Macrophytes as na indicator for environmental changes in Lake Durowskie

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- Introduction
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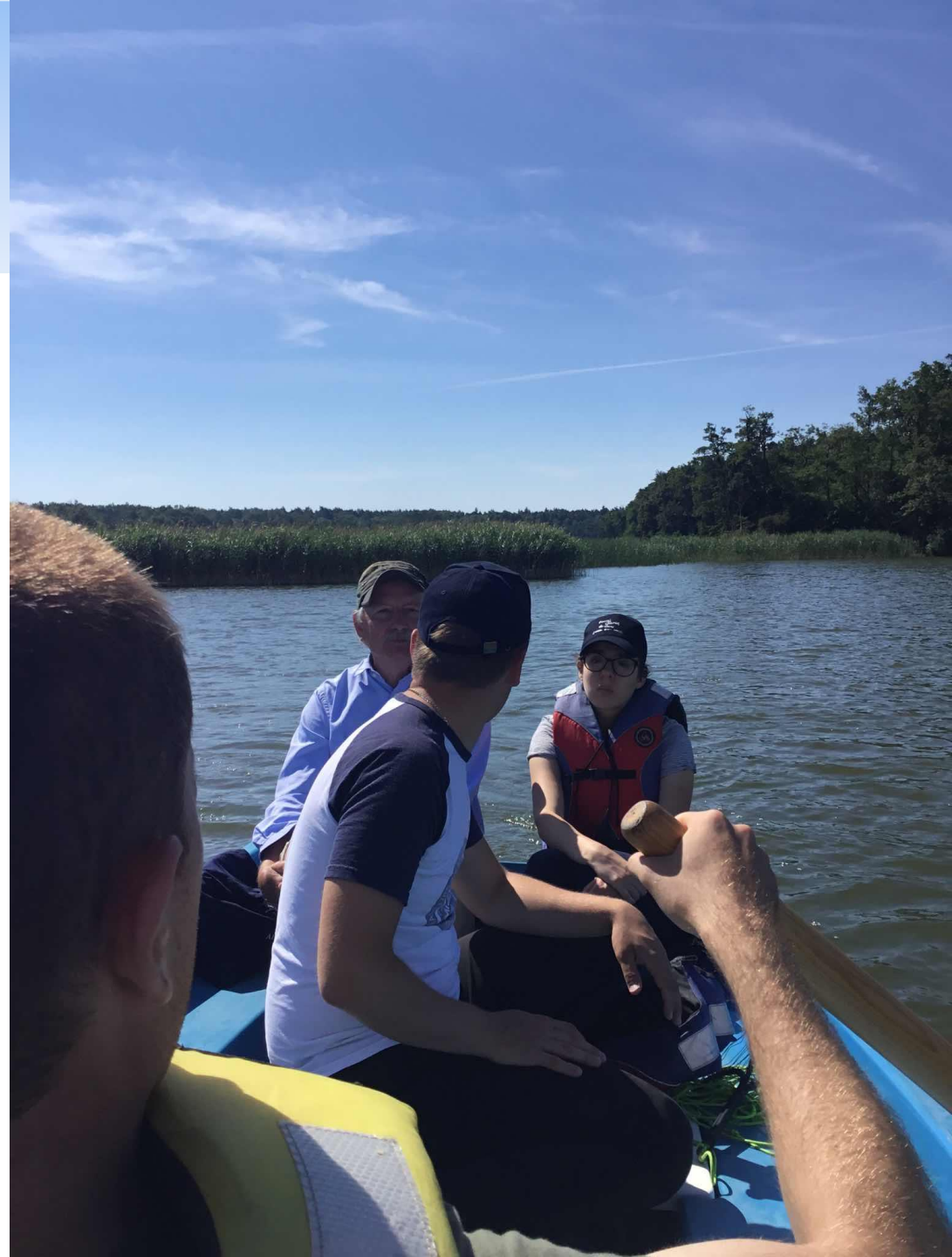
Introduction:

- Macrophytes provide key ecosystem services in freshwater ecosystems, including preventing erosion, providing protection from toxic chemicals and nutrient regulation. .
- Macrophyte species also provide refuge and food for a range of invertebrate species, including zooplankton which regulate the ecosystem (for example, zooplankton is known to reduce the occurrence of excessive cyanobacteria blooms).
- The objectives of this study were to assess the ecosystem health at Lake Durowskie, using a range of macrophyte indicator species. In particular, the study sought to assess the effectiveness of restoration measures and to identify opportunities for improvement.

Area of study:

- Poland, Wielkopolska, Wągrowiec
- Lake Durowskie
- Struga Gołaniecka river

Data gathering:



Data analysis:

- Coordinates were imported to QGIS for conversion to a shapefile and then moved to ARCGIS.
- Layers were created for each species association using GPS point data.
- Spatial areas of extent were calculated.
- Calculation of the ESMI and MIR indices and total % areas were performed in Microsoft Excel.

ESMI formula:

$$ESMI = 1 - \exp\left[-\frac{H}{H_{max}} \cdot Z \cdot exp\left(\frac{N}{P}\right)\right]$$

$$H = -\sum \frac{n_i}{N} \cdot \ln \frac{n_i}{N}$$

$$H_{max} = \ln S$$

$$Z = \frac{N}{P_{isob2.5}}$$

H – diversity index of phytocenosis

ni – area of polygons one of association in percent per cover

N – all cover of macrophytes

Hmax - coefficient of variation of the theoretical maximum

S – number of associations

Z – occupancy index

izob. 2.5m – area of littoral limited by isobath 2.5m

P – area of the lake

MIR formula:

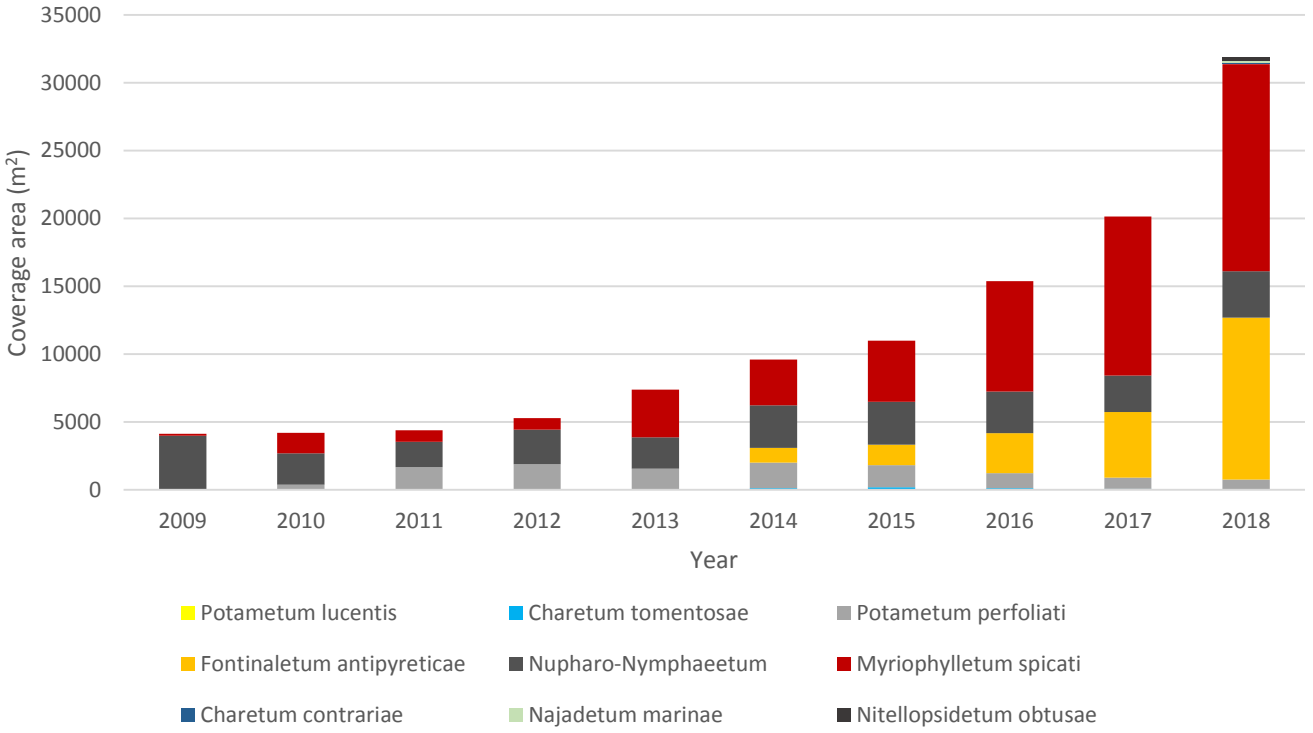
$$\text{MIR} = \frac{\sum L_{i*} W_{i*} P_i}{\sum W_{i*} P_i} * 10$$

L and W are indicator values for each species and P = percentage coverage (split into discrete categories) for that species.

Results:

- During the study, 23 different associations were observed. *Phragmitetum communis* was by far the most widespread association, occupying almost 58% of all macrophyte covered areas in the lake.

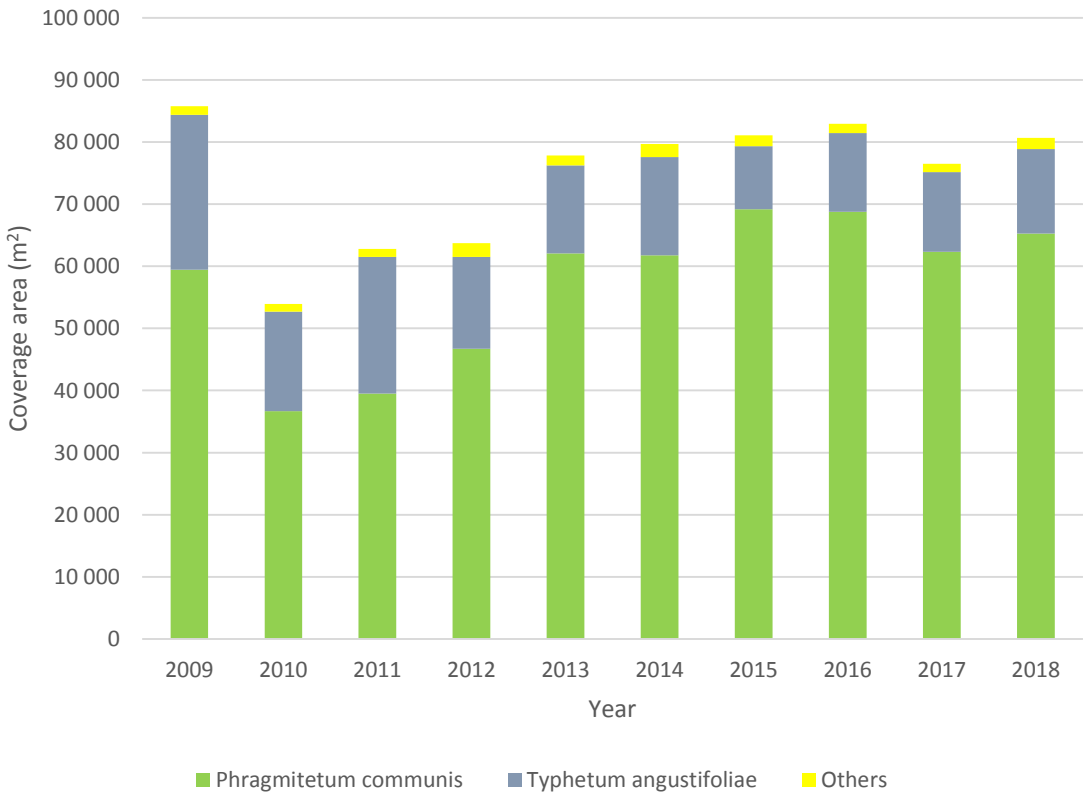
Submerged macrophyte area comparison:

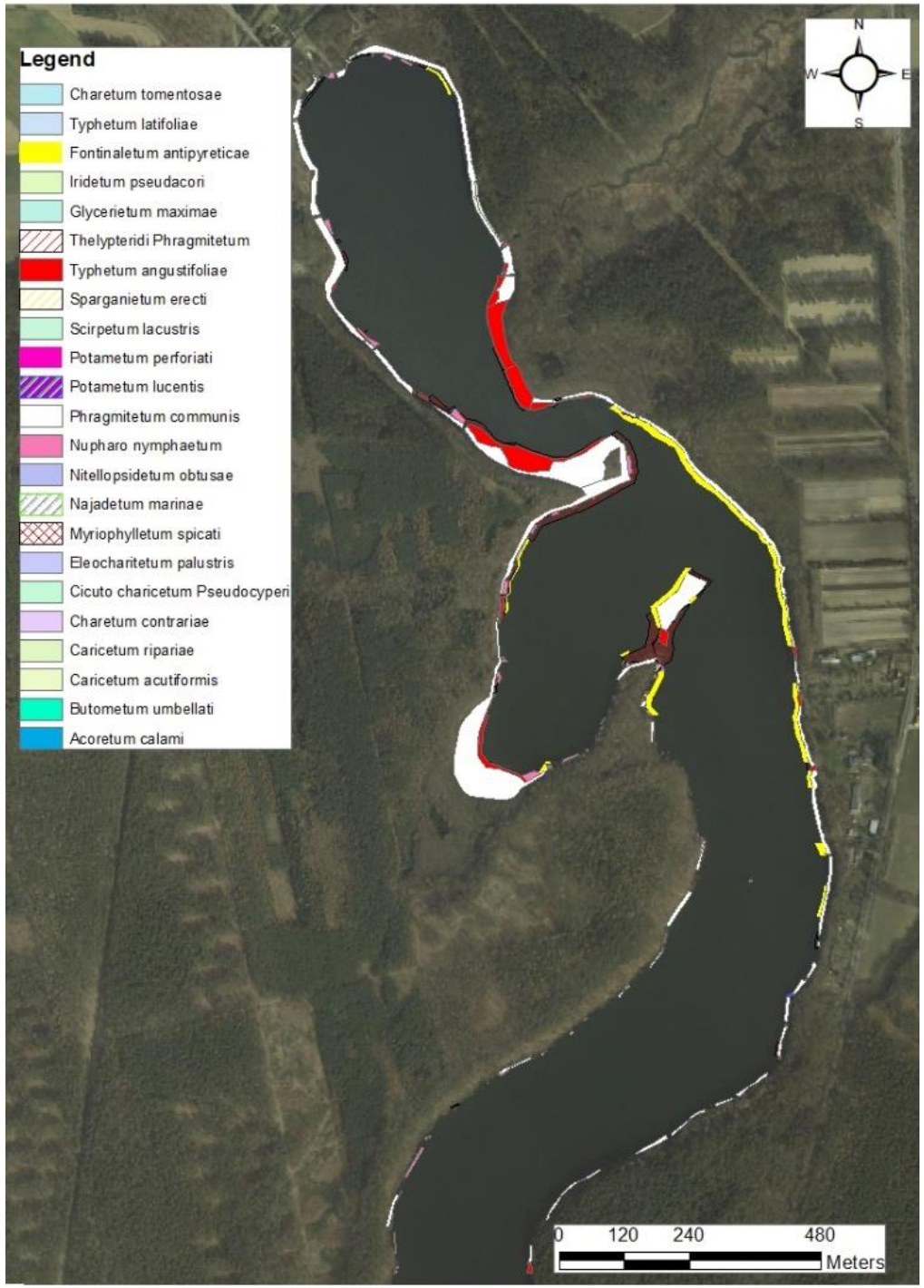


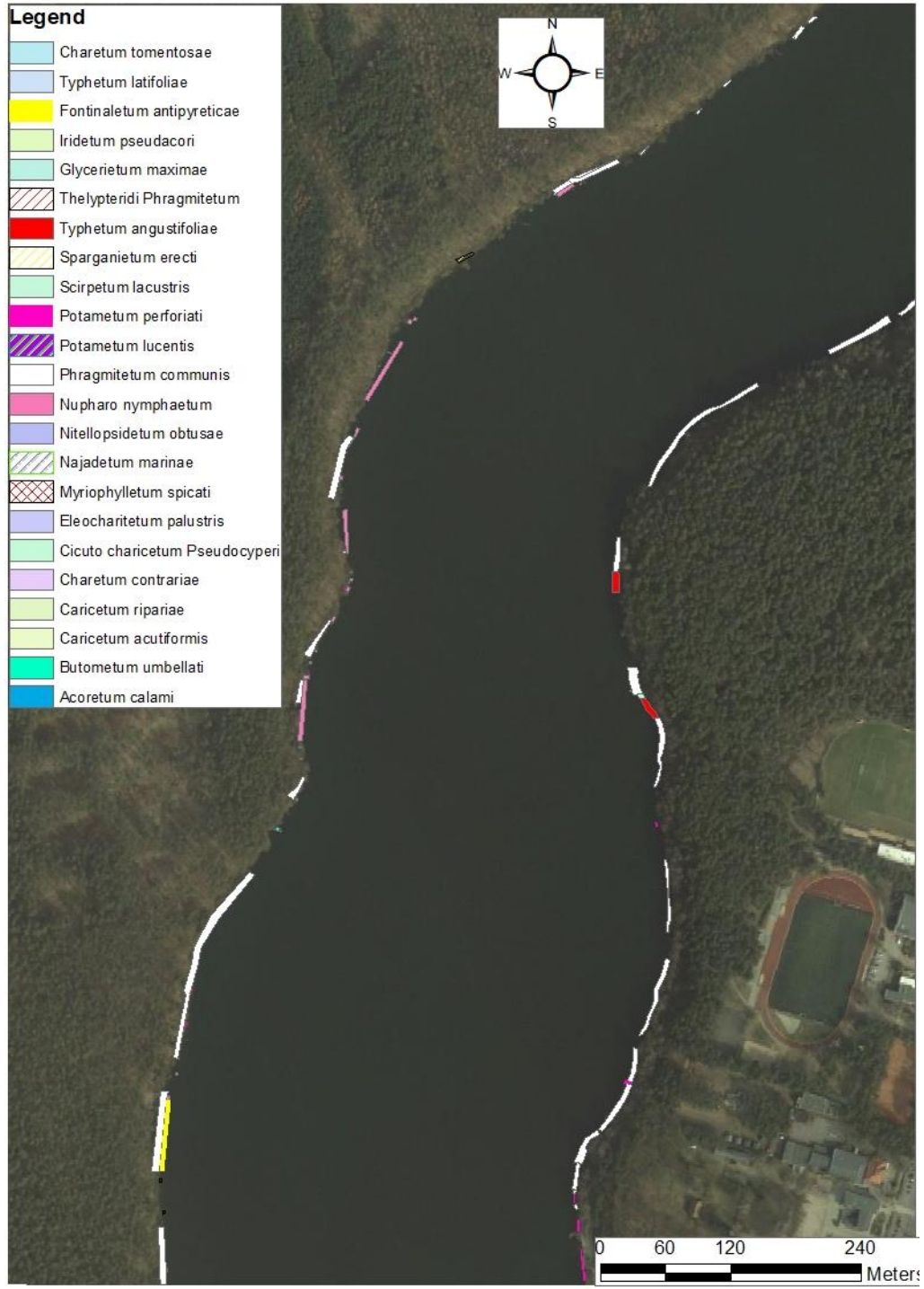
- *Charetum contrariae, Nitellopsidetum obtusae* and *Najadetum marinae* were observed for the first time this year, bringing the number of submerged macrophyte associations to 8.

- *Myriphiletum spicatti* remains the most abundant species, although *Fontinaletum antipyreticae* also increased substantially.

Emergent macrophyte area comparison:




Legend
Charetum tomentosae
Typhetum latifoliae
Fontinaletum antipyreticae
Iridetum pseudacori
Glycerietum maximae
Thelypteridi Phragmitetum
Typhetum angustifoliae
Sparganietum erecti
Scirpetum lacustris
Potametum perforiati
Potametum lucentis
Phragmitetum communis
Nupharo nymphaetum
Nitellopsidetum obtusae
Najadetum marinae
Myriophylletum spicati
Eleocharitetum palustris
Cicuto charicetum Pseudocyperi
Charetum contrariae
Caricetum ripariae
Caricetum acutiformis
Butometum umbellati
Acoretum calami
N
W
E
S
0
120
240
480
Meters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Butometum umbellati
Acoretum calami
N
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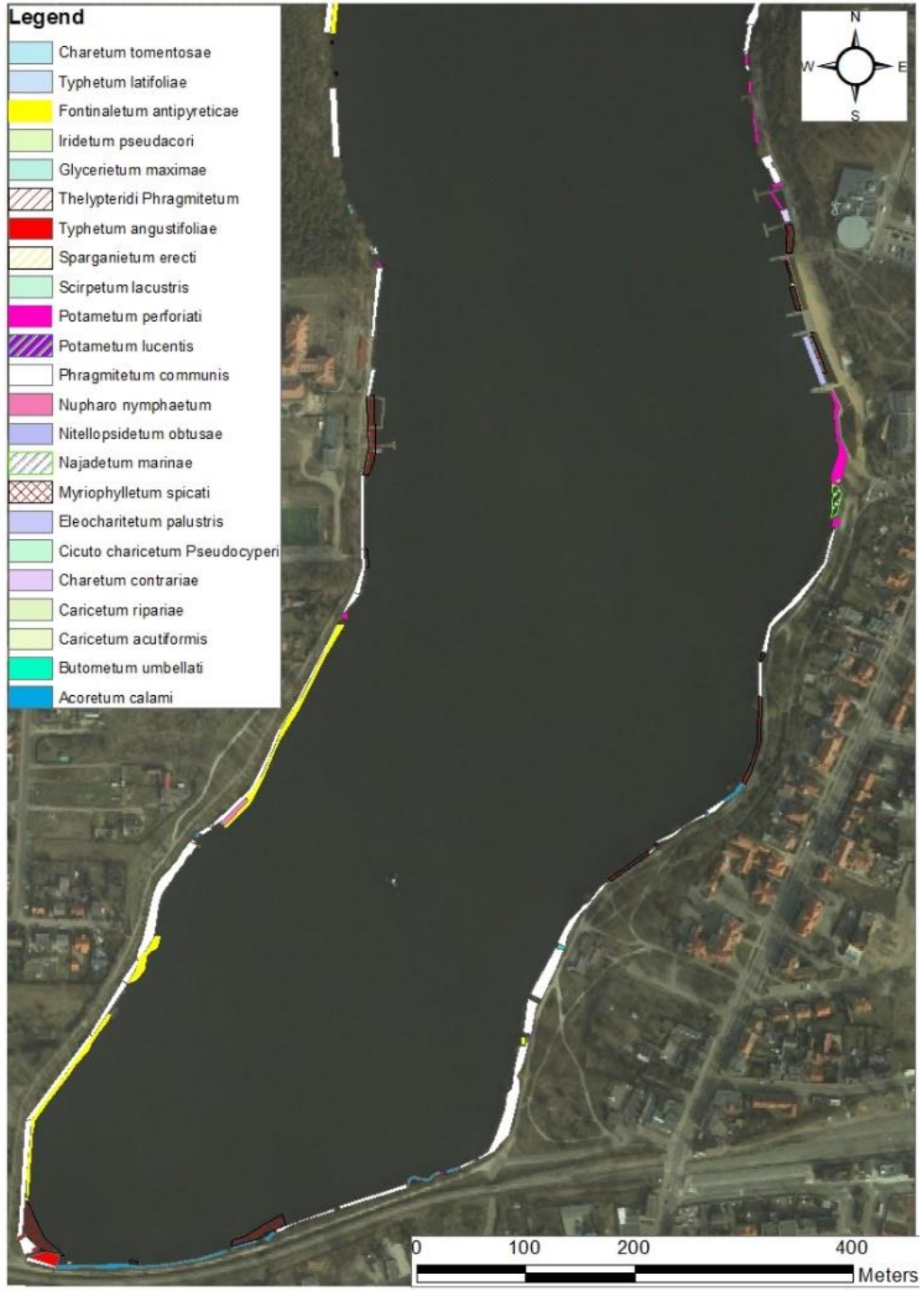
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Charetum contrariae
Caricetum ripariae
Caricetum acutiformis
Butometum umbellati
Acoretum calami
N
W
E
S
0
100
200
400
Meters

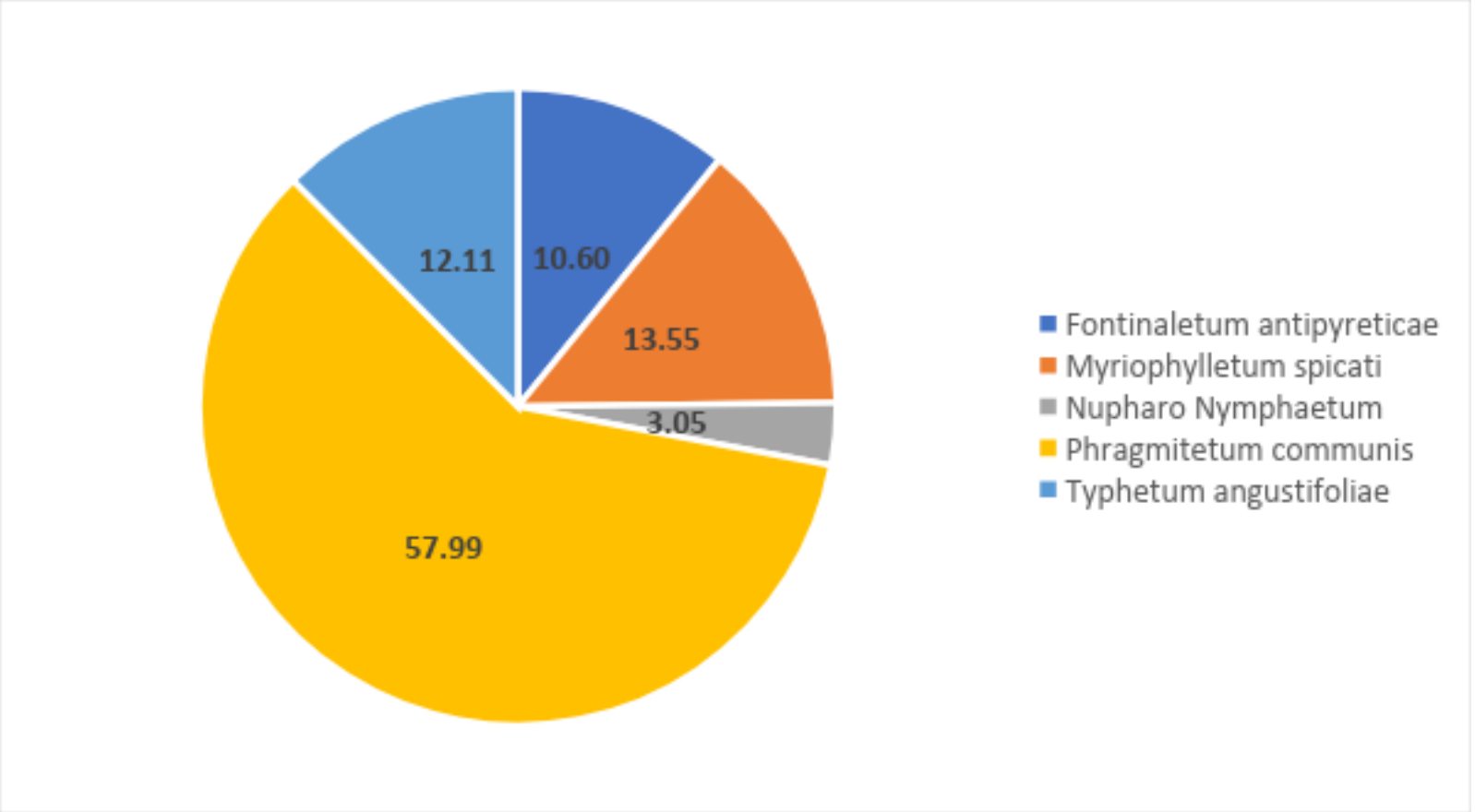
Comparison of ESMI and MIR with previous years:

- Methods of calculation to find out the ecological state of the water quality: the ESMI (Ecological State Macrophyte Index) and the MIR(Macrophyte Index for Rivers).

Ecological status	ESMI Index	MIR Index
Very good	≥ 0,680	≥44.5
Good	≥ 0,410	44.5-35.0>
Moderate	≥ 0,205	35.0-25.4>
Poor	≥ 0,070	25.4-15.8>
Bad	< 0,070	<15.8

Index	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
ESMI	0,11	0,1	0,12	0,12	0,14	0,15	0,14	0,17	0,18	**0,21**
MIR	30,6	31,7	29,8	33,4	26,1	29	36,4	37,8	29,09	**43,3**

Main plants species associations:



Phragmitetum communis:

65243 m2

By Botaurus stellaris
https://commons.wikimedia.org/w/index.php?curid=1340323

Myriophylletum spicati:

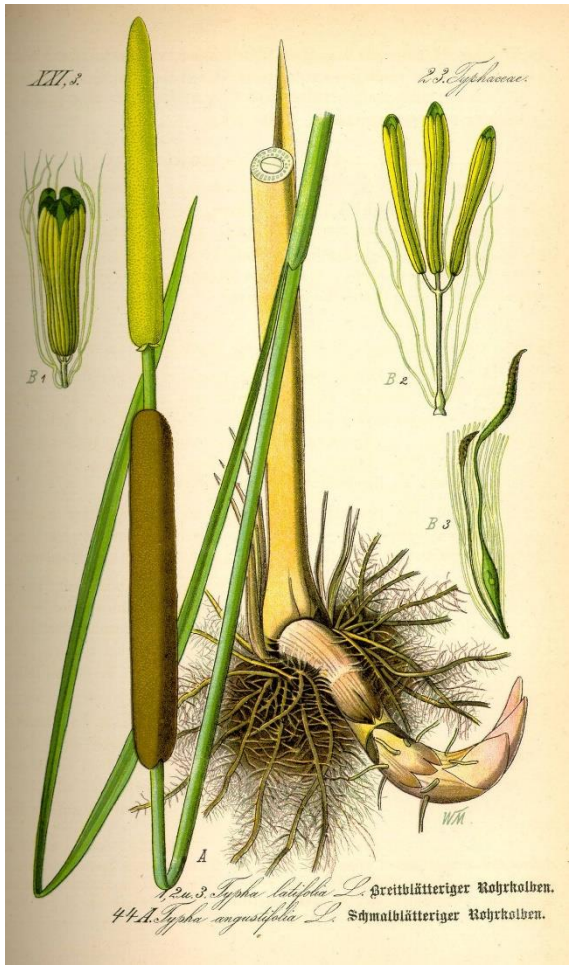
15238 m2

http://jollydiver.com/fauna-i-flora/myriophyllum-spicatum/

https://commons.wikimedia.org/w/index.php?curid=8803

Typhetum angustifoliae:

3430 m2



https://atlas.roslin.pl/plant/8127

Nupharo-Nymphaeetum:

13628 m2

https://atlas.roslin.pl/plant/7455

Fontinaletum antipyreticae:

11930 m2

Discussion:

- *Ceratophyllum demersum* is a returning species, which was found in the north side of the lake.
- *Phragmetum communis* and *Typhetum angustifolium* are the most common associations. Both of them thrive under eutrophic conditions so their abundance is not necessarily a good indicator for improving lake status.
- *Myriophylletum spicati* was the most common submerged macrophyte community; diversity of submerged communities improved significantly from previous years.

Discussion:

- The number of associations observed increased significantly from last year. 18 different associations were observed in 2017, compared to 23 this year.
- The new associations will provide habitats for a broader range of fish, invertebrate and microplankton species, filter out different pollutants and be more resistant to a broader range of problems.
- The ESMI index the ESMI index also witnessed a noticeable improvement, the overall ESMI status is still Moderate. It is possible that the lake itself continues to absorb unwanted nutrients and contaminants, thus keeping the outflow relatively healthy.
- The MIR index 42.33 indicate good status of the lake outflow, suggesting that restoration actions have improved the state of the lake.

Conclusion:

- Overall, the lake appears to be in moderate to good condition. However, some weaknesses and threats remain – in particular, continuing inflow of nutrients and contaminants from the lakes and rivers upstream, outside of Wągrowiec's jurisdiction.

Recommendations:

- Cooperation with other universities and affiliates is recommended, as new perspectives and new knowledge bases could help to improve the situation on Lake Durowskie at a faster pace and with greater resource efficiency.
- It is also important to reduce or eliminate pollution from the source (e.g. upstream). Continuing restrictive measures to prevent pollution is recommended.
- Artificially reintroducing strong native species of submerged macrophytes, such as charophytes, can accelerate the improvement of water quality in Lake Durowskie and provide a more resilient foundation for the ecosystem.

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