5-YEAR REVIEW
Hine's Emerald Dragonfly (*Somatochlora hineana*)

GENERAL INFORMATION:

**Species:** Hine's emerald dragonfly (*Somatochlora hineana*)
**Date listed:** January 26, 1995
**FR citation(s):** 60 FR 5267-5273
**Classification:** Endangered species

BACKGROUND:


**FR Notice citation announcing this status review:** 83 FR 18075, Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of Five Listed Animal Species, April 25, 2018.

ASSESSMENT:

**Information acquired since the last status review:**
This 5-year review was conducted by the U.S. Fish and Wildlife Service's (USFWS) Chicago, Illinois Field Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on April 25, 2018. We also conducted a literature search and a review of information added to our files since the last review. USFWS Field Offices within the Hine’s emerald dragonfly’s range, Illinois, Michigan, Missouri and Wisconsin were provided a draft of this five-year review for their input.

We have reviewed the most recent status review and assessed new information on the Hine’s emerald dragonfly. The most recent status review is still an accurate assessment of the species status and threats, however, we note new progress in the areas of sites occupied and conservation of the species.

Distribution and Status

While there is not information indicating a significant change in population numbers, there have been seven new sites confirmed since the last 5-year review in 2013. Two of the recently confirmed sites have verified breeding habitat that have geological characteristics that are different than what is typical for Hine’s emerald dragonfly habitat, specifically the soil depth to bedrock. This new information suggests that the species is not as habitat limited as previously
understood; however, this information does not change our understanding of the species’ needs or how the species is influenced by threats or stressors. The following is an update on Hine’s emerald dragonfly populations by state.

Illinois
Breeding Sites Verified in Illinois Since Previous 5-year Review

*Galloping Hill Fen - Spring Creek Valley Forest Preserve, Cook County, Illinois*

In June 2014, an Ecologist with the Forest Preserve District of Cook County, Deborah Antlitz identified and photographed an adult male Hine’s emerald dragonfly at Galloping Hill Fen in northwest Cook County, Illinois. The photograph was verified to be a Hine’s emerald dragonfly by Dr. Daniel Soluk, University of South Dakota, Dr. Everett Cashatt, Illinois Museum (now retired), and Kristopher Lah, Service - Chicago Illinois Field Office. On July 1, 2014 at noon a single male Hine’s emerald dragonfly was photographed on the wing at low resolution. On July 4, 2014, a Hine’s emerald dragonfly was confirmed by close-up photography. Subsequent visits throughout the year by Deborah Antlitz and Dr. Soluk detected three adult male Hine’s emerald dragonflies, likely on territorial patrol over small streamlets in a sedge meadow near a calcareous spring. They also documented a one possible female (on the wing) (Illinois Department of Natural Resources Element Occurrence Record 2014). Again, in June 2015, multiple observations of male Hine’s emerald dragonflies were observed doing territorial patrols at the site, and photographed by Deborah Antlitz and Marla Garrison, Service volunteer (Garrison 2015 and Illinois Department of Natural Resources Endangered Species Element Occurrence record 2015). As a result of the multiple adult observations and behavior indicative of breeding, a larval habitat assessment and sampling was conducted to confirm breeding habitat (June through August 2015). A streamlet and flowage systems at Galloping Hill Fen in the Spring Creek Forest Preserve was sampled to confirm that this area in Cook County as breeding habitat for Hine’s emerald dragonfly (Soluk et al. 2016).

*Argonne National Laboratory, DuPage County, Illinois*

In 2016 and 2017, adults and larvae Hine’s emerald dragonfly were verified in different areas of Argonne National Laboratory property by surveys performed under contract by Dr. Soluk at the University of South Dakota (T. Velat, Forest Preserve District of DuPage County, e-mail and maps July 22, 2016 and Dr. D. Soluk, University of South Dakota, e-mail and maps June 30, 2017). The discovery of larval habitat at the Argonne National Laboratory as well as those at Spring Lake Valley Forest Preserve are particularly interesting because the dolomitic bedrock at these sites is approximately 20 meters below the surface (typical Hine’s emerald dragonfly larval habitat has bedrock within a few meters of the surface).

Adult Hine’s Emerald Dragonfly Observations Verified Since Last 5-year Review

*Spring Lake Nature Preserve – Spring Creek Valley Forest Preserve, Cook County, Illinois*

Multiple observations of adult male Hine’s emerald dragonflies have been reported for Spring Lake Nature Preserve in 2014, 2015 and 2016 (Cashatt, 2016, Garrison 2015 and 2016). While some of these observations where of adult male Hine’s emerald dragonflies on territorial patrol, larval surveys have not yet been conducted at this location. Spring Lake Nature Preserve is also part of the Spring Creek Valley Forest Preserve but it is approximately three miles north of Galloping Hill Fen where Hine’s emerald dragonfly larval habitat and multiple adult observations have been confirmed (see above).
Cherry Hill Woods and Horsetail Lake, Cook County Illinois
In 2014-2016, Marla Garrison observed and photographed both male and female Hine’s emerald dragonfly at Cherry Hill Woods near potential breeding habitat and nearby Horsetail Lake (Cashatt 2015 and 2016; Garrison 2016). However, in the fall of 2016, biologists with the Service, Illinois Department of Natural Resources, and the Forest Preserve District of Cook County were not able to confirm the presence of Hine’s emerald dragonfly after sampling several burrows at Cherry Hill and Horsetail Lake (K. Lah, U. S. Fish and Wildlife Service, pers. comm. October 2016).

Palos Fen Nature Preserve, Cook County, Illinois
In 2012, a citizen reported observing an adult male Hine’s emerald dragonfly conducting a territorial patrol, which is indicative of larval habitat at Palos Fen Nature Preserve in Cook County, Illinois. Photographs were submitted and multiple Hine’s emerald dragonfly experts confirmed that the pictures were of an adult Hine’s emerald dragonfly. In 2014, Marla Garrison surveyed Palos Fen and reported an unidentified Somatochlora female that was seen flying an area of standing shallow water with low vegetation on the southeast side of the fen (Cashatt 2015). In 2016, Garrison (2016) verified the presence of up to four adult male Hine’s emerald dragonflies at the fen as well as 2-3 female unidentified Somatochlora.

Private Property, Winnebago County, Illinois
In July 2018, Hine’s emerald dragonflies were confirmed from photographs submitted by Joyce Gibbons and Edward Cope, Natural Lands Institute. The photograph identifications were confirmed by Dr. Daniel Soluk, University of South Dakota, Dr. Everett Cashatt, Illinois Museum (retired) and Kristopher Lah, Service to be Hine’s emerald dragonflies. Kristopher Lah visited the site with Joyce Gibbons, Edward Cope and others in September 2018. The site contains appropriate habitat conditions to provide larval habitat for the Hine’s emerald dragonfly, including slow moving groundwater as sheet flow through hummocks containing crayfish burrows (K. Lah, U.S. Fish and Wildlife Service, pers. comm. September 2018).

Michigan
Adult Hine’s Emerald Dragonfly Observation Verified Since Last 5-year Review
On August 4, 2015, adult Hine’s emerald dragonflies were observed at Summerby Swamp, increasing the occurrence distribution (Cashatt 2016). The species was found during a meander survey just south of Summerby Swamp, south of Highway M-123 where a large wetland complex consists of mainly cedar swamp with small pockets of open areas of northern fen habitat.

Missouri
In 2014, the Missouri Hine’s Emerald Dragonfly Study Group estimated the population size of Hine’s emerald dragonfly at Johnson Shut-ins State Park in Reynolds County, Missouri (walker and Smentowski 2014). They did a mark-recapture study where they marked and released 112 Hine’s emerald dragonflies, 80 males and 32 females, from June 16 through June 20. They made 154 recapture observations starting June 17 through July 13. The estimate of the population is 176 individuals, 103 males and 73 females.
Cashatt reported (2016) that in 2015, another mark-recapture study was conducted in Missouri at Centerville Slough, Reynolds County. A total of 99 individuals were marked; 49 were recaptured. Researchers noted that the study may have been impacted by the rain events early in the first week. Additional observations were made between June 29 and July 7, 2015 to identify previously marked individuals. There were five incidental takes, which were preserved for DNA studies.

**Adult Hine’s Emerald Dragonfly Observation Verified since Last 5-year Review**  
**Private Property, Reynolds County, Missouri**  
In 2015, Richard Day surveyed for new potential Hine’s emerald dragonfly habitat in Reynolds County revealed a new site at a fen on private property. One male was vouchered from this site (Cashatt 2016).

**Wisconsin**  
No status updates.

**Conservation Agreements:**  
A habitat conservation plan (HCP) was approved and a 20-year incidental take permit was issued to Commonwealth Edison in 2014 (Commonwealth Edison, 2014 Low-Effect Habitat Conservation Plan for the Hine’s emerald Dragonfly, Blanding’s Turtle, Spotted Turtle, Black-billed Cuckoo, Lakeside Daisy and Leafy Prairie Clover). The area of land that is subject to this HCP includes a Planning Area that is approximately 2,901 acres that also consists of a Permit Area that is approximately 403 acres. The overriding biological goal of this HCP is to contribute to the conservation of the federal and state threatened and endangered species found in the permit area: Federal and Illinois endangered Hine’s emerald dragonfly, and its critical habitat in Illinois; Illinois endangered Blanding’s turtle (*Emydoidea blandingii*); Illinois endangered spotted turtle (*Clemmys guttata*); Illinois threatened black-billed cuckoo (*Coccyzus erythropthalmus*); Federal threatened and Illinois endangered lakeside daisy (*Hymenoxys acaulis*); Federal and Illinois endangered leafy prairie clover (*Dalea foliosa*).

**Recovery Actions:**  
**Research and Development of Environmental Deoxyribonucleic acid - eDNA**  
Environmental Deoxyribonucleic acid (eDNA) has been an exciting area of research and development for to address the time consuming and costly challenge of locating Hine’s emerald dragonfly habitat and verifying breeding habitat. Historically, Hine’s emerald dragonfly habitats were detected using adult or larval surveys. However, adult Hine’s emerald dragonfly can range over distances of at least 5.4 km (3.4 miles) (Cashatt and Vogt 1996), so observing an adult Hine’s emerald dragonfly is only indicative of the presence of the species in a general area. Adult surveys are also difficult because the entire flight period is only 4-6 weeks and during that time adults are only active on sunny days when temperature and wind conditions are suitable. Field surveys for Hine’s emerald dragonfly larvae occur over a longer season and identify specific areas of habitat within a wetland system. An alternative to costly and time-intensive surveys for HED is the use of eDNA, DNA extracted directly from the environment. This methodology has been used to successfully detect the presence of rare species or those of
conservation concern in the last few years (Francis-Thomsen et al. 2011). Environmental DNA is especially promising for reducing the time and personnel costs associated with surveying for the Hine’s emerald dragonfly within complex landscapes. The relatively simple sample collection methods used in eDNA monitoring will also work well with potential Hine’s emerald dragonfly habitat because of the low flows and volumes in most systems where the larvae are present. Furthermore, the ability to collect samples from areas downstream of larval streamlet habitat may ameliorate issues of access to larval habitat that can limit surveying in some cases.

Working under a Service funded Science Support Partnership Grant, researchers at the U.S. Geological Survey and University of South Dakota mapped the complete mitochondrial genome of the endangered Hine’s emerald dragonfly and developed two eDNA markers each for the Hine’s emerald dragonfly and the devil crayfish (Cambarus Diogenes) (Jackson et al. 2018). These markers have successfully detected eDNA from both species in lab and field samples. Results from lab experiments with these markers suggest optimum sampling temperatures and duration of eDNA persistence in the environment. We have used the Hine’s emerald dragonfly markers to identify unknown larvae from Michigan collected in 2015 as Hine’s emerald dragonfly. They also determined that the markers can be used to identify Hine’s emerald dragonfly exuviae. Identification of small larvae and exuviae will be useful to managers.

Using Hine’s emerald dragonfly and devil crayfish eDNA detection protocols simultaneously in the field, will allow the Service to more efficiently prioritize survey locations on a landscape level even at spatial scales where Hine’s emerald dragonfly is relatively rare. This is because areas that do not contain devil crayfish are unlikely to support the dragonfly. As with Hine’s emerald dragonfly the development of the eDNA markers has included extensive testing to minimize the probability of false positives generated by other species. However, defining the detection limits under field conditions will still require substantial additional efforts that will need to include evaluating eDNA presence for this species across a wide range of densities and field conditions.

Captive Rearing
The Lower DesPlaines River Valley (Cook, DuPage and Will Counties of Illinois) population of Hine’s emerald dragonfly is in the most danger of near-term extirpation; a rapidly developing urban matrix has fragmented the habitat into small patches. Soluk and Mierzwa (2012) estimated that the Lower DesPlaines River Valley population generates only 86-313 adults per year and has been on a downward trend since the 1990s. This exposes the population to extirpation by demographic stochasticity. Given the urgency of the situation, two strategies have been implemented to recover the population: 1) habitat restoration/creation, and 2) augmentation of the population in existing and restored habitat.

The ongoing captive rearing and population augmentation project was designed to produce individuals for reintroduction or augmentation without requiring significant impact to adult production from existing sites. It accomplishes this by having trained personnel collect either eggs or recently hatched or young of year larvae from the field, where they have very little chance of surviving 5 years as larvae to become adults, and moving them into captivity where they may have more than a 30% survival rate to adult.

- In 2015, over 1,600 eggs were collected from 9 females. In addition, 880 (approx.) eggs were collected from Door County, Wisconsin (Soluk 2016a).
• In 2016, Overall number of eggs collected from the Illinois population was approximately 865 from 9 females, for a yield of only 8.3 eggs per person hour (Soluk 2016b).

• In 2016, 16 adults were released into the Lower DesPlaines River Valley population (Soluk 2017).

• In 2017, approximately 1,758 eggs were collected from 13 females in the Lower DesPlaines River Valley population for a yield of only 8.3 eggs per person x hour. In addition, 958 eggs were collected from 5 females in Wisconsin (Soluk 2018).

• In 2017, 18 adults had emerged in e-cages, and 11 were from Illinois and were released into the Lower DesPlaines River Valley population (Soluk 2018).

• In 2018, approximately 3,579 eggs were collected from 15 females in the Lower DesPlaines River Valley (25 total females captured). In addition, approximately 2,030 eggs were collected from 11 females in Wisconsin of the 21 total females captured (Soluk 2018).

• In 2018, 45 Hine’s emerald dragonfly larvae had emerged successfully as adults and 43 of these were released back into the Lower DesPlaines River Valley population (Soluk 2018).

For mass captive rearing to successfully augment the Lower DesPlaines River Valley population and reduce its chances of being extirpated, there will need to be substantial increases in the effort to collect females and obtain eggs. Given that the population in the Lower DesPlaines River Valley may be experiencing steep declines, collecting more females and eggs will be difficult in the near future.

Conclusion:
After reviewing the best available scientific information, we conclude that the Hine’s emerald dragonfly remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in our 2013 status review remains an accurate reflection of the species current status.

RECOMMENDATIONS FOR FUTURE ACTIONS

1) Continue to implement Hine’s emerald dragonfly captive rearing and augmentation in the Lower DesPlaines River Valley population.

2) Coordinate efforts with partners to restore and manage larval and adult (including recharge areas) habitat in existing, historic, and new sites as they are verified.

3) Assist in groundwater and habitat protection, enhancement and management efforts:

4) Identify and survey potential larval habitat.

5) Conduct a range wide species distribution model using a GIS-based method to produce predictive maps of where Hine’s emerald dragonfly larval habitat is likely to occur.
6) Implement eDNA survey protocols with partners across the species historic range.

7) Monitor and estimate the size of Hine's emerald dragonfly populations.
Lead Field Supervisor, Fish and Wildlife Service

Approve ___________________________ Date 4/30/19

Acting for
Louise Clemency
Literature Cited


T. Velat, Forest Preserve District of DuPage County, e-mail and maps July 22, 2016 and Dr. D. Soluk, University of South Dakota, e-mail and maps June 30, 2017.