

Occurrence, threats and protection of the endangered lake minnow, *Eupallasella percnurus* (Pall.), in Pomorskie Voivodeship in Poland

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Abstract. This paper is a summary of the historic and current knowledge of the occurrence of lake minnow, *Eupallasella percnurus* (Pall.) in Pomorskie Voivodeship in Poland. It considers factors threatening the existence of this species, and determines possibilities for the conservation and protection of sites which it inhabits. Currently, *E. percnurus* is known to inhabit 102 sites in the voivodeship, which constitutes 59.3% of all known sites in Poland (172). The main threats to *E. percnurus* sites and/or populations in Pomorskie Voivodeship include the draining and drying up of water bodies and their transformation for recreational use. Currently, only 10 of the sites are classified as threatened to a low level, while 44 sites are endangered to a high level. Almost half of all the sites (45) are subject to protection within the framework of the European Ecological Natura 2000 Network, and these probably have the greatest chance of survival.

Keywords: lake minnow, distribution, threats, Natura 2000, Pomorskie Voivodeship (Poland)

Introduction

The lake minnow, *Eupallasella percnurus* (Pall.), is a small cyprinid fish with a vast geographical range in

Eurasia, and is not considered a species which is threatened globally (Kottelat and Freyhof 2007). The territory of Poland lies at the western border of its range of occurrence, and in this region it is one of the rarest, most endangered freshwater fish species. Consequently, it has an exceptionally high ecological and conservation status which means it is (1) under strict protection (Wolnicki 2005), (2) included in the Polish Red Data Book of Animals (Kusznierz 2001), and (3) designated as one of the priority species within the European Ecological Natura 2000 Network (Kusznierz et al. 2005).

Pomorskie Voivodeship is of a particular importance in the history of the quest to preserve the occurrence of *E. percnurus* in Poland. The first confirmed record of it in Poland, and indeed in Central Europe, was made in this region in the vicinity of Gdańsk (Benecke 1881). In the twentieth century other sites inhabited by *E. percnurus* were discovered in Pomorze (e.g., Seligo 1916, Oliva 1963, Gąsowska and Rembiszewski 1967, Kusznierz 1995, Radtke 1995), which means that this region was then the largest *E. percnurus* sanctuary in Poland beside the area of Polesie Lubelskie and its surroundings, which are presently partially included in Lubelskie Voivodeship (Kusznierz 1996). Nevertheless, at that time, the present Pomorskie Voivodeship was not subjected to any systematic field inventories, nor were any of the remaining voivodeships within the range of *E. percnurus* occurrence in Poland, i.e.,

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Kujawsko-Pomorskie, Lubelskie, Mazowieckie, or Wielkopolskie.

In the early 2000s, extensive new field inventories were begun in four of the voivodeships mentioned above, excluding Wielkopolskie. These efforts revealed the existence of many previously-unknown *E. percnnurus* sites (Radtke et al. 2003, 2004, 2006, Wolnicki et al. 2006, 2007a, 2007b, 2008b). The principle aim of the present work was to describe and summarize all published and unpublished data on the past and present distribution of *E. percnnurus* sites in Pomorskie Voivodeship. Threats to the survival of extant sites and possibilities for their conservation and protection in the near future were also assessed.

Study area, material and methods

The study area comprised approximately 750 sites where *E. percnnurus* populations were likely to occur; these were either isolated single water bodies or smaller and larger complexes of water bodies (Wolnicki and Radtke 2009). All of them were located within the boundaries of Pomorskie Voivodeship, especially in its principle mezoregion of the Kashubian lakeland (Kondracki 2009). The field studies were conducted from 2002 to 2011. The most widely-exploited source of information used as an aid in field inventories was topographic maps on a scale of 1:25,000. Much valuable information was also obtained from local communities, including anglers.

In 2002-2004, the occurrence of *E. percnnurus* in individual water bodies was determined with angling or lift nets. Since 2005, fishing was performed exclusively by deploying specialized folding, baited traps with two openings (25 x 25 x 40 cm; mesh 3 mm; opening diameter 60 mm). This subsequently became the standard method in similar field studies (e.g. Wolnicki et al. 2006, 2011). Fishing was conducted from April to October, and trap exposition time usually ranged from 0.5 to 24 h. Single sampling events (when successful) or more frequently multiple attempts to trap fish were made within the same year or from year to year. All fish were released

alive immediately after capture. Water bodies were confirmed as *E. percnnurus* sites when at least one individual was trapped.

The geographical location of all the water bodies inhabited by *E. percnnurus* was determined using a handheld GPS receiver (Garmin GPSmap 60C; accuracy 3-5 m). When sites comprised more than one basin, the geographical location was identified for the central water body. The origins of the water bodies were determined when possible. Information from historical maps, local communities, or visible changes in water body morphometry were used for this purpose. The present conservation status was determined at all sites confirmed to be inhabited by *E. percnnurus*, as were all important factors that posed threats to fish habitats and/or populations. The degree of threat to the continued existence of each site was assessed according to criteria developed by Wolnicki and Radtke (2009, 2010).

Results

From 2005 to date, several tens of new *E. percnnurus* sites have been identified. As of June 2011, there are 102 confirmed sites inhabited by *E. percnnurus* in Pomorskie Voivodeship (Table 1). The field inventory confirmed the existence of some sites found in the twentieth century, e.g. Gogolewo and Nowa Kiszewa. However, in spite of numerous attempts to catch *E. percnnurus* at several sites confirmed to be inhabited by them as recently as a few years ago, such as Elżbietowo, Juszki, Mały Klincz, or Przywidz, none was successful.

In Pomorskie Voivodeship, *E. percnnurus* occurs mainly in the Vistula River catchment area (Fig. 1), where populations inhabit closed-drainage water bodies with depths of up to 2-3 m and strongly diverse surface areas ranging from approximately 0.002 to 2-2.5 ha. The largest of these are located in Kłobuczyno, Dąbrówka, and Buszkowy, among other areas, and are the largest Polish reservoirs inhabited by *E. percnnurus*. Strong differentiation in terrain hypsometry, especially in the central Kashubian

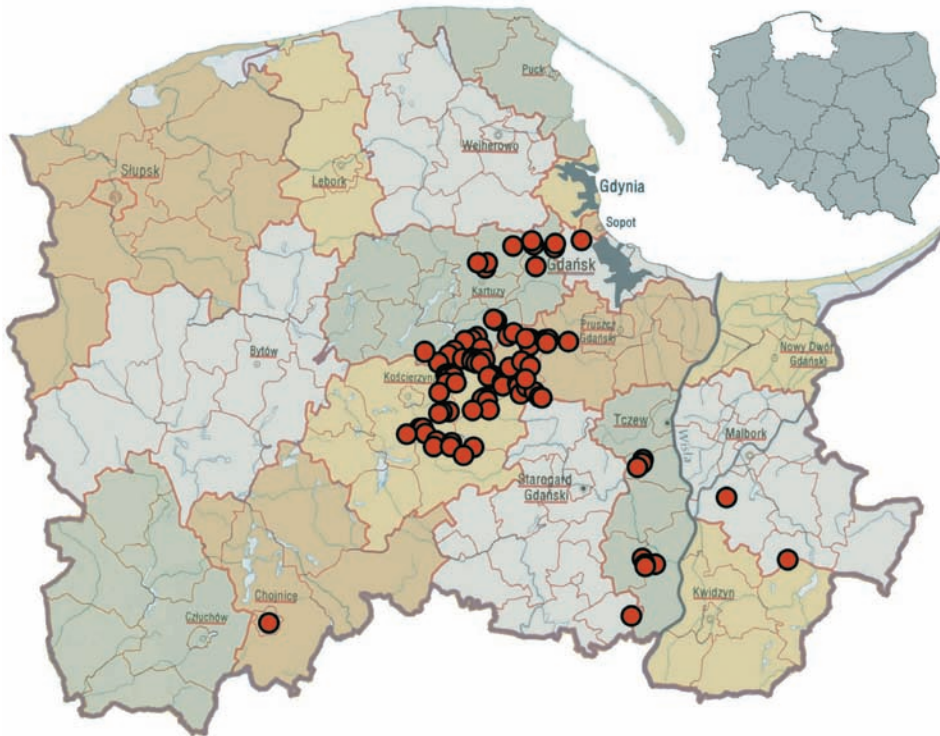


Figure 1. Present distribution of *Eupallasella percunurus* sites in Pomorskie Voivodeship in Poland.

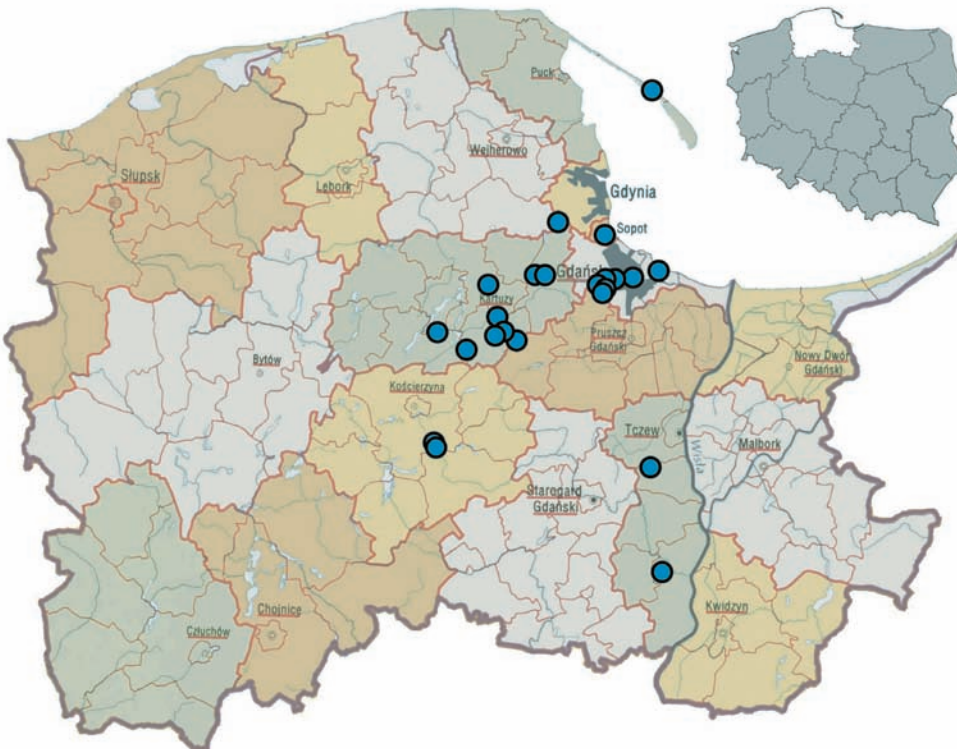


Figure 2. Distribution of *Eupallasella percunurus* sites in today's Pomorskie Voivodeship in Poland by the end of the twentieth century.

Table 1List and general characteristics of extant *E. percunurus* sites in Pomorskie Voivodeship in June 2011

| No. | Site/year of last confirmation | Geographical coordinates | Origin ¹ | Number of water bodies | Status of protection ² | Identified threats ³ | Level of threat ⁴ |
|-----|--------------------------------|--------------------------|---------------------|------------------------|-----------------------------------|---------------------------------|------------------------------|
| 1 | Banino 1/2011 | 54°24'08"; 18°23'17" | NA | 1 | NOP | ALT, SHA, AGR | M |
| 2 | Banino 2/2011 | 54°24'29"; 18°24'06" | UN | 1 | NOP | DRA, SHA | M |
| 3 | Będominek/2005 | 54°08'09"; 18°05'54" | NA | 2 | NOP | SHA | H |
| 4 | Buszkowy Górne/2008 | 54°13'42"; 18°24'36" | NA | 1 | N20 ⁵ | INT | M |
| 5 | Celmerostwo/2006 | 54°07'30"; 18°23'10" | NA | 1 | N20 ⁶ | | L |
| 6 | Chojnice/2011 | 53°40'51"; 17°35'31" | NA | 3 | NOP | SHA, FIL | H |
| 7 | Czarna Huta/2008 | 54°11'47"; 18°14'57" | NA | 2 | NOP | AGR, SHA | H |
| 8 | Częstocin/2009 | 54°11'47"; 18°14'48" | NA | 2 | NOP | SHA | M |
| 9 | Dąbrówka 1/2008 | 54°09'40"; 18°05'03" | MM | Complex | N20 ⁷ | | L |
| 10 | Dąbrówka 2/2008 | 54°09'39"; 18°05'37" | NA | 1 | N20 ⁷ | AGR | M |
| 11 | Drzewina/2008 | 54°08'03"; 18°22'05" | NA | 1 | N20 ⁶ | | L |
| 12 | Dzierżążno 1/2008 | 53°49'47"; 18°43'35" | NA | 1 | NOP | AGR | M |
| 13 | Dzierżążno 2/2008 | 53°49'25"; 18°43'50" | NA | 1 | NOP | AGR | M |
| 14 | Egiertowo/2009 | 53°14'01"; 18°11'27" | NA | 2 | NOP | AGR | M |
| 15 | Gdańsk-Osowa/2008 | 54°25'34"; 18°27'58" | UN | 1 | NOP | ALT, INT | H |
| 16 | Gogolewo/2004 | 53°49'34"; 18°45'43" | NA | 1 | NOP | AGR | M |
| 17 | Gołubie/2008 | 54°13'34"; 18°27'58" | NA | 4 | NOP | SHA | M |
| 18 | Grabowska Huta 1/2006 | 54°10'52"; 18°10'38" | NA | 1 | NOP | SHA | H |
| 19 | Grabowska Huta 2/2008 | 54°11'21"; 18°09'58" | NA | 2 | N20 ⁸ | SHA | M |
| 20 | Grabówko/2009 | 54°09'28"; 18°10'49" | NA | 2 | NOP | SHA | H |
| 21 | Grzybno 1/2004 | 54°21'42"; 18°13'07" | NA | 1 | N20 ⁹ | SHA | H |
| 22 | Grzybno 2/2009 | 54°21'28"; 18°12'53" | NA | 1 | N20 ⁹ | SHA | H |
| 23 | Guzy 1/2010 | 54°08'41"; 18°19'20" | UN | 3 | N20 ¹⁰ | SHA | M |
| 24 | Guzy 2/2008 | 54°08'26"; 18°18'47" | NA | 1 | NOP | SHA | M |
| 25 | Hopowo 1/2008 * | 54°15'57"; 18°14'29" | NA | 1 | N20 ¹¹ | | L |
| 26 | Hopowo 2/2009 * | 54°16'04"; 18°13'46" | NA | 1 | NOP | SHA | H |
| 27 | Horniki Górne/2009 | 54°08'34"; 18°11'30" | NA | 1 | NOP | SHA | H |
| 28 | Huta Dolna/2009 | 54°13'49"; 18°20'20" | NA | 1 | N20 ¹² | | L |
| 29 | Huta Górna 1/2007 | 54°13'22"; 18°19'38" | NA | 1 | NOP | SHA, AGR | H |
| 30 | Huta Górna 2/2007 | 54°13'10"; 18°20'23" | UN | 1 | NOP | AGR | H |
| 31 | Jasiowa Huta/2006 | 54°10'43"; 18°11'24" | NA | 2 | NOP | SHA | H |
| 32 | Kaliska Kościerskie/2006 | 54°10'59"; 18°03'36" | MM | 1 | NOP | SHA | M |
| 33 | Katarynki/2008 | 54°12'41"; 18°20'30" | NA | 1 | NOP | AGR | L |
| 34 | Kawle Górne/2009 | 54°23'18"; 18°16'23" | UN | 1 | NOP | SHA, AGR | H |
| 35 | Kłobuczyno/2008 | 54°10'28"; 18°05'11" | NA | 1 | N20 ⁷ | INT | M |
| 36 | Kozia Góra/2008 | 54°13'02"; 18°23'57" | NA | 1 | N20 ⁵ | SHA | H |
| 37 | Liniewko/2005 | 54°05'53"; 18°10'24" | MM | Complex | NOP | SHA, DRA | H |
| 38 | Liniewo/2008 | 54°05'48"; 18°13'50" | UN | 2 | N20 ¹³ | AGR, DRA | M |
| 39 | Lubieszyn/2008 | 54°06'52"; 18°13'11" | NA | 1 | N20 ¹³ | SHA | H |
| 40 | Lubieszyn/2006 | 54°06'52"; 18°13'11" | NA | 3 | N20 ¹³ | AGR | M |
| 41 | Majdany/2009 | 54°14'23"; 18°17'58" | MM | 1 | NOP | SHA | H |
| 42 | Małe Stawiska/2004 ** | 54°02'55"; 18°01'58" | MM | 2 | NOP | SHA, DRA, INT | H |
| 43 | Mały Podleś/2011 | 54°05'27"; 18°02'50" | MM | 1 | NOP | SHA, AGR | H |
| 44 | Mikołajki Pomorskie/2008 | 53°50'20"; 19°10'42" | NA | 1 | N20 ¹⁴ | | L |
| 45 | Miszewo 1/2011 | 54°22'49"; 18°21'01" | NA | 1 | NOP | SHA | M |
| 46 | Miszewo 2/2011 | 54°22'44"; 18°21'38" | NA | 1 | NOP | SHA | M |
| 47 | Nowa Karczma/2007 | 54°08'31"; 18°14'13" | NA | 1 | NOP | SHA | H |
| 48 | Nowa Sikorska Huta 1/2008 | 54°11'41"; 18°05'38" | UN | 3 | N20 ¹⁵ | SHA | M |

cont. Table 1

| No. | Site/year of last confirmation | Geographical coordinates | Origin ¹ | Number of water bodies | Status of protection ² | Identified threats ³ | Level of threat ⁴ |
|-----|--------------------------------|--------------------------|---------------------|------------------------|-----------------------------------|---------------------------------|------------------------------|
| 49 | Nowe Polaszki 1/2005 | 54°01'58"; 18°06'49" | NA | 1 | NOP | AGR | M |
| 50 | Nowe Polaszki 2/2005 | 54°01'34"; 18°06'45" | MM | Complex | NOP | SHA, DRA, AGR | H |
| 51 | Nowy Wiec/2007 | 54°08'12"; 18°20'36" | UN | 2 | NOP | SHA, TRA | M |
| 52 | Pępowo/2011 | 54°22'46"; 18°21'51" | NA | 1 | NOP | SHA | H |
| 53 | Piekło Górne 1/2008 | 54°10'36"; 18°20'52" | UN | Complex | N20 ¹⁶ | DRA | L |
| 54 | Piekło Górne 2/2008 | 54°10'59"; 18°19'10" | NA | 1 | NOP | AGR | M |
| 55 | Piotrowo 1/2008 | 54°11'14"; 18°08'39" | UN | Complex | N20 ⁸ | | L |
| 56 | Piotrowo 2/2008 | 54°11'22"; 18°10'06" | NA | 2 | N20 ⁸ | SHA | M |
| 57 | Połączyno/2005 | 54°12'18"; 18°11'49" | MM | 2 | NOP | EXT | H |
| 58 | Pomlewo/2007 | 54°13'38"; 18°23'41" | NA | 1 | N20 ⁵ | SHA | M |
| 59 | Rekownica 1/2007 | 54°09'07"; 18°07'14" | NA | 2 | NOP | SHA, AGR | H |
| 60 | Rekownica 2/2007 | 54°08'16"; 18°07'12" | NA | 2 | NOP | DRA, SHA | H |
| 61 | Rybaki /2009 | 54°13'48"; 18°09'13" | NA | 5 | NOP | SHA, ALT | H |
| 62 | Rymanowiec/2005 | 54°07'48"; 18°19'19" | NA | 1 | NOP | SHA | M |
| 63 | Sztumskie Pole/2008 | 53°56'38"; 18°58'53" | NA | 2 | N20 ¹⁷ | | L |
| 64 | Sikorzyño/2006 | 53°49'34"; 18°45'43" | NA | 2 | NOP | SHA | H |
| 65 | Skrzydłowo/2005 | 54°08'13"; 18°15'49" | NA | 2 | NOP | SHA, AGR | H |
| 66 | Sławki Górne/2009 | 54°14'59"; 18°11'48" | NA | 1 | NOP | SHA, AGR | H |
| 67 | Smarzewo/2008 | 53°45'13"; 18°42'32" | MM | 1 | NOP | SHA, AGR | H |
| 68 | Smęgorzyño/2006 | 54°20'40"; 18°29'20" | NA | 1 | NOP | ALT, INT | H |
| 69 | Somonino/2007 | 54°01'71"; 18°11'16" | MM | 1 | NOP | ALT | H |
| 70 | Sośniak/2008 | 54°21'35"; 18°13'40" | MM | Complex | N20 ⁹ | SHA | H |
| 71 | Stara Huta/2007 | 54°12'15"; 18°01'11" | NA | 2 | NOP | AGR | M |
| 72 | Stare Czaple/2009 | 54°13'52"; 18°16'37" | NA | 1 | NOP | | M |
| 73 | Starkowa Huta/2005 | 54°13'28"; 18°10'13" | NA | 2 | NOP | SHA | M |
| 74 | Stary Barkoczyń/2004 | 54°05'28"; 18°06'06" | NA | 2 | NOP | SHA | H |
| 75 | Stary Bukowiec 1/2008 | 54°01'24"; 18°03'45" | UN | 3 | N20 ¹⁸ | SHA, ALT | M |
| 76 | Stary Bukowiec 2/2008 | 54°01'59"; 18°03'52" | NA | Complex | N20 ¹⁸ | SHA, AGR | M |
| 77 | Starzęcin/2006 | 54°00'00"; 18°42'12" | UN | 1 | N20 ¹⁹ | SHA, AGR | H |
| 78 | Stawiska 1/2011 | 54°03'32"; 18°00'59" | NA | Complex | N20 ²⁰ | DRA, SHA | H |
| 79 | Stawiska 2/2008 | 54°03'34"; 18°01'21" | NA | 1 | N20 ²⁰ | AGR | M |
| 80 | Sucha Huta/2007 | 54°09'28"; 18°20'12" | NA | 1 | N20 ¹⁰ | SHA | M |
| 81 | Szatarpy/2008 | 54°08'34"; 18°16'25" | UN | 2 | N20 ²¹ | SHA, AGR, ALT | H |
| 82 | Szpon/2010 | 54°11'06"; 18°12'31" | NA | 3 | NOP | AGR | H |
| 83 | Sztofrowa Huta/2009 | 54°10'28"; 18°12'03" | NA | 2 | NOP | SHA | M |
| 84 | Szumleś Królewski 1/2007 | 54°09'15"; 18°13'38" | NA | 2 | N20 ²¹ | SHA, ALT, AGR | H |
| 85 | Szumleś Królewski 2/2005 | 54°08'56"; 18°14'34" | NA | 2 | N20 ²¹ | SHA, ALT, AGR, FIL | H |
| 86 | Szumleś Szlachecki/2008 | 54°08'55"; 18°15'50" | NA | Complex | N20 ²¹ | ALT | M |
| 87 | Szymbark/2006 | 54°12'12"; 18°06'55" | NA | 1 | NOP | SHA | M |
| 88 | Śledziowa Huta/2007 | 54°09'19"; 18°05'49" | NA | 1 | N20 ⁷ | AGR | M |
| 89 | Trzepowo 1/2005 | 54°10'36"; 18°17'22" | NA | 1 | NOP | SHA | H |
| 90 | Trzepowo 2/2007 | 54°10'59"; 18°15'00" | NA | 2 | NOP | SHA | M |
| 91 | Wacmierz 1/2008 | 54°00'35"; 18°42'45" | NA | 1 | N20 ¹⁹ | AGR, INT | M |
| 92 | Wacmierz 2/2008 | 54°00'58"; 18°42'49" | NA | 1 | N20 ¹⁹ | AGR, INT | M |
| 93 | Wielki Kamień/2005 | 54°09'06"; 18°13'18" | NA | 2 | N20 ²¹ | SHA, DRA | H |

cont. Table 1

| No. | Site/year of last confirmation | Geographical coordinates | Origin ¹ | Number of water bodies | Status of protection ² | Identified threats ³ | Level of threat ⁴ |
|-----|--------------------------------|--------------------------|---------------------|------------------------|-----------------------------------|---------------------------------|------------------------------|
| 94 | Wielki Klincz 1/2009 | 54°05'24"; 18°05'02" | MM | Complex | N20 ²² | AGR | M |
| 95 | Wielki Klincz 2/2009 | 54°05'23"; 18°04'29" | UN | 3 | N20 ²² | AGR | M |
| 96 | Wielki Klincz 3/2009 | 54°06'01"; 18°05'29" | NA | 1 | NOP | SHA, AGR | M |
| 97 | Wieżyca/2010 *** | 54°13'08"; 18°08'18" | NA | 2 | N20 ²³ | SHA | M |
| 98 | Wilcze Błota/2008 | 54°00'46"; 18°09'21" | MM | Complex | N20 ²⁴ | DRA, SHA | H |
| 99 | Wysin/2006 | 54°07'07"; 18°15'45" | NA | 2 | NOP | AGR, SHA | M |
| 100 | Zielenina/2008 | 54°07'23"; 18°23'34" | NA | 1 | N20 ⁶ | AGR, INT | M |
| 101 | Zielona Wieś 1/2010 | 54°07'17"; 18°12'33" | NA | 1 | N20 ¹³ | AGR | M |
| 102 | Zielona Wieś 2/2006 | 54°07'02"; 18°12'16" | NA | 1 | N20 ¹³ | SHA, ALT | M |

¹Origin: MM – man-made; NA – natural; UN – unspecified

²Status of protection: N20 – protected within Natura 2000 Network; NOP – non-protected

³Identified threats: SHA – permanent shallowing of water body bodies and overgrowing; AGR – intensive agriculture in the vicinity; EXT – industrial extraction of peat or other materials in the neighbourhood; DRA – intentional draining; FIL – intentional filling in; ALT – alteration of the water body into recreational reservoir; INT – fish introductions or presence of invasive fish species

⁴Level of threat: L – low; M – medium; H – high

⁵PLH 220092 “Pomlewo”; ⁶PLH 220065 “Zielenina”; ⁷PLH 220088 “Dąbrówka”; ⁸PLH 220091 “Piotrowo”; ⁹PLH 220080 “Prokowo”; ¹⁰PLH 220068 “Guzy”; ¹¹PLH 220010 “Hopowo”; ¹²PLH 220089 “Huta Dolna”; ¹³PLH 220074 “Lubieszyn”; ¹⁴PLH 220076 “Mikołajki Pomorskie”; ¹⁵PLH 220090 “Nowa Sikorska Huta”; ¹⁶PLH 220025 “Przywidz”; ¹⁷PLH 220087 “Sztumskie Pole”; ¹⁸PLH 220082 “Stary Bukowiec”; ¹⁹PLH 220031 “Waćmierz”; ²⁰PLH 220034 “Jezióra Wdzydzkie”; ²¹PLH 220086 “Szumles”; ²²PLH 220083 “Wielki Klincz”; ²³PLH 220095 “Uroczyska Pojezierza Kaszubskiego”; ²⁴PLH 220093 “Wilcze Błota”

*formerly described as Wyczechowo; **formerly described as Nowa Kiszewa; ***formerly described as Wierzyca

Lake District, means there are significant differences in water body elevation. The basin at the highest altitude is located at 250 m a.s.l. in the vicinity of Wieżyca, which is at the highest elevation in northern Poland. A majority of the water bodies are of natural origin. Consequently, 75 sites are natural, 13 have formed from human activity (mainly peat exploitation), and 14 are of origins that are difficult or impossible to determine (Table 1). More than half of the sites (54) comprise single water bodies that are clearly isolated from others. Of the sites that are currently extant, 45 are included within the European Ecological Natura 2000 Network.

The degree to which *E. percnurus* sites are threatened in Pomorskie Voivodeship is highly differentiated, with those that are threatened to a high degree dominating (44; Table 1). Only ten sites are classified as threatened to a low degree. The most common threat that directly affects *E. percnurus* habitats are

the shallowing of water bodies, overgrowth by aquatic vegetation (SHA), and intense agriculture in their immediate vicinity (AGR). Anthropogenic stress from the transformation of the sites into recreational reservoirs and stocking with other species (ALT) was noted at 11 sites. Nine sites were threatened by the intentional drainage of water bodies or of areas in their immediate vicinity (DRA).

Discussion

Historical state of occurrence

Benecke (1881) published the first record of *E. percnurus* occurrence in Poland in small water bodies near Gdańsk. Treichel (1891) and Seligo (1902) reported it inhabiting water bodies in the villages of

Gołubie and Stare Czaple near Kościerzyna, while Seligo (1916) also found another site in the village of Jasień and in Sianki, which is today Gdańsk Stogi. During this period, *E. percunurus* could have inhabited a very small water body near the village Jastarnia on the Hel Peninsula, according to information disclosed much later by Kaj (1953).

Subsequent finds of *E. percunurus* in Pomorskie Voivodeship date to the years following World War II. Oliva (1963) confirmed the occurrence of this species in 1961 not only near Jasień, but also in another village, Karczemki Kiełpińskie, at a distance of just 1 km from Jasień. According to Oliva, the site in Jasień might have been the same as the one reported by Seligo (1916). In 1962, a new site in Wyczechowo was identified by Kulamowicz and Klimkiewicz (1962). The site in Jasień, as reported by Oliva (above), was reported by Gąsowska and Rembiszewski (1967) as having become extinct in 1964-1965. Simultaneously, however, the same authors discovered a new site in Jasień. They also mentioned five other sites located in Kiełpino, Kartuzy, Migowo Dolne, Migowo Górne, and Żukowo. According to Kuszniierz (1995, after Heese unpubl. data), *E. percunurus* probably occurred in Sopot in 1982.

In the mid of 1990s, further discoveries were reported by Kuszniierz (1995 and unpubl. data) who confirmed the occurrence of *E. percunurus* in Elżbietowo (site discovered in 1991), Majdany and Szadółki (1992), Hopowo (1993), Waćmierz (1996), and Wyczechowo (1993). The site in Wyczechowo was a different one from that reported by Kulamowicz and Klimkiewicz (1962). Simultaneously, Radtke (1995) reported four previously unknown sites in Gogolewo, Nowa Kiszewa, Stawiska, and Wierzyca, which were all found in 1994.

Because of the lack of precise geographical co-ordinates and superficial descriptions of the vast majority of *E. percunurus* sites, the exact number of sites found in the past by all of the aforementioned researchers remains unknown. All of the existing published and unpublished scientific data summarized by Wolnicki and Sikorska (2009) indicate,

however, that over the course of 120 years, including the period from Benecke's (1881) first report to the end of the twentieth century, a maximum of 22-25 sites were found to occur in the region of today's Pomorskie Voivodeship (Fig. 2). As indicated by Kuszniierz (unpubl. data from 1991-1996), Radtke et al. (2004, 2006), and Kuszniierz et al. (2005), only eight of these sites were confirmed to have survived to the end of the twentieth century: Elżbietowo, Gogolewo, Hopowo, Nowa Kiszewa, Stawiska, Waćmierz, Wierzyca, Wyczechowo. Two other sites – Majdany and Szadółki, are also presumed to have survived.

Present state of occurrence

Eight new finds of *E. percunurus* sites were reported in the early of 2000s (Radtke et al. 2003, 2004, Kuszniierz et al. 2005), namely Grzybno, Juszki, Mały Klincz, Przywidz, Sośniak, Stary Barkoczyn, Szpon, and a second site in Stawiska named Stawiska 2. After Radtke et al. (2006) confirmed *E. percunurus* occurrence in Liniewko, Połączyno, Rekownica, Szumleś Królewski (also reported by Zarembka 2006a, 2006b), and Wielki Kamień, the total number of existing Pomeranian sites increased to 23.

The most effective field inventory to date was conducted in 2007-2011. Most of the data collected have remained unpublished, with the exception of just two new discoveries – Rymanowiec and Trzepowo, reported by Wolnicki et al. (2007b). These data permit increasing the total number of *E. percunurus* sites in Pomorskie Voivodeship to 102. This figure, however, probably does not reflect the entire state of occurrence of this species, as it is likely that a number of sites remains unknown. Therefore, further inventories are necessary, particularly in parts of the voivodeship which are potentially within the range of *E. percunurus* occurrence, but have not yet been researched systematically. Heavily urbanized and intensely cultivated areas, particularly those to the west of Gdańsk and in the southern part of the voivodeship are the priority areas for such inventories.

Threats

During the last few years in Pomorskie Voivodeship, and particularly in the Kashubian Lake District which is abundant in small natural water bodies, residential and recreational development has been on an exceptionally intense scale not noted in other voivodeships. Road infrastructure has also been developing very rapidly. The increasing anthropogenic stress resulting from these undertakings poses an immediate threat to existing *E. percnurus* sites. Construction and road development are frequently accompanied by the backfilling, dehydration, or transformation of small water bodies inhabited by this species, and inevitably this leads to the rapid extinction of local populations. This was noted at the sites confirmed in Juszki and Przywidz, where water bodies were deepened and stocked with commercial fish species. While water body basins in Elżbietowo and Mały Klincz were not compromised, the introduction of predatory fish species resulted in the extinction of *E. percnurus*. The future of the population of this fish at a site discovered in 2006 in Smęgorzyno near Gdańsk, which is the area of the historical occurrence of this species at the now non-existent sites in Jasień and Karczemki (Seligo 1916, Oliva 1963), is also uncertain. After the transformation in 2008 of the central part of the original peatland into a recreational reservoir, the occurrence of lake minnow is currently recognised as critically threatened, if even at all possible.

Another significant threat to *E. percnurus* sites in Pomorskie Voivodeship is the intentional, systematic draining or backfilling of small water bodies mainly in areas of intense agriculture. In the central and south-western parts of the region, sites were only found sporadically, whereas such work was the most intense in this same area. The mass disappearance of small water bodies, intensified by draining, is evidenced by comparing the current number of them with that marked on maps from approximately 40 years ago. Such comparisons reveal that nearly half of the water bodies present then have disappeared. Similar phenomena are also noted in other Polish voivodeships (Pieńkowski et al. 2010).

In Pomorskie Voivodeship, the most common native species co-habiting with *E. percnurus* are crucian carp, *Carassius carassius* (L.), and sunbleak, *Leucaspius delineatus* (Heckel) (Radtke unpubl. data). Thus far, no occurrences of other alien or invasive fish species, apart from Prussian carp, *Carassius gibelio* (Bloch) have been confirmed in small water bodies in the area. This differentiates Pomorskie Voivodeship from other districts, particularly Lubelskie Voivodeship (Wolnicki et al. 2011).

Currently, it is difficult to estimate the impact of global climate change on *E. percnurus* populations. Over the past few years, however, climate change has been seen to impact numerous assemblages of animals, including fish, inhabiting smaller and larger water bodies (Gyllstrom et al. 2005, Jeppesen et al. 2010). In small, shallow water bodies such changes are reflected in overheating, drying out, and vegetation overgrowing, which are, in fact, accelerated natural succession processes. Increasing drought has been noted in Poland during the past few years, and forecasts from climate models predict further, significant increases in this phenomenon (Walczykiewicz and Łaciak 2011). The terrain and climate conditions in the Kashubian Lake District, which has the most water bodies inhabited by *E. percnurus*, differ from those in other areas of Poland. Lower mean air temperatures mean that the potential for conservation of the fish is greater in the region in view of climate change.

Protection

Due to the specificity of the occurrence and threats to *E. percnurus* in Pomorskie Voivodeship as compared to those in other areas of Poland, conservation programs for this species should focus on protecting its natural habitats from degradation rather than on applying active protection measures. In view of growing anthropogenic stress related mainly to land development, further inventories of the occurrence of *E. percnurus* are necessary. These must be accompanied by the identification of the types and degrees of threats the sites are facing, and an estimation of

possibilities for future conservation. Another fundamental issue is monitoring changes occurring at sites found previously. Observations have thus far indicated a sharp, progressive decline in the number of *E. percunurus* sites in Pomorskie Voivodeship. The discovery of new sites is accompanied by the simultaneous disappearance of those discovered previously, which is evidence that studies of the sites and measures to conserve them are insufficient. It is highly probable that the data on the number of sites in Pomorskie Voivodeship presented in this paper are already partially invalid. Some of the sites might not exist anymore, particularly those discovered prior to 2007 and which were classified as endangered to a high degree (Table 1).

The 45 sites within the Natura 2000 network are the least likely to become extinct. The majority are located far from large human settlements, and are usually surrounded by forests or tree stands, and are located in undulating areas where the potential influence of anthropogenic stress stemming from dehydration or land development is the lowest. Sites located outside of protected areas are threatened to a much greater degree. In these cases, because of the critically endangered status of *E. percunurus*, the conservation status of the water bodies should be specified.

Among a range of conservation measures, establishing sufficiently wide protection belts around water bodies inhabited by *E. percunurus* is the most important. These riparian buffer zones protect water bodies from interference and the inflow of pollutants from catchment areas (Lee et al. 2004, Ohliger and Schulz 2010). The type and width of these zones is adjusted to local conditions, and the necessity of their implementation must be considered in local spatial management plans.

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Streszczenie

Występowanie, zagrożenia i ochrona zagrożonej strzebli błotnej *Eupallasella percunurus* (Pall.) w województwie pomorskim w Polsce

Od pierwszego stwierdzenia obecności strzebli błotnej na ziemiach polskich (i w Europie) w okolicach Gdańska w końcu XIX wieku, do końca XX wieku wymieniono w źródłach publikowanych lub niepublikowanych od 22 do 25 stanowisk, zlokalizowanych głównie na obszarze Pojezierza Kaszubskiego. Jedynie 8 stanowisk dotrwało na pewno do początków bieżącego stulecia, a dwa inne prawdopodobnie. W wyniku szeroko zakrojonych prac inwentaryzacyjnych, przeprowadzonych w latach 2002-2011, odnaleziono ponad 100 nieznanymi stanowisk strzebli błotnej, notując jednocześnie zanik kilku innych. W efekcie obecny stan występowania tego gatunku w województwie pomorskim ocenia się na 102 stanowiska, która to liczba stanowi 59,3% wszystkich stanowisk istniejących w kraju (172). Ponad połowę (54) stanowisk pomorskich stanowią pojedyncze, izolowane zbiorniki wodne, przede wszystkim naturalne lub powstałe wskutek dawnej eksploatacji torfu. Podstawowymi zagrożeniami dla strzebli błotnej w województwie są: zasypywanie, odwadnianie i przekształcanie zbiorników wodnych, związane z postępującą zabudową mieszkalną i rekreacyjną, osuszanie i zanik

zbiorników wskutek prac melioracyjnych, przebudowa zbiorników i ich zarybianie innymi gatunkami. Obecnie tylko dziesięć stanowisk jest zagrożone w niskim stopniu, podczas gdy 44 uznaje się za zagrożone w stopniu wysokim. Pomimo tego wydaje się, że w województwie pomorskim strzebla błotna ma większą niż w innych regionach kraju szansę na przetrwanie, między innymi z uwagi na sprzyjające ukształtowanie terenu i uwarunkowania klimatyczne. Spośród aktualnej liczby stanowisk, 45 z nich zostało włączone do sieci Natura 2000. Głównymi kierunkami działań ochronnych w województwie pomorskim powinno być zabezpieczenie istniejących stanowisk strzebli błotnej przed degradacją oraz ich regularny monitoring. Ważną kwestią jest szczegółowa inwentaryzacja jeszcze nie rozpoznanych siedlisk oraz ustalenie statusu ochronnego stanowisk nie objętych dotychczas ochroną w sieci Natura 2000. Dla wszystkich stanowisk strzebli błotnej powinny zostać utworzone strefy ochronne, chroniące siedliska tej ryby przed bezpośrednim wpływem czynników zewnętrznych, a ich granice powinny zostać uwzględnione w miejscowych planach zagospodarowania przestrzennego.