Re-Establishment Plan for the Natura 2000 Species *Najas flexilis* in Poland

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1 Introduction

Slender Naiad (*Najas flexilis* [Willdenow] ROSTKOVIUS et W. L. E. SCHMIDT 1824) is an aquatic macrophyte of the family Najadaceae. It is native to Europe and America and has a submeridional-nordic temperate distribution (CASPER & KRAUSCH 1980, HULTEN 1958, LANG 1994, MOSSBERG & STENBERG 2003, PRESTON et al. 2002, ROTHMALER 2002). Fig. 1-1 shows the global distribution of *N. flexilis* (HULTEN 1958).

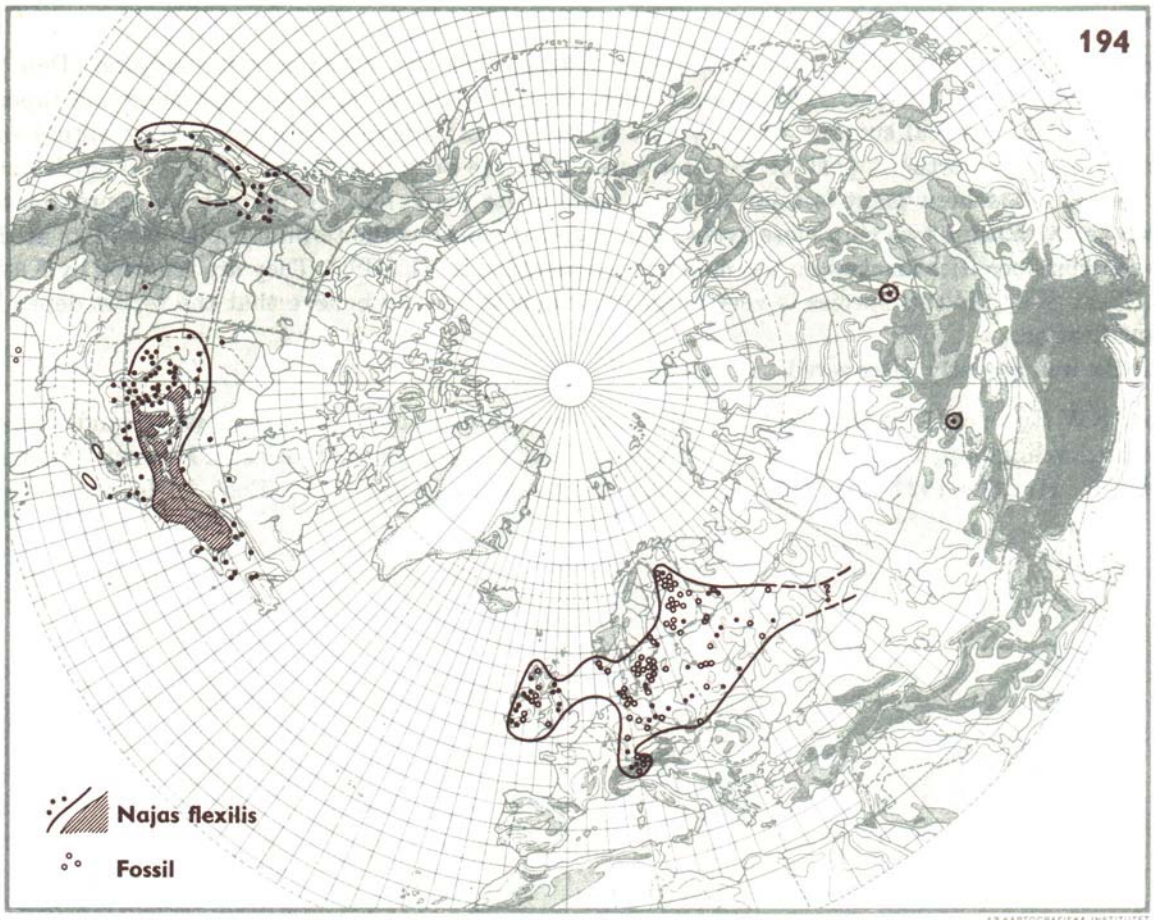

Fig. 1-1: Distribution map of *N. flexilis* (HULTEN 1958)

During the Pliocene and Pleistocene, *N. flexilis* occurred throughout much of Europe (LANG 1994, SAMUELSSON 1934, SCULTHORPE 1967), but since the postglacial, it has undergone a significant decline and reduction in range (see fig. 1-2). It continues to decline in Central Europe and is extinct in Germany, Poland and Switzerland (CASPER & KRAUSCH 1980, DOLL & PANKOW 1989, KÄSERMANN 1999, PHILIPPI 1998, ZALEWSKA 1999, ZALEWSKA-GAŁOSZ 2001a). It is still known from 36 10 km^2 in Great Britain and Ireland (PRESTON *et al*. 2002). *N. flexilis* is listed in the Annex 2 and 4 of the EU Habitats Directive and Appendix I of the Bern Convention.

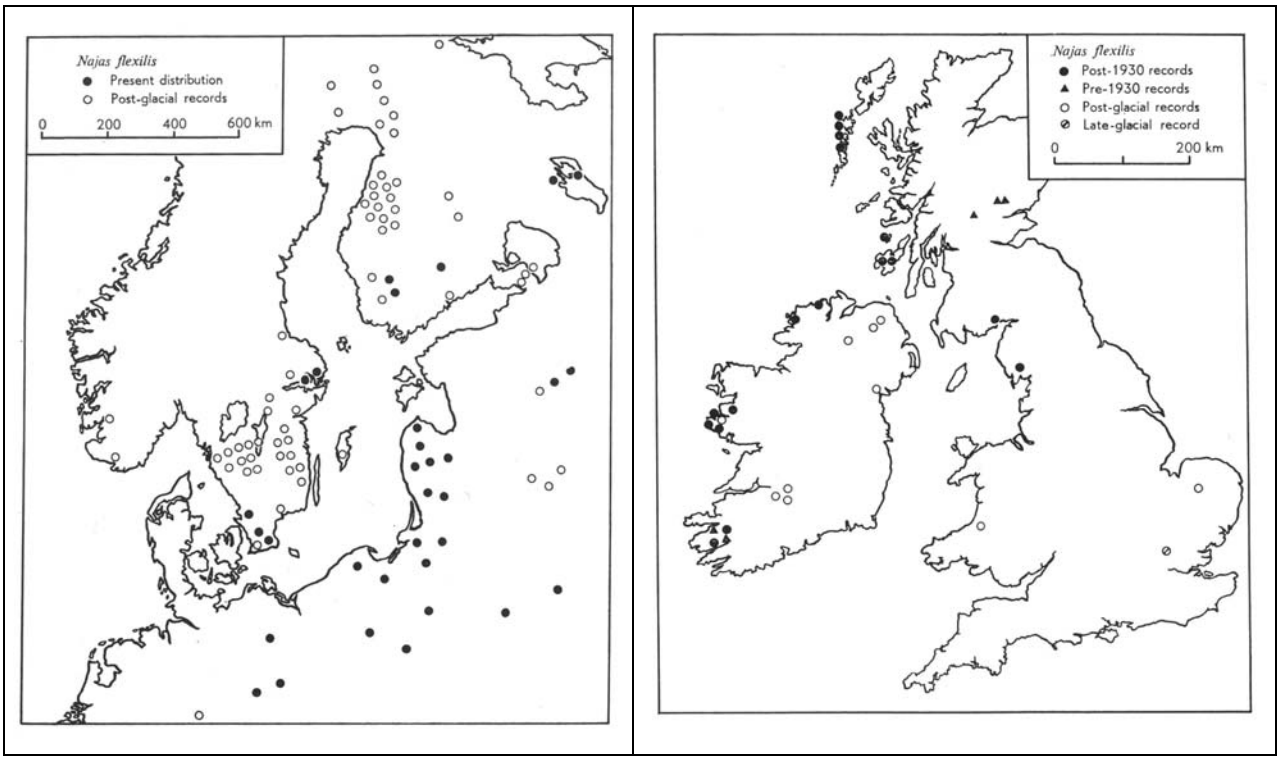

Fig. 1-2: The past and resent distribution of *N. flexilis* in the British Isles and in north-west continental Europe (SCULTHORPE 1967)

The aim of this study is to assess the potential to re-establish *N. flexilis* in Poland, based on a comprehensive review of available information on its biology and ecology.

2 Methods

Two lakes from which *N. flexilis* has been recorded in the past (chapter 3) were surveyed by scuba-diving (after FARTMANN *et al*. 2001), including collection of sediment samples. The determination of the sediment samples was performed by U. W. ABTS.

Fig. 2-1: Macrophyte survey by scuba-diving (photo: B. Migdalska)

3 Distribution of *Najas flexilis* in Poland

Najas flexilis has been recorded from four localities in Poland: "Binowskie Lake", "Glinna Lake", "Okunite Lake" and "Dłużek Lake" (ZALEWSKA 1999). Two other records, from "Linunie Lake" and "Ruciane" appear to be the result of misidentification (ZALEWSKA 1999). Herbarium specimens have been revised by J. ZALEWSKA-GAŁOSZ (Fig. 3-1). Fig. 3-2 shows the distribution of *N. flexilis* in Poland (ZALEWSKA-GAŁOSZ 2001a).

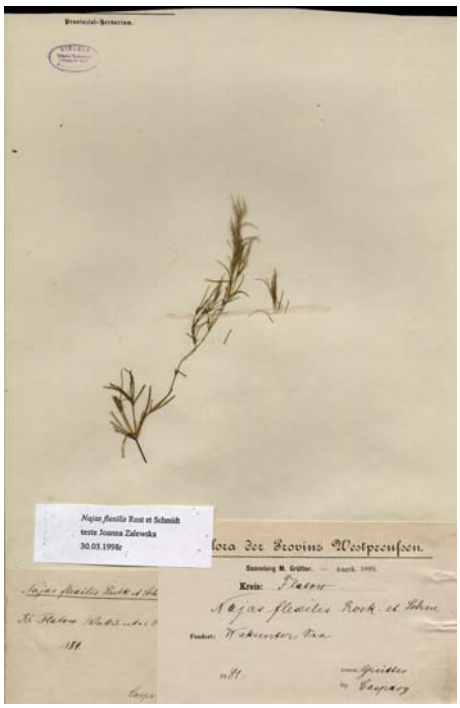

Fig. 3-1: Herbarium voucher of *N. flexilis* (TRN, photo by J. ZALEWSKA-GAŁOSZ)

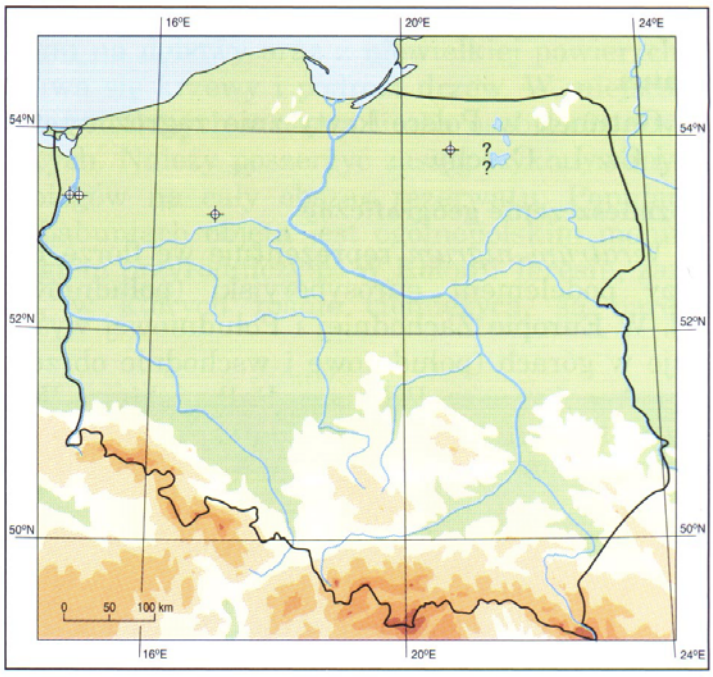

Fig. 3-2: Distribution of *N. flexilis* in Poland (ZALEWSKA- GAŁOSZ 2001a)

4 Biology and Ecology of *Najas flexilis*

In comparison with other macrophytes such as *Luronium natans* (LANSDOWN & WADE 2001) or *Potamogeton polygonifolius* (VAN DE WEYER 1997) very little is known about the biology and ecology of *N. flexilis* (CASPER & KRAUSCH 1980, DIERSSEN 1996, DOLL & PANKOW 1989, FARTMANN et al. 2001, KÄSERMANN 1999, LANG 1973, 1994, PHILIPPI 1998, RODWELL et al. 1995, SAMUELSSON 1934, SCULTHORPE 1967, THE UK STEERING GROUP REPORT 1995, ZALEWSKA 1999, ZALEWSKA- GAŁOSZ 2001a).

N. flexilis is monoecious and is an annual hydrophyte, reproducing by tubers and seeds, the seeds apparently show extended dormancy capacity. Little is known about the conditions necessary for germination of *N. flexilis*. It can be considered a ruderal, according GRIME et al. (1988) and in this way is similar to some species of the Characeae.

N. flexilis grows in calcium-rich, neutral-alkaline, oligotrophic and mesotrophic water bodies and according to SAMUELSSON (1934) it also occurs in eutrophic sites. *N. flexilis* prefers shallow parts of lakes up to a depth of 2 m but can also occur in depths of up to 6 m, it generally grows on sandy and silty sediments, but can also grow on substrates with a shallow layer of mud.

Only a few quadrats appear to have been collected from *N. flexilis* populations in Europe. It growths together with *N. marina* and *N. minor* and is a characteristic species of the Najadetum intermediae. *N. flexilis* will also occur in other plant communities of the Potametea such as the Potamogetonetum filiformis and the *Potamogeton perfoliatus-Myriophyllum alterniflorum*-community.

Like most ruderals, *N. flexilis* appears to be a poor competitor and most recent losses appear to be the result of eutrophication caused by sewage effluent, fish farms etc., leading to increased competition with other macrophytes.

5 The Study Sites

5.1 Binowskie Lake

Binowskie Lake is in Western Pomerania. According ZIARNEK (in litt.) at the beginning of the last century, it was oligotrophic, however, during the 20th century it received significant quantities of sewage from the village. During the second half of the 20th century recreational areas with summerhouses and beaches were established and in the wider area, orchards and fields have been created.

Fig. 5-1, 5-2: Binowskie lake

5.1.1 Aquatic Macrophytes

At present, the dominant aquatic macrophytes in Binowskie Lake are *Ceratophyllum demersum*, *Nuphar lutea* (local), *Potamogeton lucens* (local), *Potamogeton praelongus* (local) and *Nitellopsis obtusa* (local). Most of these species are typical of mesotrophic or eutrophic waters. The maximum depth of the vegetation was 4.5 m, which is typical of meso-eutrophic lakes in Eastern Germany (HOESCH & BUHLE 1996, MAUERSBERGER & MAUERSBERGER 1996). The record of *Potamogeton filiformis* is remarkable, this species is listed in the Red Data Book of Poland (ZALEWSKA- GAŁOSZ 2001b) and was last recorded from Binowskie Lake in 1961 (ZALEWSKA 2001). The aquatic macrophytes which were recorded in 2004 are listed in tab. 5-1.

Some species typical of oligo-mesotrophic waters which were recorded in the 19th and 20th centuries, but which were not re-found in 2004 include: *Najas flexilis, Littorella uniflora, Myriophyllum alterniflorum, Potamogeton gramineus, Ranunculus reptans* and *Lychnothamnus barbatus* (CELIŃSKI 1964, KRAUSE 1997, MÜLLER 1911, ROSTKOVIUS & SCHMIDT 1824).

Tab. 5-1: Aquatic Macrophytes of Binowskie Lake in 2004

Phanerogams:
Ceratophyllum demersum
Eleocharis acicularis
Elodea canadensis
Hottonia palustris
Hydrocharis morsus-ranae
Lemna trisulca
Myriophyllum spicatum
Nuphar lutea
Potamogeton compressus
Potamogeton crispus
Potamogeton filiformis
Potamogeton lucens
Potamogeton obtusifolius
Potamogeton pectinatus
Potamogeton praelongus
Ranunculus circinatus
Stratiotes aloides
Charophytes:
Chara contraria
Chara globularis
Nitella cf. flexilis
Nitella mucronata
Nitellopsis obtusa
Mosses:
Fontinalis antipyretica

Fig. 5-3, 5-4: Aquatic Macrophytes from Binowskie lake: *Potamogeton praelongus* (left) and *Potamogeton filiformis* (right)

5.1.2 Sediment Samples

Analysis of the sediment sample (by U. W. ABTS) identified different Ostracoda, Mollusca and Bryozoa, it also included charophyte oospores and seeds of two Angiospermae, but no fruits of *Najas flexilis* were found (tab. 5-2).

Tab. 5-2: Sediment sample of Binowskie Lake in 2004

Ostracoda:
Cyclocypris laevis
Limnocythere inopinata
Candona rostrata agg.
Mollusca:
Bithynia tentaculata
Pisidium spec.
Bryozoa:
Cristatella mucedo
Angiospermae:
Potamogeton pectinatus
Zannichellia palustris
Characeae:
Chara tomentosa
Chara cf. contraria
Chara globularis
Chara spec.
Tolypella intricata/prolifera

5.2 Glinna Lake

5.2.1 Aquatic Macrophytes

Fig. 5-5, 5-6: Glinna Lake

Glinna Lake is also located in Western Pomerania and supports a sparse vegetation of macrophytes typical of eutrophic habitats. The maximum depth of the vegetation was < 1 meter, which is typical of polytrophic lakes in Eastern Germany (HOESCH & BUHLE 1996, MAUERSBERGER & MAUERSBERGER 1996). The record of the rare *Potamogeton* hybrid *P.* x *salicifolius* is remarkable, as this hybrid had not previously been recorded from Glinna Lake (ZALEWSKA-GAŁOSZ 2003). The following aquatic macrophytes were recorded in 2004, but no sign of *N. flexilis* was found:

Tab. 5-3: Aquatic Macrophytes of Glinna Lake in 2004

Phanerogams:
Ceratophyllum demersum
Lemna gibba
Lemna minor
Lemna turionifera
Najas marina ssp. intermedia
Nuphar lutea
Potamogeton crispus
Potamogeton lucens
Potamogeton pectinatus
Potamogeton perfoliatus
Potamogeton x salicifolius (P. lucens x P. perfoliatus)
Ranunculus circinatus
Spirodela polyrhiza
Charophytes:
Chara globularis
Mosses:
Fontinalis antipyretica

Fig. 5-7, 5-8: Aquatic Macrophytes from Glinna Lake: *Potamogeton* x *salicifolius* (left) and *Lemna turionifera* (right)

5.2.2 Sediment Samples

Analysis of the sediment sample (by U. W. ABTS) identified different Ostracoda, Mollusca and Bryozoa, it also included oospores from one *Chara* species. The only angiosperm fruits found were of *Alnus glutinosa*. No fruits of *Najas flexilis* were found (tab. 5-4).

Tab. 5-4: Sediment sample of Glinna Lake in 2004

Ostracoda:
Cyclocypris laevis
Limnocythere inopinata
Candona rostrata agg.
Mollusca:
Bithynia tentaculata
Pisidium spec.
Bryozoa:
Cristatella mucedo
Angiospermae:
Alnus glutinosa
Characeae:
Chara cf. globularis

6 Discussion

In Poland, *Najas flexilis* was extremely rare in the 19th and 20th centuries and now appears to be extinct . Its decline may be due to a combination of climate change and eutrophication. Different authors present varying hypotheses to explain the rarity of this species in northern Europe. SAMUELSSON (1934) suggests that the main reasons for its decline are likely to be eutrophication and climatic change, whilst LANG (1994) suggests that a decrease in alkalinity may be the main reason, this may be true for acid water, but will not be for waters that are rich in calcium carbonate. SCULTHORPE (1967) describes the decline of *N. flexilis* as follows: "There is substantial evidence that the present narrow European range of *Najas flexilis*, noticed earlier in the context of amphi-Atlantic taxa, is a result of post glacial restriction. Scandinavian and British fossil records suggest that this species spread widely as the climate improved after the last glaciation, and reached its highest frequency and extent during the Boreal period. During subsequent time, as conditions became cooler, it retreated to areas where a more oceanic climate persists." It may be supposed that the present climate in Poland is not optimal for *N. flexilis*.

Najas flexilis typically occurs in oligotrophic and mesotrophic water bodies. Due to its annual life cycle the it is a poor competitor and needs microhabitats which are sparsely covered with other macrophytes. Between the early 1900s and 2004, the trophic status of Binowskie Lake changed from oligotrophic to meso-eutrophic. There are still some species which are characteristic of medium concentrations of nutrients, such as *Potamogeton filiformis* and some charophytes. Binowskie Lake appears to represent more suitable habitat for *N. flexilis* than Glinna Lake due to its currently lower trophic status, although surveys found no evidence of *N. flexilis*, either as living plants or in the seed bank.

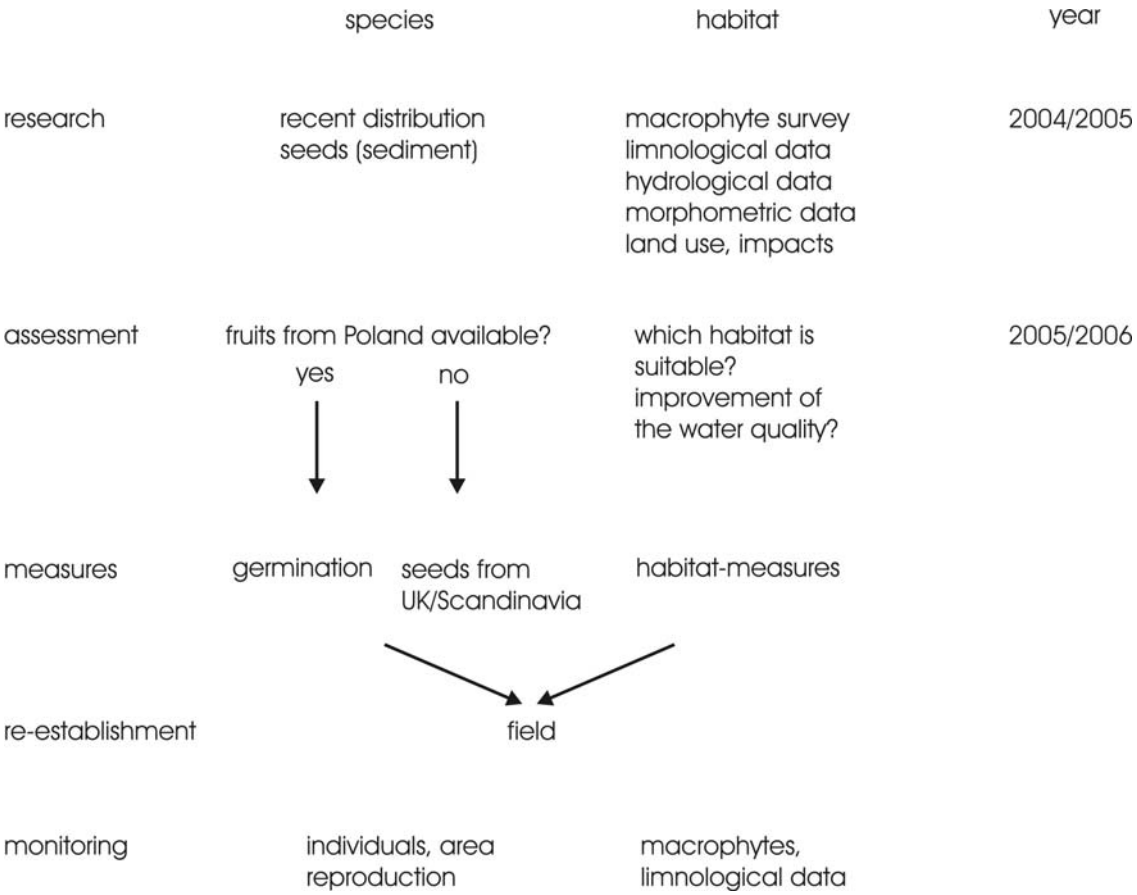

Fig. 6-1: Action Plan for *Najas flexilis* in Poland

The action plan for *Najas flexilis* (fig. 6-1) comprises research, assessment, measures and monitoring for the species and the habitat. The species research includes surveys of the recent distribution and seeds (in sediment) of *Najas flexilis*. The habitat research involves macrophyte, limnological, hydrological and morphometric surveys (area, volume, maximum and medium depth etc.), as well collection of data on land use, current anthropogenic factors affecting potential habitats etc.

Tab. 6-1 shows the timetable for research into *N. flexilis* in Poland. Sediment samples should be taken from deeper parts of both Binowskie Lake and Glinna Lake. In addition, there is a need for limnological (nutrients, Chloropyhll a, Secchi-depth) and morphometric survey, as well as preparation of maps showing adjacent land-use, discharges into the lakes etc. This type of information should also be collected for Dłużek Lake and Okunite Lake.

Tab. 6-1: Time Table for Research on *Najas flexilis* in Poland

	Binowskie Lake	Glinna Lake	Okunite Lake	Dłużek Lake
macrophyte survey	completed	completed	2005	2005
sediment samples, shallow parts	completed	completed	2005	2005
sediment samples, deep parts	2005	2005	2005	2005
limnological data	2005	2005	2005	2005
morphometric data	2005	2005	2005	2005
map (land use, discharge etc.)	2005	2005	2005	2005

Following these surveys and data compilation, if seeds of *N. flexilis* are found at any of the Polish sites they should be grown on in plastic tanks, because of the limited availability of data on the conditions required for seed germination in *Najas flexilis*, cultivation should employ sandy substrates and calcium-rich, neutral to alkaline, oligotrophic water. Research into *Potamogeton* species (BRUX et al. 1987) has shown that seeds which are treated with 0.1 NHCL show better germination rates than untreated seed. If no seeds are found by surveys in Polish survey sites, plant material or seeds from the UK or Scandinavia could be cultivated for the re-introduction of *Najas flexilis*. In the UK this would require a government licence, but is likely to be supported by the relevant government bodies.

If no evidence of *N. flexilis* is found by surveys in Poland, then it is critical that a thorough assessment of the current suitability of potential reintroduction sites is completed before any attempt is made to reintroduce it. Both Binowskie and Glinna Lakes are currently eutrophic. If the trophic status of the water is to be improved before the sites may be considered suitable, then a number of measures will be needed: cessation of effluent discharge into the lake, combined with rehabilitation ground water in the catchment feeding the lakes. This means changing land-use from fields and orchards to woodland. However, it must be made clear that even enhancement of water quality will not automatically result in re-establishment of *Najas flexilis*. In Lake Constance, *N. flexilis* was last recorded in 1973 (LANG 1973, PHILIPPI 1998), however, it has subsequently disappeared due to eutrophication. Improvements in the water quality in the last few years however have not resulted in any new records of *Najas flexilis* (SCHMIEDER 1998).

If the decision is reached that habitat conditions are suitable for *N. flexilis* and suitable material can be obtained for cultivation, then work should be undertaken toward re-establishing suitable habitats so that reintroduction can take place. Reintroduction should not be carried out without a comprehensive monitoring programme (EUROPEAN COMISSION 2004, FARTMANN *et al*. 2001).

7 Acknowledgements

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8 Literature

BRUX, H., TODESKINO, D., WIEGLEB, G. 1987: Growth and reproduction of *Potamogeton alpinus* BALBIS growing in disturbed habitats. Arch. Hydrobiol. Beih. Ergeb. Limnol. 27: 115-127

CASPER S. J., KRAUSCH, H.-D. 1980: Pteridophyta u. Anthophyta, 1. Teil, Süßwasserflora von Mitteleuropa, Bd. 23: 403 pp. Gustav Fischer Verlag/Stuttgart, New York

CELIŃSKI, F. 1964: Vascular plants of the Beech-Forest (Puszcza Bukowa) near Szczecin. Prace Kom. Biol. PTPN 29: 1-190

DIERSSEN, K. 1996: Vegetation Nordeuropas: 838 pp., Ulmer/Stuttgart

DOLL, R. PANKOW, H. 1989: Die Verbreitung der Sippen der Gattung *Najas* L. in den Nordbezirken der DDR. Feddes Repertorium 100: 431-438

EUROPEAN COMISSION 2004: Assessment, monitoring and reporting of conservation status – Preparing the 2007 report under Article 17 of the Habitats Directive (DocHab-04-03/03 rev.1), September 2004, Brussels

GRIME, J. P., HODGSON, J. G., HUNT, R. 1988: Comparative plant ecology - a functional approach to common British species: 742 pp., Unwin Hyman/London

FARTMANN, T., GUNNEMANN, H., SALM, P., SCHRÖDER, E. 2001: Berichtspflichten in Natura-2000-Gebieten – Empfehlungen zur Erfassung der Arten des Anhangs II und Charakterisierung der Lebensraumtypen des Anhang I der FFH-Richtlinie. Angewandte Landschaftsökologie 42: 725 pp., Bonn.

HOESCH, A., BUHLE, M. 1996: Ergebnisse der Makrophytenkartierung Brandenburgischer Gewässer und Vergleich zum Trophiestufensystem der TGL. Beiträge zur angewandten Gewässerökologie Norddeutschlands 2: 84-101

HULTEN, E. 1958: The amphi-atlantic plants and their phyto-geographical connections. Kung. Svenska Vet. Acad. Handl Fjarde Serein 7 (1): 340 pp., Almquist & Wiksell/Stockholm

KÄSERMANN, C. 1999: EX *Najas flexilis* (WILLD.) ROSTK. & W. L. E. SCHMIDT – Biegsames Nixenkraut – Najadaceae. Merkblätter Artenschutz – Blütenpflanzen und Farne. http://www.cjb.unige.ch/rsf/deu/fiches/pdf/naja_flex_dx.pdf

KRAUSE, W. 1997: Charales (Charophyceae). In: ETTL, H., GÄRTNER, G., HEYNIG, H., MOLLENHAUER, D. (Hrsg.): Süßwasserflora von Mitteleuropa 18: 202 pp., G. Fischer, Jena/Stuttgart/Lübeck/Ulm

LANG, G. 1973: Die Vegetation des westlichen Bodenseegebietes. Pflanzensoziologie 17: 451 pp., G. Fischer/Jena

LANG, G. 1994: Quartäre Vegetationsgeschichte Europas. 462 pp., G. Fischer/Jena, Stuttgart, New York

LANSDOWN, R., WADE, P. M. 2001: Determining the ecological requirements of floating water-plantain (*Luronium natans* (L.) Rafinesque): 71 pp., Ardeola Environmental Services, Floral Cottage, Upper Springfield Road, Stroud, England

MAUERSBERGER, H., MAUERSBERGER, R. 1996: Die Seen des Biosphärenreservats „Schorfheide-Chorin" – eine ökologische Studie. Dissertation Ernst-Moritz-Arndt-Universität Greifswald

MOSSBERG, B., STENBERG, L. 2003: Den nya nordiska Floran: 928 pp., Wahlstöm & Widstarnd

MÜLLER, W. 1911: Flora von Pommern, 3. Aufl., J. Burmeister/Stettin

PHILIPPI, G. 1998: Najadaceae – Nixenkrautgewächse. In : Sebald, O., Seybold, S., Philippi, G. Wörz, A.: Die Farn- und Blütenpflanzen Baden-Württembergs, Band 7, Spezieller Teil, Butomaceae bos Poaceae: 47-52, Ulmer/Stuttgart

PRESTON, C. D., PEARMAN, D. A., DINES, T. D. 2002: New Atlas of the British & Irish Flora: 910 pp., Oxford University Press

RODWELL, J. S. (ed.), PIGOTT, C. D., RATCLIFFE, D. A., MALLOCH, A. J. C., BIRKS, H. J. B., PROCTOR, M. C. F., SHIMWELL, D. W., HUNTLEY, J. P., RADFORD, E., WIGGINTON, M. J., WILKINS, P. 1995: British Plant Communities, Vol. 4/Aquatic communities, swamps and tall-herb fens: 283 pp., Cambridge University Press, Cambridge/New York/Melbourne

ROSTKOVIUS F. G. T., SCHMIDT, E. L. G. 1824: Flora Sedinensis exhibens plantas phanerogamas spontaneas nec non plantas praecipuas agri Swinemundii. Sedini Formis Struckianis: 411 pp, Stettin

ROTHMALER, W. 2002: Exkursionsflora von Deutschland, Bd. 4: 948 pp., edited by E. J. JÄGER & K. WERNER. Spektrum Akademischer Verlag/Heidelberg, Berlin

SAMUELSSON, G. 1934: Die Verbreitung der höheren Wasserpflanzen in Nordeuropa (Fennoskandinavien und Dänemark). Acta Phytogeografica Suecica VI: 211 pp., Uppsala

SCHMIEDER, K. 1998: Submerse Makrophyten der Litoralzone des Bodensees 1993 im Vergleich mit 1978 und 1967. Ber. Int. Gewässerschutzkommission Bodensee 46: 171 pp.

SCULTHORPE, C. D. 1967: The Biology of Aquatic Vascular Plants: 610 pp., Edward Arnold/London

THE UK STEERING GROUP REPORT 1995: Volume II: Action Plans (December 1995, Tranche 1, Vol 2): p.189

WEYER, K. VAN DE 1997: Untersuchungen zur Biologie und Ökologie von *Potamogeton polygonifolius* POURR. im Niederrheinischen Tiefland. Dissertationes Botanicae 278: 178 pp.

ZALEWSKA, J. 1999: The genus Najas (Najadaceae) in Poland: remarks on taxonomy, ecology, distribution and conservation. Fragm. Flor. Geobot. 44: 401-422

ZALEWSKA, J. 2001: Potamogeton filiformis i P. pectinatus (Potamogetonaceae) w Polsce. Fragm. Flor. Geobot Polonica. 8: 79-91

ZALEWSKA-GAŁOSZ, J. 2001a: *Najas flexilis* (Willd.) Rostk. et Schmidt. In: Polish Academy of Sciences, W. Szafer Institute of Botany, Institute of Nature Conservation: Polish Red Data Book of Plants, Pteridophytes and Flowering Plants, Krakow, p. 410-412

ZALEWSKA- GAŁOSZ, J. 2001b: *Potamogeton filiformis* Pers. In: Polish Academy of Sciences, W. Szafer Institute of Botany, Institute of Nature Conservation: Polish Red Data Book of Plants, Pteridophytes and Flowering Plants, Krakow, p. 405-407

ZALEWSKA-GAŁOSZ, J. 2003: Remarks on *Potamogeton* hybrids based on characters of *P*. x *salicifolius* WOLFG. from a new locality in Poland. Acta Societatis Botanicorum Poloniae 72: 259-262