

APPENDIX 3

Guidelines for locating Hine's emerald dragonfly adults

Below are guidelines for locating adult Hine's emerald dragonflies and potential habitat. It has been compiled from Part I of this Plan with additional information. It includes descriptions of Hine's emerald dragonfly habitat, a list of dragonfly species co-occurring with Hine's emerald dragonfly, a map of surface dolomite deposits, and descriptions of adult Hine's emerald dragonfly behaviors. Illustrations of a Hine's emerald dragonfly adult and larva are presented in Figures 1 and 2 of this Plan. This guide will aid in distinguishing suitable Hine's emerald dragonfly habitat. Due to the difficulty in identifying this species in flight, a description of flight behaviors are provided below to help distinguish this species from others while in flight. It should be noted that a USFWS permit is required to capture, even temporarily, Hine's emerald dragonfly individuals. If potential habitat is located, please contact the USFWS, Chicago Field Office, Barrington, Illinois at (847) 381-2253 for further information. TTY users may contact the Chicago, Illinois Field Office through the Federal Relay Service at 1-800-877-8339.

Locations to Consider

Potential Range. The potential historical range of Hine's emerald dragonfly is presented in Figure 6. The potential range was estimated from the known occurrences of Hine's emerald dragonfly occurrences, the range of a closely related species, and Bailey's (1995) ecoregions as modified by Keys *et al.* (1995). Hine's emerald dragonfly has been collected from Illinois, Wisconsin, Michigan, Ohio, Missouri, Indiana, and Alabama. *Somatochlora tenebrosa* was identified as the closest related species to the Hine's emerald dragonfly, *S. hineana*, based on mitochondrial DNA analysis (Purdue *et al.* 1996). *S. tenebrosa*'s distribution includes Alabama, Arkansas, Connecticut, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, and Wisconsin in the United States and New Brunswick, Nova Scotia, Ontario, and Quebec in Canada. Hine's emerald dragonfly could potentially occur within this area. It should be noted that *S. tenebrosa* inhabits both alkaline and acidic systems, and it appears that *S. hineana* inhabits alkaline systems. Incorporating *S. hineana* occurrences and *S. tenebrosa*'s range, Bailey's (1995) ecoregions, as modified by Keys *et al.* (1995), were used to estimate the potential range of Hine's emerald dragonfly. The upper portion of the range is made up of the Warm Continental Division, and the Hot Continental Division makes up the lower portion. The Warm Continental Division is comprised of the Laurentian Mixed Forest Province and the Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province. The Warm Continental Division has both boreal and broadleaf deciduous forests and is characterized by warm summers and cold winters with ample rainfall. The Hot Continental Division consists of the following provinces: Eastern Broadleaf Forest (Oceanic), Eastern Broadleaf Forest (Continental), Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow, and Ozark-Broadleaf Forest-Meadow. The Hot Continental Division is characterized by winter deciduous forests, dominated by broadleaf trees, and a climate of hot summers and cool winters.

Geological Characteristic. Known Hine's emerald dragonfly populations occur in association with dolomitic bedrock. Wetlands meeting the description below that occur near surface dolomite deposits should be considered potential habitat. Figure 7 presents large areas of surface dolomite deposits within the potential range of this species. Areas near these deposits may be more likely to have Hine's emerald dragonfly populations. Smaller dolomite deposits are not illustrated on this map and can also represent suitable locations to search for this species. Areas of surface dolomite deposits should be determined on a local level. State Geological Surveys are good source of information regarding locations of surface dolomite deposits on a local level.

Habitat Descriptions.

The General Habitat section has been compiled from the following reports: Vogt and Cashatt (1990), Kirk and Vogt (1995), Mierzwa *et al.* (1995a), Cashatt and Vogt (1996), Soluk *et al.* (1996, 1998).

General Habitat. Known Hine's emerald dragonfly sites are made up of a mosaic of the following community types: fen, marsh dominated by cattails, sedge meadow, swamp dominated by northern white cedar, wet prairie, thicket/brush, floodplain forest, wet-mesic and mesic upland forest, and pond/pool. Typically, a site will be composed of at least one wetland community type with a forest community nearby. It appears that the wetland community is the most important aspect of the habitat because it provides appropriate larval habitat. Floral composition and substrate types are some of the visible differences among the Hine's emerald dragonfly sites in Illinois, Wisconsin, and Michigan. Forested areas near or adjacent to the Illinois' sites are mainly floodplain deciduous forests, while in Wisconsin and Michigan conifer swamps and forests are common. In Michigan, marl is a common substrate type in the wetland communities, and in Illinois and Wisconsin, muck is the predominant substrate.

The wetland community is the critical component for Hine's emerald dragonfly habitat because it provides appropriate conditions for larval development. Hine's emerald dragonfly larvae often have been found in wetland complexes that can be broadly characterized as fens. Fens are defined as wetlands dominated by graminoid or graminoid-like plants and fed primarily by calcareous groundwater through seeps and/or springs. The microhabitats this dragonfly appears to use for breeding are small channels flowing through seepage fed marshes and sedge meadows dominated by graminoid and graminoid-like plants. The flowing water can range from barely detectable sheet flow to deeper, well-defined streamlet channels. These slow-moving aquatic systems provide appropriate habitat for larval development. Parts of the streamlet channels are usually covered by vegetation such as cattails or sedges. Small sections of the streamlet channel with exposed water also appears to be important for oviposition (Mierzwa *et al.* 1998). The substrate of these channels is usually comprised of fine silt or muck and detritus from partially decomposed cattails and sedges. Soil types of these aquatic systems can range from organic muck to mineral soils like marl. It is important to note that larvae have been collected from streamlets that have been observed to dry up and appear uninhabitable.

Two important characteristics common to wetlands inhabited by this species appear to be underlying dolomitic bedrock or calcareous limestone and cool, shallow water slowly flowing

through vegetation. Two other important components of Hine's emerald dragonfly habitat appear to be open, vegetated areas and nearby or adjacent forest edge. Areas of open vegetation serve as places for adults to forage. Forests, trees, or shrubs provide protected, shaded areas for adult Hine's emerald dragonflies to perch and roost.

Adult Breeding and Foraging Habitat. In 1996, habitat preference studies in Illinois were conducted at Material Service Corporation sites (TAMS 1997) and at Lockport Prairie Nature Preserve (Soluk *et al.* 1996, 1998). At Material Service sites, Hine's emerald dragonfly was shown to prefer sedge meadow and sweet flag (*Acorus calamus*) marsh for breeding habitat. Foraging habitat was fairly evenly distributed over the following nine community types sampled (in order of high to low percent observed use): sedge meadow, reed canary grass marsh, isolated shrubs/trees, cattail marsh, sweet flag marsh, floodplain forest, dolomite prairie, successional field, and disturbed land. At River South, almost 90% of adult observations occurred within 15 meters of habitat edge, "defined as a change in vegetation height" (e.g., cattail marsh/sedge meadow borders). An apparent correlation between habitat edge and the number of adult Hine's emerald dragonfly observations was also identified by Nuzzo (1995). In 1996 at River South, approximately 60% of the foraging observations occurred within 60 m of known breeding sites. At Lockport Prairie Nature Preserve, most observations also took place near edge habitat in both the forest edges and at the borders of cattail marsh and sedge meadows versus pond, seep outlet, dry prairie fields, and streamlet channel habitats (Soluk *et al.* 1996, 1998). In each habitat type, breeding behaviors represented up to 13% of the observations, and foraging and transient flight made up to 83% to 100% of the observations.

Oviposition has been documented in cattail seepage marshes, seepage sedge meadows, sedge hummocks near a marshy stream edge, near the edge of a swale, in muck in sluggish water at the margin of a spring run, in small puddles, and in streamlets (Vogt and Cashatt 1994, Soluk *et al.* 1996, 1998). Numerous females have also been observed ovipositing between the hummocks in the shallow water of the sheet flow in seepage sedge meadows (Vogt and Cashatt 1997, 1998 in progress).

Associated Species. Species associated with Hine's emerald dragonfly habitat may also be useful in determining appropriate locations to search for this species. Odonate species co-occurring with Hine's emerald dragonfly are listed in Table 3. Searches for additional populations should be considered in an area fitting the habitat description above with at least three of the species listed in Table 3. Locations with increased number of the odonate species may be more likely to support Hine's emerald dragonflies. Due to the lack of information on the habitat requirements for the Hine's emerald dragonfly, areas fitting the habitat description above with none of the odonate species listed in Table 3 should still be considered as potential habitat. Rare species associated with Hine's emerald dragonfly sites are listed in Appendix 5.

Behavior Considerations:

Optimal Times to Search for Adults. During Hine's emerald dragonfly peak flight season, searches should be conducted in the morning between 9:00 a.m. and 12:00 p.m. under ideal weather conditions. Ideal weather conditions are subjectively defined as follows: cloud cover < 20%, temperature 70-90E F, and wind < 10 MPH. Peak flight season usually varies between

late June through July depending on the weather and the location of the sites. Locations further north may have peak flight seasons later in the season than locations in the south. Hine's emerald dragonflies have been observed from late May to early October in Illinois and late June to late August in Wisconsin.

Flight Behavior. On days when maximal temperatures reach 35-38°C, Hine's emerald dragonflies are observed occasionally before 7:00 a.m. feeding on small dipterans. Williamson (1922) observed morning (5:00-9:00 a.m.) activity of *S. linearis* and *S. ensigera* in Indiana when daily maximal temperature ranged from 30-38°C. Hine's emerald dragonfly frequently flies over open fields at most sites. These flights typically cover a range of 10-25 m at a height of 1-3 m. Flight courses are irregular and often near clusters of shrubs or the forest edge. At Lockport Prairie Nature Preserve (Illinois) and Mud Lake Wildlife Area (Wisconsin) they also fly at 1-3 m height over narrow roads (grass/dirt, gravel, or paved).

Adult crepuscular and midday feeding swarms have been observed in Illinois and Wisconsin (Vogt and Cashatt 1992,1994, Kirk and Vogt 1995). These feeding swarms ranged from 12 to 70 individuals. A feeding swarm describes a group of individuals that are foraging, usually on a swarm of prey, within in a localized area. A crepuscular feeding swarm occurs at twilight or dusk. The location, time of day, and flight height of the dragonfly's feeding swarm may vary depending on their prey. Feeding swarms also can be influenced by climate. Hine's emerald dragonfly crepuscular feeding swarms have been observed just after sunset and a light, brief rain and also after a light rainshower. Hine's emerald dragonflies have been observed swarming over a sedge meadow and a narrow road while foraging on small dipterans. Observed flight heights of Hine's emerald dragonfly swarms ranged between 0.1-3.0 m. Other odonate species have been both present and absent from observed *S. hineana* feeding swarms; a few *S. walshii*, *S. williamsoni*, and *Aeshna umbrosa* were observed with *S. hineana* in a crepuscular feeding swarm in Wisconsin. A. F. Combs (Walker 1925:145) observed similar flights along Lake Superior by *S. incurvata*, *S. franklini*, *S. williamsoni*, and *Aeshna* spp.

In cattail seepage marshes, territorial patrols are usually within small clearings of cattails, just above lower emergent vegetation (*Sagittaria* sp.), or just above cattails. Males often assume territorial patrols over a streamlet and hover within 0.3 m of the surface. Occasionally they perch near the top of cattail floral spikes. Territorial patrols are similar in seepage sedge meadows in that males fly just above emergent vegetation (tussock sedge). In contrast, at The Ridges Sanctuary, patrols are frequently one m above emergent vegetation in swales.

Figure 6. Map of Hine's emerald dragonfly populations, occurrences, and identified search area. The survey area is based on known locality, distribution of a closely related species (*Somatochlora tenebrosa*), ecoregions from Bailey (1995), and as modified by Keys *et al.* (1995). The two divisions used from Bailey's ecoregions were the Warm and Hot Continental Divisions.

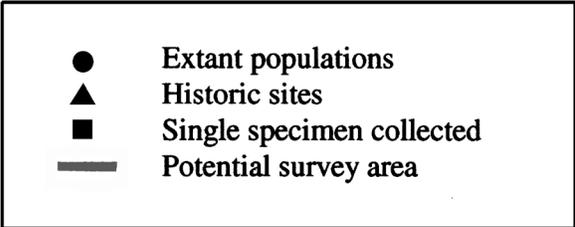
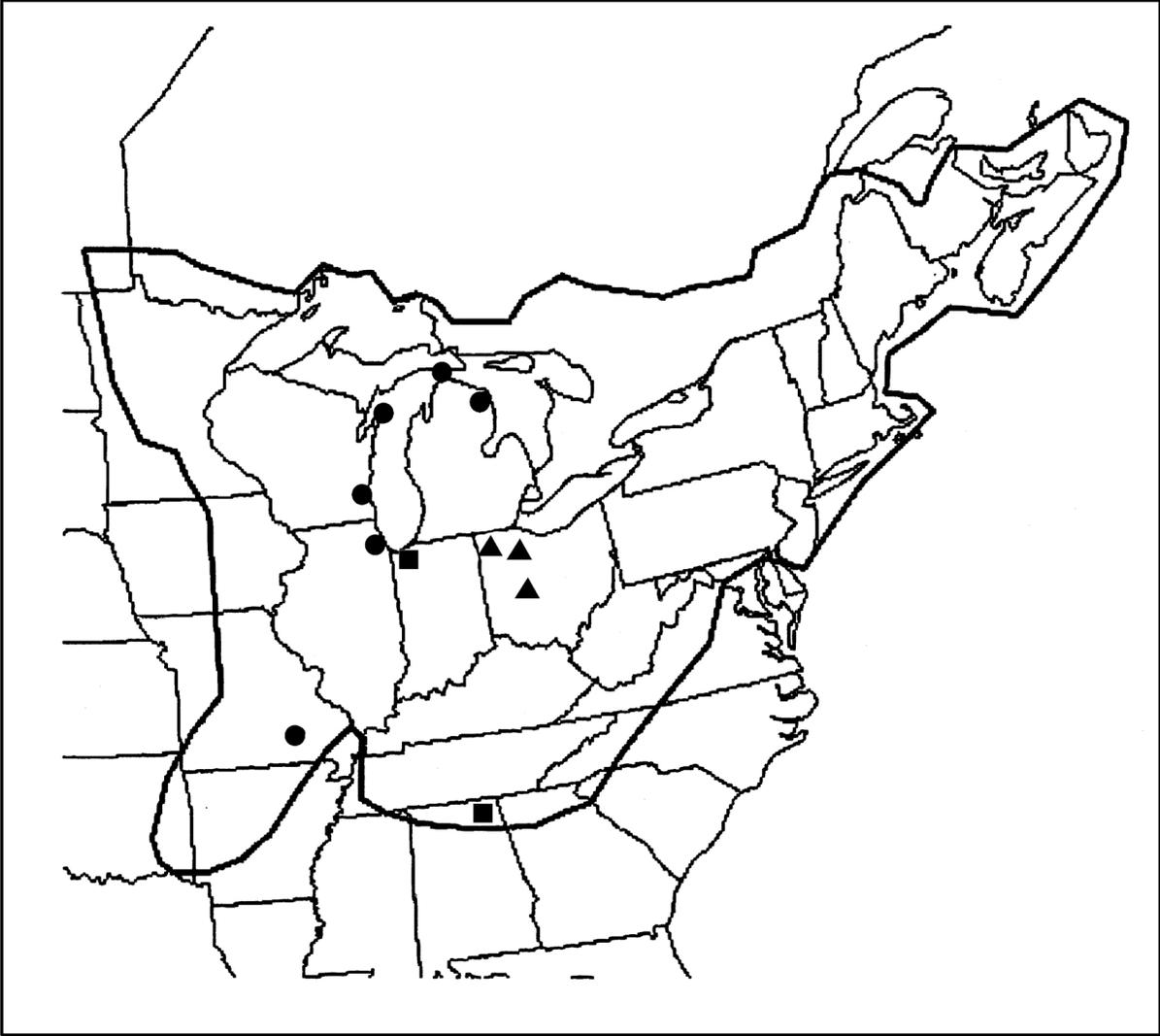


Figure 7. Locations of surface dolomite deposits within the potential range of Hine's emerald dragonfly. The surface dolomite deposits represent areas that may have greater potential to be inhabited by Hine's emerald dragonfly. This map presents large areas of surface dolomite deposits and does not show smaller deposits that may also be appropriate locations to search for this species. Upper Silurian deposits are the youngest rocks and Lower Silurian deposits are the oldest. Map prepared by R. Krumm, Illinois State Geological Survey, from King and Beikman (1974).

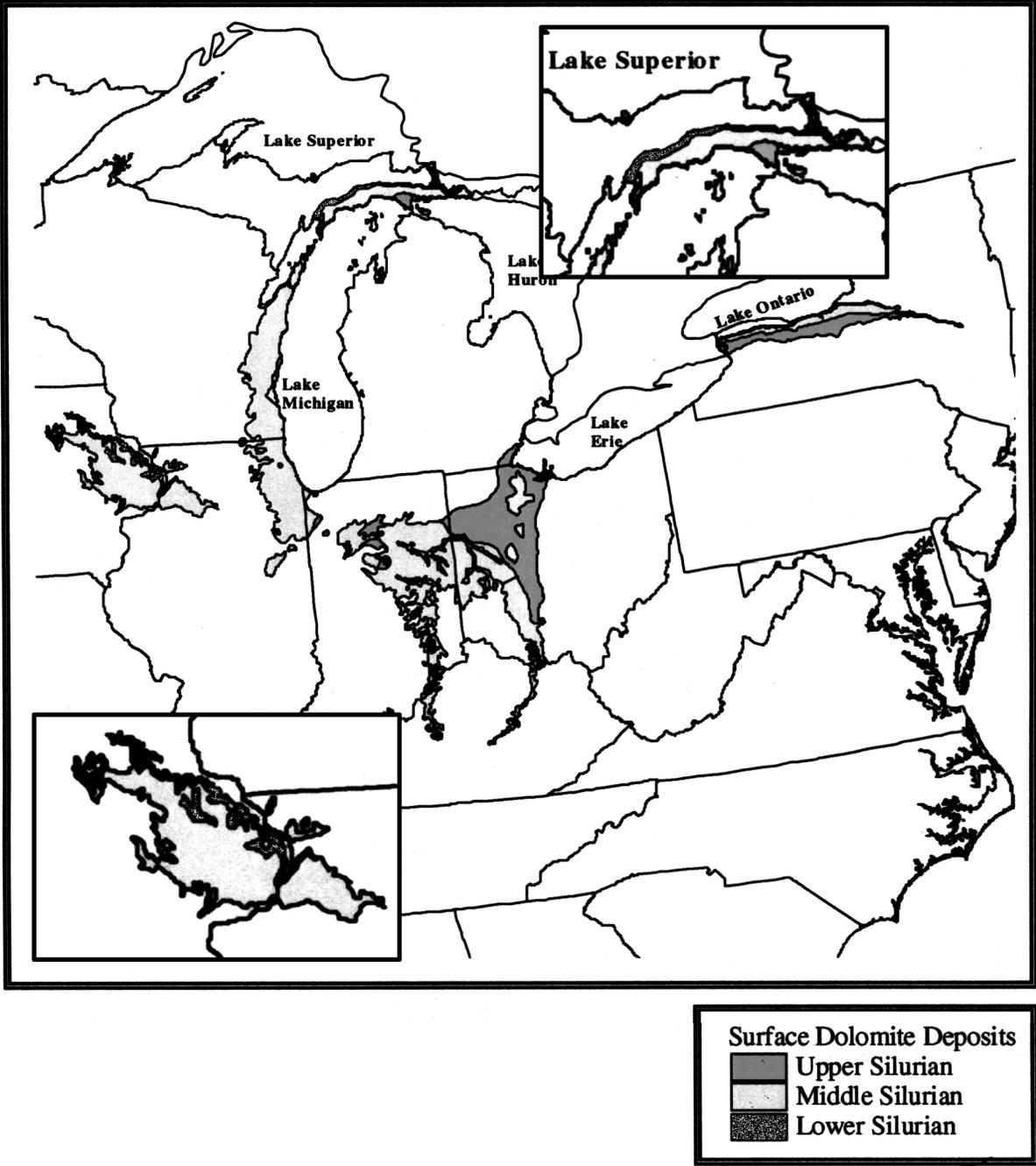


Table 3. Odonates indicative of Hine’s emerald dragonfly habitat. The listed odonate species are indicative of areas where *S. hineana* may be found. These species can aid in identifying suitable *S. hineana* habitat. This table is not a complete list of odonate species associated with *S. hineana*.

	Illinois	Wisconsin	Michigan
ANISOPTERA - DRAGONFLIES			
Aeshnidae - Darners			
<i>Aeshna canadensis</i>		X	X
<i>Aeshna constricta</i>	X		
<i>Aeshna sitchensis</i>			X
<i>Aeshna umbrosa</i>	X	X	X
<i>Aeshna verticalis</i>			X
Corduliidae - Green-eyed Skimmers			
<i>Epitheca (Tetragoneuria) canis</i>		X	
<i>Somatochlora forcipata</i>			X
<i>Somatochlora incurvata</i>			X
<i>Somatochlora kennedyi</i>			X
<i>Somatochlora walshii</i>		X	X
<i>Somatochlora williamsoni</i>		X	X
Libellulidae - Common Skimmers			
<i>Leucorrhinia hudsonica</i>			X
<i>Leucorrhinia proxima</i>			X
<i>Libellula semifasciata</i>	X		
<i>Nannothemis bella</i>			X
<i>Sympetrum costiferum</i>		X	X
<i>Sympetrum danae</i>		X	X
<i>Sympetrum rubicundulum</i>	X	X	
<i>Sympetrum semicinctum</i>	X	X	
ZYGOPTERA - DAMSELFLIES			
Lestidae - Spreadwing Damselflies			
<i>Lestes dryas</i>	X	X	X
<i>Lestes forcipatus</i>	X		X
<i>Lestes unguiculatus</i>	X		
Coenagrionidae - Narrow-winged Damselflies			
<i>Amphiagrion saucium</i>	X		X
<i>Chromagrion conditum</i>		X	

