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The ecology and conservation of the Bog Hawker *Aeshna subarctica* WALKER, 1908 (Odonata: Aeshnidae) in Latvia

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Abstract: The Bog Hawker or Subarctic Hawker, *Aeshna subarctica* WALKER, 1908, is a declining and already regionally extinct species in some areas in Europe. Published and all known unpublished data have been used to present and analyse its distribution, population size, habitat selection, and conservation status.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 *A. subarctica* has been mapped using a basic grid of 5x5 km squares in the Baltic grid system. In total, *A. subarctica* has been recorded from 21 squares and 21 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 northern and southern 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. *A. subarctica* has mostly been recorded in primary habitats in Latvia, such as raised bogs with bog pools, lakes and lakes within fens and bogs. The flight season of the *A. subarctica* in Latvia ranges mainly from August to September. The conservation measures are suggested.

Key words: Odonata, *Aeshna subarctica*, distribution, habitat selection, conservation, Latvia.

Introduction

The Bog Hawker or Subarctic Hawker, *Aeshna subarctica* WALKER, 1908, is a circumboreal species, occurring throughout central and northern Europe, Eurasia and Japan (Dunkle 2000, Djikstra 2006, Paulson 2009). However, it is declining and

is already regionally extinct in some areas in Europe. In Europe, it currently exists mostly in rather localised areas, at individual and scattered localities or in their small concentrations (Djikstra 2006). Available habitats continue to decline due to the drainage of wetland areas and climatic changes (Raeymaekers 1998, Salmiņa 2010).

Pollution and overgrowth of habitats also may threaten the survival of this species. Therefore, *A. subarctica* has been classified as Least Concern (LC) species in the European Red List of Dragonflies (Kalkman et al. 2010), and in the European Union also as Least Concern species with the decreasing population trend (Kalkman et al. 2010).

The aim of this paper is to summarize the knowledge of the distribution and habitats of *A. subarctica* in Latvia. This dragonfly is not protected in Latvia, but so far the data on it have not been analysed and the species' current population status has not been assessed.

Methods

The analysis of distribution and habitat preference is based on: (a) all published data, (b) author's unpublished data collected between 1999 and 2010, (c) unpublished data collected by entomologists before 2011. Both historical and recent data, in total 31 records of *A. subarctica*, were included in a Microsoft Office Access geodatabase prepared by the author.

The distribution of *A. subarctica* 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 author and others in the field. Potential habitats, such as raised bogs with bog pools and lakes, lakes within fens and bogs and post-excavation peat bogs were examined. Visual search for imagines and exuviae was made. Egg laying microhabitat and substratum was registered when egg-laying females observed. Data on particularly protected nature territories come from the website of the Nature Conservation Agency (Nature Conservation... 2011).

The quantitative field data on dragonflies exuviae in Lielais Ķemeru tīrelis Bog were collected in 16 sampling plots on 16 and 19 July 2007. The survey of dragonflies and the evaluation of vegetation were carried out within a 100 m long and a 5 m wide transect in each sampling plot. The percentage of the coverage of different vegetation forms, the impact of trees, the dragonfly species and the number of individuals were evaluated in each 20 metres in the transect. The habitat groups were chosen for the arrangement of sampling plots by maps at the landscape level, choosing

the most typical habitats, but transects were chosen by ten categories of vegetation developed by the author's and as well as by accident. Each transect was run through two times, i.e. back and forth and all exuviae were collected.

The quantitative field data on dragonflies imago were collected in Grabatiņš Lake and Meistars Lake. The survey of dragonflies were carried out within a transect along lake bank. All observed specimens were counted. The length of bank of Grabatiņš Lake is 300 m, of Meistars Lake is 550 m.

The areas measured on orthophoto maps, scale 1:10 000 from the third cycle (2007-2008) of aerial photography (Latvian Geospatial Information agency) using Arc GIS 9 software. Geographical coordinates are only given for several localities, localisation of which could be difficult. Vegetation descriptions concern a zone inhabited by *A. subarctica*.

Explanations of abbreviations: *Aessub* – *Aeshna subarctica*, PPNT – particularly protected nature territory, d. – district, vill. – village. The number of observed imagines or collected exuviae of *A. subarctica* (*Aessub*) 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

Twenty one locality of *A. subarctica* has been recorded in Latvia so far. Geographical coordinates are only given for several localities, localisation of which could be difficult. Vegetation descriptions concern a zone inhabited by *A. subarctica*.

1. Lielaucē Lake (Auce d.). August of 1949, *Aessub*: 1 female was caught (Spuris 1952; 1956). Information about locality (vegetation) was not described in detail in the original publication, the data on vegetation concern its current composition. The lake is large and rich in diverse habitats and one part of lake are fen (~200 ha). The locality has had PPNT status since 1999. It is situated in the nature reserve “Viķu purvs” and in the NATURA 2000 area (site code: LV0504700).

2. Complex of bog pools S of Gārģaļu Lake and at the NE part of large Lielais Ķemeru tīrelis Bog (Tukums d.). Large (~5000 ha) active raised bog with large complexes of bog pools. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp.,

Rhynchospora alba, *Scheuchzeria palustris*, *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia* (Table 1). 06.08.2003, *Aessub*: 1 female caught (M. Kalniņš); 18.07.2007, *Aessub*: 11 exuviae near five bog pools (Table 1) (M. Kalniņš) (Kalniņš, Medne 2007). 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 *A. subarctica* (Kūze, Priede 2008). The locality has had PPNT status since 1973. It is situated in the Ķemeru National Park and in the NATURA 2000 area (site code: LV0200200).

3. Pakujezers Lake near Ezerkalni (Baldone d.). A dyseutrophic lake (~1 ha), bordered by a wide (5–10 m) *Sphagnum* zone with *Sphagnum cuspidatum*, *Carex limosa*, *Eriophorum* sp., *Rhynchospora alba*, *Calluna vulgaris* and *Andromeda polifolia*. 01.06.2008, *Aessub*: 1 exuviae (M. Kalniņš).

4. Sudas Bog, SE part, SE from Velna Lake env. near small bog pool (Līgatne d.). 17.06.2006, *Aessub*: 2 exuviae (M. Kalniņš); Sudas Bog, Central part, Salas Lake env. near small bog pool 19.06.2006, *Aessub*: 1 individual (M. Medne); Large (~2600 ha) active raised bog

with numerous bog pools and small lakes. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Scheuchzeria palustris*, *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia*. 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).

5. Pekšu Lake (Pārgaujas d.). A eutrophic lake (~10 ha) with rich and diverse vegetation – *Phragmites australis*, *Typha* sp., *Equisetum* sp., *Menyanthes trifoliata*, *Nuphar lutea*, *Nymphaea* sp., *Potamogeton* sp. and others. 09.08.1999, *Aessub*: 1 individual (M. Kalniņš) (Kalniņš et al. 2007). 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).

6. Grabatiņš Lake in Grabatpurvs Bog (Krimulda d.). Active raised bog (~250 ha), with relative small (~50 ha) open (non-owergrown) area and two small lakes. Grabatiņš Lake is a dystrophic lake (~0.6 ha), bordered by a narrow (1–5 m) *Sphagnum* zone with *Carex limosa*. 31.07.2005, *Aessub*: totally 10 individuals recorded and 3 exuviae (R. Bernard, M. Kalniņš).

7. Niedrāju-Pilkas Bog, SW part

of bog pools complex (Limbaži d.). Active raised bog (~500 ha), with open (non-overgrown) bog pools area (~100 ha). Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Ledum palustre*, *Calluna vulgaris*. 06.08.2009, *Aessub*: 17 exuviae (M. Kalniņš). The locality has had PPNT status since 1987. It is included in the Northern Vidzeme Biosphere Reserve, in the nature reserve “Niedrāju-Pilkas purvs” and in the NATURA 2000 area (site code: LV0509800).

8. Oļļas Bog near Mazezers Lake (Mazsalaca d.). 01.08.2005, *Aessub*: several individuals (R. Bernard).

9. Oļļas Bog near Lejasdīriķi (Mazsalaca d.). 01.08.2005, *Aessub*: 1 exuviae (M. Kalniņš).

Both localities are situated in large active raised bog (~3000 ha) with numerous bog pools and two lakes. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Scheuchzeria palustris*, *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia*.

The distance between localities No 8 and 9 is 2 km. The localities have had PPNT status since 1997. It is included in the Northern Vidzeme Biosphere Reserve, in the nature reserve zone “Ziemeļu purvi” and in

the NATURA 2000 area (site code: LV0000130).

10. Kārķu Bog, small bog pools near Bezdibenis Lake (Valka d.). Active raised bog (~300 ha) with one lake and ~60 bog pools. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Ledum palustre*, *Calluna vulgaris* and *Andromeda polifolia*. 02.08.2005, *Aessub*: totally 1 individual recorded near small complex of bog pools; near lake individuals were not observed (M. Kalniņš). The locality has had PPNT status since 1977. It is included in the Northern Vidzeme Biosphere Reserve, in the nature reserve “Kārķu purvs” and in the NATURA 2000 area (site code: LV0515300).

11. Taures Bog (Valka d.). Partly degraded raised bog by peat extracting (~400 ha) and partly active raised bog (~200 ha) with ~60 bog pools. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Scheuchzeria palustris*, *Carex lasiocarpa*, *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia*. 15.09.2006, *Aessub*: 6 individuals (including pairs *in copula*) and 2 males (M. Kalniņš) (Kalniņš, Medne 2007).

12. Meistars Lake NW of Mārkalne vill. (Alūksne d.). A

small (~2 ha) lake surrounded by *Sphagnum* sp. a transition-mire vegetation bordering the water table. 03.08.2005, *Aessub*: totally 1 male and 2 females (laid eggs) observed (R. Bernard, M. Kalniņš).

13. Palšu Bog, NW of Jumurda vill. (Ērgļi d.). Active raised bog (~700 ha) with numerous bog pools. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba* and *Andromeda polifolia*. 11.07.2001, *Aessub*: 1 female caught (M. Kalniņš). The locality has had PPNT status since 1999. It is included in the nature reserve "Palšu purvs" and in the NATURA 2000 area (site code: LV0526200).

14. Vārnezers Lake SE of Ineši vill. (Vecpiebalga d.). A small dystrophic, Brown-water lake surrounded by a *Sphagnum* bog, the water table bordered by a transition mire mainly with *Carex rostrata*, *C. lasiocarpa* and *Eriophorum* sp. and *Sphagnum cuspidatum*. Total area ~0.9 ha, open water ~0.1 ha. 07.08.2005, *Aessub*: 2 teneral females and 18 exuviae (R. Bernard, M. Kalniņš).

15. Bezdibenis Lake, E of Jumurda vill. (Ērgļi d.). A small (~1.3 ha) dystrophic, Brown-water lake surrounded by a *Sphagnum* bog (~0.4 ha), the water table bordered by a narrow zone of *Rhynchospora alba*

and *Carex lasiocarpa*. 07.08.2005, *Aessub*: 19 exuviae (M. Kalniņš).

16. The NW part of large Teiči bog (Madona d.). 04.07.2004, *Aessub*: 1 female caught (G. Akmentiņš).

17. Kurtavas Lake at the W part of large Teiči bog (Madona d.). 17.08.2006, *Aessub*: 1 female caught (G. Akmentiņš).

18. The Central part of large Teiči bog (Varakļāni d.). 11.–27.06.1997 and 20.08–03.09.1997, "fairly numerous imagines" (Matthes & Matthes 1997), their habitat not described.

All three localities are situated in large active raised bog (~18000 ha) with numerous bog pools and lakes. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba*, *Scheuchzeria palustris*, *Ledum palustre*, *Vaccinium uliginosum*, *Calluna vulgaris* and *Andromeda polifolia*. In Teiči bogs almost all kinds of bog vegetation are presented.

The distance between localities No 16 and 17 is 2 km and between localities No 16, 17 and 18 is 8 km. Localities have had PPNT status since 1982. They are included in the Teiči Strict Nature Reserve and in the NATURA 2000 area (site code: LV0100500).

19. Gaiņu Bog S Part (Līvāni d.). Active raised bog

(~700 ha) with ~30 bog pools. Vegetation with *Sphagnum cuspidatum* and *Sphagnum* sp., *Eriophorum* sp., *Rhynchospora alba* and *Carex* sp. 25.09.2009, *Aessub*: 1 female caught (G. Akmentiņš).

The locality has had PPNT status since 1977. It is included in the nature reserve “Gaiņu purvs” and in the NATURA 2000 area (site code: LV0525400).

20. Two small forest lakes (A and B), 5.1 km NW of Andrupene, 2.6 km W of the western shores of the southern part of Viraudas Lake, 56°13'10" N 27°20'25-50" E (Rēzekne d.). The Lake A is 140x80 m; surrounded by pine forest with addition of spruce and birch); the water table bounded by narrow *Sphagnum* mats (0.5-3 m broad, only locally up to 5-7 m) with: *Carex limosa*, *C. rostrata*, *C. nigra*, *C. elata*, *Scheuchzeria palustris*, *Menyanthes trifoliata*, *Calla palustris*, *Eriophorum angustifolium*, *E. vaginatum*, *Potentilla palustris*, *Oxycoccus palustris*; along one shore *Sphagnum* mats with peninsulas and bays, with *Carex elata* at the edge of mats and in shallow water next to them (accompanied there locally by *Calla palustris*); rare *Numphaea* sp.; water clear with the transparency minimum 2 m. The lake B is 100x60 m; surrounded by pine forest with spruce addition an a belt of partly dried pine

peaty forest with birch; the water table bounded by *Sphagnum* mats (2-7 m broad) with *Scheuchzeria palustris*, *Rhynchospora alba*, *Andromeda polifolia*; along the edges of mats, in shallow (up to 40 cm) water, a “collar” of *Carex limosa* (0.3-2 m broad) locally with floating *Sphagnum*; water brownish. 09.07.2002, *Aessub*: 3 exuviae in Lake A, 1 exuviae with teneral female in Lake B (Bernard 2003).

21. A small lake (90x70 m) NW of Cucuri, S of Rundāni, 56°12'42" N 27°50'23" E (Ludza d.). 06.08.2005, *Aessub*: some individuals (R. Bernard).

Discussion

Distribution

A. subarctica is a Holarctic widespread (circumboreal) species with the range extending from 5° E, from Belgium, France and Norway up to easternmost Japan. The species also occurs in North America – Alaska east to Newfoundland; south to Massachusetts, Michigan, Wyoming and Oregon (Dijkstra 2006, Catling 2003, Discover Life 2011). In Europe, the species has been recorded between eastern France, Italy, Switzerland, Slovenia and the Bulgaria in the South and northern Norway, Finland

and Russia, between 45.2° and 61.6° N (Dijkstra 2006, Boudot et al. 2009, Skvorstov 2010). However, the main species' European range is around the Baltic Sea (Dijkstra 2006).

The assessments mentioned above indicate that the territory of Latvia was and still is an important component in the European range of *A. subarctica*. The species has been recorded in 21 TKS-squares (5x5 km) in Latvia so far (Fig. 1) that constitute 2.5 % of the 839 Latvian squares for which data on dragonflies are known and 0.8 % of all (2785) squares covering the territory of the country.

Only one locality (0.3 %) of *A. subarctica* was recorded in the historical period (before 1991)

and twenty (3.1 %) in the current period (from 1991). However, due to limited and diverse intensity of odonatological studies in various regions, 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 territory of Latvia. However, *A. subarctica* remains unknown west of 22°52' E and only one locality has been recorded in large areas west of 23°30' E (Fig. 1). This distribution pattern probably results in part from the diverse intensity of odonatological studies in various regions: they have

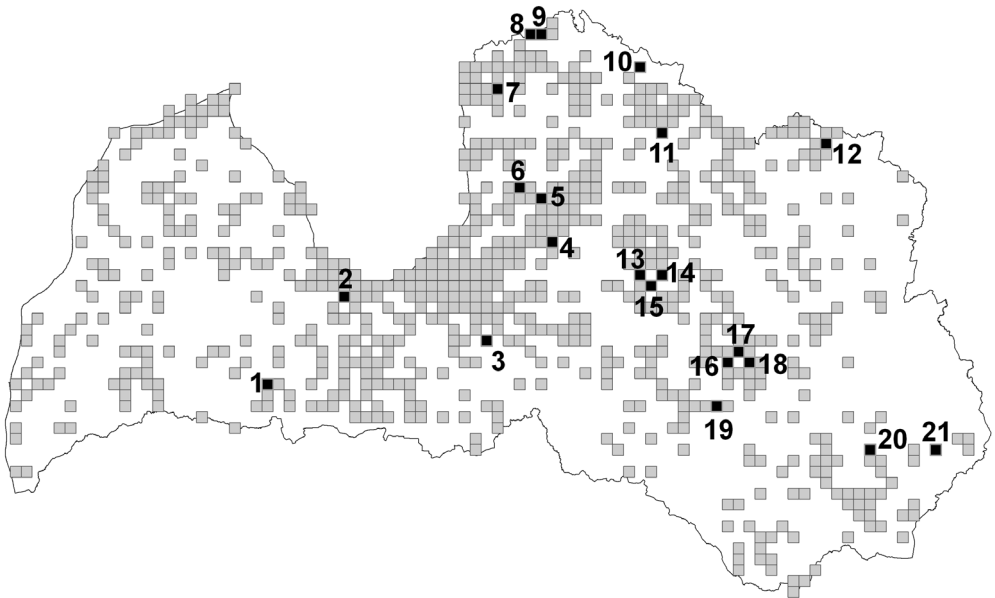


Figure 1. Distribution of *Aeshna subarctica* in Latvia (black 5x5 km squares) and all TKS-1993 squares with records of dragonflies (grey squares) before 2011. The localities are numbered according to the numbering in the text.

been carried out more intensively in central and eastern parts than in the West of the country. An analysis of a potential basis for such a pattern has not revealed a clear cause as the known distribution of *A. subarctica* 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 raised bogs, thus potential habitats of the species, undoubtedly result in greater numbers and concentration of its localities. This general relationship is especially recognizable from the example of western Latvia, occupied by a large

raised bog district which is a part of a great mires chain extending through several countries (Fig. 2). Some relationship between the distribution of *A. subarctica* and climatic regionalisation (sensu Kalniņa 1995) has also been recognisable as the majority of known localities (90 %) 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).

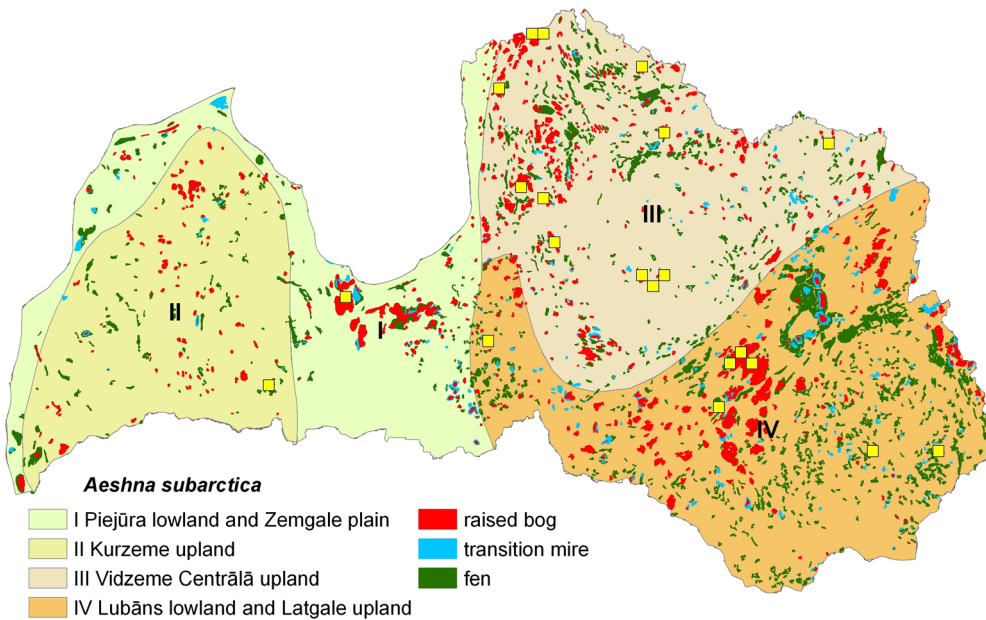


Figure 2. A distribution of *Aeshna subarctica* in Latvia (yellow squares) according to climatic regions (sensu Kalniņa 1995) and mire distribution (mire layer prepared by SIA “Envirotech”, database GIS Latvija 9.2).

Habitats and populations

A. subarctica inhabits moors and bogs with floating peatmoss (Dijkstra 2006). The habitats selected by *A. subarctica* in Latvia are mostly primary, i.e. natural. For some dragonfly species, e.g. *Nehalennia speciosa*, this strong preference is typical of the species in the core of its distribution range (cf. Bernard, Wildermuth 2005). In Latvia, *A. subarctica* inhabits (1) raised bogs with bog pools and lakes and (2) lakes within fens and bogs. It seems that the preference of *A. subarctica* towards

large and relative large raised bogs with numerous bog pools and lakes (Fig. 3). Eight localities of twenty one locality (38 %, No 2, 4, 7, 8, 9, 16, 17, 18) are situated in large raised bog areas – 2600 and 18000 ha in size and the next four localities (19 %, No 10, 11, 13, 19) are situated in large raised bog areas – 300 and 700 ha in size, all of them with several dozens bog pools at least. The second group of *A. subarctica* habitats composed by lakes within fens and bogs – seven localities (33 %, No 3, 6, 12, 14, 15, 20, 21), but for two localities (10 %, No 1, 5) no accurate data on habitat.



Figure 3. A primary habitat of *Aeshna subarctica* in Latvia – active raised bog with numerous bog pools and lakes in Niedrāju-Pilkas Bog; locality No. 7 in the text (photo by M. Kalniņš).

No records in Latvia from secondary habitats as post-excavation peat pools, although such *A. subarctica* habitats known from Sweden (Scholl 2001). In all cases exuviae's was found and egg lying was observed in pools ~30-1000 m². This concurrent with observations in Czech Republic, were the species are occurring in small (ca. 50 m²) peat pools and large (ca. 1000 m²) peat lakes, but most abundant in pools with surface ca. 300 m² (Holuša 2000). However in Germany egg lying and exuviae's was observed in small pits made by red deers *Cervus elaphus* and wild boar

Sus scrofa (Bönsel 1999).

The species composition of vegetation at Latvian localities is frequently relative poor. Floating *Sphagnum cuspidatum* is the most frequent and the most abundant representative of the mosses preferred for egg lying by *A. subarctica* (Fig. 4). Other *Sphagnum* species as *Sph. magellanicum*, *Sph. rubellum*, *Sph. flexuosum*, though generally slightly rarer and less abundant, is also selected for egg lying by the Bog Hawker. Apart from other typical components of the Bog Hawker's habitats (for emergence), e.g.



Figure 4. A primary habitat of *Aeshna subarctica* in Latvia – a bog pool with *Sphagnum cuspidatum* in Taures Bog; locality No. 11 in the text (photo by M. Kalniņš).

Eriophorum sp., *Rhynchospora alba*, *Scheuchzeria palustris*, *Andromeda polifolia*, some rather untypical plant species occur, such as *Carex limosa*, and *C. lasiocarpa*. Although Holuša (2000) mentioned, that egg lying in *Carex paupercule* zone were observed and exuviae were found.

A. subarctica was not found in secondary, i.e. partly anthropogenic, habitats in Latvia. However several post-excavation peaty pools are visited and appropriate habitats (with floating peatmoss etc.) are recorded. Thus, such the peaty pools are situated in degraded raised bogs with an advanced natural regeneration, should not be excluded *a priori*, but should also be carefully searched for *A. subarctica*. These localities may have long-term significance for *A. subarctica* 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 are the most frequent.

The flight period of *A. subarctica* in Europe ranges from the late May till the first late September, but mainly August and September

(Dijkstra 2006). The Latvian dates completely correspond to this period as the earliest record was made on the 1st June and the latest record on the 25th September, but they were most abundant in July and August.

Conservation

A. subarctica is declining and is already regionally extinct in some areas in Europe. This species belong to the species sensitive in a longer time-perspective group (Sahlen et al. 2004). In Europe, it currently exists mostly in rather localised areas, at individual and scattered localities or in their small concentrations (Dijkstra 2006). Available habitat continues to decline due to the drainage of wetland areas and climatic changes (Raeymaekers 1998, Sahlen et al. 2004, Salmiņa 2010). Pollution and overgrowth of habitats also may threaten the survival of this species. Due to this unfavourable conservation status, *A. subarctica* has been classified as Least Concern (LC) species in the European Red List of Dragonflies (Kalkman et al. 2010), and in the European Union also as Least Concern species with the decreasing population trend (Kalkman et al. 2010). In this instance, although this species are classified as Least Concern species on a global

scale, their Mediterranean population are under threat, due to their marginal and sometimes relict distribution in the region, and because of the fact that *A. subarctica* is very sensitive to global warming and the desiccation of breeding habitats (Riservato et al. 2009).

The main factors and processes currently threatening *A. subarctica* constitute: (a) drying out of habitats as a result of drainage, extreme weather events and climatic changes (global warming), (b) changes in

the 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 (Riservato et al. 2009, Termaat et al. 2010).

In Latvia, 13 of 21 known localities have an official conservation status (PPNT) (Fig. 5). Nature management plans are prepared (or in process) for five PPNT (nature reserve “Vīķu purvs”, Ķemeri National Park, Gauja National Park, nature reserve

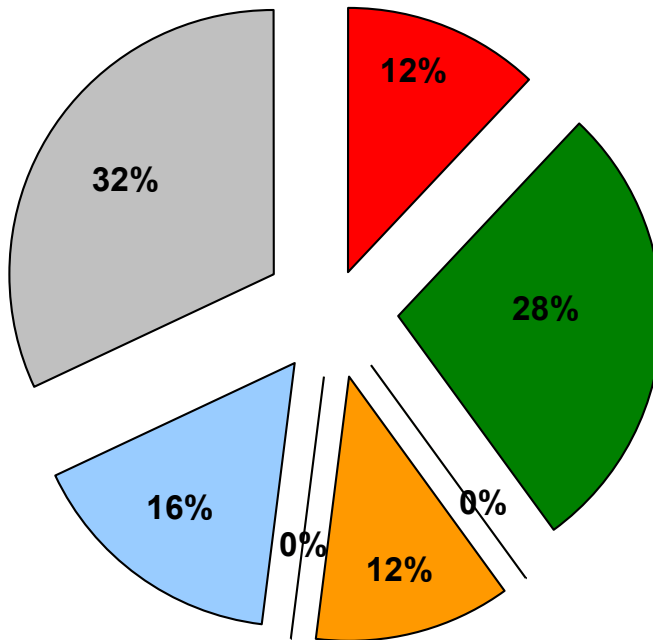


Figure 5. The current (January 2011) official conservation status of localities inhabited by *Aeshna subarctica* in Latvia. Red – strict nature reserve, green – nature reserve, orange – national park, blue – biosphere reserve, grey – localities without conservation status; 0% – nature park & protected landscape area.

“Palšu purvs” Teiči Strict Nature Reserve) which cover 8 localities. *A. subarctica* is not included in these plans (Nature Conservation... 2011).

The following conservation measures are suggested for *A. subarctica* in Latvia:

Policy. The species should be included into Regulations of the Cabinet of Ministers concerning the list of specially protected species and species with exploitation limits (Regulations... 2000). The dataset of the species' localities for governmental institutions should be imported to “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). At the same time there is an urgent need to improve the nature management plans for PPNTs and to include requirements concerning *A. subarctica* into these plans.

Research. The search for species at old locality and intensive search for new localities is needed both in western Latvia and near known localities in other territories. As the habitats suitable for *A. subarctica* are widespread in Latvia and the habitat conditions at old localities have not changed significantly (Pakalne 2008), the Bog Hawker 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 best localities by their integration in officially protected territories. At the same time, a complete assessment of factors and processes currently threatening *A. subarctica* should 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 are currently unnecessary in Latvia, but should be recommended as scientific and practical nature conservation experience.

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Table 1. The mean percentage of the coverage of water and vegetation structures in sampling plots and number of founded exuviae in Lielais Ķemeru tīrelis Bog in 2007.

Sampling plot No.	Open water	Water with <i>Sphagnum</i> mosses	Wet sunken <i>Sphagnum</i> mosses	Hummocks of <i>Sphagnum</i> mosses	<i>Sphagnum</i> mosses with <i>Eriophorum</i> sp.	<i>Sphagnum</i> mosses with <i>Rhynchospora alba</i> and <i>Scheuchzeria palustris</i>	<i>Sphagnum</i> mosses with <i>Carex limosa</i>	<i>Ledum palustre</i> and <i>Vaccinium uliginosum</i>	<i>Calluna vulgaris</i> and <i>Andromeda polifolia</i>	High sedges <i>Carex</i> sp.	Trees	Exuviae
K4	24	13	20	3	1	8	0	3	28	0	1	1
K6	0	42	36	2	2	9	0	0	9	0	0	1
K8	21	5	24	3	9	24	0	0	14	0	0	1
K9	26	1	9	2	2	44	0	1	15	0	0	3
K12	20	19	18	5	4	14	0	0	20	0	1	5
Average	18	16	21	3	4	20	0	1	17	0	Total	11