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DIVERSITY AND DISTRIBUTION OF THE PLANT COMMUNITIES, THEIR BOTANICAL COMPOSITION, STRUCTURE, AND CHANGES OVER THE MONITORING PERIOD 2011–2015 AND IMPACTS ON AQUATIC WARBLER IN THE PROJECT AREAS „PAPE" AND „LIEPĀJAS EZERS" (LATVIA)

MONITORING REPORT

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VEGETATION TYPES AND CHANGES IN VEGETATION (2011 VS. 2015) IN AIZRAĶE MEADOWS (NATURA 2000 SITE „LIEPĀJAS EZERS")

Plant communities and their cover in Aizraķe Meadows (Liepājas ezers)

The vegetation complex encompasses 13 plant communities (except open water communities) differentiated according to the similarity of the present vascular plant species (Central-European classification). The plant communities were distinguished to the association or alliance level. In cases when the community was dominated by a single species it was named after the dominant species. In most cases, few species were prevailing, and the overall species diversity within a community was relatively low. The plant communities and their cover in hectares are given in *Table 1*.

Table 1

The coverage of plant communities in Aizraķe Meadows (Liepājas ezers), 2011–2015

Plant community	2011		2013		2015	
	Area, ha	Area, %	Area, ha	Area, %	Area, ha	Area, %
Alnion glutinosae	4.2	2.1	4.2	2.1	4.2	2.1
Salicion albae	29.1	14.7	27.6*	13.9*	27.6*	13.9*
Caricetum distichae	4.2	2.1	4.2	2.1	4.2	2.1
Caricetum acutae	94.8	47.9	94.8	47.9	94.8	47.9
Phragmites australis community	45.8	23.1	45.8	23.1	45.8	23.1
Acorus calamus community	2.2	1.0	2.2	1.0	2.2	1.0
Phalaridion arundinaceae	6.4	3.2	6.4	3.2	6.4	3.2
Caricetum nigrae	0.3	0.2	0.3	0.2	0.3	0.2
Filipendula ulmaria community	9.0	4.5	9.0	4.5	9.0	4.5
Bromopsis inermis community	0.7	0.4	0.7	0.4	0.7	0.4
Calystegia sepium community	0.9	0.5	0.9	0.5	0.9	0.5
Anthriscus sylvestris community	0.3	0.2	0.3	0.2	0.3	0.2
Elytrigia repens community	0.2	0.1	0.2	0.1	0.2	0.1
Unstable plant communities after clearing the bushes (potential *Phragmito-Magnocaricetea*)	0.0	0.0	3.3	1.7	3.3	1.7
Totally:	**198.1**	**100.0**	**198.1**	**100.0**	**198.1**	**100.0**

* Alone-standing shrub patches (<0.01 ha) were not mapped as separate vegetation community patches.

The plant communities established after clearing the shrubs in 2012, are not stable yet, therefore in 2013 they were classified as potential *Phragmiti-Magnocaricetea* community (in all cases, similar to the surrounding vegetation dominated by tall sedges). In 2015, the patches of cleared shrubs were classified as *Phragmiti-Magnocaricetea* community, but in the future the species composition of these patches is depending on the management applied. Natural succession will lead back to formation of shrub patches, while regular management (mowing) will prevent formation of shrubs from offspring and will maintain grassland or fen communities.

An overview on the plant communities differentiated in broader units (vegetation classes) is given in *Table 2*.

Table 2

The coverage of plant communities belonging to the different vegetation classes in Aizraķe Meadows (Liepājas ezers), 2011–2015

Vegetation classes	2011		2013		2015	
	Area, ha	Area, %	Area, ha	Area, %	Area, ha	Area, %
Alnetea glutinosae	4.2	2.1	4.2	2.1	4.2	2.1
Salicetea purpureae	29.1	14.7	27.6	13.9	27.6	13.9
Phragmito-Magnocaricetea	153.4	77.4	153.4	77.4	153.4	77.4
Scheuchzerio-Caricetum nigrae	0.3	0.2	0.3	0.2	0.3	0.2
Molinio-Arrhenatheretea	9.7	4.9	9.7	4.9	9.7	4.9
Galio-Urticetea	1.4	0.7	1.4	0.7	1.4	0.7
Unstable plant communities after clearing the bushes (potential *Phragmito-Magnicaricetea*)*	0.0	0.0	1.5	0.8	0.0	0.0
Totally:	**198.1**	**100**	**198.1**	**100**	**198.1**	**100**

* Patches, where the shrubs were removed. In 2015, offspring were recovering. The future vegetation type strongly depends on regular management type (grassland vegetation vs. recovery of shrubs).

The **compendium of the plant communities** present in Aizraķe Meadows is as follows:

Cl. *ALNETEA GLUTINOSAE* Br. Bl. & T. Tx. 1943 emend. Schub. 1995
- O. *Alnetalia glutinosae* R. Tx. 1937
  - All. *Alnion glutinosae* (Malc. 1929), Meijer Drees 1936

Cl. *SALICETEA PURPUREAE* Moor 1958
- O. *Salicetalia purpureae* Moor 1958
  - All. *Salicion albae* Sóo 1930

Cl. *PHRAGMITO-MAGNOCARICETEA* Klika in Klika et Novak 1941
- O. *Phragmitetalia* W. Koch 1926 emend. Pign. 1953
  - All. *Magnocaricion elatae* Koch 1926
    - Ass. *Caricetum distichae* (Nowinski 1928) Jonas 1933
    - Ass. *Caricetum acutae* Tx. 1937
    - *Phragmites australis* community
    - *Acorus calamus* community
  - All. *Nasturio-Glycerietalia* Pign. 1953
    - Ass. *Phalaridion arundinaceae* Kopecký 1961

Cl. *SCHEUCHZERIO-CARICETUM NIGRAE* (Nordh. 1936) R. Tx. 1937
- O. *Caricetalia nigrae* (W. Koch 1926) Nordh. 1936 emend. Br.-Bl. 1949
  - All. *Caricion nigrae* W. Koch 1926 emend. Klika 1934

Cl. *MOLINIO-ARRHENATHERETEA ELATIORIS* R. Tx. 1937
- O. *Molinietalia caeruleae* W. Koch 1926
  - All. *Alopecurion pratensis* Passarge 1964
    - *Bromopsis inermis* community
    - *Filipendula ulmaria* community

Cl. *GALIO-URTICETEA* Pass. et Kopecky 1969
O. *Calystegietalia sepium* R. Tx. 1950
Calystegia sepium community
Anthriscus sylvestris community
Elytrigia repens community

Short description of the plant communities and changes observed after management applied in 2012, 2013 and 2014

The plant communities were first mapped in 2011. In 2013 and 2015, the management areas were repeatedly surveyed and changes in vegetation cover was documented.

In 2012, the shrubs were cut, and late mowing without collecting the hay was carried out. In 2013 and 2014, repeated mowing was performed. In 2014, patches dominated by reed *Phragmites australis* were cut and collected. The management covered eight of 12 monitoring plots, therefore the unmanaged plots can be used as control.

Alnion glutinosae

Alnion glutinosae community is found on the bank of the canal on the northern part of the project territory totally covering 4.2 ha. The community is located linearly along the canal. No post-management changes were observed in 2013 and 2015 (no management applied).

Salicion albae

The *Salicion albae* willow communities (29.1 ha in 2011, 27.6 ha in 2015) occur in overgrown former meadows, established within several decades as a result of natural succession caused by abandonment, or in smaller patches throughout the area. Willow communities occur mostly along River Bārta. The recently overgrown parts of meadow complex are dominated by *Salix viminalis*, while the willow woodland is dominated by *Salix alba*. There are also stands of *Alnus incana*, mixed with willows *Salix* spp. and *Salix alba*. In the western part of the territory near River Bārta, there is a recent, few years old clear-cut densely overgrown with offspring and young shrubs of *Salix spp*. and *Alnus incana*, which has recently transformed into a dense mixed willow and alder communities. The undergrowth is dominated by tall herbs.

The willow shrubland can be restored into open tall sedge-dominated grassland or fen or other floodplain vegetation communities, however, the restoration measures have to be regular and removal of shrubs should be repeated every year at least 3–5 years, since intensive regeneration by offspring might be expected. During the project, part of the area was restored by clearing the shrubs.

In 2015, expansion of the shrub patches was observed in the unmanaged part, while shrub cover in the restored part had decreased.

As a result of recent management, the scrub-dominated plant communities were replaced by other vegetation types. Separate and alone-standing bushes have been removed from areas of ca. 133 hectares. Thus, after the management in 2015 most of the Aizraķe Meadows are covered by open grassland habitats (except densely overgrown areas along River Bārta). In 2013, the shrub removal resulted in open patches with sparse vegetation cover, where formerly the bushes created shadow with no understory (Fig. 1). In 2015, they were almost overgrown with the surrounding vegetation. The surrounding plant species gradually are invading the patches. In 2013, the partly open patches in all cases belonged to the surrounding vegetation types in early successional

phases (Fig. 1), classified as potential *Phragmito-Magnocaricetea*. In 2015, some cut down shrub patches were overgrown with tall sedges (*Carex acuta*, *Carex disticha*) and other vascular plant species typical for the surrounding vegetation. In some patches, offspring from young shrubs are regrowing. Overall, shrub cutting and mowing was effective in surpressing the shrub vegetation.

Fig. 1 Temporary shrub cutting effects – bare or sparsely vegetated patches, which are being gradually invaded by the surrounding herbaceous species. Regeneration degree of shrub offspring is low

Caricetum distichae

The *Caricetum distichae* communities (4.2 ha) occurs in relatively dry parts of the meadow complex and forms patches on slight elevations. The micro-relief is flat, without tussocks. The structure of the plant community has two vegetation layers, where the first layer is dominated by *Carex disticha* and the second layer by *Menyanthes trifoliata* indicating nutrient-rich, slightly acidic to neutral soil with high groundwater table. The dominating species are accompanied by *Comarum palustre*, *Carex vesicaria*, *Equisetum fluviatile*, *Galium palustre*, *Stellaria palustris* and other hygrophytic fen plant species. In lower depressions the plant community is accompanied by *Carex acuta* indicating higher ground water table (*see description of Caricetum acutae*).

No significant changes in the plant community and its distribution patterns, structure and composition was observed during the monitoring period. In some patches, increasing proportion of other species than *Carex disticha*, e.g. *Comarum palustre*, *Menthanthes trioliata* was observed (Fig. 2A, 2B), which perhaps indicate gradual paludification or can interpreted as natural fluctuation.

In some patches, *C. disticha* is being gradually replaced by *C. acuta* and *vice versa*, which is most probably influenced by slight shifts in soil moisture, but long-term trend remains unknown.

Fig. 2A Plot L08 in 2011. *Caricetum distichae* vegetation with well-pronounced dominance of *Carex disticha*

Fig. 2B Plot L08 in 2015. The vegetation is still dominated by *Carex disticha*, no significant changes hav occurred since 2011

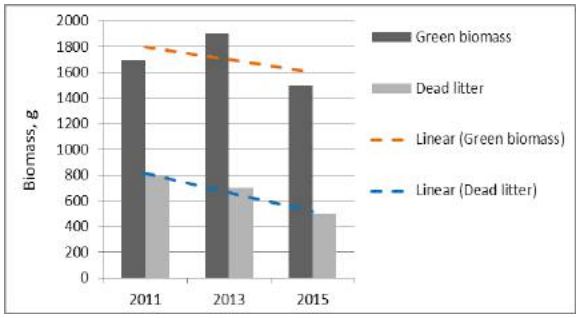

Fig. 3 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Caricetum distichae* community in Aizraķe

In *Caricetum distichae* community, the green aboveground biomass was slightly fluctuating during the monitoring period with a tendency to decrease, which is most probably a natural shift, while the dead litter tends to decrease as it is being well decomposed and does not accumulate in the humid environment (Fig. 3).

Caricetum acutae

Caricetum acutae, the dominant plant community in the area (94.8 ha in 2011, 96.3 ha in 2015), occurs on wet depressions and marshy parts of the meadow complex. The micro-relief is typically dominated by tussocks, often with shallow open water in hollows among the tussocks. The moisture conditions are dynamic and directly influenced by the water table fluctuations in Lake Liepāja.

Typically the plant community is dominated by *Carex acuta*. In drier parts *Carex disticha* co-dominate in the community. As accompanying species few tall herbs are present, e.g. *Iris pseudacorus*, *Filipendula ulmaria*, *Lythrum salicaria*, *Lysimachia vulgaris*, *Rumex aquaticus*, *Glyceria maxima*, while on wetter depressions the fen species such as *Carex lasiocarpa* and *Menyanthes trifoliata* are present.

In parts of meadow, which were abandoned for longer time (mostly wet depressions covered with shallow water), as a result of succession *C. acuta* is co-dominated by *Phragmites australis*, sometimes *P. australis* prevail. The depth of water and abandonment has often caused transformation of *C. acuta* communities in sparse species-poor marsh with *C. acuta* and *P. australis* stands, often with dense cover of dead litter (last year's reed) significantly decreasing the species diversity.

Within the last four years, increasing dominance of *P. australis* (both density and cover) was observed in the unmanaged area, while no significant changes occurred in the managed part of the meadow complex (Fig. 4A, 4B). But since *C. acuta* is still the co-dominant species in herb layer, in 2015 the patches invaded by reed were still classified as *Caricetum acutae*.

Fig. 4A Plot L06 in 2011. *Caricetum acutae* community before management

Fig. 4B Plot L06 in 2015. *Caricetum acutae* community, the plot was mowed in 2012 and 2013

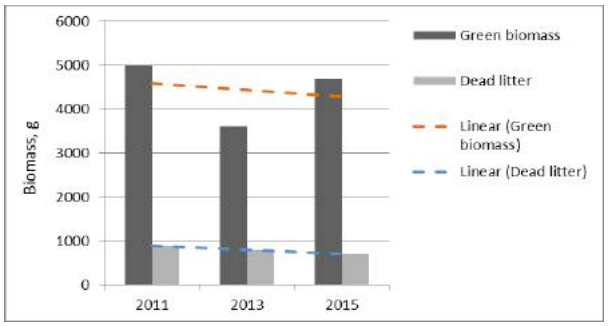

Fig. 5 Changes in the amount of green above-ground green biomass and dead litter in 2011–2015 in *Caricetum acutae* community in Aizraķe

In *Caricetum distichae* community, the green aboveground biomass was slightly fluctuating during the monitoring period with a little tendency to decrease (unclear trend). The amount of dead litter tends to decrease as it is being well decomposed and does not accumulate in the humid environment (Fig. 5).

Acorus calamus community

Acorus calamus is an introduced, fully naturalized plant species; it was brought to the territory of Latvia already in the 16th century. The species is relatively common throughout the country, especially in shallow standing waters, e.g. eutrophic ponds.

In Aizraķe Meadows, the species forms a transitional community (2.2 ha), composed of tall sedges *Carex disticha*, *C. acuta* or rarely with *C. vesicaria*, occurs in moist depressions with shallow water (marshy habitats). Usually *A. calamus* is co-dominating, well-pronounced dominance was observed only in relatively small patches in wet depressions or the former, currently overgrown oxbows, sometimes it occurs in narrow belts along the former river beds and old overgrown drainage ditches (Fig. 6A, 6B). In parts of the meadow complex abandoned for longer time, the micro-relief is formed by high tussocks and marshy ground, sometimes with shallow open water covering the ground.

No significant changes in the *A. calamus* dominated vegetation were observed during the monitoring period in plots under mowing management.

Fig. 6A Plot L11 in 2011 before management

Fig. 6B Plot L11 in 2015 recovered after mowing. No significant changes in vegetation were observed

***Phragmites australis* community**

The community is covering large areas (45.8 ha) and has formed of *Caricetum acutae* and *Caricetum distichae* communities as a result of natural succession in unmanaged patches. The formation of the *Phragmites australis* community is promoted also by natural conditions (high water table). The community prevails in parts of the meadow complex, which are abandoned for a longer period of time (usually wet depressions) as well as along the oxbows and ditches. The vegetation structure varies from dense to sparse, loose reed stands with dense layer of dead litter and surface water (can be up to ~0.5 m deep). The marginal reed beds are overgrown with *Salix spp*.

The *P. australis* community is expanding in the abandoned parts of Aizraķe Meadows by invading the wet tall sedge communities. In 2013 and 2015, the transitional *Carex acuta-Phragmites australis* dominated plant communities were still classified as *Caricetum acutae*, because *Carex acuta* was still present occupying at least 50 % of the vegetation, although the patches of vegetation with reed in the first vegetation layer are increasing. The cover of *P. australis* is increasing in the unmanaged part along River Bārta on the expense of tall sedge communities (*Caricetum acutae*, *Caricetum distichae*) (Fig. 7A, 7B).

Fig. 7A Plot L12 in 2011, *Phragmites australis* community in the abandoned part of the meadow complex

Fig. 7B Plot L12 in 2015, *Phragmites australis* community in the abandoned part of the meadow complex

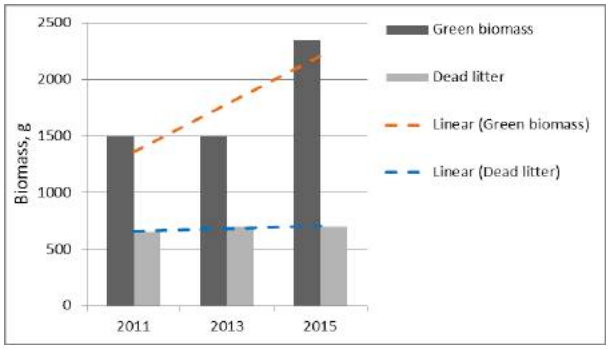

Fig. 8 Changes in the amount of green above-ground green biomass and dead litter in 2011–2015 in *Phragmites australis* community in Aizraķe.

In *Phragmites australis* community, the green aboveground biomass has increased during the monitoring period. The amount of dead litter remained less or more the same without well pronounced changes (Fig. 8).

Phalaridion arundinaceae

The community occurs in similar conditions as the *Filipendula ulmaria* community – on relatively dry elevations, in belts along the streams and on the banks of the polder canal, sometimes forming mosaic-like patches with *Filipendula ulmaria* community. The community covers ca. 6.4 ha and is dominated by *Phalaris arundinacea*. The species diversity within the community is low, only few accompanying species are present.

Some vegetation changes in the community cover were observed comparing data of 2011, 2013 and 2015. In the plot without management, the vegetation changes toward *Filipendula ulmaria* community. In the managed plot the dominance of *Phalaris arundinacea* is increasing, and the total number of species is declining. Generally, no significant changes in species composition or structure were observed (Fig. 9A, 9B).

Fig. 9A Plot L07 in 2011, *Phalaridion arundinaceae* community in the management part of the meadow complex

Fig. 9B Plot L07 in 2015, *Phalaridion arundinaceae* community in the management part of the meadow complex.

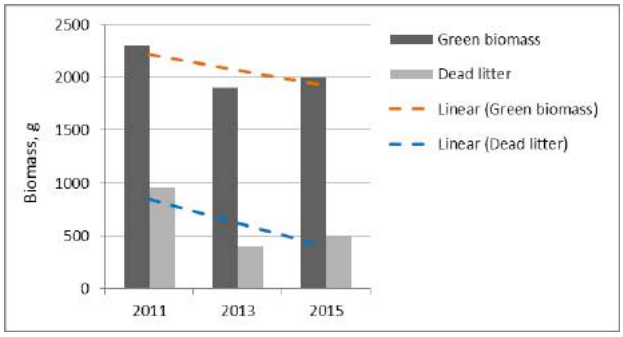

Fig. 10 Changes in the amount of green above-ground green biomass and dead litter in 2011–2015 in *Phalaridion arundinaceae* community in Aizraķe

In *Phalaridion arundinaceae* community, the green aboveground biomass shows a tendency to decrease, which is probably causing increasing proportion of other plants. The amount of dead litter has decreased during the monitoring period, which is probably related to high decomposition rates (Fig. 10).

Caricion nigrae

Caricion nigrae community covered only ca. 0.3 ha, a small patch, enclosed by tall sedge communities. The community is composed by *Carex nigra* as the dominant species and several species of fens and transitional mires, e.g. *Menyanthes trifoliata*, *Comarum palustre*, *Eriophorum polystachion*, *Peucedanum palustre*, *Equisetum fluviatile*, *Calamagrostis canescens* indicating conditions characteristic for nutrient-rich, slightly acidic to neutral fens, and the species of alluvial meadows present also in the neighbouring communities, e.g. *Lysimachia vulgaris*, *Polygonum lapathifolium*, *Carex vesicaria*. During the monitoring period, the cover of *Phragmites australis* was slightly increasing.

Bromopsis inermis community and *Elytrigia repens* community

Both plant communities are present only in small patches on the banks of the channelized River Bārta. *Bromopsis inermis* is a typical species in alluvial meadows, however, in this case both communities are fragmentary and do not represent the typical vegetation types. Most probably, their presence is related to anthropogenic disturbances (river bank-dam, low intensity road) and ruderalization. Both communities are species-poor with a presence of ruderal nitrophilous species (e.g. *Cirsium arvense*, *Urtica dioica*, *Galium aparine*). Since the communities are found only in small patches (*Bromopsis inermis* community – ca. 0.7 ha and *Elytrigia repens* community – ca. 0.2 ha) and are mainly related to human-caused disturbances, the monitoring plots were not established within these patches.

In 2013 and 2015, increasing cover of *Bromopsis inermis* was observed, but only in the unmanaged parts of the meadows along River Bārta. As a result of abandonment, the species tend to expand in the unmanaged part.

Filipendula ulmaria community

The community covers ca. 9 ha and occurs on relatively drier elevations, both on natural elevations and on the banks of the river and the polder canal. The community is dominated by *Filipendula ulmaria*, sometimes mixed with *Phalaris arundinacea*, while the number and covers

of other accompanying species is low. The well-pronounced dominance of *F. ulmaria* is promoted by abandonment.

During the monitoring period, the number of species has decreased in both sample plots, however, almost all of them except *F. ulmaria* are with very small covers. During the monitoring period, no significant changes in vegetation structure were observed (Fig. 11A, 11B).

Fig. 11A Plot L05 in 2011. *Filipendula ulmaria* community with low proportion of other plant species

Fig. 11B Plot L05 in 2015. *Filipendula ulmaria* community with low proportion of other plant species. Almost no changes within four years were observed

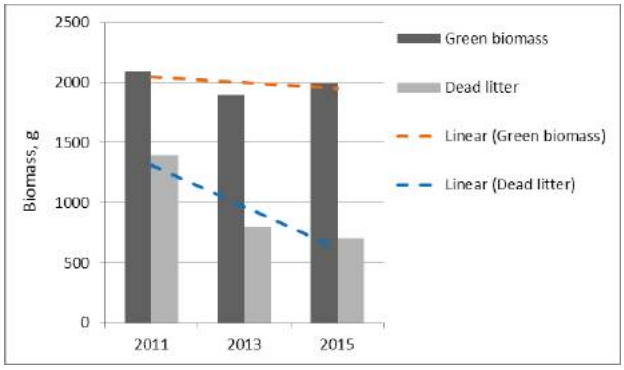

Fig. 12 Changes in the amount of green above-ground green biomass and dead litter in 2011–2015 in *Filipendula ulmaria* community in Aizraķe

In *Filipendula ulmaria* community, the green aboveground biomass shows a little tendency to decrease, which is most probably a natural fluctuation. The amount of dead litter decreased over the monitoring period (Fig. 12).

Calystegia sepium community

The community covered ca. 0.9 ha and occurs in narrow (up to few metres) belts along River Bārta and the polder canal. The community is typical for nutrient-rich soils, commonly occurs along streams. In the community, *Calystegia sepium* is the dominant species, while the accompanying species encompass mostly the species occurring in the other communities present in the site, e.g. *Phalaris arundinacea*, *Phragmites australis*, *Filipendula ulmaria*, etc. as well as woody species such as *Salix* spp. and *Alnus incana*. Also a non-native species, a garden escapee, *Echinocystis lobata* is present in the community, although mostly as few individuals.

Since the community is fragmentary, monitoring plots were not established there.

Anthriscus sylvestris community

The community (0.3 ha) occurs in a single patch on the southern part of the territory near the polder canal. The presence of the community is most probably related to a human-caused soil disturbance (increased nutrient level). The community is dominated by tall herbs typical for ruderal vegetation: *Anthriscus sylvestris* and *Urtica dioica* with few accompanying species, e.g. *Elytrigia repens*, *Glechoma hederacea*, *Carduus crispa*, *Artemisia vulgaris* etc.

Since the community is fragmentary, not typical for the territory and occurs only in a single small patch, monitoring plots were not established there.

Changes in vegetation in Aizrakje Meadows, 2011–2015: summary

Major changes in vegetation during the monitoring period have occurred in the unmanaged part of Aizrakje Meadow complex. The vegetation in the wet parts of the abandoned meadow complex is changing toward *Phragmites australis* communities. Changes occur both at community level, resulting in inceasing dominance of reed and at landscape level – increasing patches of reed-dominated vegetation. The cause of these changes is lack of management. In the patches managed during the project, the changes in vegetation composition and structure are not significant neither at landscape (except removal of shrub patches), nor at community level as the wet meadow communities do not react rapidly to management.

The number of vascular plant species per sample plot varied during the monitoring period (Fig. 13), both in managed and unmanaged plots. No clear trends in the number of species were found either in managed, or in abandoned part of the meadow complex. The changes seem to be more related to natural fluctuations than to the effect of management, which could have a detectable effect after longer period of regular mowing.

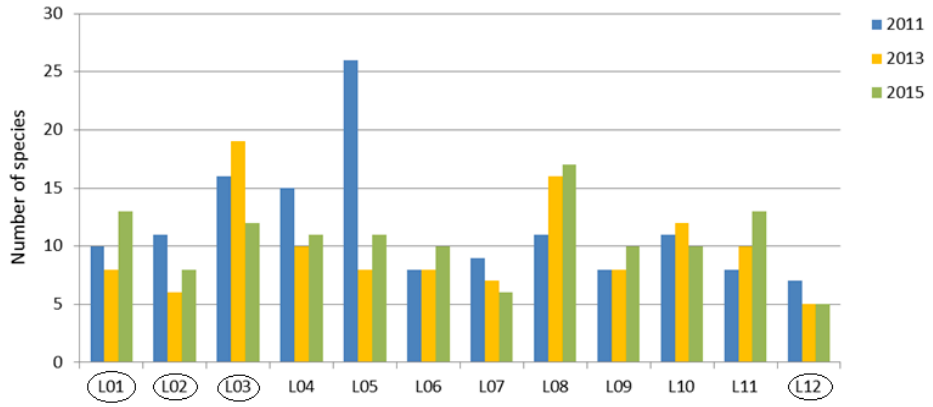

Fig. 13 Number of vascular plant species per sample plot, 2011–2015. ID codes of unmanaged plots are marked with circle. L01, L12 – *Phragmites australis* community; L02, L06 – *Caricetum acutae*; L03, L07 – *Phalaridetum arundinaceae*; L04, L05 – *Filipendula ulmaria* community; L08, L10 – *Caricetum distichae*; L09, L11 – *Acorus calamus* community.

The average annual amount of green biomass slightly varied during the monitoring period with no clear trend (Fig. 14) suggesting that wet grassland-fen vegetation is rather stable and does not react to management or abandonment rapidly. The average annual amount of dead litter (Fig. 14) decreased during the monitoring period, which is probably related to increased

decomposition rates (can be promoted by increased humidity during the warm vegetation season or other factors). Majority of sample plots occured in the managed part, thus the decreased amount of dead litter might be related also to the management applied (mowing and chipping the grass, which could increase the decomposition rate).

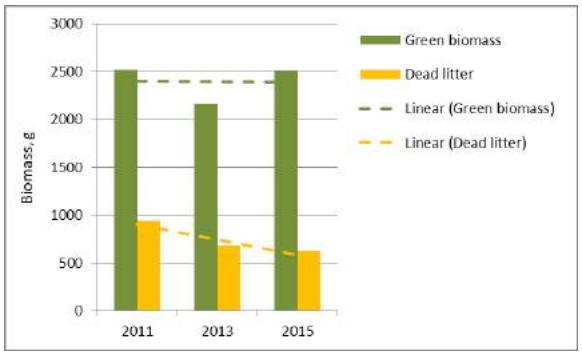

Fig. 14 Changes in average annual green biomass and amount of dead litter in Aizraķe meadows, 2011–2015

The hydrological regime remains the same as at the beginning of the monitoring: fluctuating and dynamic, the water table in the meadow depends on the water table in Lake Liepāja, thus hydrological changes cannot be judged as having a significant impact on vegetation. Majority of changes might be related to natural fluctuations. Clear trends could be drawn after more years of monitoring. Right now the changes observed can be influenced by climatic conditions (amount of precipitation) over the monitoring period, some accidental impacts (wild animals, wind direction causing the temporary rise of the water level at Lake Liepāja from the Baltic Sea etc.).

SUITABLE PARTS OF THE TERRITORY FOR THE AQUATIC WARBLER

The most suitable vegetation types at Aizraķe Meadows suitable for Aquatic Warbler *Acrocephalus paludicola* are tall sedge communities *Caricatum acutae*, followed by *Caricetum distichae*. The project territory provides relatively large areas of these plant communities (94.8 ha of *Caricetum acutae* and 4.2 ha of *Caricetum distichae*) in medium quality. It has been recognized on *ex-ante* evaluation of the Aizraķe Meadows (first visit in 2003 by Aquatic Warbler Conservation Team led by Dr. Martin Flade, and other visits by Dr. Alexander Kozulin in April 2011 and October 2012) that this territory was the best of all project territories (including Lithuanian ones), but site is not occupied by Aquatic Warbler due to its northernmost location of all territories, where singing Aquatic Warblers have been observed during the last decade in the world. Recently it is probably abandoned not only due to overgrowth by reed and bushes, but also by being on the margin in a declining population (similarly to West-Pomeranian population in Germany/Poland).

The removal of bushes and mowing of the meadows in 2012 and 2013 has enhanced the habitat in the territory for Aquatic Warbler, Corncrake *Crex crex* and Great Snipe *Gallinago media* (Great Snipe was observed at Aizraķe Meadows in 1997 and 1999, when the meadows were still partly used for agriculture).

During the monitoring counts of the birds carried out every year during the project, no clear trends of the bird population numbers were observed. The fluctuations rather showed short term effects of the water table at the site, e.g. the last count on July 17, 2015 record number of the

Spotted Crake *Porzana porzana* – 14 calling males were observed due to very high water table at the site. No singing Aquatic Warbers were observed during the project period at Aizraķe site.

In August 2014, bird trapping during the autumn migration of *Acrocephalus* warblers were carried out at Aizraķe site. We used 6 mist-nets 16 × 16 mm mesh size; height of the nets – 2.5 m, length of one net – 12 m, thus the total length of all nets were 72 m. In order to attract the target species – Aquatic Warbler, playback of the male song was used to attract the birds. The playback was switched on every morning at dawn (3:00 a.m.). All captured individuals of all species were ringed.

In total, during the period between August 11 and August 26 on 14 days (two days the catching was impossible due to strong wind and rainfall) 318 birds of 22 species were captured and ringed (*Table 3*). The most numerous species captured was Sedge Warbler *Acrocephalus schoenobaenus* – 199 individuals. This shows that the playback was attracting birds, since part of the song between Aquatic Warbler and Sedge Warbler are similar, thus by playing Aquatic Warbler male song, also Sedge Warblers are attracted to the nets.

Among the other species the most valuable was the capture of the Great Snipe, which was the first confirmed observation of this bird species since the beginning of the project. This indicates that Aizraķe site is suitable for Great Snipe at least during the migration as stop-over site, but most likely it is suitable for the species also during the breeding period. Two individuals of another specially protected species – Bluethroat *Luscinia svecica*, were also captured.

Table 3

Birds captured at Lake Liepāja (Aizraķe) site August 11 – August 26, 2016.

Nr.	Species common name	Species scientific name	Ringed individuals
1.	Sedge Warbler	*Acrocephalus schoenobaenus*	199
2.	Reed Warbler	*Acrocephalus scirpaceus*	37
3.	Grashopper Warbler	*Locustella naevia*	16
4.	Marsh Warbler	*Acrocephalus palustris*	15
5.	Reed Bunting	*Emberiza schoeniclus*	11
6.	Great Reed Warbler	*Acrocephalus arundinaceus*	8
7.	Whinchat	*Saxicola rubetra*	6
8.	Savi's Warbler	*Locustella luscinioides*	5
9.	Willow Warbler	*Phylloscopus trochilus*	4
10.	Bluethroat	*Luscinia svecica*	2
11.	Snipe	*Gallinago gallinago*	2
12.	Red-backed Shrike	*Lanius collurio*	2
13.	Whitethroat	*Sylvia communis*	2
14.	Barred Warbler	*Sylvia nisoria*	1
15.	Blackcap	*Sylvia atricapilla*	1
16.	Lesser Whitethroat	*Sylvia curruca*	1
17.	Spotted Crake	*Porzana porzana*	1
18.	Barn Swallow	*Hirundo rustica*	1
19.	Chifchaf	*Phylloscopus collybita*	1
20.	Wood Sandpiper	*Tringa glareola*	1
21.	Great Snipe	*Gallinago media*	1
22.	Kingfisher	*Alcedo atthis*	1
	Totally:	22 species	318

UNSUITABLE PLANT COMMUNITIES FOR THE AQUATIC WARBLER AND RECOMMENDATIONS

Expansion of monotonous *Phragmites australis* community is the greatest threat to Aquatic Warbler and all other target species at Aizraķe Meadows. The reed community has to be cut and expansion of reeds stopped in order to ensure the good quality of meadow habitat. In initial period it is recommended to mow the reed in July in order to decrease the potential of reeds to regenerate (Aivars Mednis, pers. comm.) In general, mowing of the Aizraķe Meadows is the main management solution in order to preserve the meadows suitable for all target species of this LIFE project.

VEGETATION TYPES IN PAPE (NATURA 2000 SITE „PAPE")

The territory lies on the western shore of the Lake Pape, between Pape village and the lake. Part of the area is located on a higher elevation on sandy dune soils, while the rest occurs in the floodplain of the lake, thus being a wet marshy area, the transitional zone between the lakeshore reed beds and the terrestrial area.

Plant communities and their cover in Pape site

The vegetation complex encompasses eight plant communities differentiated according to the similarity of the present vascular plant species (Central-European classification) and transitional successional phases, which emerged after clearing of shrubs in 2012. The plant communities were distinguished to the association or alliance level, in cases when the community is dominated by a single species, it was named after the dominant species. The plant communities and their cover in hectares are given in *Table 4*. An overview on the plant communities differentiated in broader units (vegetation classes) is given in *Table 5*.

Table 4

The coverage of plant communities in Pape site, 2011–2015

	2011		2013		2015	
Plant community	**Area, ha**	**Area, %**	**Area, ha**	**Area, %**	**Area, ha**	**Area, %**
Alnion glutinosae	0.5	1.5	0.5	1.5	0.5	1.5
Salicion cinereae	11.7	34.2	8.0	23.5	2.8	8.3
Caricetum acutae	0.07	0.2	0.07	0.2	0.07	0.2
Caricetum distichae	0.5	1.5	0.5	1.5	0.5	1.5
Carici-Menyanthetum trifoliatae	4.2	12.0	4.2	12.0	4.2	12.0
Caricetum nigrae	4.3	12.7	4.3	12.7	4.3	12.7
Deschampsion cespitosae	5.2	15.0	5.2	15.0	4.1	12.2
Plantagini-Festucion	7.8	23.0	7.8	23.0	7.8	22.0
Unstable grassland plant communities formed after clearing of shrubs	0.0	0.0	3.6	10.7	10.0	29.5
Totally:	**34.0**	**100.0**	**34.0**	**100.0**	**34.0**	**100.0**

Table 5

The coverage of plant communities belonging to the different vegetation classes in Pape site, 2011–2015

Vegetation classes	2011		2013		2015	
	Area, ha	**Area, %**	**Area, ha**	**Area, %**	**Area, ha**	**Area, %**
Alnetea glutinosae	12.2	35.8	8.5	25.0	3.3	9.8
Phragmito-Magnocaricetea	4.8	14.2	4.8	14.2	4.8	13.7
Scheuchzerio-Caricetum nigrae	4.1	12.0	4.1	12.0	4.3	12.7
Molinio-Arrhenatheretea	5.1	15.0	5.1	15.0	4.1	12.1
Koelerio-Corynephoretea	7.8	23.0	7.8	23.0	7.8	22.0
Unstable grassland plant communities formed after clearing of shrubs (potentially *Phragmito-Magnocaricetea*, *Deschampsion cespitosae* or *Caricetum nigrae*)	0.0	0.0	3.6	10.6	10	29.5
Totally:	**34.0**	**100.0**	**34.0**	**100.0**	**34.0**	**100.0**

The **compendium of the plant communities** present in Pape is as follows:

Cl. *ALNETEA GLUTINOSAE* Br. Bl. & R. Tx. 1943 emend. Schub. 1995
- O. *Alnetalia glutinosae* R. Tx. 1937
  - All. *Alnion glutinosae* (Malc. 1929) Meijer Drees 1936
  - All. *Salicion cinereae* Th. Müller et Görs 1958

Cl. *PHRAGMITO-MAGNOCARICETEA* Klika in Klika et Novak 1941
- O. *Phragmitetalia* W. Koch 1926 emend. Pign. 1953
  - All. *Magnocaricion elatae* Koch 1926
    - Ass. *Caricetum acutae* Tx. 1937
    - Ass. *Caricetum distichae* (Nowinski 1928) Jonas 1933
    - Ass. *Carici-Menyanthetum trifoliatae* Steffen 1931

Cl. *SCHEUCHZERIO-CARICETUM NIGRAE*
- O. *Caricetalia nigrae* (Koch 1926) Nordh. 1936 emend. Br.-Bl. 1949
  - All. Caricion nigrae (Koch 1926) Nordh. 1936 emend. Br.-Bl. 1949
    - Ass. Caricetum nigrae Br.-Bl. 1915

Cl. *MOLINIO-ARRHENATHERETEA* R. Tx. 1937
- O. *Molinietalia* Koch 1926
  - All. *Deschampsion cespitosae* Horvatić 1930

Cl. *KOELERIO-CORYNEPHORETEA* Klika ap. Klika et Novak 1941
- O. *Corynephoretalia* Klika 1934
  - Ass. *Plantagini-Festucion* Passarge 1964

Short description of the plant communities and changes observed after management applied in 2012, 2013 and 2014

The plant communities were first mapped in 2011. In 2013 and 2015, the management sites were repeatedly surveyed and changes on vegetation cover were documented.

The areas covered by the plant communities first mapped in 2011, have not much changed since then, except decrease of the shrub cover (*Salicion cinereae*) because of clearing the shrubs during the project (*Table 3*). In 2012, the shrubs were cut down and removed from central part of Pape project area. The roots of the shrubs were chipped together with the soil surface. As a result, a pioneer grassland community has emerged. It is composed of the species typical for the surrounding vegetation (*Deschampsia cespitosa*, *Lysimachia vulgaris*, *Carex nigra*, *Phragmites australis* etc.) but it still lacks the structure typical for semi-natural grasslands. These could belong to *Phragmito-Magnocaricetea*, *Deschampsion cespitosae* or *Caricetum nigrae* (depending on the local moisture conditions) in the future if continuous mowing management with hay removal will be applied.

The management covered eight of 14 monitoring plots, therefore the unmanaged plots can be used as control.

Alnion glutinosae

A small *Alnion glutinosae* woodland patch (0.5 ha) occurs in the southern part of the Pape project area. The tree layer is dominated by *Alnus glutinosa*, the ground vegetation cover is eutrophicated, covered by nitrophilous vegetation (ruderalized), which is composed by the tall herbs, e.g. *Urtica dioica*, *Epilobium hirsutum*, *Anthriscus sylvestris*, etc., and grassland species present in the surrounding vegetation, e.g. *Geum rivale*, *Caltha palustris*, *Iris pseudacorus*, *Deschampsia cespitosa*, *Lysimachia vulgaris*, *Juncus conglomeratus*. No management in the *Alnion glutinosae* was applied, no significant changes in the vegetation were observed during the monitoring period.

Salicion cinereae

The secondary shrub community (11.6 ha in 2011, 2.8 ha in 2015) has formed as a result of natural succession induced by abandonment. Most of the meadow area has not been managed at least over the last two decades, thus it has overgrown with dense willow shrub patches. *Salix cinerea* prevail in the community, accompanied by other *Salix* species, *Betula* spp., rarely by *Frangula alnus* and other woody species.

In 2012, the shrubs were cleared and removed from the central part of Pape project area, thus the open grassland area has significantly increased providing suitable conditions for recovery of grassland communities. Also alone-standing shrub patches and trees (each covering areas under the mapping threshold units) have been removed from there. In summer 2013, the vegetation in the managed area was patchy, dominated by unstable plant communities which formed after clearing of the formerly dense shrubland. Under shrub cover the herbaceous vegetation was sparse with some bare soil patches. After clearing the shrubs, the herbaceous vegetation was recovering, however, within a year the herbaceous vegetation cover was still not closed (Fig. 15). In 2015, the former dense shrub patches were still not fully covered by herbaceous vegetation, the vegetation was sparse and the effect of shrub cutting was still noticeable.

In 2013, the plant communities were largely dominated by few grassland species, such as *Agrostis stolonifera*, *Gnaphalium uliginosum*, *Deschampsia cespitosa* with regrowing offspring of the woody species (mostly *Salix* spp. and *Betula pendula*) (Fig. 15, 16). In 2015, the composition of herbaceous vegetation was similar, with increasing dominance of *Deschampsia cespitosa*, *Carex nigra*, *Calamagrostis canescens* and *Lysimachia vulgaris*, though also large proportion of *Phragmites australis* in the plant community was observed (Fig. 17, 18). The cover of mosses (*Calliergon giganteum*, *Calliergonella cuspidata*) was increasing in the patches of cleared shrubs.

The regrowth of woody offspring was low, the chipping of the stumps was efficient method to suppress resprouting. Clearing of shrubs has diminished the fragmentation effect and opened gaps for recovery of grassland communities, however, this can be expected only if regular management will be applied. If repeated mowing of shrub offspring and herbaceous layer with hay removal or grazing will be applied, formation of closed herbaceous layer similar to the surrounding grassland vegetation might be expected.

Fig. 15 The effects of shrub cutting area in Pape – bare soil patches

Fig. 16 The effects of shrub cutting area in Pape. The former dense shrubland about one year after cutting. Unstable plant communities with some bare soil patches prevail. In summer 2013, the offspring of woody species reached about one meter height

Fig. 17 In 2015, after repeated mowing, the regrowth of woody offspring was low. The vegetation is dominated by few grassland species and reed

Fig. 18 In 2015, the bare soil patches created by shrub clearing are overgrown with plants typical for the surrounding vegetation, however, the vegetation structure is still patchy and uneven

Caricetum acutae

Overall, tall sedge communities are not typical for Pape project area, because most of the area is too dry and the soil is naturally well drained as it lies on sand deposits. The community occurs only in small (0.07 ha) patches, enclosed by the willow communities in the overgrown part of the grassland complex. The community occurs in moist depressions. The vegetation is dominated by *Carex acuta* forming tussock micro-relief. Due to abandonment the sedge community is being invaded by reed and willows. The diversity of accompanying species is low, the accompanying species are *Lysimachia vulgaris*, *Solanum dulcamara*, *Lathyrus palustris*, *Lychnis flos-cuculi*.

In *Caricetum acutae* patches, no mowing or shrub cutting management was applied. Continuous ruderalization, e.g. establishment of *Urtica dioica*, and increasing dominance of *Phragmites australis* was observed (Fig. 19A, 19B).

Fig. 19A Plot P02 in 2011. Abandoned tall sedge dominated grassland (*Caricetum acutae*) with relatively low density of *Phragmites australis*

Fig. 19B Plot P02 in 2015. Abandonend tall sedge dominated grassland (*Caricetum acutae*) continously overgrowing with *Phragmites australis* and shrubs

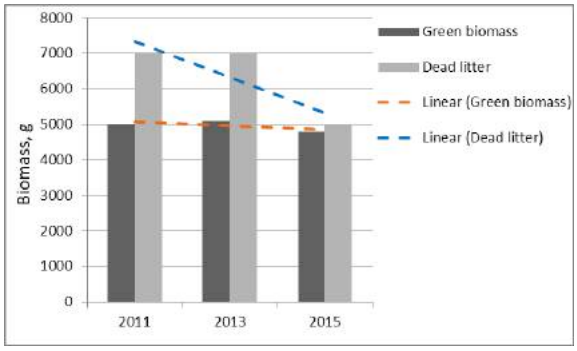

Fig. 20 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Caricetum acutae* community in Pape

The green aboveground biomass has changed insignificantly during the monitoring years, while the amount of dead litter tends to decrease (Fig. 20), which might be explained by increased shading.

Caricetum distichae

Caricetum distichae community is present in the Pape project area, however, covers a small area (0.5 ha). It forms several patches in slight depressions with higher moisture in soil. Normally, the depressions are not wet during the summer season, which is indicated by the species composition. There is a well-pronounced dominance of *Carex disticha*, the vegetation is relatively sparse in comparison to typical *Caricetum distichae* vegetation in floodplain grasslands. There is absence of very few individuals of hygrophytic species, the accompanying species of *Deschampsion cespitosae* and *Caricetum nigrae* (the adjoining plant communities) and moderately moist grassland types, e.g. *Deschampsia cespitosa*, *Galium uliginosum*, *Rumex acetosa*, *Ranunculus acris*. Overall, the number of accompanying species is low. The micro-relief is flat, no tussocks were observed.

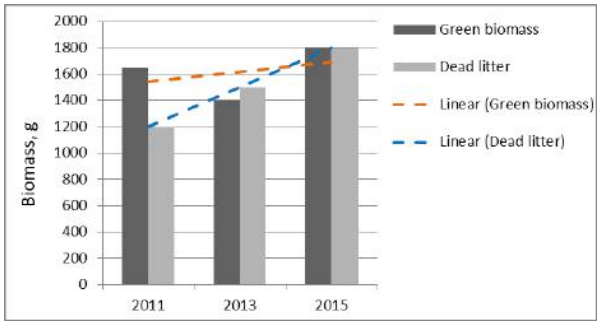

Fig. 21 Changes in the amount of green above-ground green biomass and dead litter in 2011–2015 in *Deschampsion cespitosae* community in Pape

In *Caricetum distichae*, no management effects were observed (occur in abandoned part of grassland). The vegetation is changing due to natural succession. *Caricetum distichae* community tends to turn into *Deschampsion* as the proportion of plant species of dried grassland types is increasing (Fig. 22A, 22B).

Both green aboveground biomass and dead litter tend to increase as a result of abandonment (Fig. 21).

Fig. 22A Plot P04 in 2011, *Carex disticha* predominates in the vegetation

Fig. 22B Plot P04 in 2015, *Caricetum distichae* vegetation is gradually turning into *Deschampsion cespitosae* community

Carici-Menyanthetum trifoliatae

The fen community (4.2 ha) occurs on the flat shore of Lake Pape, in the transitional zone between grasslands and lakeshore reed stands. The soils are waterlogged and rich in nutrients, in lower depressions the soils are covered with shallow water and seasonally flooded.

The vegetation is dominated by *Menyanthes trifoliata*, *Equisetum fluviatile*, *Iris pseudacorus* and tall sedges. Accompanying species are hygrophytic plants typical for fens and alluvial grasslands, e.g. *Rumex aquaticus*, *Solanum dulcamara*, *Comarum palustre*, *Cicuta virosa*, *Lysimachia vulgaris*, *Galium uliginosum*, *Typha latifolia*, *Lythrum salicaria*, *Carex diandra*, etc.

In 2012 and 2013, mowing was applied on the area. However, mowing does not seem to have any significant effect on the composition of fen vegetation. The vegetation structure is being locally influenced by beaver activities (gnawing and tramping effects, creating small channels and dams, gnawing of some lakeside shrubs). In the species composition changes in the proportions of the dominant species were observed, e.g. *Lysimachia vulgaris* and *Equisetum fluviatile* replaced by *Iris pseudacorus* or *vice versa* (Fig. 24A, 24B), however, this is most probably a natural fluctuation and is not related to mowing effects or hydrological changes. The unmanaged part of the lakeside fen is overgrowing with shrubs (*Salix* spp.).

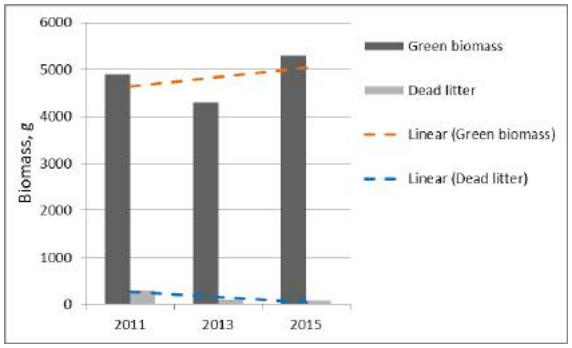

Fig. 23 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Carici-Menyanthetum* community in Pape

In *Carici-Menyanthetum* community, the green aboveground biomass was slightly fluctuating during the monitoring period with a tendency to increase, which is most probably a natural shift, while the dead litter tends to decrease as it is being well decomposed and does not accumulate in the humid environment (Fig. 23).

Fig. 24A Plot P03 in 2011. Lakeside fen vegetation

Fig. 24B Plot P03 in 2015. Lakeside fen vegetation. Only insignificant shifts in species composition were observed, caused by natural successsion and beaver impacts. In this plot, no management was applied

Caricetum nigrae

Caricetum nigrae community (4.3 ha) occurs on moist, slightly acidic to moderately acidic sandy soils with shallow peat layer or without it. In Pape project area, the community was found in the belt between the dryer meadow part and the lakeshore reed beds and is seasonally flooded.

Historically, the territory was used for hay cutting and pasturing, however, in a longer time as a result of abandonment the vegetation has transformed into a fen with a tussock-dominated micro-relief (low tussocks). Most probably, the dominance of *Carex nigra* has increased replacing the previously more species-rich vegetation. High species richness with presence of specialist species has survived only in small patches, while the rest is dominated by mainly *Carex nigra* and/or *Deschampsia cespitosa*, often with high proportion of *Phragmites australis*.

Juncus conglomeratus, *J. effusus*, *J. filiformis*, *Lysimachia vulgaris*, *Iris pseudacorus* are constant accompanying species or co-dominants. *Galium uliginosum*, *Potentilla anserina*, *Carex vesicaria*, *C. leporina*, *Peucedanum palustre*, *Eriophorum polystachion*, *Cardamine pratensis*,

Comarum palustre, *Scutellaria galericulata* are constant accompanying species in the community. Orchids (*Dactylorhiza baltica*, *D. incarnata*) are frequent in the plant community.

Fig. 25A Plot P09 in 2011. *Caricetum nigrae* vegetation slightly invaded by *Phragmites australis*, enclosed by dense shrubs

Nearly all territory, where *Caricion nigrae* was found was cleared from shrubs in 2012, thus increasing open patches potentially suitable for this grassland community (Fig. 25A, 25B, 25C). Due to lack of regular mowing or grazing the plant community is being invaded by *Phragmites australis*. In 2015, in comparison to 2013, the proportion of *Carex nigra* has increased in the cleared patches, but still these patches are covered with unstable vegetation, though expansion of *Caricion nigrae* community might be expected.

Fig. 25B Plot P09 in 2013. *Caricetum nigrae* vegetation with loose *Phragmites australis* cover, the surrounding shrubs were cut down in 2012

Fig. 25C Plot P09 in 2015. Mowing of grass was applied in 2013. No significant changes since 2013 were observed. The species richness has not notably decreased, however, the vegetation structure indicates impact of abandonment (hummocks, large amount of dead litter)

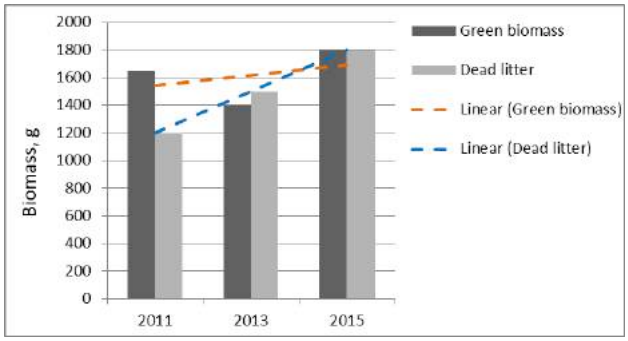

Fig. 26 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Caricetum nigrae* community in Pape

Both the green aboveground biomass and the dead litter tend to increase during the monitoring period indicating the effects of abandonment over the last decades (Fig. 26).

Deschampsion cespitosae

The community covers relatively large areas (4.1 ha) in a belt between the lakeshore reed stands, lakeshore fens and the driest part of the Pape project area. Most probably, the *Deschampsion cespitosae* grassland has formed as a result of natural succession in the former arable lands/fallows. Since mowing or pasturing is absent at least a decade or more, the dominant species *Deschampsia cespitosa* forms tussocks. Currently the grassland is overgrowing with willow shrubs.

There is well-pronounced dominance of *Deschampsia cespitosa* in the community, and the overall species diversity is relatively low. The accompanying species are plants typically occurring in moderately moist semi-natural grasslands: *Rumex acetosa*, *Ranunculus acris*, *R. repens*, *Potentilla reptans*, *P. anserina*, *Vicia cracca*, *Galium album*, and species occurring in moister grasslands, e.g. *Galium uliginosum*, *Lychnis flos-cuculi*, *Geum rivale*, *Peucedanum palustre*, in micro-depressions – *Iris pseudacorus*, *Juncus conglomeratus*, *J. effusus*, and *Elytrigia repens*, a species that indicates the past use of the territory (arable fields/fallows) or recent soil disturbances along with abandonment effects.

Fig. 27A Plots P13 in 2011. Mesic *Deschampsia cespitosa* dominated grassland

The patches of *Deschampsion cespitosae* grasslands with monitoring plots were not managed during the project. Significant changes are caused by intensive soil disturbances caused by wild boars in 2011 (Fig. 27A, 27B, 27C) promoting decline of graminoids and establishment of ruderal species. In 2015, the soil disturbances were completely overgrown with vegetation, however, this has increased the dominance of ruderal plant species. Overall, the *Deschampsion cespitosae* grassland is becoming gradually ruderalized as it is abandoned.

Fig. 27B Plot P13 in 2013. Mesic *Deschampsia cespitosa* grassland, changes in vegetation and soil disturbances caused by wild boars, increasing dominance by ruderal species

Fig. 27C Plot P13 in 2015. The disturbed soil openings have overgrown with ruderal grassland vegetation, mostly by *Elytrigia repens*

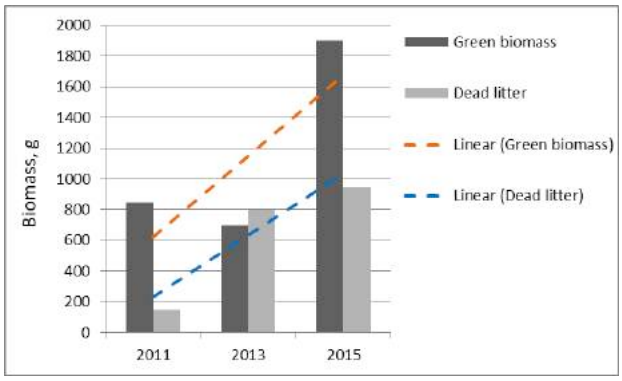

Fig. 28 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Deschampsion cespitosae* community in Pape.

Both the green aboveground biomass and the dead litter tend to increase during the monitoring period indicating the effects of abandonment over the last decades (Fig. 28). The sharp increase of green biomass is, most probably, caused by the wild boar disturbances in 2011 as the open soil patches have overgrown with ruderal vegetation.

Plantagini-Festucion

Plantagini-Festucion community covers large proportion of the Pape project area (7.8 ha), part of it has transformed into dense shrubland (mainly willows). The dry grassland has probably formed on the former arable fields and fallows on dry sandy soils. The community representing dry semi-natural vegetation is species-rich, characteristic with presence of numerous indicator species of semi-natural grasslands and polydominant vegetation structure. The sward is low, composed of species of dry, acidic, nutrient-poor grasslands, the vegetation cover is relatively sparse, no tussocks were observed. The plant community is polydominant with high proportion of *Poa angustifolia*. The species present in the community are e.g. *Trifolium arvense*, *T. dubium*, *Agrostis tenuis*, *Festuca pratensis*, *Holcus lanatus*, *Rumex acetosa*, *Anthoxanthum odoratum*, *Ranunculus acris*, *Plantago lanceolata*, *Dactylis glomerata*, *Leucanthemum vulgare*, *Achillea millefolium*, *Daucus carota* etc. The community is accompanied by typical dry semi-natural grasslands species such as *Pilosella officinarum*, *Hieracium umbellatum*, *Sedum acre*, *Sieglingia decumbens*, *Dianthus deltoides*, *Linaria vulgaris*, *Saxifraga granulata*, *Viola rupestris*. In some patches *Carex arenaria* or *Helictotrichon pubescens* prevail.

The vegetation structure is patchy, with some dry patches with sparse herbaceous vegetation and dominance of bryophytes and lichens, e.g. *Polytrichum juniperinum*, *Pleurozium schreberi*, *Brachytecium albicans*, *Rhytidiadelphus squarrosus*, *Tortula ruralis* and *Peltigere* spp.

The community belongs to the habitat type *6120* Xeric sand calcareous grasslands* listed in the Habitats Directive's Annex I. Several rare, redlisted plant species in Latvia were found: *Ranunculus bulbosus*, *Trifolium dubium*, *Platanthera bifolia*, *Dactylorhiza baltica* and *D. incarnata*.

Part of the territory has been used for drying the cut reed sheaves. No grassland management is being applied at least a decade before the project activities. Cutting of shrubs and pine trees in 2013 and mowing in 2014 has increased the open grassland area. Comparing the changes in vegetation between 2011 and 2015, the shift in species composition was insignificant and related mostly to natural fluctuations (Fig. 29A, 29B).

Fig. 29A Plot P08 in 2011, unmanaged part of area

Fig. 29B Plot P08 in 2015, unmanaged part of the area

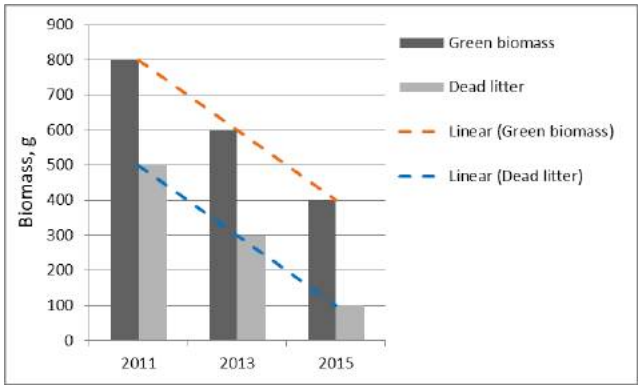

Fig. 30 Changes in the amount of green aboveground green biomass and dead litter in 2011–2015 in *Plantagini-Festucion* community in Pape

In *Plantagini-Festucion*, both the green aboveground biomass and the dead litter decreased during the monitoring period (Fig. 30). Perhaps in this situation, grassland on dry soil, it indicates the effect of abandonment over the last decades: the proportion of vascular plants decreases in the community and the dominance of mosses and lichens increase, thus the vascular plant biomass decreases producing lower amount of dead litter.

Changes in vegetation in Pape, 2011–2015: summary

The number of vascular plant species per sample plot varied considerably during the monitoring period (Fig. 31), both in managed and unmanaged plots. No significant difference in changes in the number of species were found between managed and unmanaged plots. The changes seem to be more related to natural fluctuations than the effect of management.

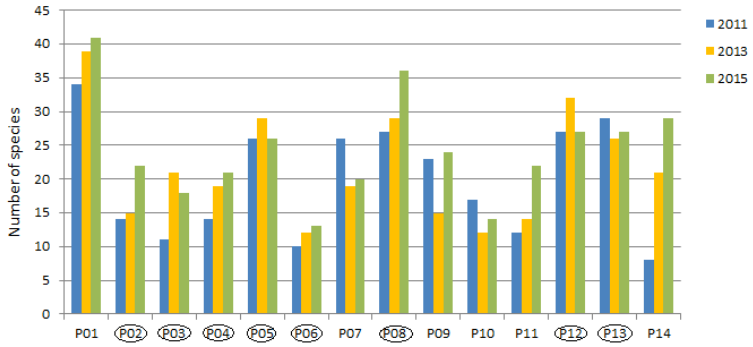

Fig. 31 Number of vascular plant species per sample plot, 2011–2015. ID codes of unmanaged plots are marked with circle. P01, P08 – *Plantagini-Festucion*; P02, P14 – *Caricetum acutae*, P03, P06 – *Carici-Menyanthetum*; P04, P05 – *Caricetum distichae*; P07, P09 – *Caricetum nigrae*; P10, P11 – *Carex nigra-Phragmites australis* community; P12, P13 – *Deschampsion cespitosae*

The average annual amount of green biomass was flucuating during the monitoring period, but tends to increase (Fig. 32). This might be related to the effect of abandonment in the unmanaged part of the area, where expansive herbs and grasses are gradually invading the vegetation (e.g. *Urtica dioica*, *Phragmites australis*). The average annual amount of dead litter (Fig. 30) tends to decrease during the monitoring period, which is difficult to explain, perhaps being related to decreased production of biomass in the previous year (not measured) or increased decomposition rates in the fen, or management effects.

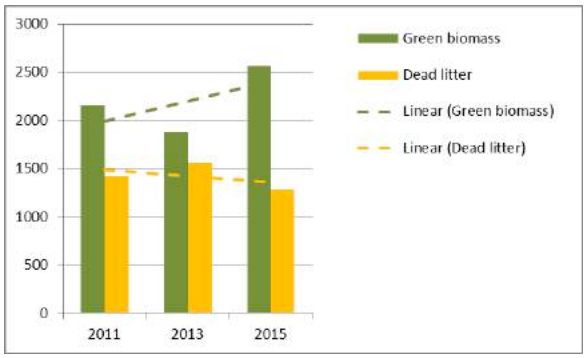

Fig. 32 Changes in average annual green biomass and amount of dead litter in Pape during the time period 2011–2015

Majority of changes might be related to natural fluctuations. Clear trends could be drawn after more years of monitoring. Right now the changes observed can be influenced also by climatic conditions (amount of precipitation over the monitoring period, some accidental impacts (wild animals, etc.). Ruderalization of the abandoned part of the area is promoted by soil disturbances caused by wild boars in the previous years.

Overall, the vegetation changes caused by clearing of shrubs and mowing have opened gaps for grassland communities, but the time period since re-establishing the management was too short to expect formation of stable, species-rich communities. Monitoring along with regular mowing management should be continued to figure out the role of management and natural factors.

SUITABLE PARTS OF THE TERRITORY FOR THE AQUATIC WARBLER

The most suitable vegetation types at Pape Meadows (coast of Lake Pape) for Aquatic Warbler are *Carici-Menyanthetum trifoliatae* (4.2 ha), followed by *Caricetum distichae* (0.5 ha) and *Caricetum acutae* (0.07 ha). The Aquatic Warbler breeding in Pape have never been confirmed (the only spring observation is on May 13, 1990), but Pape site is the most important stop-over site in Latvia. After two years without any observations, the Aquatic Warbler was captured in *Carici-Menyanthetum trifoliatae* community on August 6, 2013. One might speculate that the clearing of bushes might have made the site most attractive to Aquatic Warblers, because, when the meadows were still mowed and the bushes were not present – in 1989, five Aquatic Warblers were captured at the site in July/August.

Capturing of birds by mist-nets was organized at Lake Pape every year by the Laboratory of Ornithology of the Institute of Biology, University of Latvia. During the last three years (2013, 2014, 2015) every year at least one individual of Aquatic Warbler have been captured. The most recent captures were two individuals captured on August 10, 2015. The capture site was at the area, where the shrubs have been cleared by the project management activities, despite that there

were other set of nets at the unmanaged (still shrubland) area, where the playback of Aquatic Warbler was played also on the morning of bird captures in 2015. This might once indicate that also on stop-over sites during migration Aquatic Warblers avoid visiting shrubland if more suitable, open grassland and fen areas are available.

UNSUITABLE PLANT COMMUNITIES FOR THE AQUATIC WARBLER AND RECOMMENDATIONS

Bush or small tree communities: *Alnion glutinosae* and *Salicion cinereae* are not suitable habitats neither for Aquatic Warbler, nor for other target species (e.g. Corncrake) in Pape site. Presence of shrub vegetation makes the habitat status unfavourable, since it always threatens the site with fast overgrowing potential in case, when bushes are already present even in small areas. Therefore it is recommended to remove all bushes and trees in former meadow areas including the lakeshore and *Carici-Menyanthetum trifoliatae* wetlands.

At lesser extent also invasion of reed is a threat to the habitat (Fig. 7A, 7B) likewise at Liepāja Lake site.

Unstable pioneer plant communities after clearing of shrubs has to be mown in order to establish permanent grassland vegetation preferred by all target species in contrast to bush or reed communities.

CONCLUSIONS

(1) The management applied in **Aizraķe Meadows (Liepāja Lake)** has decreased the shrub covered areas, decreased the fragmentation effect and increased the potential coverage of tall sedge communities.

The major changes in vegetation of Liepāja Lake area (Aizraķe Meadows) are related to natural succession and removal of shrubs. Mowing does not seem to have any significant effect on the vegetation composition yet.

The vegetational changes are mostly related to continuous paludification in some parts of the meadows (establishment of typical fen species, e.g. *Comarum palustre*, *Equisetum fluviatile* etc. in tall sedge communities) and transformation of the tall sedge communities into reed beds due to abandonment. Mostly plant communities remain relatively stable. The most significant changes observed are invasion of reed in abandoned wet parts of the meadows along River Bārta. The least changes in the composition and structure in the vegetation were observed in tall sedge communities (*Caricetum acutae*, *Caricetum distichae*, *Acorus calamus* community). No or slight, insignificant changes were observed in *Filipendula ulmaria* community. *Caricetum distichae* in some parts of the meadow complex is being gradually replaced by *Carex acuta*, which is most probably a result of natural succession promoted by increased moisture.

(2) Shrub clearing and mowing in **Pape area** has significantly decreased the fragmentation effect and increased the area suitable for formation of semi-natural grassland communities.

The major changes in vegetation of Pape area in the managed parts are related to clearing of shrubs (increasing the light availability and space for grassland plant species). Moreover, the open grassland area has increased also as a result of removal of alone-standing pines in the dry grassland. In 2013 and 2015, the vegetation in the former shrub patches was composed of pioneer plant communities. Recovery of vegetation typical for semi-natural grasslands (*Phragmiti-*

Magnocaricetea tall sedge communities, *Caricetum nigrae* or *Deschampsion cespitosae* communities) will, most probably, take several years.

In unmanaged parts, the changes are related to natural succession due to abandonment (continuous overgrowing with shrubs, increasing dominance of reed in tall sedge communities, increasing dominance of nitrophilous ruderal species in grasses-dominated mesic communities). Ruderalization of grassland vegetation is promoted both by soil disturbances caused by wild boars and abandonment. Natural succession leads to degradation of semi-natural grassland communities.

(3) The habitats of Aquatic Warblers at both project sites are restored to the condition, where they are suitable for the species. Aquatic Warbler prefers open habitats (without shrubs or dense reed) not only on breeding sites, but also during the migration on stop-over sites.