

Supplementary Material

Appendix A. Target Habitat Selection

The available pool of sample sites for target habitat surveys varied (Figure 1). The open alpine community of the Adirondack High Peaks is mapped in 20 occurrences ranging from 0.2 ha to 25.4 ha, totaling 70.1 ha (New York Natural Heritage Program, 2017; Howard et al., 2021). Barrens are unvegetated or sparsely vegetated communities with large areas of bare rock or sand. They are grouped in the state classification (Edinger et al., 2014) with woodlands, which are sparsely treed communities but that may still have unvegetated openings. We included 12 natural community types comprising 63 patches ranging from 1.2 ha to 1998.7 ha (New York Natural Heritage Program, 2017), totaling 11,251.7 ha. Coastal dunes in New York include the Great Lakes dunes bordering Lake Ontario and the maritime dunes bordering Long Island Sound and Atlantic Ocean. Great Lakes dunes are mapped in nine patches ranging from 2.0 to 102.5 ha, totaling 322.8 ha. Maritime dunes are mapped in 10 patches ranging from 4.6 ha to 366.5 ha, totaling 880.1 ha. Open peatlands are present throughout New York State, and in consultation with our advisory committee and NYNHP ecologists, we focused on seven natural community types: black spruce-tamarack bog, dwarf shrub bog, highbush blueberry bog thicket, inland poor fen, medium fen, patterned peatland, and perched bog. Peatlands were mapped in 215 patches ranging from 0.1 ha to 2,368.4 ha, totaling 7,045.8 ha statewide.

Late-successional (“old growth”) forests are centered primarily in three regions in New York—Allegany, Adirondacks, and Catskills—but smaller, more isolated examples are scattered around the state. No comprehensive map of late-successional forests exists for New York. Our element occurrence database (New York Natural Heritage Program, 2022) contains approximately 50 old growth occurrences ranging from 2–28,350 ha in many different forest community types, including maple-basswood rich mesic forest, hemlock-northern hardwood forest, spruce-fir swamp, floodplain forest, spruce flats, mountain spruce-fir forest, maritime holly forest, limestone woodland, northern white cedar swamp, coastal oak-laurel forest, oak-tulip tree forest, pine-northern hardwood forest, balsam flats, beech-maple mesic forest, and hemlock-hardwood swamp. These total at least 166,350 acres, with about one-third in hemlock-northern hardwood stands. In addition, our files and other resources (e.g., McMartin 1994, McGee et al. 1999, Kudish 2000, Davis 2003, Kershner and Leverett 2004) contain leads for at least this much more acreage at many additional locations around the state.



Figure 1. Open alpine communities (blue triangles) in the Adirondack High Peaks (top left); barrens communities from the NYNHP element occurrence database (sand-colored circles) and coastal barrens grid cells from the Northeast Terrestrial Habitat Map (brown; top right); Lake Ontario dunes, including early post-glacial dunes east of the lake, as red hexagons (middle left); Long Island dunes as red hexagons (middle right); Open peatlands from the NYNHP significant natural community layer (bottom left); late-successional forests (green squares; bottom right).

Appendix B. Conservation Status Ranking Details

We estimated Range Extent by calculating both a minimum convex polygon (MCP) and an alpha hull (AH) around all recent records. Calculations were done in R (R Core Team, 2021), with the AH methods generally following the guidance in Master et al. (2012). The MCP yields larger Range Extent estimates since it includes all the area in between records, while the AH excludes large unoccupied areas. The AH method considerably underestimated Range Extent in cases with highly clustered records and was ignored in those cases. When these two methods yielded different values of Range Extent, we selected a final value that reflected this uncertainty. When the raw value for Range Extent was within 10% of the lowest bound of the next highest bin, we included both bins to represent the uncertainty in the calculation.

We counted 4-km² grid cells with recent records and assigned Area of Occupancy values accordingly. When the raw value for AOO was within 10% of the lowest bound of the next highest bin, we included both bins to represent uncertainty in the calculation. The most common species appeared to be more broadly distributed than the calculated AOO suggested, so we widened the range of uncertainty for these species to include the largest category.

We estimated number of occurrences (in the Heritage network sense of discrete populations, rather than individual observation or collection records) by grouping records according to standard “separation distances” based on NatureServe’s existing distances for other taxa and expert opinion. When the raw value for Number of Occurrences was within 10% of the lowest bound of the next highest bin, we included both bins to represent uncertainty in the calculation. The most common species seemed likely to be more broadly distributed than the calculated number of occurrences suggested, so we widened the range of uncertainty for these species to include the largest category. For some other species, it appeared that including this rank factor was artificially lowering their ranks, so in those cases we excluded it.

For some species, we retained the Threat Impact value that arose from the threat-by-threat calculation of scope and severity based on advisor input and literature review, while for others we determined threats were unknown and we assigned Intrinsic Vulnerability. In some instances, we used values from NatureServe.

Lacking data on absolute population decline or increase, we followed Telfer et al. (2002) in calculating relative change in range based on county occupancy historically (1999 and earlier) and post-2000. This methodology was used previously for dragonflies and damselflies in the northeastern U.S. (White et al., 2015). To calculate relative change in range, proportions of counties occupied in each time period were log transformed and the later time period’s values regressed on the former’s. Regression residuals are an index of a species’ change relative to other species. This method accounts for unequal survey effort in each time period but cannot account for variation in collection or survey focus; i.e., if mining bees were all the rage in the 1950s but other bees were ignored, whereas since 2000 all bees have been given equal attention (a dubious claim), the method could not account for that bias. Only species present in five or more counties pre-2000 were included. We calculated the change index twice, once including all taxa, and once separately for each of the four insect orders.

To translate this relative change index to Long-term Trend factor categories we calibrated based on known declines in *Bombus* and the raw numbers of counties occupied in the two time periods. Species with values of relative change -2.5 and smaller were assigned AB (≥80% decline), those with values between -2.5 and -1.0 were assigned AD (≥50% decline), those with values between -1.0 and -0.5 were assigned AF (≥10% decline), those between -0.5 and 1.0 were assigned G (relatively stable), and those with values >1.0 were assigned HI (≥10% increase). Species that declined from 5 occupied counties or more to 0 were assigned a value of AB (≥80% decline). Species

for which the relative change index could not be calculated, but that increased from 0 to 5 counties occupied, or for which the number of counties at least tripled were assigned a value of HI ($\geq 10\%$ increase). All other species were assigned U (unknown). Species for which the two calculations of relative change conflicted were assigned a final value reflecting that uncertainty.

Table 1. Select rank factor values from NatureServe's (Faber-Langendoen et al., 2012; Master et al., 2012) conservation status ranking methodology used in this study.

Range Extent A = <100 square km (< about 40 square mi) B = 100-250 square km (about 40-100 square mi) C = 250-1,000 square km (about 100-400 square mi) D = 1,000-5,000 square km (about 400-2,000 square mi) E = 5,000-20,000 square km (about 2,000-8,000 square mi) F = 20,000-200,000 square km (about 8,000-80,000 square mi) G = 200,000-2,500,000 square km (about 80,000-1,000,000 square mi) H = >2,500,000 square km (> 1,000,000 square mi) U = Unknown	Overall Threat Impact A = Very High B = High C = Medium D = Low U = Unknown
Area of Occupancy (number of 4-km² grid cells) A = 1 B = 2 C = 3-5 D = 6-25 E = 26-125 F = 126-500 G = 501-2,500 H = 2,501-12,500 I = >12,500 U = Unknown	Intrinsic Vulnerability (Only used if Overall Threat is Unknown or Null) A = Highly vulnerable B = Moderately vulnerable C = Not intrinsically vulnerable
Number of Occurrences A = 1 – 5 B = 6 – 20 C = 21 – 80 D = 81 – 300 E = >300 U = Unknown	Long-term Trend A = Decline of >90% B = Decline of 80 - 90% C = Decline of 70 - 80% D = Decline of 50 - 70% E = Decline of 30 - 50% F = Decline of 10 - 30% G = Relatively Stable ($\leq 10\%$ change) H = Increase of 10 - 25% I = Increase of >25% U = Unknown

Table 2. S-rank definitions. Adapted from Master et al. (2012).

RANK	DEFINITION
SX	Presumed Extirpated — Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered. [equivalent to "Regionally Extinct" in IUCN Red List terminology]
SH	Possibly Extirpated — Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching and/or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.

RANK	DEFINITION
S1	Critically Imperiled — At very high risk of extirpation in the jurisdiction due to very restricted range, very few populations or occurrences, very steep declines, severe threats, or other factors.
S2	Imperiled — At high risk of extirpation in the jurisdiction due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
S3	Vulnerable — At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
S4	Apparently Secure — At a fairly low risk of extirpation in the jurisdiction due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
S5	Secure — At very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats.
SU	Unrankable — Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA	Not Applicable — A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities. This rank is given to nonnative species and vagrants without regular occurrences in New York.

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