and resting. Although we did not observe pool-using amphibians or reptiles other than spring peeper and red-spotted newt, the hardwood swamps and vernal pools on and overlapping the southern end of the Future Parkland are only about 600 feet north of additional offsite swamps and pools, thus it is possible that some amphibians or reptiles move between these two complexes of small wetlands.

The invertebrate communities of vernal or temporary pools can be species-rich, including fairy shrimps, clam shrimps, fingernail clams, and many beetles and other insects, and can provide abundant food for songbirds such as yellow warbler, common yellowthroat, and Louisiana waterthrush (SGCN). Large and small mammals use pools for foraging and as water sources. Certain rare plants, such as false hop sedge (T; S2), cattail sedge (E; S2), and American featherfoil (T; S2), grow in intermittent woodland pools, but were not found at the Future Parkland.

Stream and spring
We mapped seven springs, one long intermittent stream, and several short intermittent streams, all in the southern half of the property. Most of the springs emitted more-or-les a trickle during mid-summer (with one exception), but may flow more heavily during other seasons and wetter summers. One mapped spring was actually a small seepage area of around 35 square yards. Springs and seeps originating from deep groundwater sources flow more or less continuously and emerge at a fairly constant temperature, creating an environment that is often cooler in summer and warmer in winter than the surroundings. As such, springs potentially constitute cool spots that provide summer refuges for organisms of more northerly affinities. They often support aquatic invertebrates, and also serve as water sources for terrestrial animals during droughts and in winter when other water sources are frozen.

The southeastern stream, which ran about 800 feet across the property before exiting in a (dry) waterfall to the railroad grade, was not flowing during our summer surveys but contained several long, shallow pools and puddles that were frequented by ebony jewelwings. The stream was flowing slowly on 22 October. The riparian flora of the stream (within 3-6 feet of its bank), excluding the small swamps discussed above, was a mixture of upland and wetland species. Multiflora rose and catbriar grew abundantly in streamside thickets. Harlequin maple and stout woodreed were common. Several species were present around the stream and spring but rare or absent elsewhere within the oak forest, including the invasives harlequin maple, northern catalpa,

round-leaved bittersweet, multiflora rose, and autumn clematis; and natives such as bitternut hickory, shagbark hickory, American beech, slippery elm, winterberry, sweet pepperbush, stout woodreed, and wild sarsaparilla.

Intermittent streams are the headwaters of most perennial streams, and are significant water sources for lakes, ponds, and wetlands of all kinds. They provide microhabitats not present in perennial streams, supply aquatic organisms and organic drift to downstream reaches, and can be important local water sources for wildlife (Meyer et al. 2007). They have been found to support species-rich aquatic invertebrate communities, including regionally-rare mollusks (Gremaud 1977) and dragonflies. Both perennial and intermittent streams provide breeding, larval, and adult habitat for northern dusky salamander, northern red salamander, and northern two-lined salamander.

Birds

We observed the following bird species at the Future Parkland (*b* indicates the species probably breeds onsite or very nearby):

great blue heron (river edge)
Canada goose (river edge)
turkey vulture (overhead)
bald eagle (overhead)
ring-billed gull (river)
chimney swift (b)
eastern screech-owl (b)
pileated woodpecker (recent feeding sign; b)
red-bellied woodpecker (b)
downy woodpecker (b)
great crested flycatcher (b)
Carolina wren (b)
tufted titmouse (b)
black-capped chickadee (b)
white-breasted nuthatch (b)
American crow (b)
fish crow
blue jay (b)
eastern bluebird (possible breeder)
hermit thrush (possible breeder)
ruby-crowned kinglet (migrant)
red-eyed vireo (b)
pine warbler (b)
palm warbler (migrant)
yellow-rumped warbler (migrant)
indigo bunting (b)
northern cardinal (b)
chipping sparrow (b)

song sparrow (b)
American goldfinch (b)

Graham encountered 13 bird species on his 28 June survey. Kiviat added more species on other dates, including 22 October when small flocks of migrant songbirds were foraging onsite. Nonetheless, the list seems short, likely because the survey was at the tail end of the high-activity (i.e., intense singing) part of the breeding season. Also, the site is small for some species of birds, and the high noise levels from freight trains, U.S. Military Academy helicopters, and power boats may deter some species from breeding. On 22 October, Kiviat observed songbirds flushed by train noise well west of the railroad. Nonetheless, we expect that additional species breed, winter, or stop over on the site. A Drury Lane resident reported a flock of wild turkey there; turkeys presumably range over the Future Parkland.

Most of the species encountered are common in the region, although eastern screech-owl is uncommon in our region, and pine warbler may be an uncommon breeder. A screech-owl called persistently in the northern end of the site during the moth survey on the evening of 14 September. Graham heard and observed a single pine warbler singing in each of the two pine barrens areas. The chimney swift is an uncommon breeder. Kiviat observed seven chimney swifts flying around Peregrine Hall about 1730 h EDT on 25 June; likely these birds were nesting in the Peregrine Hall chimneys.

The Orange County naturalist Edgar Mearns collected birds in the Highland Falls vicinity in 1878. Among several common species was a specimen of the sedge wren (*Cistothorus stellaris* was the contemporary scientific name; https://siarchives.si.edu/collections/fbr_item_modsi2879). Sedge wren is now very rare in the Hudson Valley. The species breeds in wet meadows with variable mixtures of sedges, grasses, and shrubs, and also in hay fields. We do not believe the small meadows at the Future Parkland offer potential habitat for this species. Many other observations and specimens of birds, mammals, reptiles, and amphibians were reported from the vicinity of Highland Falls by Mearns (1878, 1879, 1898, etc.); however, the exact locations of the species reported can not be determined from his publications. Mearns' field notebooks are in the Smithsonian Institution but are only accessible in person. His published notes on the local fauna indicate many possible changes in occurrence and abundance during the past century and a half.

Amphibians and reptiles

We detected few species of reptiles and amphibians on and near the site:

red-spotted newt
red-backed salamander
spring peeper
five-lined skink
black rat snake

A lizard, the five-lined skink, was found under a rock in oak forest of the northern portion of the site. The site overall seems to offer good habitat for this species, given the open-canopy rocky

areas of the rocky barrens, pine barrens, and oak forest. The black rat snake was a large dead adult by the railroad about 500 feet south of the site. Rat snakes are evidently common in the Hudson Highlands west of the river (e.g., at the Bear Mountain area), and almost certainly range onto the Future Parkland site. There were adult newts in the ledge-bordered pool just south of the site; this species presumably ranges onto the site either as aquatic adults in the small stream flowing from the pool across the site (Figure 1) or as terrestrial immatures (*red efts*). Spring peeper *fall calls* were heard at three locations widely spread around the site on 22 October. On the same date, we found three adult red-backed salamanders, all of the red color phase, under logs at separated locations on the site.

The small size of the site and its developed surroundings may have reduced the herpetofauna, and we were not able to begin the surveys during the early to mid-spring season that is often most productive in herpetofaunal surveys. Moreover, the herpetofauna in general is notoriously cryptic. Notwithstanding, we were surprised not to find additional, urban-tolerant, species such as American toad, brown snake, and garter snake. Gray treefrog and brown snake have been reported from the Highland Falls area on iNaturalist. Worm snake has been found west of Route 9W near Highland Falls (New York Natural Heritage Program data); this poorly-known and elusive species sometimes occurs in urban areas and is a possibility at the Future Parkland site.

Butterflies and moths

We observed these species of butterflies at the Future Parkland:

black or spicebush swallowtail (spicebush swallowtail more likely based on forested habitats)
cabbage white
banded hairstreak
eastern tailed-blue?
eastern comma
question mark
mourning cloak
harvester
red-spotted purple
hackberry emperor
little wood satyr
common ringlet
silver-spotted skipper

This is a modest butterfly fauna, probably limited by the well-wooded character of the environment and perhaps also affected by summer drought. Two species, hackberry emperor and harvester, are uncommon and possibly regionally-rare. We were impressed by the abundance of banded hairstreak, the species seen most often onsite; it was reported to be common in the region (Glassberg 1993). Hackberry emperor and harvester are probably regionally-rare in the Hudson Valley. Glassberg (*ibid.*) called harvester “usually quite rare and a good find.” A review of iNaturalist data indicate additional species from the Highland Falls area but not at the Future Parkland site: eastern tiger swallowtail, red-spotted purple, great spangled fritillary, Horace’s duskywing, and northern broken dash.

We identified 76 species of moths (listed in Appendix 2) in 63 genera and 17 families. Although we lack local data for comparison, we believe the moth fauna of the site is fairly species-rich. This diversity may be a factor of the variety of habitats and the number of larval host plant species. Additional moth species probably fly in spring and between the survey dates (i.e., in July-August). Moreover, there could be moths we did not encounter because they were restricted to more southerly portions of the site or are not susceptible to the ultraviolet light or sugaring survey techniques.

Five species were ranked as "Uncommon" in Beadle and Leckie (2012), and 11 species are not included in that field guide. We identified orange virbia (*Virbia aurantiaca*) flushed from vegetation in the afternoon. This moth is ranked as G5 (common and secure globally) and SU (unrankable in New York due to lack of, or conflicting, information) (Schlesinger 2017) – the species could be rare in New York. Our occurrence record awaits expert verification. It should be noted that only a few groups of moths have been reviewed and ranked by the New York Natural Heritage Program, and it is possible that the species Beadle and Leckie (2012) considered "Uncommon" and perhaps others would be given S1, S2, or S3 ranks (various levels of rarity, explained in Methods) for New York.

The site lacked scrub oak (*Quercus ilicifolia*) which is commonly associated with pitch pine in our region. Abundant scrub oak can support a rare species, the barrens buck moth (*Hemileuca maia*). Another rare moth, *Speranza exonerata*, is also a scrub oak specialist (Nelson 2015). Grand and Mello (2004) discussed ten species of rare moths in pitch pine – scrub oak habitats in southeastern Massachusetts. We did not identify any of those species, perhaps due to absence of scrub oak, inadequate surveying, or ecological differences between the pitch pine habitats on rocky substrates in the Future Parkland and the sandy substrates of eastern Massachusetts. Additional rare moth (and butterfly) species specialize on blueberry and other plants in shrubby, barrens-like habitats of New England and southeastern New York (Wagner et al. 2003). Hillside blueberry, a "lowbush" species of blueberry, is common at the Future Parkland, but we did not identify any of those species.

Additional moth species reported from the Highland Falls area on iNaturalist are pale-banded dart, Polyphemus moth, snowberry clearwing, ultronia underwing, copper underwing, and grape leaf-folder.

Miscellaneous Observations

Mammals that we observed opportunistically were gray squirrel, woodchuck (burrow), raccoon, and white-tailed deer. There was sign of white-footed mouse (*Peromyscus leucopus*) in the form of gnawed acorns beneath downed logs. We saw probable coyote scat onsite. A Drury Lane resident reported having a black bear on his property about 2000 feet SSW of the Future Parkland. There is ample summer roosting and nursery microhabitat for bats under loose bark of dead trees and in the bark furrows of larger black locusts. Bats could also be using the relict chimney in the northern ruins; we did not survey bats.

During the June moth survey, Kiviat photographed and collected specimens of a cave cricket beneath a small overhanging rock and on an adjacent tree base. We submitted specimen material to an expert, Matthew Niemiller, for genetic analysis. The results suggested a match with *Diestrammena japanica,* nonnative in North America, but the identification is not definitive. The establishment of *D. japanica* in houses in the U.S. has been documented recently (Epps et al. 2014). A cricket we collected on Little Stony Point across the river a year ago (Kiviat and Graham 2021) was identified by Niemiller as *Diestrammena asynamora*, a common and widespread nonnative species, also found in U.S. houses (Epps et al. 2014). Additional study of the site's cave crickets, and cave crickets elsewhere in the Hudson Highlands, is warranted.

There was a large chorus of common true katydid (*Pterophylla camellifolia*) on the evening of the second moth survey, 14 September. This large, conspicuous insect is rare in New York City and the urban-industrial New Jersey Meadowlands region (Kiviat and MacDonald 2022) and is a very weak flyer. We appreciate that it is doing well on the somewhat isolated, post-industrial Future Parkland site.

Kiviat briefly observed a phantom crane fly (*Bittacomorpha clavipes*) flying at the open-area edge of a perhaps 15 m^2 stand of knotweed hanging over a streamlet at the end of Havens Road. This is an uncommon and very beautiful insect most often associated with calcareous wetlands in the Hudson Valley.

We found typical invertebrates beneath cover objects, including earthworms, leopard slugs, sowbugs, millipedes, centipedes, wood roaches, and ground beetles (Carabidae).

Rock tripe lichen (two species of *Umbilicaria s.l.*) were prominent on some ledges and boulders although uncommon site-wide. Rock tripes appear to be an *urban-sensitive* group of lichens, in part because of sensitivity to air quality. iNaturalist has very few records of rock tripes in the New York Metropolitan Region, but many records, for example, in northwestern New Jersey.

On 30 July, Graham found two young (circa 2-3 in. dbh), sickly chestnut oaks with yellowing, wilting leaves and cracked and pocked bark. Both had copious insect visitors, including cicada killer, a large fly, smaller flies, a greenish beetle, a dark red elater (click beetle), and (butterflies) question mark, red-spotted purple, and hackberry emperor. The large flies, at least, seemed to have their mouth parts buried in the narrow cracks in the bark, which were lined with a black substance. When revisited on 24 August, the trees seemed to be completely free of insects. The authors are unsure of what had infected these trees or why it was so attractive to so many different insects. The bark and leaf appearance did not match pictures of sudden oak death (*Phytophthora ramorum*)-infected trees found on the internet.

Discussion and Recommendations

The Future Parkland is overlapped by several special biodiversity designations (see Study Area, above). Moreover, the site supports non-trivial areas of combined rocky barrens, pine barrens, and oak forest of apparently good quality. These habitats are characterized by shallow soils and patches of bare bedrock, which we expect to be droughty (i.e., to have little moisture-retention

capacity), nutrient-poor, and acidic. Several regionally-rare or uncommon species of plants and animals are present.

Birds
Bird diversity and abundance seemed low. This may be due to the initiation of our survey in the latter part of the breeding season in mid-June, the narrow width and relatively small size of the site with the noisy freight railroad bordering the east side, and disturbance from the suburban development on the west side. However, pine warbler and eastern screech-owl are uncommon or regionally-rare breeders in the Hudson Valley. The chimney swift, an uncommon breeding bird, although probably nesting offsite (at Peregrine Hall), is foraging over the Future Parkland. And there seems to be significant use of the site by fall-migrant songbirds. These observations indicate the conservation value of the site for birds.

Fire
Pitch pine, and pitch pine–oak vegetation, are often conditioned and maintained by fire, as these species tend to resist fire whereas competitors such as maples are more readily injured or killed by fire. Of course, the pitch pines at the site may be more a response to the shallow, rocky, droughty, and perhaps nutrient-poor and acidic soils than to fire. We observed very little evidence of fire (charcoal on standing tree stems, stumps, or logs) compared to many barrens-like areas in the Hudson Highlands. Vegetation fires were presumably much more common in the Highlands in and before the early 1900s, when fire protection equipment was less mobile and technologically developed than it is today, and there were large numbers of dying American chestnut trees. Because of the small size of the site and the proximity of built structures west and north of the Future Parkland, prescribed fire is not a management option.

Education opportunities
The oak forest, pine barrens, and rocky barrens of the site are scenic, and many park visitors will find them attractive and interesting. These habitats are also sensitive to trampling. Although we do not recommend extensive trail transits of the more natural, rocky areas, a single trail spur or transit, or a loop trail (as recommended) can be used for interpretation with a simple sign or small brochure. The article about “mountain ecology” (Kiviat 2001) addresses rocky crests and exposed meadows in the Hudson Highlands and similar landscapes and can be used as a starting point for interpretation. The information in the current report, especially the comprehensive flora data, is unusual for a new park and well-suited for interpretive purposes.

General trail routing
Trail(s) should avoid areas of exposed rock where lichens or mosses are abundant. We suggest that trails be routed on areas of deeper soil, avoiding the rocky barrens as much as possible, with only one or two segments or spurs to rocky locations with views.

For our review, we were given a site map that showed a potential trail route, and during field work we observed flagging tape marking a second route. One of the proposed trails passed extremely close to a *Cladonia* concentration area, which is ill-advised, though we were later told that these proposed trails were obsolete and should be ignored (Rita Shaheen pers. comm.) . A well-maintained social trail originates from one of the yards neighboring the southwestern corner

of the property and extends some distance across the property (Figure 1), at least as far as a large rocky barren where trampling is evidenced by crushed, upturned, and dead mosses.

Any official trail should terminate well north of the southern end of the property, perhaps only halfway "down" the property, north to south. This would discourage park visitors from straying onto the adjoining parcel or damaging the small wetlands and pools. It would also help safeguard the integrity of the southern pine barrens, oak forest, and rocky barrens from trampling and nutrient enrichment. If dogs are permitted on the site, they should be restricted to the northern end of the trail, and leash use should be required. (There is precedent for dog "zoning" such as this in at least one town park in Dutchess County.) Free-running dogs are a hazard to wildlife and a nuisance to other walkers, and dog excreta would contribute to the fertilization of the barrens habitats.

Suggested trail route
One potential trail, drawn in orange in Figure 3, is a "lollipop" that remains in the northern half of the property, looping through the high-ecological-value rocky habitats of oak forest, pine barrens, and rocky barrens. This trail would offer good views looking east over the Hudson River in its eastern portion and would be generally scenic, with most of its length in sparse, rocky, oak- and pine-dominated habitats. It also would leave the southern, high-value oak-pine habitat complex untrammeled. It would be short (0.57 mile), however, and would pass through one of the two pine barrens on-site, where Hudsonia observed and heard singing (likely breeding) pine warblers. Pine warblers are uncommon in much of the mid- and lower Hudson Valley and do best in mature pine stands with little hardwood cover in the understory and canopy. Habitat destruction and fire suppression have diminished such habitats throughout the eastern U.S. Pine warbler is considered an edge-sensitive, forest interior species, but it is unclear whether hikers would cause enough disturbance to reduce breeding success or drive birds away, as with some forest-interior songbirds. (The literature appears to be mute on this point.)

Rare plants
Routing the trail(s) away from the well-developed lichen and moss patches on the ground-level rock outcrops will do much to protect those features. Terminating the trail north of the southern oak-pine habitat complex would also reduce risk to the fern-leaved false foxglove and downy arrowwood populations.

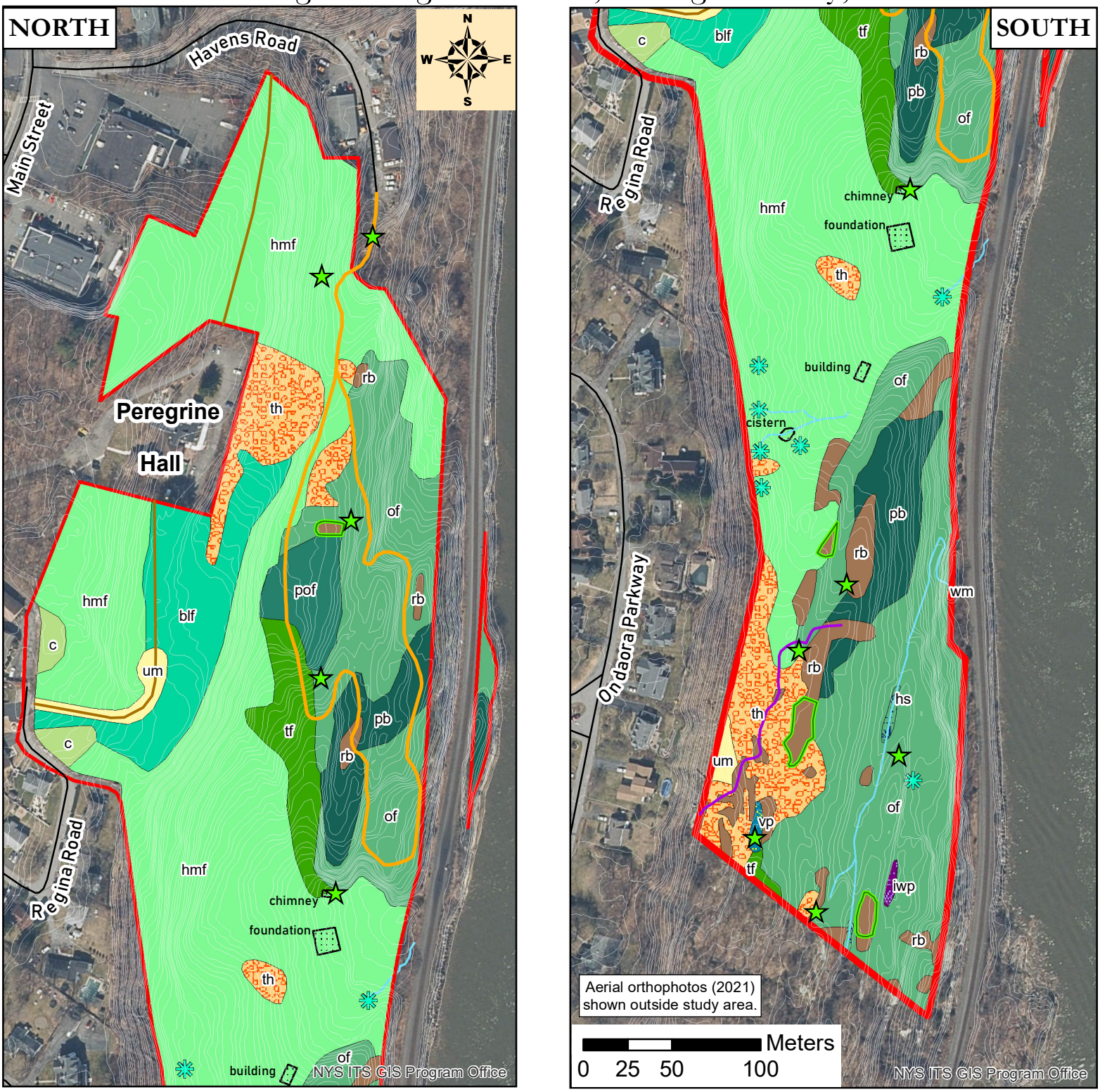
Basswood
The copious showy, fragrant flowers of the mature basswood tree at the end of Havens Road (the beginning of the potential Future Parkland trail) were very attractive to flower-visiting insects, and the tree should be protected, as shouldother basswoods on the site.

Camping
Fire rings and other evidence of camping should be removed and signs posted that fires, cutting of live or dead plants, and camping are prohibited. We encountered a fire ring, and several cut trees, in the northern pine barrens, near the eastern property boundary.

Figure 3

Proposed Trail at the Future Parkland

Village of Highland Falls, Orange County, NY



- Proposed trail
- 2-ft contour
- Road
- Woods road
- Social trail
- Study area
- Ruins
- Species of concern
- Lichen concentration

Upland habitats

- Cultural (c)
- Upland meadow (um)
- Thicket (th)
- Black locust forest (blf)
- Harlequin maple forest (hmf)
- Transitional forest (tf)
- Oak forest (of)
- Pine-oak forest (pof)
- Pine barrens (pb)
- Rocky barrens (rb)

Wetland habitats

- Spring
- Stream
- Wet meadow (wm)
- Hardwood & shrub swamp (hs)
- Intermittent woodland pool (iwp)
- Vernal pool (vp)

Bicycles
We recommend that cycling not be allowed on the Future Parkland. Bicycles cause trail erosion and would increase impacts on moss and lichen assemblages and breeding birds. Moreover, mountain bikers are notorious for proliferating illicit trails on terrain that is attractive to them, as this terrain likely would be.

Nonnative plants
Certain invasive species are well-established on the Future Parkland, probably aided by historic industrial activity, dumping, and surrounding development. For example, railroads and suburban streets are both sources of nonnative weeds. Further spread and consolidation of existing weeds, and arrival of new ones, would be facilitated by soil disturbance, removal of native vegetation, and fertilization of the soil from human activities. These effects should be minimized. Visitors to the future park will bring seeds and other propagules on their tires, boots, and clothing. A boot brush station (e.g., Lieurance et al. 2022) should be installed and maintained at the trailhead.

Athough knotweed is well established in a couple of locations, if it begins to colonize the oak forest, pine barrens, or rocky barrens habitats, or near a rare plant occurrence, the knotweed should be considered an EDRR (early detection – rapid response) species and removed by repeated hand-pulling. For example, there is a small clump in a rocky gully just north of the chimney ruins. These habitats should be monitored annually for knotweed establishment.

A small, young colony of angelica tree is established at the northern end of the northern transitional forest. We recommend removing this species non-chemically as an EDRR species; several years of cutting and hand-pulling (or weed-wrenching) may be required to eliminate the colony.

We do not recommend control of other nonnative plants unless it can be demonstrated that one is a threat to a rare plant, the oak-pine habitat complexes, or another rare or unusual element of the site. Any control should be non-chemical in order to not adversely affect non-target plants or animals.

Scrub oak restoration
It might be tempting to try establishing scrub oak at the site. (We do not know if it was once present, only that it is often associated with pitch pine barrens.) Although the barrens-like habitats seem suitable for scrub oak, it might take many years to establish a population of scrub oak large enough to attract moths or other specialized insects associated with this host plant. Moreover, any large-scale planting would cause soil disturbance and potentially create a seedbed for nonnative weeds.

Refuse
The Future Parkland site, especially the northern end, has a plethora of refuse that has been dumped over the years. Because of the lack of wheeled vehicle access to most of the site, cleanup may be challenging. We think that dumped materials should be prioritized with earliest attention to those types presenting the biggest hazard to people and wildlife. Tires, because they tend to hold water in which mosquitoes breed (including the vectors of West Nile virus), should be high on the list for removal. Bottles and cans that can trap small mammals and herpetofauna

are important, as are glass and sharp metal objects. A large concentration of bottles, cans, and other recent refuse is present next to the northern end of Regina Road and would be easy to access for clean-up. Collected materials should be recycled as much as possible.

Materials
Use of treated wood, plastic mesh, plastic landscaping fabrics (geotextiles), chips, gravel, paving, and other foreign materials should be avoided. Treated wood is toxic, some plastic meshes trap and kill snakes, and plastics generate microplastic pollution. Chips or gravel could introduce natural or anthropogenic substances adverse to native organisms associated with the local bedrock and soils. Local rocks and untreated lumber are good options for trail construction, e.g. staircases, riprap, or waterbars.

Further surveys
Given the apparent diversity of moths we identified, it may be worthwhile to survey moths at more frequent intervals during the growing season and collect specimens for expert technical identification. Surveys of birds and herpetofauna during the spring period of conspicuous activity (April through early June) would help round out the picture of the Future Parkland fauna. It would also be worth surveying lichens and mosses, especially in the oak forest, pine barrens, and rock barrens habitats, because those are in a relatively natural condition.

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Appendix 1. Vascular plants of the Aloe site, Village of Highland Falls, New York. Scientific names follow the New York Flora Atlas (https://newyork.plantatlas.usf.edu/). Common names follow regional usage where known, except that alternate names have been substituted to avoid geographic and ethnic references (see Kiviat and MacDonald 2022). (Appendix overleaf.)

Key to Appendix 1

Introduced (nonnative) species are those that are believed to have evolved elsewhere in the U.S. or world.

*Found only in transitional forest

†Found mostly or only in riparian zone within oak forest

Rank abundances. A: abundant. C: common. O: occasional. R: rare. p: patchy (clumped) distribution

Bold: canopy layer. *Italics*: understory layer. No bold/italics: ground layer

Abundance of each species is given only for highest vegetation layer in which it occurred within a given habitat, excepting vines, where abundances are given for all three layers (ground/understory/canopy). For example, pitch pine trees (canopy) are abundant, saplings (understory) occasional, and seedlings (ground) occasional in pine barrens. Only abundant (**A**) is listed in the table.

Scientific name	Common name	Native/Introduced (nonnative) N/I	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
TREES										
Acer negundo	box-elder	N				**O**				*R*
Acer platanoides	harlequin maple	I	**Op†**			**A**	**O**			
Acer pseudoplatanus	sycamore maple	I				**R**				
Acer rubrum	red maple	N	**O**	**R**		**R**		**C**		**R**
Acer saccharinum	silver maple	N				**R**				
Acer saccharum	sugar maple	N	**R**			**O**				
Ailanthus altissima	tree-of-heaven	I	*R*	**R**		**O**	*O*			
Albizia julibrissin	mimosa	I			**R**					
Amelanchier arborea	shadbush	N	*O*			**R**				
*Aralia elata**	angelica tree	I								
Betula lenta	black birch	N	*R*		**R**	**R**				
Carya cordiformis	bitternut hickory	N	**R†**							
Carya glabra	pignut hickory	N	**O**	**R**		**R**				
Carya ovata	shagbark hickory	N	**R†**		*R*					
Catalpa speciosa	northern catalpa	I	**R†**				**R**	**O**		
Celtis occidentalis	hackberry	N	**R**	**R**		**R**				
Fagus grandifolia	American beech	N	*R†*							
Fraxinus americana	white ash	N	O	*R*		*O*				
Gleditsia triacanthos	honey locust	I			**R**					
Ilex opaca	American holly	N				R				
Juglans cinerea	butternut	N				**R**				
Juglans nigra	black walnut	N				**R**				
Juniperus virginiana	eastern red cedar	N	*R*	**R**		R				
Liquidambar styraciflua	sweetgum	N								**R**
Liriodendron tulipifera	tuliptree	N				**R**				
Magnolia acuminata	cucumber tree	N				**R**				
Malus sp.	apple or crabapple	I	**R**							
Nyssa sylvatica	tupelo	N	**R**						**O**	**R**
Ostrya virginiana	hop-hornbeam	N	**R**							
Paulownia tomentosa	princess tree	I				**Op**				
Pinus rigida	pitch pine	N	**O**	**O**	**A**					
Pinus strobus	white pine	N	**O**			**R**				
Platanus occidentalis	sycamore	N				**R**				
Populus deltoides	eastern cottonwood	N				**R**				
Prunus	cherry	I?				**R**				
Prunus serotina	black cherry	N	**R**	**R**	*R*	**O**	**R**			
Quercus alba	white oak	N	**R**		*R*	**R**	**R**			
Quercus montana	chestnut oak	N	**C**			**R**				

Scientific name	Common name	Native/Introduced (N/I)	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
Quercus rubra	red oak	N	**A**	**O**	**O**	**R**	**R**			
Quercus velutina	black oak	N	**R**			**R**				
Rhamnus cathartica	common buckthorn	I	**R**	*R*			*R*			
Robinia pseudoacacia	black locust	I				**O**				
Tilia americana	basswood	N	**R**			**O**				
Tsuga canadensis	hemlock	N	**R**		**R**					
Ulmus glabra	wych elm	I				*R*				
Ulmus rubra	slippery elm	N	**R†**			*R*				
SHRUBS										
Amorpha fruticosa	false-indigo	I		*R*						
Berberis thunbergii	Thunberg barberry	I				*O*				
Cephalanthus occidentalis	buttonbush	N						*R*		
Clethra alnifolia	sweet pepperbush	N	*R†*						*R*	
Euonymus alatus	winged euonymus	I				*R*				
Gaylussacia baccata	black huckleberry	N	O		R					
Ilex verticillata	winterberry	N	*R†*							
Ligustrum	privet	I				*R*				
Lindera benzoin	spicebush	N				*Cp*				R
Lonicera ×bella	Bell's honeysuckle	I		*R*						
Lonicera maackii	Maack's honeysuckle	I		*R*		*R*				
Philadelphus	mock-orange	I	*R*			*R*				
Rhododendron viscosum	swamp azalea	N							*R*	
Rhus copallinum	winged sumac	N	*R*	*R*						
Rhus typhina	staghorn sumac	N	*R*	*R*						
Rosa	rose	I					*O*			
Rosa carolina/virginiana	Carolina/Virginia rose	N					R			
Rosa multiflora	multiflora rose	I	*Op†*	*O*		*C*	*C*			R
Rubus allegheniensis	northern blackberry	N	*R*	*O*			*O*			
Rubus flagellaris	common dewberry	N	O	O		O				
Rubus hispidus	swamp dewberry	N	R							
Rubus occidentalis	black raspberry	N	R			R				
Rubus phoenicolasius	wineberry	I	*R*	*R*		*C*	*R*			
Sambucus nigra	common elderberry	N					*R*	*R*		*R*
Spiraea alba	meadowsweet	N						*R*		
Staphylea trifolia	bladdernut	N				*R*				
Vaccinium corymbosum	high blueberry	N							*R*	
Vaccinium pallidum	hillside blueberry	N	C		Op					
Vaccinium stamineum	deerberry	N	O							
Viburnum prunifolium	blackhaw	N	*Op*				*R*			
Viburnum rafinesquianum	downy arrowwood	N	*R*	*R*						

Scientific name	Common name	Native/Introduced (N/I)	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
VINES										
Celastrus orbiculatus	round-leaved bittersweet	I	R/-/-†	R/-/-		O/R/	-/R/-	R/-		
Clematis terniflora	autumn clematis	I	R/R/R	-/R/-		R/-/-	A/C/-			
Cuscuta	dodder	N						R		
Hedera helix	common ivy	I				R/-/-	R/-/-			
Lonicera japonica	gold-and-silver honeysuckle	I	R/R/-	R/-/-		R/-/-	R/R/-			
Menispermum canadense	moonseed	N				R/R/-				
Parthenocissus quinquefolius	Virginia creeper	N	O/-/R	O/-/R		R/-/-	Op/Op			
Smilax rotundifolia	catbrier	N	Op/O/	Op/R	Op/R	R/-/-	C/Ap/-			Op/R
Solanum dulcamara	bittersweet nightshade	I						R		
Toxicodendron radicans	poison-ivy	N	R/-/-†	O	R/-/-	R/-/-	O/Cp/-			O/-/-
Vinca minor	periwinkle	I				R				
Vincetoxicum nigrum	black swallowwort	I	R	Op		Op				
Vitis aestivalis	summer grape	N				-/-/O	-/-/R			
FORBS										
Ageratina altissima	white snakeroot	N	R†			O				
Alliaria petiolata	garlic-mustard	I				C-A				
Apocynum cannabinum	hemp dogbane	N	R							
Aralia nudicaulis	wild sarsaparilla	N	R†							
Arisaema triphyllum	jack-in-the-pulpit	N				O				
Artemisia vulgaris	mugwort	I	O	Op		R	A	Op		
Aureolaria pedicularia	fern-leaved false-foxglove	N	R							
Barbarea vulgaris	wintercress	I		R						
Bidens 1	bur-marigold	N				R				O
Bidens 2	bur-marigold	N						R		
Bidens bipinnata	needles	I				R				
Boehmeria cylindrica	false-nettle	N						R		
Capnoides sempervirens	pale corydalis	N		R						
Cardamine impatiens	narrow-leaved bittercress	I				R				
Cerastium fontanum	mouse-ear chickweed	I		R						
Chelidonium majus	greater celandine	I	R							
Chelone glabra	turtlehead	N						R		
Circaea canadensis	enchanter's nightshade	N				O				
Commelina communis	dayflower	I	R	Op						
Erechtites hieraciifolius	burnweed	N	R	R		R				
Erigeron annuus	daisy fleabane	N					O			
Eurybia divaricata	white wood aster	N	R			O				
Eurybia schreberi	Schreber's wood aster	N	R			R				

Scientific name	Common name	Native/Introduced (N/I)	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
Galium aparine	cleavers	I				R				
Geranium robertianum	herb Robert	N				R	R			
Geum canadense	white avens	N				O				
Hackelia virginiana	stickseed	N				R				
Hesperis matronalis	dame's rocket	I				R				
Impatiens capensis	orange jewelweed	N	R†					Op		R
Lapsana communis	nipplewort	I	R†	O		O	Op			
Lemna minor	common duckweed	N								A
Ludwigia palustris	water-purslane	N								Op
Lythrum salicaria	purple loosestrife	I						R		R
Maianthemum racemosum	Canada mayflower	N	O			O				
Melampyrum lineare	cow-wheat	N	O		R					
Monotropa uniflora	ghost pipes	N	R							
Nabalus	rattlesnake root	N				R				
Opuntia humifusa	eastern prickly-pear	N	R	R						
Oxalis stricta	wood-sorrel	N				R				
Paronychia canadensis	smooth forked-chickweed	N	R							
Persicaria longiseta	bristly lady's-thumb	I		Op	R	R				
Persicaria punctata	dotted smartweed	N	R†							
Persicaria virginiana	jumpseed	N				O				
Phytolacca americana	pokeweed	N		R		R				
Pilea	clearweed	N	R†							
Polygonatum pubescens	hairy Solomon's-seal	N		R						
Ranunculus recurvatus	hooked crowfoot	N						R		
Reynoutria japonica	knotweed	I	R			Op				
Rumex acetosella	sorrel	I		R						
Rumex obtusifolius	bitter dock	I	R				O			
Sanguinaria canadensis	bloodroot	N				R				
Sedum sarmentosum	stringy stonecrop	I		Op						
Senecio vulgaris	common groundsel	I					R			
Silene vulgaris	bladder campion	I				R				
Solidago caesia	blue-stemmed goldenrod	N				R				
Solidago gigantea	giant goldenrod	N						R		
Solidago odora	sweet goldenrod	N								
Solidago rugosa	rough goldenrod	N		R		O	Op			R
Stellaria media	common chickweed	I		R						
Symphyotrichum	aster	N				R				
Symphyotrichum cordifolium	heart-leaved aster	N	R							
Urtica dioica/gracilis	stinging nettles	?				Op				
Uvularia sessilifolia	sessile-leaved bellwort	N	R		O					

Scientific name	Common name	Native/Introduced (N/I)	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
Verbena urticifolia	white vervain	N				R				
Veronica officinalis	common speedwell	I				R				
Viola	violet	N						R		
Viola sororia	common blue violet	N	R							
Yucca filamentosa	curly-leaved yucca	I		R						
GRAMINOIDS										
Anthoxanthum odoratum	sweet vernal grass	I	O	C	C		R			
Avenella flexuosa	common hairgrass	N	C	A	A		R			
Carex appalachica	Appalachian sedge	N				R				
Carex blanda	eastern woodland sedge	N		R		C	R			
Carex cephaloidea	thin-leaved sedge	N				R				
Carex cephalophora	oval-headed sedge	N	O			O				
Carex communis	fibrous-rooted sedge	N				R				
Carex cristatella	crested sedge	N	R†							
Carex digitalis	slender wood sedge	N				O				
Carex festucacea	fescue sedge	N				R				
Carex grisea	wood gray sedge	N				R				
Carex laxiculmis	spreading sedge	N				O				
Carex laxiflora	loose-flowered sedge	N				O				
Carex lupulina	hop sedge	N								Op
Carex normalis	greater straw sedge	N				R				
Carex pensylvanica/lucorum	Pennsylvania or Blue Ridge sedge	N	Op	R		Op				
Carex swanii	Swan's sedge	N	O			C				
Carex tribuloides	blunt broom sedge	N								O
Carex virescens	ribbed sedge	N				R				
Cinna arundinacea	stout woodreed	N	Op†					C		
Dactylis glomerata	orchard grass	I				R				
Danthonia spicata	poverty grass	N			O	R				
Dichanthelium boscii	Bosc's panic grass	N	R							
Dichanthelium clandestinum	Deer-tongue	N	Op	Op		R				
Dichanthelium depauperatum	starved panic grass	N	R							
Dichanthelium dichotomum	cypress panic grass	N				R				
Dichanthelium lanuginosum	woolly rosette grass	N	O		O					
Dichanthelium lindheimeri	Lindheimer panic grass	N		R						
Elymus hystrix	bottlebrush grass	N				Op	O			
Festuca subverticillata	nodding fescue	N				R				
Glyceria striata	fowl mannagrass	N	R†			R		R		
Juncus tenuis	path rush	N				R				
Leersia virginica	white grass	N	R†					A		
Luzula multiflora	common wood-rush	N				R				
Microstegium vimineum	stiltgrass	I				Op		O		

Scientific name	Common name	Native/Introduced (N/I)	Oak forest	Rocky barrens	Pine barrens	Harlequin maple forest	Thicket	Hardwood swamp/spring	Intermittent woodland pool	Vernal pool
Phalaris arundinacea	reed canary grass	I					Cp			
Poa compressa	flat-stemmed bluegrass	I		Op		O	O			
Poa nemoralis	wood bluegrass	I				Op				
Schizachyrium scoparium	little bluestem	N		R						
FERNS										
Athyrium angustum	northern lady fern	N				R				
Dennstaedtia punctilobula	hay-scented fern	N		R						
Dryopteris carthusiana	spinulose wood fern	N				R				
Dryopteris intermedia	intermediate wood fern	N				R				
Dryopteris marginalis	marginal wood fern	N	O			R				
Polypodium appalachianum	Appalachian rock polypody	N	Op	R	R					
Polystichum acrostichoides	Christmas fern	N				R				

Appendix 2. Moths photographed during surveys at the Aloe site in the Village of Highland Falls, New York. Species identified using Beadle and Leckie (2012) and selected professional websites (see footnotes). Common and scientific names from Beadle & Leckie for taxa included in their guide.

Common Name	Scientific Name	Jun	Sep	DF	PB
AUTOSTICHIDAE					
four-spotted yellowneck[a,b]	*Oegoconia novimundi*	x			x
CRAMBIDAE					
checkered apogeshna[b]	*Apogeshna stenialis*	x		x	x
double-banded grass-veneer	*Crambus agitatellus*	x			x
elegant grass-veneer	*Microcrambus elegans*	x	x	x	x
gold-stripe grass-veneer	*Microcrambus biguttellus*	x		x	
grass-veneer	*Crambus* sp.	x	x	x	x
hollow-spotted blepharomastix	*Blepharomastix ranalis*	x		x	
lesser vagabond sod webworm	*Agriphila ruricolellus*		x		x
Hahncappsia marculenta ?[b]	*Hahncappsia marculenta ?*	x		x	
DEPRESSARIIDAE					
four-dotted agonopterix	*Agonopterix robiniella*	x		x	
gold-striped leaftier	*Machimia tentoriferella*		x	x	x
Thelma's agonopterix[b]	*Agonopterix thelmae*		x		x
EREBIDAE					
American idia	*Idia americalis*		x	x	
banded tussock	*Halysidota tessellaris*	x		x	
brown panopoda	*Panopoda carneicosta*	x		x	
common fungus moth	*Metalectra discalis*	x			x
common idia	*Idia aemula*	x	x	x	x
dead-wood borer[c]	*Scolecocampa liburna*	x		x	
discolored renia	*Renia discoloralis*	x	x	x	x
early fan-foot	*Zanclognatha cruralis*		x		x
faint-spotted palthis	*Palthis asopialis*		x		x
false underwing	*Allotria elonympha*	x			x
Julia's idia[b]	*Idia julia*		x		x
locust underwing	*Euparthenos nubilis*	x			x
moon-lined moth	*Spiloloma lunilinea*	x			x
morbid owlet	*Chytolita morbidalis*	x		x	
orange virbia	*Virbia aurantiaca*	x			
painted lichen moth	*Hypoprepia fucosa*	x		x	x
red-lined panopoda	*Panopoda rufimargo*	x		x	
sordid underwing[c]	*Catocala sordida*	x		x	
speckled renia[b]	*Renia adspergillus*	x		x	x

yellow-spotted renia	*Renia flavipuntalis*	x			x
GELECHIIDAE					
many-spotted dichomeris[b]	*Dichomeris punctipennella*		x		x
GEOMETRIDAE					
bent-lined carpet	*Costaconvexa centrostrigaria*	x		x	
Canadian melanolophia	*Melanolophia canadaria*	x		x	
common tan wave	*Pleuroprucha insulsaria*	x		x	
elm spanworm	*Ennomos subsignaria*	x		x	
faint-spotted angle	*Digrammia ocellinata*	x		x	x
grapevine looper complex	*Eulithis gracilineata / diversilineata*	x		x	x
lesser maple spanworm	*Macaria pustularia*	x		x	x
pale-winged gray	*Iridopsis ephyraria*	x		x	
pug moth	*Eupithecia* sp.	x	x	x	x
red-fringed emerald	*Nemoria bistriaria*	x		x	
GRACILLARIIDAE					
Packard's caloptilia ?	*Caloptilia packardella ?*	x		x	
LIMACODIDAE					
Nason's slug moth[b]	*Natada nasoni*	x		x	
purple-crested slug moth	*Adoneta spinuloides*	x		x	
NOCTUIDAE					
American dun-bar	*Cosmia calami*	x		x	
beautiful wood-nymph	*Eudryas grata*	x		x	
bristly cutworm	*Lacinipolia renigera*		x		x
cloaked marvel	*Chytonix palliatricula*	x		x	
disparaged arches	*Orthodes detracta*	x		x	
The Hebrew[c]	*Polygrammate hebraeicum*	x			x
implicit arches[c]	*Lacinipolia implicata*		x	x	
knee-joint dart ?	*Feltia geniculata ?*		x		x
large yellow underwing [a]	*Noctua pronuba*	x	x	x	x
master's dart	*Feltia herilis*		x	x	
night-wandering dagger[c]	*Acronicta noctivaga*	x		x	
NOTODONTIDAE					
linden prominent	*Ellida caniplaga*	x		x	
white-dotted prominent	*Nadata gibbosa*	x		x	
OECOPHORIDAE					
Suzuki's promalactis[a,b]	*Promalactis suzukiella*		x		x
PLUTELLIDAE					
diamondback moth	*Plutella xylostella*	x		x	
PTEROPHOROIDEA					
grape plume moth	*Geina periscelidactylus*	x		x	x
PYRALIDAE					

broad-banded eulogia	*Eulogia ochrifrontella*		x	x	x
Brower's vitula [b]	*Vitula broweri*		x		x
dimorphic macalla	*Epipaschia superatalis*	x		x	
dimorphic tosale	*Tosale oviplagalis*	x		x	
drab condylolomia	*Condylolomia participialis*	x		x	
hayworm moth ?	*Hypsopygia* sp.	x		x	x
Zeller's macalla	*Macalla zelleri*	x			x
TINEIDAE					
dark-collared tinea	*Tinea apicimaculella*		x		x
TORTRICIDAE					
banded Olethreutes	*Olethreutes fasciatana*	x		x	
leafroller moth	sp.	x		x	
raspberry leafroller ?[b]	*Olethreutes permundana ?*	x			x
red-banded leafroller	*Argyrotaenia velutinana*	x		x	
reticulated fruitworm	*Cenopis reticulatana*	x		x	
three-lined leafroller	*Pandemis limitata*		x	x	x
unidentified leafroller	*?*	x		x	
ZYGAENIDAE					
grapeleaf skeletonizer	*Harrisina americana*	x			

[a] Introduced species

[b] Not in Beadle & Leckie (2012)

[c] Rated as “uncommon” by Beadle & Leckie (2012)

[d]Orange virbia (Erebidae: *Virbia aurantiaca*) found along railroad during June survey; rated as common by Beadle & Leckie and SU by NYNHP

Jun = June survey; Sep = September survey

DF = Disturbed Harlequin Maple Forest; PB = Pine Barrens and Oak Forest

Authorities for identification:

Beadle, D. & S. Leckie. 2012. Peterson Field Guide to Moths of Northeastern North America. Houghton Mifflin Harcourt Publishing Co., New York, NY. 611 p.

Also: Moth Photographers' Group, BAMONA, iNaturalist, Mass Moths (web sites)