Protected Aquatic Insects of Latvia – *Nehalennia speciosa* (CHARPENTIER, 1840) (Odonata: Coenagrionidae)

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Abstract: The Sedgling or Pygmy damselfly, *Nehalennia speciosa* (CHARPENTIER, 1840), is protected by the Regulations of the Cabinet of Ministers of Latvia. Published and all known unpublished data have been used to present and analyse its distribution, population size, habitat selection and conservation status. The distribution of *N. speciosa* has been mapped using a basic grid of 5x5 km squares in the Baltic grid system. In total, *N. speciosa* has been recorded from 36 squares and 38 localities occurring sparsely or in small concentrations over a large part of the country apart from its western territories. The majority of the recent localities are situated in northeastern and southeastern Latvia. The known pattern of the species' distribution partly results from the abundance and density of appropriate habitats and possibly a climatic influence. However, this also may be a consequence of an insufficient and uneven odonatological exploration of the country. The majority of the species' populations seem to be small. *N. speciosa* has mostly been recorded in primary habitats in Latvia, such as complexes of lakes with *Sphagnum* fens, transition mires and bogs, with a diverse, not only small, size of water body. The sedgling inhabits spatially restricted fragments of these habitats, i.e. a transition-mire zone bordering the open water table or fenny and boggy patches with a higher water level, both habitats overgrown with a specific vegetation predominated by narrow-leaved sedges. Post-excavation peaty pools in degraded raised bogs with natural regeneration play a major role among rare secondary habitats of the species. The flight season of the *N. speciosa* in Latvia ranges mainly from mid June to late July. The conservation status of the species in Latvia is described and conservation measures are suggested.

Key words: Odonata, *Nehalennia speciosa*, distribution, habitat selection, protected species, conservation, Latvia.

Introduction

The sedgling or Pygmy damselfly, *Nehalennia speciosa* (CHARPENTIER, 1840), is a trans-Palaearctic species with a very large extent of occurrence. However, it is declining and is already regionally extinct in many areas across its range. In Europe, it currently exists mostly in very small areas, at individual and widely scattered localities or in their small concentrations (Bernard, Wildermuth 2005). Available habitat continues to decline due to the drainage of wetland areas and climatic changes. Pollution and overgrowth of habitats also threaten the survival of this species. (Bernard, Wildermuth 2005, 2006). Therefore, *N. speciosa* has been classified as Near Threatened (NT) in the global IUCN Red List of Threatened Species (Bernard, Wildermuth 2006) and in the European Red List of Dragonflies (Kalkman et al. 2010), and in the European Union even as Vulnerable with the decreasing population trend (Kalkman et al. 2010).

This paper continues the series of publications on protected aquatic insects in Latvia in which two articles have already been published (Kalniņš 2007, 2008).The aim of this paper is to summarize the knowledge of the distribution and habitats of *N. speciosa* in Latvia. This damselfly is protected in Latvia (Regulations… 2000), but so far the data on it have not been analysed and the species' current conservation status has not been assessed.

Methods

The analysis of distribution and habitat preference is based on: (a) all published data,

(b) our own unpublished data collected between 2002 and 2010, (c) unpublished data collected by Latvian entomologists before 2011, including the project "*Analysis of the Specially Protected Nature Territories in Latvia and the Establishment of the EMERALD/Natura 2000 Network*" in 2001–2002, (d) the material found in collections of the following institutions: (i) Department of Zoology and Animal Ecology of the Faculty of Biology of the University of Latvia, Rīga, (ii) Institute of Biology of the University of Latvia, Salaspils, and (iii) the Natural History Museum of Latvia, Rīga. Both historical and recent data, in total 53 records of *N. speciosa*, were included in a Microsoft Office Access database prepared by one of the authors (M. Kalniņš).

The distribution of *N. speciosa* has been mapped using a basic grid of 5x5 km squares in the Baltic grid system on a Transverse Mercator projection (TKS-1993) of Latvia. The final map is based on 1:50000 scale satellite maps available for Latvia, published in 1999–2000 by the State Land Service of the Republic of Latvia.

The data on habitats (inter alia photo) were collected by the authors in the field, some physico-chemical parameters were taken from Internet resources Ezeri.lv (2011). Data on particularly protected nature territories come from the website of the Nature Conservation Agency (Nature Conservation… 2011).

Explanations of abbreviations: Ns – *Nehalennia speciosa*, PPNT – particularly protected nature territory, r. – region, vill. – village. The number of observed imagines of *N. speciosa* (Ns) is given after the date of observation and followed by references or the author of unpublished data, as e.g. (M. Kalniņš). The regions are named according to the Law on administrative territories and populated areas (2008). Some of the regional names are concurrent with district names, used by the author in previous papers (Kalniņš 2007, 2008).

Results

Thirty eight localities of *N. speciosa* have been recorded in Latvia so far. They are listed below in three sections – localities in western Latvia, in northeastern Latvia, and in the southeastern part of the country. Geographical coordinates are only given for several localities, localisation of which could be difficult. Vegetation descriptions concern a zone inhabited by *N. speciosa*. If this information was not included in the original publication, the data on vegetation concern its current composition.

Localities in the West of Latvia

1. Sapņu Lake (Talsi r.). 06.06.1960, Ns: 1 male (Spuris 1963). A small (0.3 ha) dystrophic, brownwater lake, at present bordered by a narrow zone of fen and transition-mire vegetation with *Carex rostrata*, *Menyanthes trifoliata*, *Comarum palustre*, *Sphagnum* sp., *Calla palustri*s, *Cicuta virosa*. The locality has had PPNT status since 1987 and is situated in the nature park "Talsu paguraine" and in the NATURA 2000 area (site code: LV0302000).
2. Engure Lake (Engure, Tukums, Talsi, Mērsrags r.). 1958, Ns: imagines found during the limnological investigations of this large lake with highly diverse habitats (Spuris 1960), but the species reported without any detailed information on the numbers of population and the date and site of observation. In other papers (Inberga-Petrovska 2003; Volskis 1999), the authors just cite the previous source. The locality has had PPNT status since 1957 and is situated in the nature park "Engures ezers" and in the NATURA 2000 area (site code: LV0302800).
3. An old peat-excavation pool (< 1 ha) in the peat bog N of Liliju Lake, Ķemeri National Park, 56°53'48" N 23°31'42" E (Babītes r.). Vegetation with *Sphagnum* sp., *Carex limosa* and *C. rostrata* (Fig. 4). 11.06.2006, Ns: more than 10 individuals in *C. limosa* (M. Kalniņš). Since 2006 a project for the restoration of the bog's hydrological regime – earlier seriously disturbed due to drainage – has been carried out resulting in an increased water level that will certainly improve the habitat conditions for *N. speciosa* (Ķuze, Priede 2008).
4. A small dystrophic brownwater lake near the S bank of Slokas Lake, Vecais Bog, Ķemeri National Park, 56°56'55" N 23°33'22" E (Jūrmala city). 1–5 m wide belt of *Carex rostrata* bordering the water table. 28.05.2010, Ns: 1 (M. Kalniņš).

The distance between localities No. 3 and 4 is 6 km. Localities have had PPNT status since

1997. They are situated in the NATURA 2000 area (site code: LV0200200).

5. Vīķu Bog, Lielauce Lake (Auce r.). 06.07.1950, Ns: at most 10 individuals in the part of the lake overgrown with vegetation (Spuris 1952; 1956), but not described in detail – the lake is large and rich in diverse habitats. The locality has had PPNT status since 1999. It is situated in the nature reserve "Vīķu purvs" and in the NATURA 2000 area (site code: LV0504700).

Localities in the Northeast of Latvia

6. Kangaru Lake (Ropaži r.). 20.06.2010, Ns: 1 male, (U. Piterāns, photo in www.dabasdati.lv). A dyseutrophic lake with rich and diverse vegetation, also with plant species appropriate for *N. speciosa*, such as: *Carex limosa*, *C. lasiocarpa*, *C. rostrata*, *Sphagnum* sp. The locality has had PPNT status since 1957. It is situated in the nature reserve "Lielie Kangari" and in the NATURA 2000 area (site code: LV0513400).

7. Dūņezers (Lēpītis) Lake near Garkalne (Garkalne r.). 24.07.1950, Ns: 2 males, 1 female (Spuris 1952; 1956). At present, the water table (ca. 0.9 ha) almost totally overgrown with *Carex* sp. and *Phragmites australis*.

8. Grabatiņš Lake (Krimulda r.). Bordered by a narrow (1–5 m) *Sphagnum* zone with *Carex limosa*. 31.07.2005, Ns: 2 males (R. Bernard, M. Kalniņš).

9. Linezers Lake (Krimulda r.). A mesotrophic and dysmesotrophic complex of lake and fens (also *Sphagnum* fens) with a diverse vegetation; *N. speciosa* observed within large mesotrophic *Caricetum lasiocarpae* overgrowing shallow (5–30 cm) water, with rich admixtures of *Equisetum fluviatile*, *Carex rostrata*, *Eriophorum* sp., *Menyanthes trifoliata*, *Scheuchzeria palustris*, *Typha latifolia*, *Hydrocharis morsus-ranae*, but without *Sphagnum*. 03.07.2003, Ns: numerous individuals (M. Kalniņš); 31.07.2005, Ns: several individuals observed, the population estimated at a few dozen individuals, (R. Bernard, M. Kalniņš). The locality has had PPNT status since 1999 as is included in the nature reserve "Linezers" and in the NATURA 2000 area (site code: LV0525200).

The distance between Grabatiņš Lake and Linezers Lake is 7 km.

10. Dravnieku Pond, 57°13'05" N 25°06'41" E (Līgatne r.). A man-made water body of unclear origin, possibly an extensive fish pond. 06.07.2006, Ns: 3 individuals. (D. Teļnovs). In 2009, the pond was drained (D. Teļnovs, pers. comm.). The locality has had PPNT status since 1973. It is situated in the Gauja National Park and in the NATURA 2000 area (site code: LV0200100).

11. Zilūžu Lake near Bērzaine vill. (Valmiera r.). A complex of lake, fens and a transition-mire with an abundant and diverse vegetation; *N. speciosa* observed in sedge formations (*Carex rostrata* and *Carex lasiocarpa*) with admixtures of *Equisetum fluviatile*, *Eriophorum angustifolium*, *Typha latifolia*. 04.07.2009, Ns: 1 (M. Kalniņš). The locality has had PPNT status since 1997 and is situated in the Northern Vidzeme Biosphere Reserve.

12. Burtnieku Lake (Burtnieku r.). 05.07.1962, Ns: "several dozen" [individuals] (Spuris 1963). A large lake with diverse vegetation; the exact locality and habitat of *N. speciosa* are not described. The locality has had PPNT status since 1997 and is included in the Northern Vidzeme Biosphere Reserve.

13. Seda Bog, its W edge 3 km NW of Seda (Strenči r.). Small and shallow post-excavation peat pools with *Caricetum rostratae* and *Caricetum lasiocarpae*. 26.06.2005, Ns: 5 individuals (M. Kalniņš); 02.08.2005, Ns: 1 old female in *Caricetum lasiocarpae* (R. Bernard, M. Kalniņš); 2006, Ns: "some individuals in two places" (A. Barševskis), ca 1 km N–NW of the site studied in 2005. The locality has had PPNT status since 1997. It is included in the Northern Vidzeme Biosphere Reserve, in the nature reserve "Sedas purvs" and in the NATURA 2000 area (site code: LV0526800).

14. Bednes Bog, 57°36'06" N 26°11'41" E (Valka r.). A small pool bordered with a transition-mire vegetation with *Equisetum fluviatile*, *Carex lasiocarpa*, *Eriophorum angustifolium, Sphagnum* sp. 09.06.2002, Ns: numerous individuals (M. Kalniņš). The locality has had PPNT status since 1977 and is included in the nature reserve "Bednes purvs" and in the NATURA 2000 area (site code:

LV0515800).

15. Līdaču Lake (Valka r.). A small lake with a diverse vegetation; *N. speciosa* in a narrow zone of a transition-mire vegetation (*Sphagnum* sp., *Carex lasiocarpa*, *Carex rostrata*, *Menyanthes trifoliata*, *Comarum palustre*) bordering the water table. 28.06.1963, Ns: "several dozen" [individuals] (Spuris 1964).

16. Klotiņu Lake (Alūksne r.). Bordered with transition-mire vegetation mainly formed by *Sphagnum* sp., *Carex rostrata* and *Equisetum fluviatile*, with admixtures of *Comarum palustre*, *Menyanthes trifoliata*, *Lysimachia thyrsiflora*, *Calla palustris*, *Thelypteris palustris*, *Phragmites australis*. 11.07.1963, Ns: ca. 10 individuals (Spuris 1964). The locality has had PPNT status since 1977. It is situated in the protected landscape area "Veclaicene" and in the NATURA 2000 area (site code: LV0600200).

17. Koruļu Lake (Alūksne r.). Bordered with a transition-mire vegetation mainly formed by *Carex rostrata*, *Menyanthes trifoliata* and *Equisetum fluviatile*, with some amounts of *Sphagnum* sp. and admixtures of *Comarum palustre*, *Lysimachia thyrsiflora*, *Calla palustris*, *Thelypteris palustris*, *Typha latifolia*. 11.07.1963, Ns: imagines (Spuris 1964). The locality has had PPNT status since 1977. It is situated in the protected landscape area "Veclaicene" and in the NATURA 2000 area (site code: LV0600200).

18. Mazais Paiķis Lake (Alūksne r.). A small dystrophic, brownwater lake bordered by a transition-mire vegetation consisting of *Sphagnum* sp., *Equisetum limosum Carex rostrata*, *C. limosa*, *C. lasiocarpa*, *C. diandra*, *Menyanthes trifoliata*, *Comarum palustre*, *Eriophorum angustifolium*, *Lysimachia thyrsiflora*, *Typha latifolia* (Fig. 3). 09.07.1963, Ns: "relatively numerous", 20.06.1964, Ns: imagines (Spuris 1964), 27.06.2010, Ns: ca. 30 individuals (M. Kalniņš; I. Miķelsone). The locality has had PPNT status since 1977. It is situated in the protected landscape area "Veclaicene" and in the NATURA 2000 area (site code: LV0600200).

Klotiņu Lake is situated only 1 km from Koruļu Lake and the latter – 3 km from Mazais Paiķis Lake.

19. Sīļu Lake N of Mārkalne vill. (Alūksne r.). Bordered partly by *Phragmites australis* and partly by broad *Sphagnum* mats where the transition-mire vegetation adjacent to the water table is mostly formed by *Sphagnum* sp., *Carex rostrata*, *C. lasiocarpa*, *C. limosa*, *C. diandra*, *Comarum palustre*; 04.08.2005, Ns: 2 individuals (R. Bernard, M. Kalniņš).

20. Tubuļa Lake NW of Mārkalne vill. (Alūksne r.). A small lake surrounded by *Sphagnum* mats with numerous water 'canals' and bays; a transition-mire vegetation bordering the water table and overgrowing 'canals' consists of *Carex lasiocarpa*, *C. diandra*, *C. limosa*, *C. rostrata*, *Menyanthes trifoliata*, *Comarum palustre*, *Thelypteris palustris*, *Hydrocharis morsus-ranae*, *Utricularia vulgaris*, *U. minor*, *U. intermedia*. 04.08.2005, Ns: 10 individuals (mostly old females) observed, the population numbers at the end of the flight period estimated at 30 individuals (R. Bernard, M. Kalniņš).

Sīļu Lake is situated 3 km from Tubuļa Lake.

21. Alūksnes Lake (Alūksne r.). A large lake with diverse vegetation; the exact locality and habitat of *N. speciosa* are not described. 30.07.1958, Ns: 1 male (Spuris 1963).

Localities in the Southeast of Latvia

22. Ķemeru (Puseklis) Lake (Madona r.). A small dystrophic, brownwater lake surrounded by a *Sphagnum* bog, the water table bordered by a transition mire mainly with *Carex rostrata*, *Calla palustris* and *Comarum palustre*. 17.07.1964, the term "single individuals" used for several species including *N. speciosa* (Spuris 1964).

23. Šūmānu (Šūmaņu, Domiņu) Lake at the W edge of large Teiči bogs (Madona r.). In the 1960s, a small lake mostly overgrown with vegetation and with a small area of open water bordered by *Thelypteris palustris*, *Comarum palustre*, *Menyanthes trifoliata*, *Typha latifolia*, *Sphagnum* sp. At present, totally overgrown. 13.07.1964, Ns: 1 female (Spuris 1964); 11–27.06.1997, "fairly numerous imagines" (Matthes & Matthes 1997), their habitat not described. The locality has had

PPNT status since 1982. It is included in the Teiči Strict Nature Reserve and in the NATURA 2000 area (site code: LV0100500).

24. Bojartu Lake, SW of Kūku Lake (Krustpils r.). 07.07.1960, Ns: 1 male (Spuris 1963). The habitat not described. This locality has not been found on topographic maps, its geographic situation has only been marked (Fig. 1) according to the general map given by Spuris (1963).

25. Zāļezers Lake in Zaļezera Bog, 56°28'21" N 24°34'03" E (Vecumnieki r.). A small lake in a complex of bogs and fens (also alkaline). *N. speciosa* in a narrow zone along the lake, with *Carex elata* and *C. rostrata* (Fig. 5). 30.05.2010, Ns: 8 individuals including 2 tenerals (M. Kalniņš).

26. Bārbeles Lake in Zaļezera Bog (Vecumnieki r.). A brownwater dyseutrophic lake bordered by a transition mire, in places with *N. speciosa* formed by *Carex lasiocarpa, Menyanthes trifoliata, Peucedanum palustre, Equisetum fluviatile, Galium palustre, Lysimachia vulgaris* and *Sphagnum fallax*. 30.05.2010, Ns: 7 individuals (M. Kalniņš).

Localities nos. 25 and 26 are only 1 km distant. Both have had PPNT status since 1977 and are situated in the nature reserve "Zaļezera purvs" and in the NATURA 2000 area (site code: LV0502800).

27. Ļubasts Lake, SW part (Daugavpils r.). A large rather eutrophic lake almost totally overgrown with macrophytes, the exact habitat of *N. speciosa* unknown, its occurrence possibly accidental. 29.06.2006, 1 (D. Teļnovs). The locality has had PPNT status since 2004. It is situated in the nature reserve "Ļubasts" and in the NATURA 2000 area (site code: LV0534300).

28. Žīdu Lake, 0.85 km E of the railway line Daugavpils – Rīga, ca 4.5 km N of the railway station Daugavpils-Mežciems (Daugavpils r.). A rather small (2.5 ha) lake with *Sphagnum* shores, *N. speciosa* in a narrow transition-mire zone bordering the water table, mainly with *Sphagnum* sp. (soaked and floating in shallow water), *Carex lasiocarpa*, *C. limosa*, *C. rostrata*, *Lysimachia thyrsiflora* and admixtures of *Chamaedaphne calyculata*, *Carex elata*, *Menyanthes trifoliata*, *Rhynchospora alba*, *Calamagrostis stricta*, *Comarum palustre*, *Calla palustris*. 11.07.2002, Ns: 7 individuals (R. Bernard).

29. A small lake 1.1 km N of Plocins (Platinkas) Lake ca 1.2 km NE of the railway station Daugavpils-Mežciems, 55°55'34" N 26°29'42" E (Daugavpils r.). A small lake (ca 85x50 m) in a *Sphagnum* peat bog, *N. speciosa* in a narrow transition-mire zone bordering the water table, with *Sphagnum* sp. (also submerged), and low (20–30 cm) *Carex limosa* and *Rhynchospora alba*. 11.07.2002, Ns: 11 individuals (R. Bernard).

Ļubasts Lake is situated 1.8 km from Žīdu Lake and 3.8 km from locality no. 29. Žīdu Lake and the small lake no. 29 are 3.5 km distant.

30. Stropu Lake (Daugavpils city). A large lake, the exact site and habitat of *N. speciosa* not given 14.07.1958, Ns: 3 individuals (Spuris 1963).

31. Ilgas environs (Daugavpils r.) (Spuris 1998). The exact locality of *N. speciosa* not given. The locality has had PPNT status since 1977. It is situated in the nature park "Silene" and in the NATURA 2000 area (site code: LV0300400).

32. Suklādes Baltais Lake (Daugavpils r.). A rather small lake surrounded by *Sphagnum* bogs and fens. *N. speciosa* recorded in a narrow transition-mire zone bordering the water table of small lake bays and in a small flooded depression in *Sphagnum* mats. The vegetation in these places mainly formed by *Carex lasiocarpa* (selected by *N. speciosa*), *Carex rostrata* and *Thelypteris palustris*, with admixtures of *C. limosa*, *Agrostis canina*, *Comarum palustre*, *Typha angustifolia*, *Utricularia minor*, *U. intermedia*. 06.08.2005, Ns: 5 individuals, near the end of the flight period (R. Bernard, M. Kalniņš).

33. Mazais Āžuknis (Ožukns, Ožuhņu) Lake (Krāslava r.) 05 and 12.07.1953, Ns: up to 10–15 specimens at both dates (Spuris 1956). The lake partly bordered with transition-mire vegetation, also with *Sphagnum* sp., *Carex* sp and *Menyanthes trifoliata*, but the exact habitat of *N. speciosa* not described. The locality has had PPNT status since 1977. It is situated in the nature park "Dridža ezers" and in the NATURA 2000 area (site code: LV0300900).

34. Rāznas Lake near Zosna vill. (Rēzekne r.). A large lake, the exact locality and habitat of *N. speciosa* not given. 08.08.1956, 1 female (Spuris 1963). The locality has had PPNT status since 2007. It is included in the Rāzna National Park and in the NATURA 2000 area (site code: LV0303400).
35. A small lake (100x60 m), 5.1 km NW of Andrupene, 2.65 km W of the western shores of the southern part of Viraudas Lake, 56°13'12" N 27°20'22" E (Rēzekne r.). The water table bounded by *Sphagnum* mats, *N. speciosa* in a narrow *Carex limosa* belt (with floating *Sphagnum*) bordering the water table. 09.07.2002, Ns: 1 (Bernard 2003).
36. Koņevas Lake to the W of Koņeva, 3 km NE of Rundēni (Rundāni), 0.3 km N of the Rundēni–Lauderi road, 56°17'49" N 27°51'26" E (Ludza r.). A mesotrophic complex of a small (100x50 m) lake, *Sphagnum* bogs, transition mires and alkaline fens. *N. speciosa* in a transition-mire zone bordering the water table and additionally in water-filled depressions in the zone of bogs and fens, mainly with *Carex elata* and additionally with *C. limosa*, *C. diandra*, *C. lasiocarpa*, *Menyanthes trifoliata*, *Rhynchospora alba*, *Scirpus hudsonianus*, *Comarum palustre*, *Thelypteris palustris*, *Utricularia intermedia*, *Scorpidium scorpioides*. 10.07.2002, Ns: al least 15 individuals, including 2 tandems and a copulation (R. Bernard).
37. A small lake (90x70 m) NW of Cucuri, S of Rundāni, 56°12'42" N 27°50'23" E (Ludza r.). A small lake surrounded by *Sphagnum* bogs. *N. speciosa* in a belt of *Carex limosa* with abundant *Sphagnum* sp. (0.2–2 m wide) bordering the water table. 06.08.2005, Ns: 10 individuals, near the end of the species' flight period (R. Bernard, M. Kalniņš).
38. Mazais Asūnes Lake (Dagda r.). A medium-sized lake almost totally overgrown with macrophytes, the habitat of *N. speciosa* not described. 30.06.2006, Ns: 2 individuals (D. Teļnovs). The locality has had PPNT status since 2004. It is included in the nature reserve "Asūnes ezeri" and in the NATURA 2000 area (site code: LV0532400).

Discussion

Distribution in Latvia

N. speciosa is a trans-Palaearctic species with the range extending between 5º and 145º E, from Belgium and France up to easternmost Japan. In Europe, the species has been recorded between northern Italy, central Romania and the Crimean Peninsula in the South and southern Sweden and southern Finland in the North, between 45.2º and 61.6º N (Bernard, Wildermuth 2005; Dijkstra 2006; Manci 2009; Skvorstov 2010). However, the species' European range has probably always been patchily populated and only locally concentrated. Bernard and Wildermuth (2005) assume that originally a core range existed in mideastern Europe comprising easternmost Germany, Poland, the Baltic States (thus Latvia), Belarus, northern Ukraine and the central latitudes of Russia.

Significant changes in distribution and population strength must have occurred in the European range of *N. speciosa*, especially drastic in the border parts of the range and more intense in the second half of the 20th century. This has become obvious in the complete withdrawal of the species from some regions and in decreased numbers of colonized localities or weakened population strengths in others. As a result, *N. speciosa* currently occurs mainly in Eastern Europe (up to Estonia, Latvia, Lithuania, N and E Poland, S Belarus, and possibly 52–54° N in Russia) and in the Bavarian Prealpine Region. In all the other regions it has survived in single or rare local populations (Bernard & Wildermuth 2005, 2006). Due to this unfavourable conservation status, the species qualifies for the category Near Threatened in both the global IUCN Red List (Bernard, Wildermuth 2006) and the European red list of dragonflies (Kalkman et al. 2010), and even for the category Vulnerable (VU) in the red list of dragonflies of the European Union (Kalkman et al. 2010).

The assessments mentioned above indicate that the territory of Latvia was and still is an important component in the European range of *N. speciosa*. The species has been recorded in 36 TKS-squares (5x5 km) in Latvia so far (Fig. 1) that constitute 4 % of the 773 Latvian squares

for which data on dragonflies are known and 1.3 % of all (2785) squares covering the territory of the country.

Sixteen localities of *N. speciosa* were recorded in the historical period (before 1991) and twenty four in the current period (from 1991). Only two of these localities were recorded in both periods, i.e. Mazais Paiķis Lake in 1963 and 2010 and Šūmānu Lake in 1964 and 1997. However, due to limited and patchy studies, especially in the past, it is impossible to compare the species' extent of occurrence and occupancy between the historical period and the current period.

The species' extent of occurrence theoretically covers the whole of Latvia. However, *N. speciosa* remains unknown west of 22°30' E and only four localities in five squares have been recorded in large areas west of 24° E (Fig. 1). This distribution pattern probably results in part from the diverse intensity of odonatological studies in various regions: they have been carried out more intensively in central and eastern parts than in the West of the country. Nevertheless, this pattern can reflect, at least partly, the true situation of the species in these areas as it resembles the picture known for Lithuania (Bernard, Wildermuth 2005; Švitra, Gliwa 2008; R. Bernard unpublished data). An analysis of a potential basis for such a pattern has not revealed a clear cause as the known distribution of *N. speciosa* does not correlate with the delineation of Latvia into physiographic regions (sensu Ramans, Zelčs 1995) or geobotanical regions (sensu Kabucis 1995). However, the richness and abundance of standing waters (lakes, small water bodies, bogs, fens), thus potential habitats of the species, undoubtedly result in greater numbers and concentration of its localities. This general correlation is especially recognizable from the example of southeastern Latvia, occupied by a lake district which is a part of a great lake chain extending through several countries. Some correlation between the distribution of *N. speciosa* and climatic regionalisation (sensu Kalniņa 1995) has also been recognisable as the majority of known localities (84 %) are situated in two climatic regions (Fig. 2). These climatic regions are characterized by higher humidity (hydrothermal coefficient 1.6–2.4) and a more continental climate in comparison with other two climatic regions (Kalniņa 1995).

Habitats and populations

N. speciosa inhabits stagnant, permanent, shallow, mostly acidic waters of low trophy, overgrown with specific vegetation predominated by narrow-leaved helophytes, especially *Carex limosa* and *C. lasiocarpa* (Bernard & Wildermuth 2005).

The habitats selected by *N. speciosa* in Latvia are mostly primary, i.e. natural. This strong preference is typical of the species in the core of its distribution range (cf. Bernard, Wildermuth 2005). In Latvia, *N. speciosa* inhabits (1) lakes and pools surrounded by fens and bogs and (2) fens and bogs with a high water level. It finds suitable microhabitats 1) in a transition-mire zone, i.e. the zone of floating and flooded vegetation bordering the open water table of lakes and pools, and (2) in shallow water bodies, such as flooded areas/depressions, within fens (more frequently) and bogs. Though this habitat selection totally coincides with the habitat's diagnosis given for Europe by Bernard and Wildermuth (2005), the habitat spectrum in Latvia is generally more fen-based than bog-based.

While Bernard and Wildermuth (2005) stressed the preference of *N. speciosa* towards small water bodies (<1 ha) in Poland and the Baltic States, lakes inhabited by it in Latvia are frequently larger than 1 ha. Fourteen out of thirty four lakes (41 %, Nos. 6, 9, 11, 15, 16, 17, 18, 19, 22, 28, 30, 32, 33, 38) are between 1 and 10 ha in size and the next nine lakes (26 %, Nos. 2, 5, 12, 21, 23, 24, 26, 27, 34) are greater than 10 ha, four of them (Nos. 2, 12, 21, 34) even greater than 1000 ha. This shows that *N. speciosa* does not avoid larger, seemingly inappropriate water bodies and can inhabit small patches of appropriate habitats within predominating obviously unsuitable habitats. At some medium-sized and large lakes *N. speciosa* could use vegetation not directly bordering the water table, but being a part of accompanying complexes of wetlands. Thus, such larger lakes, especially those dystrophic, mesotrophic and weakly eutrophic with rich and abundant surrounding vegetation, should not be excluded

a priori, but should also be carefully searched for *N. speciosa*.

The species composition of vegetation at Latvian localities is frequently rich, reflecting the mosaic nature and locally mixed or higher trophy of habitats. *Carex lasiocarpa* is the most frequent and the most abundant representative of the narrow-leaved plants preferred by *N. speciosa*. *C. limosa*, though generally slightly rarer and less abundant, is also always selected by the sedgling. The common and abundant *C. rostrata* may also be used by *N. speciosa*, but if *C. lasiocarpa* and *C. limosa* occur, they are strongly preferred. Additionally, at two localities, *C. elata* was the leading species in the habitat of *N. speciosa*. Apart from other typical components of the sedgling's habitats, e.g. *Sphagnum* sp., *Utricularia* sp., *Menyanthes trifoliata*, *Comarum palustre*, *Lysimachia thyrsiflora*, *Equisetum limosum* (cf. Bernard and Wildermuth 2005), some rather untypical plant species occur, such as *Thelypteris palustris*, *Typha latifolia*, and *Hydrocharis morsus-ranae*. Their presence suggests the dyseutrophic nature of some habitat patches.

Physico-chemical conditions are known only for several localities (Table 1). They reflect fairly acidic up to neutral water, which is poor or fairly poor in electrolytes and fairly rich or rich in huminic acids. The vegetation and physico-chemical conditions describe these four lakes as dystrophic and dyseutrophic, and meso- to polihumic.

Secondary, i.e. partly anthropogenic, habitats play a rather marginal role in the habitat spectrum of *N. speciosa* in Latvia. They are represented by two post-excavation peaty pools (Nos. 3 and 13) and a man-made water body of unclear origin, possibly an extensive fish pond (No. 10), i.e. in a total of three out of thirty seven localities (8 %) for which the kind of a water body is given. The peaty pools are situated in degraded raised bogs with an advanced natural regeneration. These localities may have long-term significance for *N. speciosa* as bogs occupy large areas and probably always included a mosaic of habitats, from active peaty post-excavation places to active raised bogs.

Due to incomplete data or late dates of observations it is impossible to reliably assess the size of the population at many Latvian localities. However, it seems that large populations are rare and small populations the most frequent. This situation is typical for all the Baltic States (Bernard and Wildermuth 2005). Only Linezers (no. 9) and Bednes Bog (14) harboured really large populations and three other localities (12, 15, 18) – at least fairly large populations while the size of seventeen populations was small or even very small. It should be stressed, however, that the data from thirteen localities are 47–61 years old and the current conservation status of these populations is unknown.

The flight period of *N. speciosa* in Europe ranges from the second decade of May till the first decade of September, but mainly from early June to early August (Bernard, Wildermuth 2005). The Latvian dates totally correspond to this period as the earliest record was made on 28th May and the latest record on 8th August. Due to the northern location of the country the main flight season of *N. speciosa* in Latvia is slightly shorter than that given for Europe and ranges from mid June to late July.

Conservation

The main factors and processes currently threatening *N. speciosa* constitute: (a) drying out of habitats as a result of drainage, extreme weather events and climatic changes (global warming), (b) changes in the species composition and structure of vegetation caused by an increased load of nutrients from deforested or agriculturally used surroundings, aerial influx and recreational activities (e.g., angling), (c) overgrowth of habitats, especially of secondary ones (Bernard & Wildermuth 2005).

In Latvia, 23 of 38 known localities have an official conservation status (PPNT) (Fig. 6). Nature management plans are prepared (or in process) for nine PPNT, which cover 11 localities. *N. speciosa* is included in six plans in the following aspects (Nature Conservation… 2011):

1) nature reserve “Zaļezera purvs”: (a) short information about new localities, the species' occurrence, habitats and threats (overgrowing with trees), (b) suggestions to

evaluate the influence of drainage ditches on Ezera Bog and to reduce this influence, (c) suggestions to build dams, especially three dams near Lake Zāļezers as well as to retain beaver dams on drainage ditches;
2) nature park "Dridža ezers": (a) an occurrence of the species according to publications (Spuris 1952, 1956) with short and general information on the habitat and flight time, (b) threats to the species such as water pollution, changes in the hydrological regime and water level influencing associations of water vegetation;
3) nature reserve "Sedas purvs": (a) information about two localities of *N. speciosa*, (b) short and general conservation suggestions such as to control the water level to prevent its decrease, to prevent the area from overgrowing by trees;
4) nature reserve "Burtnieku ezera pļavas": an occurrence of the species according to a publication (Spuris 1963) with information that suitable habitats still occur in this territory;
5) nature park "Engures ezers": an occurrence of the species species believed to be given according to unpublished data (S. Inberga-Petrovska), which actually contain published data (Spuris 1960), but without an exact locality, (b) a suggestion to search for exact *N. speciosa* localities/habitats and to evaluate habitat quality and real and potential threats to the species (M. Kalniņš);
6) Rāzna National Park: the species listed as one of the protected species occurring in the park without any other information and without a reference to the data source.

The following conservation measures are suggested for *N. speciosa* in Latvia:

POLICY. The database of the species' localities for governmental institutions should be prepared in "OZOLS", i.e. the Nature data management information system funded by the European Regional Development Fund and developed by the Nature Conservation Agency (Nature Conservation… 2011). As the process of establishing new PPNTs is quite long and complicated, we propose to include *N. speciosa* into Regulations of the Cabinet of Ministers concerning the establishment, protection and management of microreserves (Regulations… 2001). The establishment of microreserves is fairly rapid and not very complicated. At the same time there is an urgent need to improve the nature management plans for PPNTs and to include requirements concerning *N. speciosa* into these plans.

RESEARCH. The search for species at old localities and intensive search for new localities is urgently needed both in western Latvia and near known localities in other territories. As the habitats suitable for *N. speciosa* are widespread in Latvia and the habitat conditions at old localities have not changed significantly (Pakalne 2008; Ezeri.lv 2011), the sedgling probably occurs at more localities. Assessment of the size of every population is necessary and a long-term monitoring of this size is required at least for major Latvian populations.

HABITAT AND SITE-BASED ACTIONS. Priority must be given to the full conservation of all localities by their integration in officially protected territories. At the same time, a complete assessment of factors and processes currently threatening *N. speciosa* should urgently be prepared for each locality and, where it is needed, detailed conservation measures should be planned.

Species-based actions, such as local reintroduction or establishing new localities – though generally recommended (Bernard and Wildermuth 2005) and possible due to the species' genetic structure (Bernard and Schmitt 2010) – are currently unnecessary in Latvia.

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Table 1. Physico-chemical conditions in some lakes inhabited by *Nehalennia speciosa* in Latvia (according to Ezeri.lv 2011). The numbers of localities refer to the numbers given in the text.

Lake, locality No.	pH	Conductivity, µS/cm	Water colour, mg Pt/l
Sapņu, 1	5.2–6.0	31–39	82–217
Lielais Kangaru, 6	7.6	88	426
Zilūžu, 11	5.6–7.2	126	90
Bārbeles, 26	5.9–6.3	47–57	461

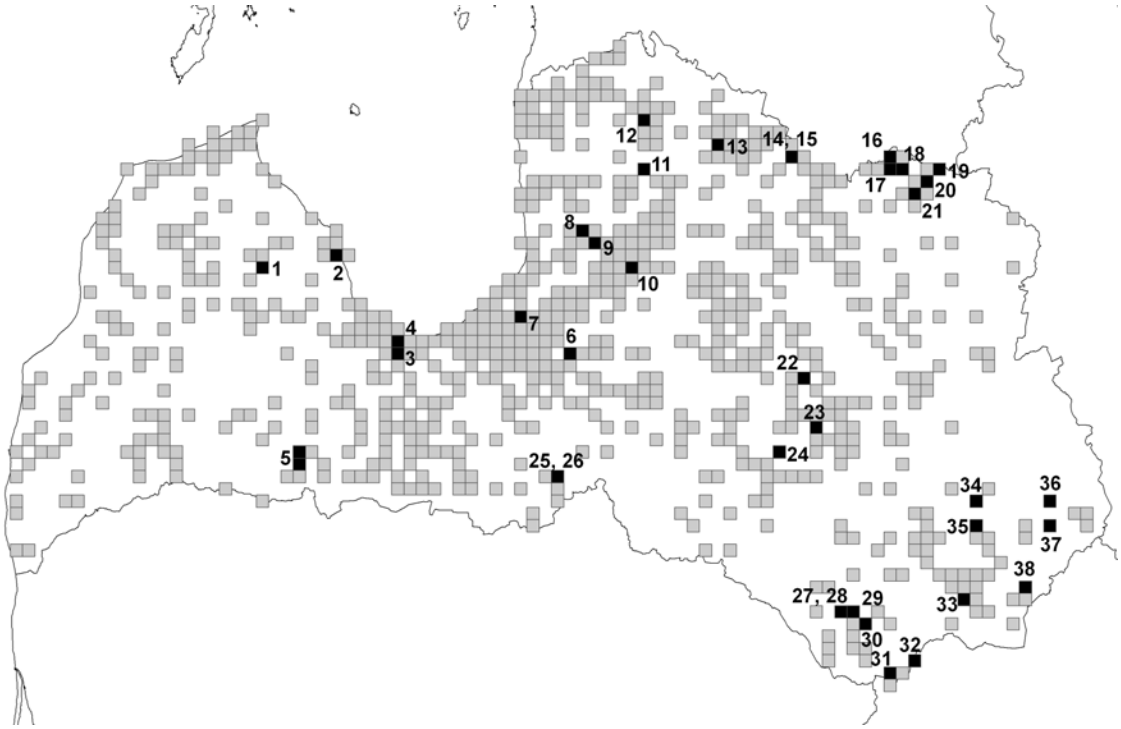

Figure 1. Distribution of *Nehalennia speciosa* in Latvia (black TKS-1993 5x5 km squares) and all TKS-1993 squares with records of dragonflies (grey squares) before 2011. The localities are numbered according to the numbering in the text.

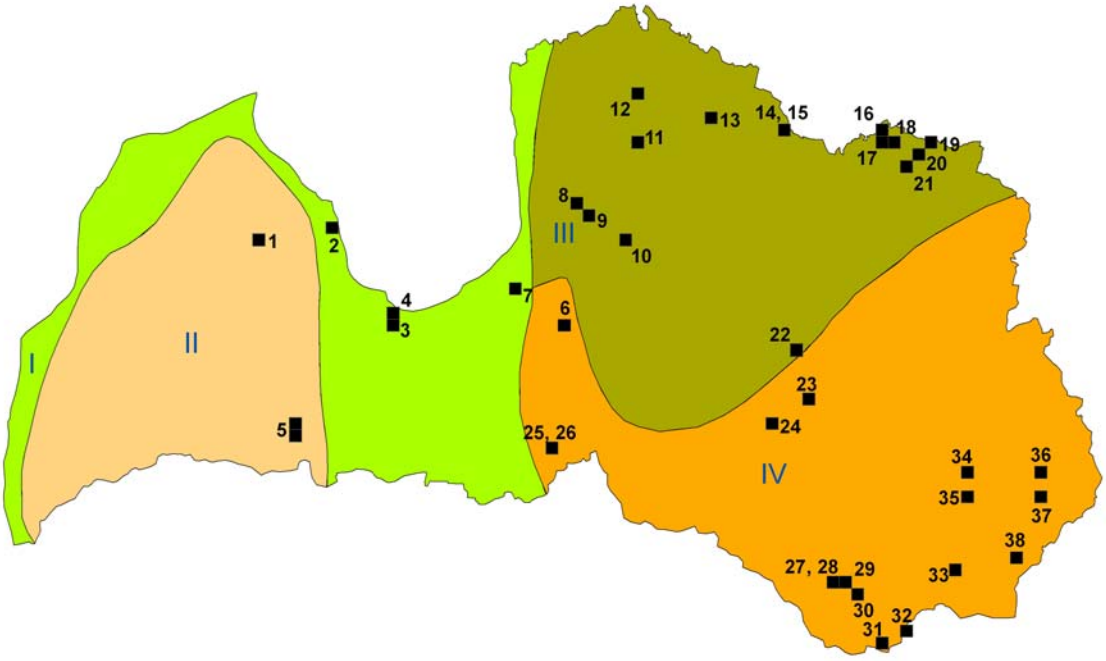

Figure 2. A distribution of *Nehalennia speciosa* in Latvia according to climatic regions (sensu Kalniņa1995). I. Piejūra lowland and Zemgale plain; II. Kurzeme upland; III. Vidzeme Central upland; IV. Lubāna lowland and Latgale upland.

Figure 3. A primary habitat of *Nehalennia speciosa* – a transition-mire zone with rich and abundant vegetation at Mazais Paiķis Lake in Latvia; locality No. 18 in the text (photo: M. Kalniņš).

Figure 4. A secondary habitat of *Nehalennia speciosa* – a renaturalized old post-excavation peaty pool with *Carex limosa* and *C. rostrata* in Ķemeri Bog in Latvia; locality No. 3 in the text (photo: M. Kalniņš).

Figure 5. A primary habitat of *Nehalennia speciosa* – a *Carex elata* and *C. rostrata* zone along Zāļezers Lake in Latvia; locality No. 25 in the text (photo: M. Kalniņš).

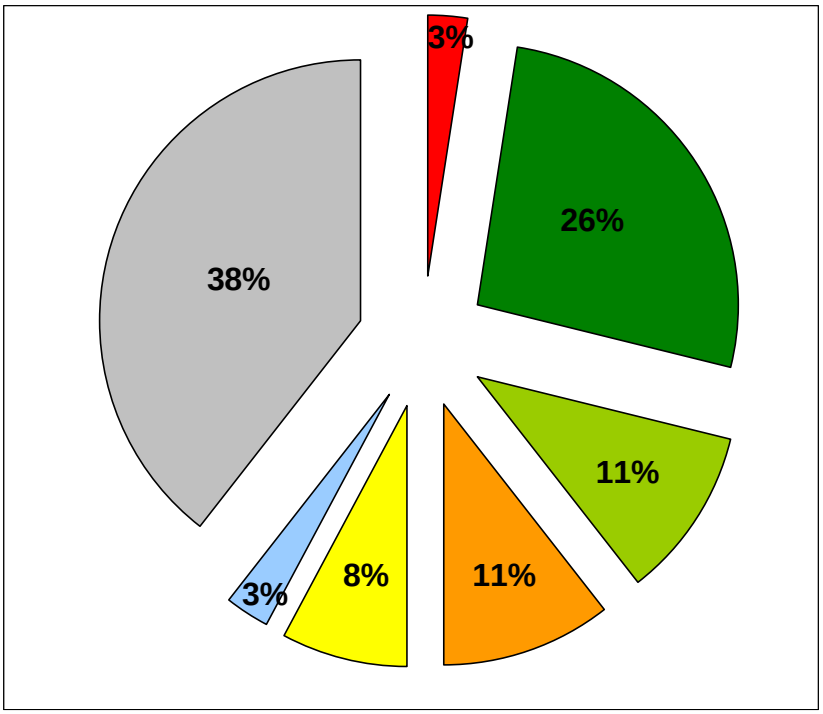

Figure 6. The current (January 2011) official conservation status of localities inhabited by *Nehalennia speciosa* in Latvia. Red – strict nature reserve, dark green – nature reserve, light green – nature park, orange – national park, yellow – protected landscape area, blue – biosphere reserve.