The project “Stepping stones towards ensuring long-term favourable conservation status of Aquatic warbler in Lithuania” (LIFE MagniDucatusAcrola) No. **LIFE15 NAT/LT/001024** is financed by the EU LIFE Programme, Ministry of Environment of the Republic of Lithuania and project partners.

BASELINE MONITORING REPORT

Compiled by:
Gintaras Riauba
Žymantas Morkvėnas
Dr. Aleksandr Kozulin
Dr. Žydrūnas Preikša
Dr. Dalytė Matulevičiūtė
Dr. Andrius Petrašiūnas

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1. Introduction

1.1. Project overview

The project "Stepping stones towards ensuring long-term favourable conservation status of Aquatic Warbler in Lithuania" (LIFE MagniDucatusAcrola) No. LIFE15 NAT/LT/001024 is financed by the EU LIFE Programme, Ministry of Environment of the Republic of Lithuania and project partners. Main objectives of the project are:

- Reduction of fragmentation of Aquatic Warbler breeding habitats in Lithuania and Belarus and stimulation of connectivity between isolated population;
- Development and application of new conservation measures;
- Setting up long-term socioeconomic preconditions to maintain AW breeding habitats.

Concrete conservation actions, such as removal of reed and scrub, management of water or rehabilitation of exploited peatland, are implemented in 4 project sites in Lithuania and 3 project sites in the Republic of Belarus (Fig. 1). Total area of the project sites 20 509 ha.

In order to assess the impact of management activities on the populations of Aquatic Warbler and the habitats suitable for this species, monitoring of birds, invertebrates, vegetation and hydrological regime will be carried out in all project areas. A summary of the monitoring data collected during the first year of the project is presented in this baseline monitoring report.

Fig. 1. General map of the project sites

1.2. Aquatic Warbler (*Acrocephalus paludicola*)

Formerly common and widespread species in Europe, during the last century Aquatic Warbler disappeared from many European countries. Nowadays its global population is estimated to be about 10 000 singing males, which regularly being recorded in less than 40 sites. Few years ago Aquatic

warbler regularly bred in 6 countries – Belarus, Germany, Poland, Ukraine, Hungary and Lithuania, irregularly in Russia and Latvia. However, since 2011 birds were not recorded breeding in Hungary and Germany.

Aquatic Warbler is highly specialised species, adapted to occupy sedge fen mires and similarly structured open wetland habitats with a vegetation height usually lower than 1 m and a water level slightly above the soil surface. In recent decades the vast majority of such habitats in Europe faced extinction or degradation due to drainage and habitat destruction for agriculture or peat extraction. Remaining fens also are overgrowing with reeds and woody vegetation due to eutrophication or abandonment of former land use.

Aquatic Warbler *Acrocephalus paludicola* – the rarest and the only globally threatened passerine bird species of continental Europe. The species is listed in Annex I of the EU Birds Directive (2009/147/EC), Bern convention Annex II, Bonn convention Annex I. In year 2010 competent authorities of 15 countries signed "Memorandum of Understanding concerning conservation measures for the Aquatic Warbler" and decided to work closely together to improve the conservation status of the species through its breeding, migrating and wintering range.

1.3. The Baseline monitoring report

The Baseline monitoring report summarises results of Project monitoring activities, which lay under project action D.1 and were undertaken mainly in year 2017. For project sites Some data available before the very beginning of the project were also used as a baseline, because project activities in Belarus started in late 2017.

Data presented in this report will serve as a baseline for evaluation of the effect of concrete conservation actions, which will take place in the project sites. All the Project's monitoring activities were implemented in accordance with the Detailed monitoring program, and includes results of monitoring of Aquatic Warbler and other target bird species, vegetation monitoring, monitoring of invertebrates (serves as an evaluation of food availability), and data on measurement of water level as well. The monitoring program, can be downloaded from the project site. The location, timing and main findings of the implemented individual monitoring schemes are presented in relevant chapters of this report.

2. Executive summary

The period for collecting of baseline data of monitoring activities was year 2017. However, as the project activities in Belarus were only launched at the end of 2017, this report also used data collected in the project areas in Belarus at the beginning of year 2018 as well. Several years of data were used to evaluate the abundance of Aquatic Warbler. Such data better reflect the overall population status in the short term period, as the number of birds in a particular year can fluctuate significantly and may not reflect the general state of the population but the increase or decrease of the population in a particular year.

The structure of the report reflects all the most important monitoring activities implemented in the individual project sites. First of all, we have described the results of bird monitoring, paying attention to the status of the Aquatic Warbler population in the area (if Aquatic Warbler is currently breeding in the site). Then we provide detailed descriptions of vegetation studies, which will later be used to assess habitat changes associated with the implementation of habitat management activities. Subsequently, data on the results of invertebrate monitoring were presented as they mostly relate to the evaluation and comparison of the Aquatic Warbler nutritional base in different areas. Finally, data on the monitoring of water level changes ("Hydrological monitoring") in the project areas were provided, as groundwater dynamics is the most important factor for the development of sedge dominated plant communities. Some areas of the project have also been subjected to an analysis of the chemical composition of water, which is also associated with formation of suitable vegetation. The chemical composition of surface waters in different project areas is presented in a separate section of the report.

Below is a brief overview of each project area, based on the results of the monitoring activities.

LT/01-Tyrai. The area consists of four distinct fragments of open habitats, separated by forested belts and channels. The area is unique by the fact that it is adjacent to the Tyrai mire, where the biggest Lithuanian breeding population of Aquatic Warbler is found. The implementation of habitat management activities in this part of the swamp will created a suitable habitat for the Aquatic Warbler, which can enable the local Aquatic Warbler population to expand even further. Aquatic Warblers currently were not observet in the project site. Two breeding pairs of Common Redshank (*Tringa totanus*) and 12 species of other birds were observed in the area during the breeding season 2017. The vegetation of Tyrai wetland consist of tall sedge communities, transition mire, fen, and wet meadow (*Molinietum caeruleae*) communities, which cover nearly 80% of the area's surface. However, reeds and single shrubs are found in almost all the examined plots. Reed and woody vegetation are more prevalent in the northern part of the area where surface water mineralization is higher. Tyrai had the least diverse and least balanced insect communities (lowest values of H') with strong domination of one group – Chironomidae, which made up around 59% of total number of specimens, although the total number of invertebrates caught there and the biomass of cought insects was the second-highest after LT/03-Zuvintas. Thus, in terms of the nutritional base, the site is suitable for Aquatic Warbler. Nevertheless, the area should be seen as degraded, severely damaged and still influenced by human activity, and the impact of nature management activities should continue to be monitored.

LT/02-Apvardai. The Aquatic Warblers in the area were discovered in 2008, but there is no data on their presence in these project areas during the last decade. The area is important for wetland birds such as Common redshank (*Tringa totanus*) (1 breeding pair), Black-tailed Godwit (*Limosa limosa*) (1 breeding pair), and Spotted Crake (*Porzana porzana*) (13 calling males). In total, 19 species of birds were found during the breeding season 2017. The area is also characterized by the predominance of plant communities typical to transitional mire, which are in some places covered with reeds and woody plants. Open mire occupies almost a half of the wetland area, the rest of the

mire is overgrown with shrubs and reeds. The abundance and variety of insects in the area also seems to be sufficient, but there is concern about the high water level, which keeps 10-20 centimeters above the surface of the soil almost throughout the vegetation period.

LT/03-Zuvintas. The area is important because there is a small local AW population that was near the extinction in 2011-2013. This isolated population is more than 150 kilometers away from other Aquatic Warbler breeding places in Lithuania. During the period of 2014-2017, the numbers of recorded Aquatic Warbler calling males ranged from 4 to 7. The area is important for wetland birds such as Citrine Wagtail *(Motacilla citreola*) (2 breeding pairs)*,* Common redshank (*Tringa totanus*) (2 breeding pairs), Black-tailed Godwit (*Limosa limosa*) (2 breeding pairs), Spotted Crake (*Porzana porzana*) (4 calling males) and Corncrake (*Crex crex*) (3 calling males). In total, 19 species of birds were found during the breeding season 2017. The results of invertebrate monitoring revealed that Žuvintas areas had most diverse and well-balanced invertebrate communities with most evenly distributed specimens, and the highest total number of invertebrates caught. Plant monitoring was not carried out here in 2017, but based on expert judgment, it is necessary to regularly mow reeds in almost all areas of the project, as they are widespread here. These data are confirmed by the results of the chemical analysis of the surface water, as the total amount of dissolved minerals in the samples was about 700 mg/l. The problem of improving water quality in this area is likely to be very important.

LT/04-Sysa/Sausgalviai. With the total population ranging from 22 to 43 males of Aquatic Warbler males in the period 2014-2017 these areas remain important species breeding places in Lithuania. The area is important for wetland birds such as Great Snipe (*Galinago media*) (9 calling males), Common redshank (*Tringa totanus*) (5 breeding pairs) and Corncrake (*Crex crex*) (129-136 calling males). In total, 14 species of birds were found during the breeding season 2017. In the project sites Šyša and Sausgalviai polders sedge dominated communities (*Caricetum gr*acilis and *Caricetum distichae*) prevail in the vegetation cover, while Mesophyte dominated communities occupy minor areas. Regular mowing of meadows and removal of biomass ensures that in these meadows reeds and woody plants are not widespread, despite the high content of minerals dissolved in the surface waters. The results of invertebrate monitoring revealed that Šyša and Sausgalviai polders had the most diverse and well-balanced invertebrate communities quite evenly distributed specimens, and high total number of invertebrates caught. The importance of these areas is also defined by the fact that they are dominated by alluvial meadows, where economic interests are important for local farmers. Therefore, aligning economic interests with a well-regulated water regime and the proper use of late-mown grassland biomass are important for the long-term conservation of the AW populations found here.

BY/05-Dokudovskoe. At present, the site is not suitable for Aquatic Warbler, but it is important to test the restoration of species-relevant habitats by ensuring proper water regime and establishment of sedge-dominated plant communities. Only the primary observation of birds and the selection of possible monitoring sites were carried out in this area. The implementation of monitoring activities in this area is planned after the implementation of essential habitat restoration works.

BY/06-Servech. Total number of Aquatic Warbler counted was 48 singing males, which is a bit lower than in previous years. Two pairs of the Citrine Wagtail (*Motacilla citreola*) was registered in the project site, while other target bird species were not detected on the whole territory of the sedge mire. Two singing males of the Spotted Crake (*Porzana porzana*) were observed in the coastal zone of the lake Servech, and Eurasian Curlew (*Numenius arquata*) was irregularly registered within the mire Servech as a visitor. Typical mire vegetation suitable for Aquatic Warbler occupy 76% of the area, but ongoing overgrowth with reeds and woody wegetation is currently being monitored. The invertebrate communities are abundant and well balanced, so the nutritional needs of the Aquatic Warblers are assured. The unregulated water regime, which is heavily dependent on the hydrological

situation during the season, is a cause for concern, so it is advisable to ensure that the necessary water balance is maintained in the area.

BY/07-Zvanets. The area is known as a stable and the best known Aquatic Warbler breeding place through it's breeding range, with a total population estimated to 2063-2379 calling males in year 2017. The area is also important for wetland birds such as Great Snipe (*Galinago media*) (2 calling males), Citrine Wagtails (*Motacilla citreola*), Common Redshank (*Tringa totanus*) (3 breeding pairs), Eurasian Curlew (*Numenius arquata*) (1 breeding pair), Black-tailed Godwit (*Limosa limosa*) (23 breeding pairs), Spotted Crake (*Porzana porzana*) (2 calling males), Montagu's Harrier (*Circus pygargus*) (1 breeding pair) and Corncrake (*Crex crex*) (3 calling males). In the project sites sedge dominated communities prevail in the vegetation cover. Monitoring of water quality in this area is important for a better understanding and management of the distribution of reeds and other unwanted vegetation in the breeding habitats of Aquatic Warbler.

3. Summary of implementation

3.1. Bird monitoring

Bird monitoring activities were launched in 2017 and implemented in all project areas in Lithuania. Counts of birds were held in May-July 2017, in accordance with the procedures and requirements described in the Detailed monitoring program of the Project. The bird counts in Lithuanian project sites LT/01-Tyrai, LT/02-Apvardai and LT/04-Sysa/Sausgalviai were performed by experts hired by Baltic Environmental Forum Lithuania (BEF): dr. Ž. Preikša, R. Jakaitis, V. Eigirdas and A. Čerkauskas. Bird counts in the project sites LT/03-Zuvintas were performed by the experts of Žuvintas Biosphere Reserve: A. Pranaitis and R. Vabuolas.

Censuses of Aquatic Warbler in the project areas in Lithuania were carried out in June-July, focusing on the periods of maximum male activity, when the first and second clutches are layed. Mapping of singing Aquatic Warbler males was done in the few hours before sunset in the evening. At the same period, during a daytime visit to the sites, other birds were also inventored. All known and potential lekking places (arenas) of Great Snipe in the Šyša/Sausgalviai project sites were inspected after counts of Aquatic Warbler, but weather conditions were taked into account. The surveys of Spotted Crakes and Corncrakes were carried out by the staff of the relevant regional parks. So data on these birds were obtained from the database of National bird monitoring program. During the site visits to the project areas, the experts also collected data on all other (common) bird species. So data on all possible breeding birds are presented in Annex 3 tables.

Despite the fact, that no current data on presence of Aquatic Warbler in Lithuanian project sites LT/02-Apvardai were available since 2008, the sites were also checked for presence of the species. All the suitable habitats in the territory of Žuvintas Biosphere Reserve were also checked for presence of Aquatic Warbler. At least two site visits during the period from the end of May to the beginning of July were used for obtaining the data on presence of the species in the project sites.

In Belarus bird monitoring activities were held by experts of Scientific-Practical Center (SPC) of Natural Resources of the Belarusian National Academy of Sciences: D. Zhurauliou, M. Kalaskou, I. Bahdanovich and N. Karlionova. In project sites BY/05-Dokudovskoe, BY/06-Servech and BY/07-Zvanets bird censuses were conducted during April-July 2018. In the Zvanets site counts of singing males of the Aquatic Warbler and Citrine Wagtail *Motacilla citreola* were conducted along monitoring routes during the periods of laying of first and second clutches. The total length of the routes is 4.1 km (Fig. 2). Censuses of Eurasian Curlew *Numenius arquata,* Common Redshank *Tringa totanus*, Black-tailed Godwit *Limosa limosa,* Corncrake *Crex crex* and Spotted Crake *Porzana porzana* were conducted on 3 monitoring plots with an area of about 3,5 km^2 each. Censuses of the Great Snipe *Galinago media* were carried out on the monitoring plot with an area of about 3,5 km^2 located in the northern part of the project site. Short-eared Owl and Montagu's Harrier were counted on the monitoring plot with an area of about 45 km^2.

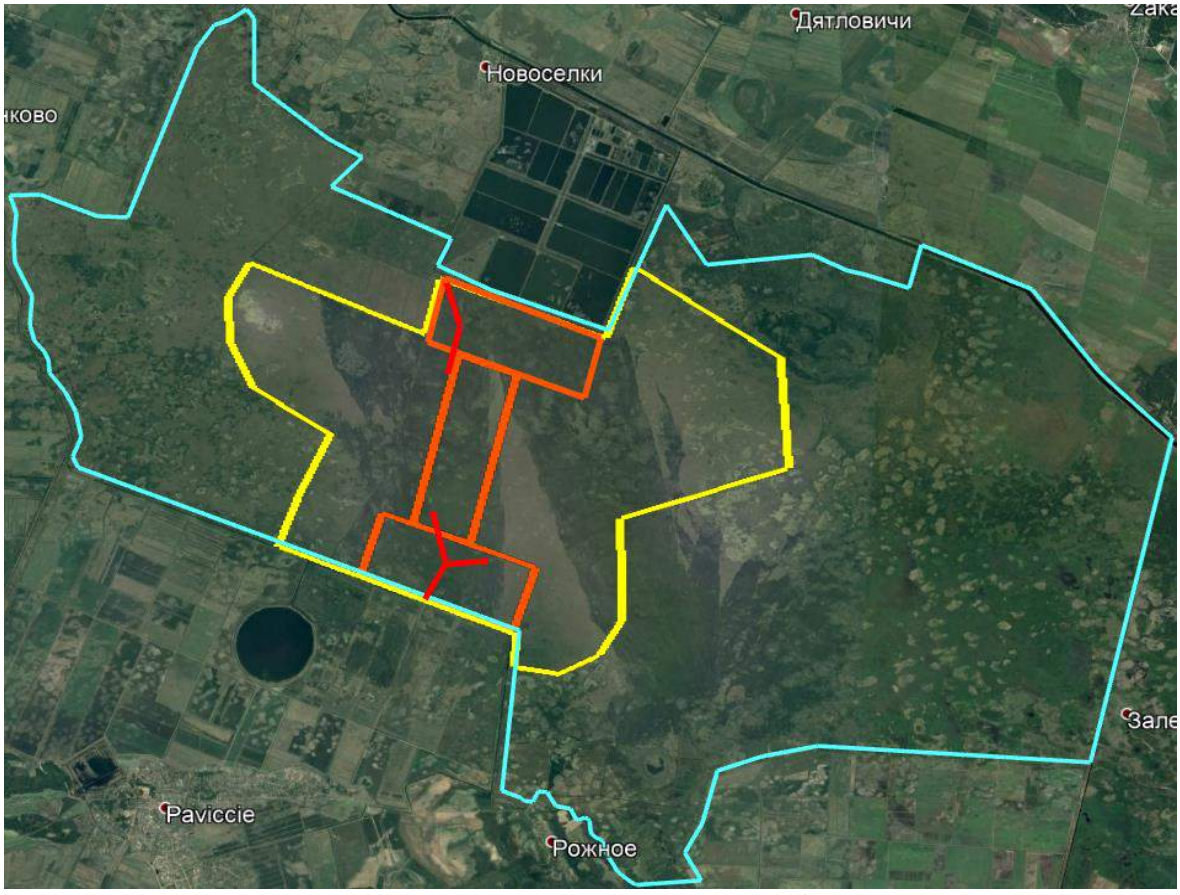

Fig. 2. Monitoring routes and plots for bird censuses in project site BY/07-Zvanets (blue line). Yellow line – monitoring plot for censuses of Short-eared Owl and Montagu's Harrier; orange – monitoring plots for censuses of waders; red – transects for monitoring of Passerine birds.

3.2. Vegetation monitoring

The vegetation monitoring in the project sites is conducted in order to detect changes in the vegetation over the period of project, and was done according the procedures described in the Detailed monitoring program. The main aim of vegetation monitoring is to identify key indicators of various vegetation characteristics, which later could be used for evaluation of possible changes in response to implemented management activities. Thus quite detailed field research is planned to implement in all the project sites.

In general, two visits during the June-August period were performed in each of the project sites monitored. Vegetation monitoring in different project sites was organized by the project partners: in Lithuanian project sites – by BEF LT, in Belarussian site – by SPC.

The final results of the vegetation monitoring were a detailed description of vegetation in permanent monitoring plots, selected by botanists during the field visits, and a GIS based layer of separate plant communities. Precise contours of plant communities were depicted and labelled. Depiction of plant communities in Lithuanian sites were performed by GIS expert in BEF, and depiction of plant communities in Belarusian sites will be performed by GIS expert of SPC.

Permanent vegetation monitoring plots were selected during the site visits at the beginning of the vegetation period.

During the field work, vegetation monitoring included the following topics:

- Study of distribution of plant communities in the vegetation cover of the trial plot (large-scale mapping of the 100×100 plot);

- Study of features of the tree layer (if present);
- Assessment of the state of undergrowth of the main forest-forming tree and shrub species (number, height, age, living condition);
- Study of features of grass-dwarf shrub and moss storeys (species composition, projective coverage, phytomass, development of indicator species);
- Study of 10x10 fields' vegetation (species composition, projective coverage, phytomass, development of indicator species).

3.3. Monitoring of invertebrates

General information. As Aquatic Warblers highly depend not only on the composition of the habitat, but also on availability of their main food – insects and other invertebrates, monitoring of the food pool in connection with various levels of habitat management is important for determination and selection of the best habitat conditions and management techniques.

During the June 2017 in many parts of Lithuania the rain was from 1.1 of the standard climate norm (SCN) in the western part, to 1.2-1.5 in the eastern part and up to 2.1 of the SCN in some of the southern regions of the country. In some cases, as on the 29 of June in Lazdijai (~20km south of Žuvintas), a local meteorological phenomenon – very strong rain was recorded. Rather similar excess of rain was received during the July as well, from 1.4 in the southern parts, 1.5-1.9 SCN in the eastern parts of the country and up to 2.2-2.5 SCN near the sea. On the 1st of July in Nida (~35 km south-west of Tyrai and 25 km west of Šyša) and on 11-12 of July in Dūkštas (~11 km west of Apvardai) a local meteorological phenomenon – very strong rain was recorded (LHS, 2017[1]). All this excess rain influenced the monitoring of the herpetobiontic invertebrates and most probably the general composition of the insect community at the project sites.

Baseline of the project data in Lithuania was set in June-early August, 2017 in four project sites: LT/01-Tyrai, LT/02-Apvardai, LT/03 - Žuvintas, LT/04 – Šyša by carrying out three stages in parallel: monitoring of herpetobiontic invertebrates (traps checked approximately every 10 days from the end of June to the beginning of August), monitoring of the hortobiontic invertebrates (traps checked approximately every 10 days from the end of June to the beginning of August) and monitoring of the flying invertebrates (netting was carried out at the end of June and end of July). General descriptions of the methods are given further in the respective parts of this report.

In total, 1876 carabid beetle specimens were caught by pitfall traps, 22280 invertebrates were caught by using the insect net and more than 69800 specimens were caugh by Malaise traps. Locations of monitoring plots in the project sites are presented in figures 5, 9, 13 and 20.

Herpetobiontic invertebrates. Monitoring of the herpetobiontic invertebrates, mainly ground beetles (Carabidae) living on the soil surface, were monitored from the end of June to the beginning of August using standard pitfall traps that were inspected every 10 days. Propylene glycol was used as a fixing agent and later the insect specimens were stored in alcohol. At each site, 15 cups were arranged along the random rectilinear transect, 5 m apart. One transect was used on every monitoring plot (Fig. 3).

[1] Lithuanian Hydrometeorological service (LHS). 2017. Monthly reviews. Available at: http://www.meteo.lt

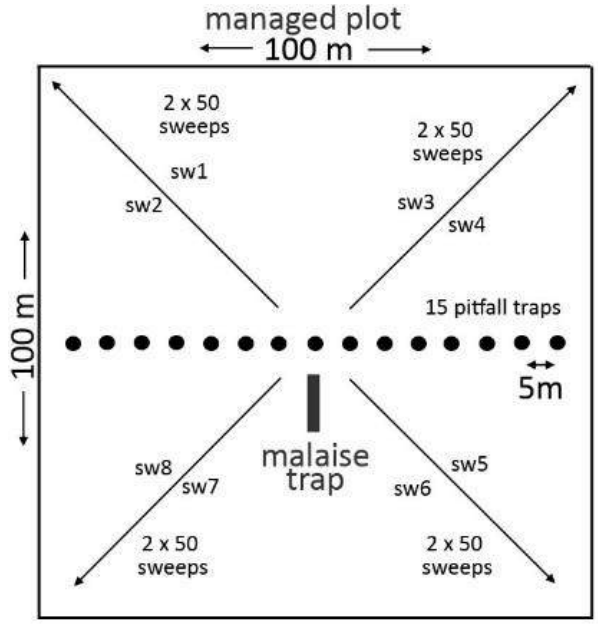

Fig. 3. Outline of the monitoring plot with indication of the methods of invertebrate monitoring (designed for 8 series of 50 sweeps)

Flying invertebrates. Monitoring of the flying invertebrates was performedusing standard full-sized Malaise traps with 70% propylene glycol as a fixing agent. Four traps were set up at the end of June, one on each of the monitoring sites - Apvardai, Šyša, Tyrai and Žuvintas. Traps were placed approximately in the centre of the Control plots (see Figures 5, 9, 13 and 20) in all the localities except Žuvintas, where the trap was on "Plot 2". This was done for the safety reasons, because the Plot 2 is inside the territory of Žuvintas Reserve and Control plot is on private land. As the plots are only several hundred meters away, it was considered that the trap will represent the insect diversity in the area. Malaise traps operated until the beginning of August, with four samples taken from each of the traps, approximately in 10 day intervals. The total time of trap exposure was 42 days for Tyrai and Šyša and 44 days for Apvardai and Žuvintas. The collected material was transferred to 70% alcohol in the laboratory for later storage and identification.

Sweep netting with the standard entomological net was used to collect invertebrates inhabiting the grass layer (hortobiontic invertebrates) on all the eight monitoring plots. Samples were collected in series of 50 sweeps, performing this procedure twice in four directions from the centre towards the corners of the monitoring plot (Fig. 1). Insects were anesthetised with ethyl acetate and placed into plastic bags in the field. Back at the laboratory they were transferred to specimen containers with 70% alcohol for storage and later identification. Sampling was performed twice on each plot, at the end of June and July.

The collected invertebrates were identified to the so-called practical taxonomical level (usually order and family) to adult or larva, and after measuring assigned to size classes. Weight was calculated using reference curves derived from dry weight determination of reference samples for large taxonomic groups (Tanneberger *et al*. 2013). Weight data were combined to weight classes (1–5 mg, 6–10 mg, 11–20 mg, > 20 mg).

Pollinating insects. Natural ecosystems deliver a range of benefits for people. These benefits are known as ecosystem services and are usually separated into four groups: Provisioning, Regulating, Cultural and Supporting services. Regulating services provide many direct and indirect benefits to humans, including clean air and water, pollination, climate regulation and disease control. The maintenance of the earth's biosphere depends on a delicate balance between these regulating

services. Sustainable ecosystem service delivery depends on the health, integrity and resilience of the ecosystem (Kumar *et al*., 2010[2]).

Worldwide, there has been growing realization of the importance of pollination services for both wild plant communities and agricultural systems. Many economically important species require pollination to produce marketable crops. Yet, hard figures on the economic value of pollination are still lacking. Very few studies have specifically conducted analyses that match the scales at which land-use decisions are made. Estimates of the annual monetary value of pollination vary widely and this wide range, to a certain extent, represents the lack of common methods for valuing pollination (Kumar *et al*., 2010).

The presence of pollinators is not necessarily proportional to service provision as there may not be crops that require pollination within the local forage range. Similarly, due to the differing forage preferences, activity periods, morphological characteristics and synergistic behaviours of pollinators, local insects supported by the habitat may not be effective pollinators of neighbouring crops. Environmental factors and long term crop and landscape patterns may affect the functional pollinator community. (Hanley *et al.* 2013[3]).

Although honey bees can pollinate many plant species, they are not always the most efficient pollinator on a bee-per-plant-visit basis. For example, bumble bees are better pollinators of blueberry or cranberry. Principal pollinators vary by plant species, geographical location, and time of year (Kearns *et al*., 1998[4]). Wild and managed pollinators can also have complementary behavioural relationships which increase the efficiency of pollination (Bauer, 2014[5]).

Typical ecosystems at intermediate latitudes harbour as many as several hundred pollinating insect species, most belonging to Hymenoptera, Lepidoptera, Diptera and Coleoptera. The vast majority of hymenopteran pollinators are solitary bees (Kearns *et al.* 1998). With the exception of butterflies, data for other pollinators, including different bee species, are fragmentary because of the lack of coordinated monitoring programmes (Potts *et al*., 2010[6]). More effort needs to be expended in learning comparable information about dipteran and coleopteran life cycles and larval diets. The role of flies as pollinators in many ecosystems seems to have been underestimated (Kearns *et al.* 1998).

As there is no universal way to evaluate the pollination service, we chose to compare the abundance of the main pollinator groups in our monitoring plots (100 m^2): Hymenoptera (all non-parasitic hymenopterans), Lepidoptera (only Nymphalidae and Pieridae were present) and Diptera (all families).

3.4. Hydrological monitoring

To monitor the dynamics of groundwater in the project sites, gauges with leveloggers were installed in Lithuanian project sites in June-August 2017. Water level measurements were performed

[2] Kumar, P., Verma, M., Wood, M.D., Negandhi, D., 2010. Guidance Manual for the Valuation of Regulating Services. UNEP, Publishing Services Section, UNON, Nairobi-Kenya

[3] Hanley N., Ellis C., Breeze T. 2013. Accounting for the value of pollination services. Valuation for Natural Capital Accounting workshop, London, November 11th 2013

[4] Kearns, C.A., D.W. Inouye, and N.M. Waser, Endangered mutualisms: The conservation of plant-pollinator interactions. *Annual Review of Ecology and Systematics*, 1998. 29: p. 83-112

[5] Bauer D. M. 2014. Chapter 7: Valuing pollination services: a comparison of approaches. In: K. N. Ninan (Ed.) Valuing Ecosystem Services. Methodological Issues and Case Studies. 148–167

[6] Potts, S.G., Biesmeijer, J.C., Kremen, C., Neumann, P., Schweiger, O. & Kunin, W.E. (2010). Global pollinator declines: trends, impacts and drivers. *Trends Ecol. Evol*., 25, 345–353

using Solinst Levelogger Model 3001. The atmospheric pressure data, required to fine-tune the values of leveloggers (compensation of atmospheric pressure), were measured using Solinst Barologger Model 3001. The locations of gauges with leveloggers and barologgers are shown in the chapters, describing hydrological monitoring in different project areas.

All the loggers were programmed using Solinst Levelogger Software Version 4.3.0 so that the pressure and temperature values are fixed twice a day for every 12 hours. The water level gauges were mounted into the wells so that their sensors are approximately 70-90 cm below the surface of the soil and during the installation were immersed into the water. At the beginning of the measurement period, the water level in the wells were measured by hand, using a metal measuring tape, and these data were used to fine-tune automatic measurements of the Leveloggers (according the procedure described by manufacturer).

The summer season of 2017 was exceptionally rainy in Lithuania, so measurements of the first season may not reflect the normal groundwater regime. However, these, though incomplete measurements, allow us to make some insights about the possible effects of the hydrological regime on the general formation of plant communities and the suitability of the entire area for Aquatic Warbler.

4. Project site LT/01-Tyrai

4.1. Bird monitoring

Aquatic Warblers currently were not observet in the project site LT/01-Tyrai. Two breeding pairs of Common Redshank (*Tringa totanus*) and in total 12 species of other birds were observed in the area during the field visits to the sites during bird breeding season in year 2017.

4.2. Vegetation monitoring

General vegetation characteristics of Tyrai wetland

Tyrai wetland is in the particular way disturbed by human activity: there occurs the channel system which not only drains the wetland but divides the wetland as well. King Wilhelm channel separates research area from the rest of wetland complex situated on the lagoon shore. The main ditch extending in the north-easterly direction from the channel divides study area into two parts. Every of these parts is divided with channels and forest belts in two areas. Thus fragmented research area consists of 4 wetland areas, separated by forest and ditches. All these areas are crossed with small ditches. The impact of the ditches is different in particular parts of the area. Due to uneven hydrological and trophic conditions the vegetation of each area is different (Fig. 4.).

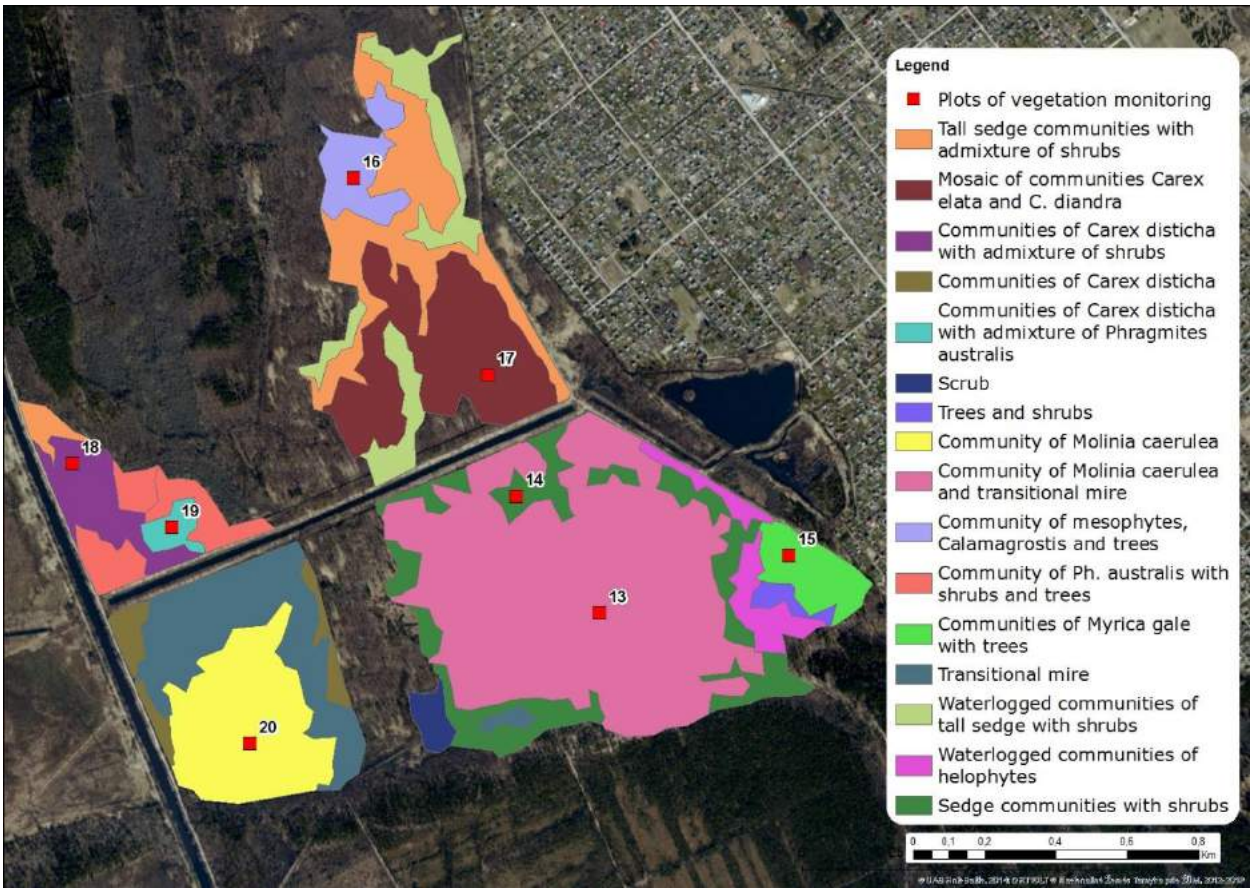

Fig. 4. Distribution of plant communities in Tyrai wetlands in 2017.

The vegetation of north-western area is uneven in different parts. Margins are overgrown with high helophytes, shrubs and single trees. Dense thickets of high helophyte with trees and shrubs are also found in southern part of the area. However, the composition of the grass layer is very different in areas with admixture of the wooden plants. On the edge of the north-western part *Salix cinerea* and *Salix aurita* are growing quite densely (sometimes with admixture of solitary *Betula pubescens* individuals). In the gaps between groups of wooden plants, plant communities with predominating tall sedges are found. In the depressions *Caricetum gracilis communities* occur. In a distance from the ditches *Caricetum distichae* community with solitary *Salix* shrubs and *Betula pubescens* (3–5 m in height) trees survived. Woody plants in these areas cover about 25 %. Grass layer is dense (coverage – 95–97 %). The 1st level reach up to 120 cm, the 2nd – up to 70cm, the 3rd – up to 40 cm, fourth – up to 20 cm in height. *Carex disticha* is a dominant species and together with quite abundant *Carex lasiocarpa* makes up first and second levels. In second level *Carex elata* also takes a significant part; *Eriophorum angustifolium* can be found ij this level as well. The 3rd level consists of the lower leafs or vegetative individuals of *Peucedanum palustre* and poorly developed *Lysimachia vulgaris* and *Lythrum salicaria* individuals. Plants of the last species are stunted because this area is developing into transition mire. *Potentilla palustris* is a dominant species in 4th level. The bryophytes are absent due to high water table in the beginning of growing season. The amount of the phytomass in 1 m^2 varies within the ranges 860–1500 g.

Analogical communities can be found in the central part and on the southern edge of the south-western area and on the western edge of the south-western area.

In the southern corner of the south-western area, *Caricetum distichae* communities are overgrown with reed and *Salix* shrubs. The coverage of *Carex disticha* is about 15 %. Solitary *Betula pubescens* and *Alnus glutinosa* individuals (400–650 cm in height) were found; their diameter at the height of 130 cm was 9–12 cm. The reed is of medium height – up to 190 cm. *Phragmites australis* predominates in grass layer. The amount of the fresh phytomass in 1 m^2 is 1300–1400 g.

On the eastern edge of the north-western area, the dense and tall reed occurs. The height of *Phragmites australis* plants reaches up to 380 cm. These plants predominate in grass layer. Sedges (*Carex acuta*) cover only 5 %. Shrubs (*Salix cinerea*) cover about 5 % and trees (*Alnus glutinosa, Pinus sylvestris*) – 10 %. The diameter of the tree trunk at the height of 130 cm is about 13–15 cm; the height of the trees reaches 700–750 cm. The amount of the fresh phytomass in 1 m^2 is 1340–1624 g.

North-eastern area is very heterogeneous. In this area as in north-western, woody plants are growing near ditches. Woody plants are more abundant on the western edge and in the northern part of the area where ditch network is denser. Near one of the ditches in more drained area a small deciduous grove is developed. In southern part of the north-eastern area are found *Caricetum elatae* communities with indications of more intensive paludification.

The south-western area is open. The higher wooden plants are concentrated on the margins of the area and near the ditches. The vegetation is quite homogenous. Major part of the area is occupied by communities with predominating *Molinia caerulea*. They are flooded in the spring time. *Caricetum distichae* communities are also found on the edges of the area.

Protected species in Tyrai wetland

In Tyrai wetland, there were found three protected species: *Carex buxbaumii, Dactylorhiza incarnata* and *Myrica gale*, which are included in Red Data Book of Lithuania.

Carex buxbaumii Wahlenb.

Included into Red Data Book of Lithuania, 3(R) category. Small plant groups of this species are distributed in north-eastern part of the north-western area (X 326151; Y 6163150) and in central part of the north-eastern area (X 326513; Y 6162320). Majority of the individuals were fertile.

Dactylorhiza incarnata (L.) Soó

Included into Red Data Book of Lithuania, 5(Rs) category. Several generative individuals were found in north-eastern margin of the north-eastern area (X 326856; Y 6162614).

Myrica gale L.

Included to Red Data Book of Lithuania, 3(R) category. *M. gale* plants area distributed in almost all north-eastern part. Majority of them are fertile.

Alien species occurring in the area

Near the edge of the area, two alien species were found.

Helianthus tuberosus L.

One *H. tuberosus* plant was found on the edge of the north-eastern area (X 326754, Y 6162720). Plant was fertile. Due to ability of this species to propagate vegetatively, this species can spread out in the territory.

Hippophae rhamnoides L.

Dense *H. rhamnoides* shrubs are overgrown all the north-eastern edge of the territory.

One alien arachnid species was found (*Argiope bruennichi*). These spiders can be found in different wetland places (X 326856, Y 6162614; X 325024, Y 6162741; X 326199, Y 6162986; X 326151, Y 6163150). In last two area individuals of *A. bruennchi* were quite abundant – approximately 3 individuals in 100 m^2 area were found.

Vegetation properties in the permanent plot No. 13

The permanent plot is situated in south-eastern part of the wetland. A habitat should be classified as a fen with some indications of the transition mire. Wetland is almost open – only solitary *Betula pubescens* trees, not exceeding 2 m in height, occur in the 100×100 m study area. *Salix* spp. shrubs are removed from the area; only *Myrica gale* shrubs are left as this species is under protection – is included into Red Data Book of Lithuania. All area can by classified as *Eriophoro-Caricetum paniceae* community.

The permanent plot distinguishes with uneven surface caused by dredgers and with tussocks of *Molinia caerulea* (coverage about 19 %). The coverage of the shrubs is rather high (13 %) *Myrica gale* shrubs take almost all coverage value while *Salix cinerea* after cutting in winter occurs only as solitary offspring. The coverage of grass layer reaches 75 %. The sedges predominate in this layer (coverage 60 %) while the coverage of other herbaceous species do not exceed 20 %. Among sedges *Carex panicea* is predominating. *Carex lasiocarpa*, *C. nigra* and *C. buxbaumii* are not abundant. The moss layer is very sparse (coverage – 0.1 %). Brown mosses (*Drepanocladus aduncus*, *Campylium stel*latum) are more abundant (coverage – 0.1 %), while *Sphagnum fallax* covers only 0.01%.

The maximum height of the levels of the grass layer: 1st – 110 cm, 2nd – 65, 3rd – 44, 4th – 22 cm.

In total, only 21 plant species were found: 18 vascular plant and 3 bryophyte species. The number is not low comparing with other permanent plots of Tyrai wetland though the species diversity is pure comparing with other territories. Among vascular plant species 16 are herbaceous plants and 2 – shrubs. Among bryophytes 2 are brown moss and 1 peat moss species.

Shrubs make more than 25 % of the fresh phytomass (Table 1); while in the dry phytomass they make about 30 %. Sedges prevail in the fresh phytomass of the herbaceous plants while Poaceae

(*Molinia caerulea*) make the major part of the dry phytomass (Table 2). The amount of the dead plant remnants is more than twice higher than alive parts in the fresh phytomass and almost twice higher in dry phytomass.

Table 1. Amount of fresh phytomass (Average and STDEV) of vascular plants in Tyrai wetland (13–15 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	13	**14**	**15**
Shrubs and dwarf shrubs	185.6±0	33.6±75.1	0.0
Ferns	0.0	0.0	0.0
Carex spp.	219.2±105.0	853.6±685.7	95.6±90.4
Other edificator (*Phragmites australis*)	0.0	0.0	0.0
Equisetum spp.	0.0	0.0	237.6±57.5
Poaceae (including *Phragmites australis*)	171.2±92.8	0.0	581.6±213.2
Phragmites australis	0.0	0.0	0.0
Other herbaceous plants	42.8±54.3	100.8±98.6	280.8±223.5
Total amount	618.8±178.6	988.0±758.8	1195.6±157.5
Dead plant remnants	1648.0±271.5	2960.0±688.7	1002.4±211.2

Table 2. Amount of dry phytomass (Average and STDEV) of vascular plants in Tyrai wetland (13–15 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	13	**14**	**15**
Shrubs and dwarf shrubs	107.3±159.1	23.3±49.0	0.0
Ferns	0.0	0.0	0.0
Carex spp.	85.3±46.2	239.1±78.4	44.6±41.1
Other edificator (*Phragmites australis*)	0.0	0.0	0.0
Equisetum spp.	0.0	0.0	60.1±9.8
Poaceae (including *Phragmites australis*)	106.8±58.9	0.0	295.0±110.2
Phragmites australis	0.0	0.0	0.0
Other herbaceous plants	20.2±27.1	24.2±12.2	86.3±68.3
Total amount	319.6±129.3	286.5±63.4	486.0±78.9
Dead plant remnants	623.0±260.8	889.6±479.4	291.3±62.6

The coverages of the layers and of plant groups (Table 3) show the high mosaicity of the vegetation. The 1st and the 4th levels of the grass layer are sparse, while 2nd is the densest. The heights of the levels as the number of the species per 1 m^2 are variable as well. Especially differ the structure of 1 m^2 plots situated in the sites damaged by dredgers during wetland management actions. *Molinia caerulea* has the most important role in the 3rd level while *Carex panicea* in the 4th (Table 4). Both these species are the most frequent in 1 m^2 plots. In spite of the high frequency *Carex nigra*, *C. lasiocarpa* and *Eriophorum angustifolium* are not abundant.

Table 3. Vegetation structure in the 1m^2 plots of the permanent plot No 13

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	9.9±18.0	0	65
	Herbs	63.7±13.3	25	90
	Bryophytes	0.2±0.4	0	1.5
	Open ground	5.4±5.3	0	22
	Dead phytomass	89.8±5.4	73	96
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	17.8±19.2	0	70
	Other herbs	47.8±23.1	6	87
	Brown mosses	0.1±0.4	0	1.5
	Sphagnum spp.	0.04±0.2	0	1
Coverage (%) of the levels of the herb layer	I	1.3±1.6	0.2	8
	II	37.0±24.7	7	82
	III	26.5±21.9	0	66
	IV	1.0±2.1	0	8.5
Height of the levels of the herb layer	I	108.6±12.4	81	138
	II	67.1±7.3	52	78
	III	43.3±6.8	34	56
	IV	17.3±5.7	8	27
Species number per 1m^2 plot	Shrubs	2.4±5.5	0	18
	Herbs	5.8±1.7	1	9
	Bryophytes	0.2±0.4	0	1
	Total	8.4±5.4	2	23

Table 4. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 13

Species	Coverage (%) of the layers *				Height (cm) of the layers *				Frequency
	I	II	III	IV	I	II	III	IV	
Calamagrostis stricta	4	0.1±0	0	0		81±0			
Carex buxbaumii	16	0	0.2±0.1	0.5±1			58.8±8.2	44±0	
Carex lasiocarpa	72	1.1±1.7	0.03±0.1	0		87.4±10.2	64±8.5		
Carex nigra	84	0	0.3±0.6	1.9±2.3	0.1±0.3		52±6.1	39±5.2	27±0
Carex panicea	96	0.01±0.04	1.5±1.6	14.9±18.2	0.1±0.4		57.9±7.6	41.8±6.0	18±6.5
Eriophorum angustifolium	84	0.03±0.1	0.9±0.7	0.7±1.2	0.1±0.2	72.3±8.8	59.4±8.3	35.7±6.4	21±2.8
Galium palustre	4	0	0	0.01±0				39±0	
Iris pseudacorus	4	0	0.2±0	0			0.2±0		
Lysimachia vulgaris	36	0	0.4±0.8	0.1±0.1	0.1±0.1		53.7±8.1	31.6±8.5	17.8±3.2
Lythrum salicaria	4	0	0.3±0	0			74±0		
Molinia caerulea	100	0.5±0.5	34.7±25.7	10.5±17.5	0.2±0.9	109.7±11.2	65.8±8.8	45.1±7.5	20.3±5.1
Peucedanum palustre	8	0	0	0.2±0.3	0.2±0.2			50±0	27±0
Potentilla palustris	56	0	0.1±0.3	0.6±0.4	0.5±0.8		49±2.6	33.5±7.0	15.8±5.5
Sanguisorba officinalis	8	0	0	1±1.4	0.1±0.7			39±0	8±0
Utricularia intermedia	4	0	0	0	0.1±0				0.5±0

* – average and STDEV

Vegetation properties in the permanent plot No. 14

The permanent plot is located on the northern edge of the south-eastern part of the territory. The area before management was overgrown with shrubs. During the management activity the surface of the peat was damaged. In the permanent plot *Caricetum distichae* community is developed. This community occupies about 40 % of the 100×100 m plot, while other part of the area is occupied with *Caricetum lasiocarpae* community. At the time of investigation, the water level was below of the peat surface.

In the permanent plot offshoots of the cut shrubs occur (coverage 6 %). The herb layer is rather dense – coverage 80 %. Of these, sedges cover 75 %. Other herbaceous plants cover 10 %. Only solitary sedge tussocks occur in the plot. The moss cover is very sparse (coverage 1 %). The open peat covers about 10 %. The herb layer is rather high – it reaches 96 cm. Other levels of the herb layer are much lower: 2^{nd} – 40 cm, 3^{rd} – 33 cm, 4^{th} – 20 cm.

The number of the species in the permanent plot is moderate – in total 24 species: shrub – 1 (*Salix cinerea*), herbaceous plant – 20, bryophytes – 3. All bryophyte species are brown mosses (*Calliergon giganteum*, *Calliergonella cuspidata*, *Campylium stellatum*). Six sedge species (*Carex elata, C. disticha, C. lasiocarpa, C. nigra, C. panicea, C. rostrata*) were found in the permanent plot.

The permanent plot No 14 distinguishes with high amount of the sedges (Tables 1 & 2) in the fresh as in the dry phytomass and the high amount of the dead plant remnants in both – as fresh as dry – phytomass measurements. It is determined by the structure of the herb layer – abundantly growing *Carex disticha* plants have slime stems which early fall down. Therefore, they were not removed during management work.

The coverages of the layers, of the levels in the herb layer and of different plant groups are very variable (Table 5). It expresses the high mosaicity of the vegetation. Disturbance of the peat surface and the vegetation cover is an additional factor increasing the mosaicity of the plant community.

The vegetation distinguishes with high (53.7±14.8 %) coverage of the 1^{st} level (Table 6). It is determined by predominance of the *Carex disticha*. The low species number per 1 m^2 plot is also the peculiarity of this permanent plot. Shrubs and bryophytes occur not in all plots: shrubs are found in 44 %, bryophytes – in 56 % of the plots.

The most frequent species are *Carex disticha, C. lasiocarpa, C. nigra, Lysimachia thyrsiflora, L. vulgaris, Peucedanum palustre,* and *Potentilla palustris*. Though, only *Carex disticha* is abundant. *Peucedanum palustre* distinguishes with participation in all levels of the grass layer.

The sedges occur in all 1 m^2 plots and in every plot are found from 2 to 4 *Carex* species.

Table 5. Vegetation structure in the 1m^2 plots of the permanent plot No 14

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	2.7±5.5	0	22
	Herbs	67.3±14.2	45	90
	Bryophytes	0.9±2.4	0	12
	Open ground	10.0±10.0	1	42
	Dead phytomass	85.3±11.0	50	95
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	57.7±13.5	30	75
	Other herbs	13.3±6.0	3.5	27
	Brown mosses	0.9±2.4	0	12
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	53.7±14.8	30	74
	II	5.4±4.1	0.6	14.5
	III	4.7±2.7	0.5	10
	IV	8.0±5.3	1.5	26
Height of the levels of the herb layer	I	95.4±13.4	72	116
	II	54.9±12.6	33	74
	III	34.8±7.1	23	48
	IV	17.9±4.9	10	26
Species number per 1m^2 plot	Shrubs	0.4±0.5	0	1
	Herbs	9.8±1.6	8	13
	Bryophytes	0.6±0.6	0	2
	Total	10.8±1.9	8	15

Table 6. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 14

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis stolonifera	4	0		0	0.1±0				7.0±0
Carex disticha	100	50.9±13.8	0.3±0	0	0	83.3±8.5	55.0±0		
Carex elata	28	5.0±0	3.3±1.9	0	0	60.0±0.0	47.0±7.4		
Carex lasiocarpa	92	1.9±2.7		0	0	96.9±12.8			
Carex nigra	84	5.4±6.2	5.05±5.6	2.2±2.08	0	49.0±6.4	49.5±10.8	34.9±5.5	
Carex panicea	16	0	1.3±1.5	4.0±0	0.5±0		51.7±17.01	29.0±0.0	13.0±0.0
Carex rostrata	4	0.5±0	0	0	0	61.0±0.0			
Eriophorum angustifolium	48	0.5±0	0.5±0.5	0.3±0.2	0			37.1±10.5	8.5±0.7
Galium palustre	28	0		0.04±0.05	0.09±0.1			23.7±4.9	9.4±6.1
Iris pseudacorus	48	0.9±1.09	0.5±0.3	0	0.1±0	72.8±11.9	60.6±13.5		10.0±0
Lycopus europaeus	24	0		0.2±0	0.5±0.58			24.0±0	11.6±8.4
Lysimachia thyrsiflora	96	0	0.3±0.07	0.8±0.7	0.47±0.35		39.5±0.7	26.3±6.6	13.9±4.2
Lysimachia vulgaris	100	0	1.1±0.9	1.5±1.09	0.55±0.44		50.8±13.2	32.1±7.3	13.8±4.8
Lythrum salicaria	64	0	0.5±0.3	0.6±0.3	0.33±0.15		48.6±10.5	28.0±7.9	16.0±7.0
Peucedanum palustre	92	0.9±0.6	1.0±0.5	1.8±2.07	0.31±0.21	85.0±9.6	51.2±12.5	31.9±9.7	12.6±4.8
Potentilla palustris	100	0	0.3±0.06	1.4±1.9	7.09±5.33		44.5±5.9	31.3±5.5	17.7±5.2
Sanguisorba officinalis	4	0	0	0	0.2±0				9.0±0
Scutellaria galericulata	4	0	0	0.2±0	0			21.0±0	
Sium latifolium	4	0	0	0.5±0	0			35.0±0	
Stellaria palustris	16	0	0	0.1±0.06	0.13±0.06			26.3±2.5	12.7±2.3
Utricularia minor	28	0	0	0	1.01±0.94				1.0±0

* – average and STDEV

Vegetation properties in the permanent plot No. 15

The permanent plot is situated on the north-eastern edge of the south-eastern part of the wetland. This edge was the most densely overgrown with shrubs and trees. The eastern corner of the area is densely overgrown with *Betula pubescens* trees and *Myrica gale* shrubs. In the winter *Salix* spp. shrubs were cut down. The solitary offshoots of cut shrubs occur. All *Myrica gale* shrubs are left. Woody plants weren't removed from the eastern corner of the area.

The 100×100 m plot includes *Molinietum caeruleae* (80 %) and *Caricetum distichae* (20 %) communities. The permanent plot No 15 is occupied by *Molinietum caeruleae* communities. The surface of the plot area is uneven due to use of the dredger for the management. The water table during the study time was below the peat surface. Shrubs were absent. The coverage of the herb layer reached 97 %. Sedges covered only 8 %, while other herbaceous plants – 90 %. *Molinia caerulea* tussocks occupy more than 70 % of the area. The height of the 1st grass level was 143 cm, 2nd – 80 cm, 3rd – 62 cm, 4th – 23 cm. Moss layer was very sparse (coverage 1 %), consisting only of brown mosses. The open peat occupies about 5 % of the plot area. The species number is rather high – in total 30 species were found. Of these 29 species were vascular plants and 1 species – bryophyte (brown moss *Calliergonella cuspidata*). All vascular plant species were herbaceous.

The permanent plot No 15 distinguishes with rather high amount of as fresh as dry total phytomass (Tables 1 & 2) and very low content of sedges in it. While Poaceae plants predominate in the phytomass. *Equisetum* spp. plants make also unusually large part of the total fresh phytomass. The amount of the dry phytomass of this group is rather low due to specific structure. The amount of dead plant remnants is low as the part of it was removed during wetland management.

The coverages of the layers and levels in the herb layer in 1 m^2 plots (Table 7) demonstrate high mosaicity of the vegetation cover. In spite of the height of the 1st and 2nd levels, their coverages were low. The highest plant concentration was in the 3rd level (coverage 63.3±21.3 %). The number of the herbaceous plants was rather high (12.4±2.5) and variable (8–15 species). Bryophytes were found in majority of the plots (84 %), however the coverage varied within wide range (from 0 to 35 %).

The most frequent species were *Equisetum palustre* and *Molinia caerulea* – plants of these species were found in all 1 m^2 plots. Though, only *Molinia caerulea* was abundant. Rather frequent species (occurred in more than 80 % of the plots) were *Lathyrus palustris*, *Peucedanum palustre*, *Potentilla palustris*, and *Sanguisorba officinalis*. Though, plants of these species were not abundant. In spite of the low abundance, *Peucedanum palustre* and *Sanguisorba officinalis* participated in all levels of the herb layer. *Molinia caerulea* was important not only in the 3rd level – it was the most abundant species in the 1st level. While in the more wet places *Carex disticha* predominated in the sparse 2nd level. *Carex lasiocarpa* solitary plants occurred in many (44 %) 1 m^2 plots.

Table 7. Vegetation structure in the 1m^2 plots of the permanent plot No 15

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	0±0	0	0
	Herbs	85.6±8.2	65	95
	Bryophytes	4.8±7.5	0	35
	Open ground	5.0±7.7	0	40
	Dead phytomass	86±10.5	53	95
Coverage (%) of the plant groups	*Phragmites australis*	0±0	0	0
	Carex spp.	8.4±15.7	0	65
	Other herbs	78.9±18.1	20	95
	Brown mosses	The4.8±7.5	0	35
	Sphagnum spp.	0±0	0	0
Coverage (%) of the levels of the herb layer	I	15.8±8.2	6	35
	II	14.9±19.4	0.5	70
	III	63.3±21.3	14	90
	IV	6.1±4.7	1	17
Height of the levels of the herb layer	I	135.9±10.2	118	159
	II	79.8±8.7	65	96
	III	53.7±8.9	31	69
	IV	23.9±3.7	15	30
Species number per 1m^2 plot	Shrubs	0±0	0	0
	Herbs	11.6±2.3	8	15
	Bryophytes	0.8±0.4	0	1
	Total	12.4±2.5	8	16

Table 8. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 15

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis canina	4	0	0	0.1±0.1	0			62.0±0	
Agrostis stolonifera	24	0	0	0.2±0.2	0.3±0.2			42.0±15.3	15.4±5.1
Calamagrostis stricta	12	0.2±0	0.7±0.5	0	0	99.0±7.1	71.5±7.8		
Caltha palustris	16	0.8±0	0	7.0±0	0.8±0.5	102.0±0		51.0±0	22.0±5.0
Carex disticha	32	2.0±0	24.6±21.4	0	0	89.0±0	77.6±9.6		
Carex lasiocarpa	44	1.0±0.9	1.3±1.2	0.1±0.1	0	99.7±10.3	77.5±7.6	43.5±12.0	
Carex nigra	40	0	0.2±0.1	2.4±2.2	0		63.3±15.8	53.9±7.4	
Carex panacea	48	0	0.5±0.3	1.0±0.8	0		57.0±4.6	41.7±8.2	
Equisetum fluviatile	60	0.07±0.1	0.1±0.1	0.2±0.2	0	91.0±5.3	71.0±13.4	50.0±6.9	
Equisetum palustre	100	1.0±0	1.3±1.0	5.6±4.1	0	72.0±0	62.3±8.0	48.5±9.2	
Eriophorum angustifolium	8	0	0.25±0.07	0	0		60.5±10.6		
Eupatorium cannabinum	4	0	26.0±0	0	0		84.0±0		
Filipendula ulmaria	56	0	3.5±5.1	3.9±3.5	0.3±0		74.0±11.8	47.8±9.2	17.5±0.7
Galium boreale	4	0	0	0.2±0	0			41.0±0	
Galium palustre	44	0	2.0±0	0.8±0.8	0.07±0.04		50.0±0	36.3±4.3	17.1±2.9
Galium uliginosum	24	0	0	0.5±0.4	0.2±0			45.0±11.9	16.0±0
Iris pseudacorus	52	0.2±0.1	2.5±2.6	0.7±0.3	0	90.0±4.6	77.5±8.4	46.7±18.3	
Lathyrus palustris	84	0	2.8±4.8	0.7±0.6	0.1±0		69.3±20.7	40.6±8.3	26.0±0
Lathyrus pratensis	20	0	0	0.4±0.4	0			36.8±5.7	
Lysimachia vulgaris	44	0	0.6±0.4	0.6±0.7	0		57.6±7.5	48.7±9.6	
Lythrum salicaria	16	0	0.4±0.1	1.65±0.9	0.5±0		72.0±8.5	42.5±6.4	12.0±0
Molinia caerulea	100	15.5±8.4	7.0±13.5	49.5±22.1	0	136.2±10.5	71.5±7.8	52.0±9.1	
Peucedanum palustre	88	0.6±0.6	0.7±0.4	6.3±3.8	0.5±0.4	93.9±11.3	77.1±9.3	48.4±9.0	21.0±4.6
Poa trivialis	8	0.2±0	0	3.0±0	13.0±0	83.0±0		41.0±0	30.0±0
Potentilla palustris	88	0	0.2±0	1.7±1.6	5.5±4.4		64.0±0	40.0±7.5	22.8±4.3
Sanguisorba officinalis	84	0.1±0	0.1±0.05	1.0±0.8	1.1±1.1	81.0±0	66.3±9.5	36.2±6.9	18.5±5.2
Scutellaria galericulata	40	0	0	0.3±0.3	0.3±0.4			33.8±4.6	16.0±4.1
Stellaria palustris	16	0	0.2±0	0.1±0	0		60.0±0	54.7±6.4	

* – average and STDEV

Vegetation properties in the permanent plot No. 16

The permanent plot is situated in the centre of north-eastern part of the Tyrai wetland. This part is almost open – only solitary *Salix cinerea* shrubs occur and sparse *Phragmites australis* are found in several parts. Such sparse *Phragmites australis* growing in *Caricetum lasiocarpae* community occur in a part (about 25 %) of the 100×100 m plot. More than a half (55 %) is occupied by *Phragmites* free *Caricetum lasiocarpae* community and bout 20 % is occupied by *Caricetum distichae* community. This community including species as of the fen (*Carex disticha*) as of the transition mire (*Carex lasiocarpa, Eriophorum angustifolium,* and *Peucedanum palustre*) occupies all permanent plot No 16. The vegetation of this wetland part was not managed. The peat surface is even and in the vegetation cover only solitary *Carex elata* tussocks occur. The water table during study time was below peat surface, while in the last decade of the July the water table was about 25 cm above it. Shrubs were absent in the plot. The herb layer was moderately thick (coverage 85 %). Sedges predominated (coverage 80 %) in the herb layer. Other herbaceous plants covered about 15 %. The Height of the herb layer was not high – the 1st level reached only 110 cm. The differences between 2nd and 3rd levels were not large – the heights were 68 and 50 cm. The 4th level is low – 22 cm. The moss cover was very scarce due to wide water table fluctuations.

Permanent plot distinguishes with very low total species number (18). Of these, 16 were herbaceous species and 2 brown mosses. Even 6 species of the vascular plants belong to *Carex* genus. *Carex disticha* predominates in the community. From brown mosses more abundant was *Calliergon giganteum*.

The amount of the fresh and dry phytomass is moderate (Tables 9 & 10). The sedges make a major part in both phytomass measurements. The amount of the dead plant remnants as in the fresh as in dried samples was moderate.

In the 1 m^2 plots, variable was not only coverage of the herb layer but also coverages of the sedges and other herbaceous plants (Table 11). Meanwhile the coverage of the dead plant remnants was similar in all plots. Rather similar were heights of the levels in the grass layer. The densest was the 1st level of the herb layer however the coverages varied from 35 to 79 %. Very variable were coverages other levels as well, while the heights of the levels were rather similar. The total number of the species in the 1 m^2 plots was low and very variable.

Rather large part of the species was constant – 4 species (*Carex disticha, C. lasiocarpa, Eriophorum angustifolium, and Potentilla palustris*) were found in all plots (Table 12). It is a quarter of the total species number of herbaceous plants. Very frequent (found in 96 % of the plots) were *Lysimachia vulgaris* and *Potentilla palustris*. Among the frequent species only *Carex disticha* was very abundant. Though, Carex lasiocarpa had a considerable role in the 1st level, while Potentilla palustris in the 3rd and the 4th.

Table 9. Amount of fresh phytomass (Average and STDEV) of vascular plants in Tyrai wetland (16–18 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	16	**17**	**18**
Shrubs and dwarf shrubs	0.0	0.0	0.0
Ferns	0.0	0.0	0.0
Carex spp.	720.0±218.9	732.0±225.4	897.6±378.6
Other edificator (*Phragmites australis*)	0.0	0.0	0.0
Equisetum spp.	1.6±3.6	0.0	0.0
Poaceae (including *Phragmites australis*)	0.4±0.9	0.0	6.4±8.3
Phragmites australis	0.0	0.0	0.0

Other herbaceous plants	128.0±89.9	117.6±89.5	279.2±136.6
Total amount	850.0±164.1	849.6±218.8	1183.2±319.7
Dead plant remnants	807.2±411.5	1158.4±581.7	780.0±257.8

Table 10. Amount of dry phytomass (Average and STDEV) of vascular plants in Tyrai wetland (16–18 permanent plots)

Plant group	**Amount of phytomass (g/m^2)**		
	16	**17**	**18**
Shrubs and dwarf shrubs	0.0	0.0	0.0
Ferns	0.0	0.0	0.0
Carex spp.	398.8±117.6	348.9±88.5	378.5±137.1
Other edificator (*Phragmites australis*)	0.0	0.0	0.0
Equisetum spp.	0.2±0.4	0.0	0.0
Poaceae (including *Phragmites australis*)	0.0	0.0	2.3±3.4
Phragmites australis	0.0	0.0	0.0
Other herbaceous plants	68.2±51.8	52.2±41.4	63.9±28.7
Total amount	467.3±82.8	401.1±83.9	444.8±150.1
Dead plant remnants	299.0±105.7	541.2±295.9	270.2±84.2

Table 11. Vegetation structure in the 1m^2 plots of the permanent plot No 16

Measurement	**Layer / Plant group / Level of the herb layer**	**Average & STDEV**	**Min**	**Max**
Coverage (%) of the layers	Shrubs	0.0±0.0	0	0
	Herbs	79.6±6.8	65	92
	Bryophytes	0.1±0.3	0	1.5
	Open ground	3.5±2.8	0	11
	Dead phytomass	91.2±3.2	84	95
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	68.6±10.6	45	85
	Other herbs	20.5±18.4	5	78
	Brown mosses	0.1±0.3	0	1.50
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	59.8±11.8	35	78
	II	13.7±8.3	2.5	30
	III	12.0±13.6	1.4	53
	IV	6.6±14.7	0.5	76
Height of the levels of the herb layer	I	103.1±5.9	91	114
	II	58.9±5.6	48	71
	III	38.7±4.5	30	47
	IV	21.5±3.5	15	28
Species number per 1m^2 plot	Shrubs	0.0±0.0	0	0
	Herbs	7±1.0	5	9
	Bryophytes	0.2±0.5	0	2
	Total	7.2±1.2	5	10

Table 12. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 16

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Calamagrostis stricta	40	0.05±0.07	0.01±0		5.0±0	74.4±9.0	47.0±0		23.0±0
Carex buxbaumii	16	0.3±0.5	0.1±0			74.0±7.5	49.0±4.2		
Carex disticha	100	49.8±15.9	11.7±8.5			77.3±8.8	57.7±5.7		
Carex elata	4	4.0±0				67.0±0			
Carex lasiocarpa	100	10.0±7.6	1.5±2.1			103.1±5.9	60.0±9.0		
Carex nigra	8	0.01±0		0.2±0		58.0±0		26.0±0	
Carex panicea	4	0.01±0	0.5±0			59.0±0	56.0±0		
Equisetum fluviatile	8	0.01±0		0.01±0		69.0±0		38.0±0	
Eriophorum angustifolium	100	1.8±1.9	1.6±0.9	0.5±0		69.3±9.3	52.5±5.9	34.7±6.5	
Galium palustre	12		0.1±0	0.1±0	0.01±0		48.0±0	29.0±0	16.5±13.4
Lycopus europaeus	12			0.2±0	0.3±0			28.5±3.5	10.0±0
Lysimachia vulgaris	96		1.3±1.5	1.8±2.6	0.4±0.3		51.2±6.6	34.2±4.9	15.9±3.8
Lythrum salicaria	4			1.2±0				38.0±0	
Peucedanum palustre	96	0.7±0.7	1.7±1.2	1.6±1.4	0.2±0.08	82.5±6.8	51.4±6.0	38.9±12.9	13.8±4.0
Potentilla palustris	100		2.4±4.4	10.4±13.3	6.1±15.0		55.6±5.3	36.9±4.7	21.0±3.6

* – average and STDEV

Vegetation properties in the permanent plot No. 17

The permanent plot is situated near south-eastern edge of the north-eastern part of the Tyrai wetland. This part is unmanaged. The area is almost open, only with solitary shrubs. *Phragmites australis* is absent. The area distinguishes with densely growing high (about 35 cm) *Carex elata* tussocks. All area of 100×100 m plot is occupied by *Caricetum lasiocarpae* community which is in the initial stage of its development and have a lot of the fen attributes. This plant community occurs in the permanent plot as well. The water table in the 2nd decade of the June was about 30 cm above peat surface while at the time of vegetation study (21.08.2017) in major part of the plot it was below the peat surface and in lower places it reached the maximum height above peat surface – 5 cm. The conductivity of the water was 0.8 S m^{-1}, the water reaction – subneutral (pH – 5.9).

The coverage of the shrubs was low – only 1 %. While the herb layer was dense – coverage reached 97 %. The sedges predominate in the herb layer – they covered about 95 %, while other herbaceous plants – only 7 %. The grass layer is medium high – the height of the 1st level is 117 cm. Rather high (82 cm) is the 2nd level as well. The 3rd level is moderate high (37 cm), while the 4th is very low (12 cm). The moss cover was very sparse (coverage 2 %) and consisted only from brown mosses. The coverage of the open peat is low – only 3 %.

The total number of species is not high (21). Of these, number of vascular plants is 18, of bryophytes – 3. Among vascular plants diversity of shrub species is low – were found only 2 species (*Salix cinerea* and *Frangula alnus*). Shrub individuals are solitary and not high (20–130 cm). In the herb layer predominate *Carex elata*, while codominant species is *Carex lasiocarpa*. From other herbaceous species more abundant is only *Potentilla palustris*. All bryophytes are typical fens species. Among them *Calliergon giganteum* and *Drepanocladus aduncus* are more abundant while *Cinclidium stygium* is very sparse.

The total amount of the fresh phytomass as in fresh as in the drayed samples is moderate (Tables 9 & 10). The phytomass of the sedges make the major part of the amount of total phytomass. The amount of dead plant remnants is higher than in unmanaged plant communities with predominating rhizomatous sedges.

The coverages of the layers and plant groups in the 1 m^2 plots demonstrate the high mosaicity of the vegetation (Table 13). Especially uneven in the permanent plot is the distribution of the shrubs, dead plant remnants and patches of the open ground. The coverages of the sedges and other herbaceous plants are variable as well.

The coverage of the 1st level in the major part of the 1 m^2 plots is the highest comparing with other levels. However sometimes in this level the gaps occur and the densest is the 2nd level. The heights of the levels and the number of the species in 1 m^2 are variable as well.

Table 13. Vegetation structure in the 1m^2 plots of the permanent plot No 17

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	2.9±11.1	0	55
	Herbs	77.4±9.7	50	92
	Bryophytes	0.2±0.4	0	1.5
	Open ground	10.8±8.6	0	35
	Dead phytomass	83.5±9.5	55	95
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	68.6±12.4	42	85
	Other herbs	15.2±12.4	2	50
	Brown mosses	0.1±0.4	0	1.5
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	62.2±18.4	11	86
	II	9.6±12.3	0.2	60
	III	9.8±10.4	0.5	44
	IV	5.4±8.2	0.3	36
Height of the levels of the herb layer	I	112.6±8.2	98	129
	II	66.6±8.4	52	82
	III	40.2±6.9	29	54
	IV	21.0±4.6	13	31
Species number per 1m^2 plot	Shrubs	0.2±0.4	0	1
	Herbs	7.0±1.2	5	9
	Bryophytes	0.4±0.7	0	2
	Total	7.6±1.5	5	12

Only *Carex elata* and *C. lasiocarpa* are found in all plots. They are the most important components of the 1st and 2nd levels. *Potentilla palustris* occurring in 96 % of the plots, predominates in the 3rd and the 4th levels, though sometimes is found in the 2nd level. Rather frequent species are *Lycopus europaeus*, *Lysimachia vulgaris,* and *Peucedanum palustre*. These plants are found in all levels though they are not abundant. Rather frequent is Eriophorum angustifolium, however is found only in the 2nd level and is not abundant. Other species are neither frequent nor abundant.

Table 14. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 17

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis stolonifera	4			0.01±0				35.0±0	
Calamagrostis stricta	24	0.1±0.04	0.1±0			90.4±4.2	63.0±0		
Carex elata	100	54.0±22.9	12.4±15.4			91.0±12.0	65.9±8.6		
Carex lasiocarpa	100	19.5±18.0	5.3±4.2			111.9±8.3	59.3±7.6		
Carex nigra	4		0.2±0				56.0±0		
Carex rostrata	4	0.01±0				69.0±0			
Epilobium palustre	28		0.2±0.05	0.3±0.3	0.4±0.2		50.5±6.9	30.8±8.4	18.0±9.9
Eriophorum angustifolium	64		1.0±0.9				57.7±5.4		
Galium palustre	36			0.1±0.06	0.1±0.1			34.2±6.5	17.2±4.4
Lycopus europaeus	64	1.5±0	0.9±1.1	0.6±0.5	2.3±3.2	93.0±0	51.5±6.0	37.3±8.0	22.8±7.9
Lysimachia vulgaris	76	1.7±0.9	2.1±1.6	1.3±1.0	0.3±0.1	87.7±10.8	63.8±11.5	40.2±6.9	18.2±1.1
Lythrum salicaria	12		1.0±0	0.6±0.6			58.0±0	30.0±2.8	
Peucedanum palustre	88	0.2±0	0.7±0.6	0.4±0.3	0.4±0.5	77.0±0	53.0±7.4	35.4±7.4	23.1±4.3
Potentilla palustris	96		2.6±1.7	9.3±9.5	5.3±8.4		44.3±4.9	38.4±6.9	20.5±4.6

* – average and STDEV

Vegetation properties in the permanent plot No. 18

The permanent plot is situated on the north-western side of the north-western part of Tyrai wetland. This side of the wetland distinguishes with plenty of woody plants growing in the helophyte communities. In the 100×100 m plot *Caricetum distichae* communities are developed. These communities in spite of predominance of the tall sedges and frequency of Iris pseudacorus, and high water table fluctuations have several features (Frequent and rather abundant *Carex lasiocarpa* and *Eriophorum angustifolium* and *Potentilla palustris*) of the transition mire.

In the area occur groups of *Salix cinerea* shrubs with the height of 1–5 m. The moderately high (2–3 m) shrubs prevail in the plot. Solitary *Betula pubescens* trees and their groups are found. The maximum height of the trees is 7 m. The water table at the study time (22.08.2017) was below the peat surface while in the 2nd decade of the June it was about 30 cm above.

The permanent plot No 18 is without woody plants. Tussocks of *Carex elata* and *Molinia caerulea* occur. They cover about 10 % of the area. The herb layer is dense (coverage – 95 %). The sedges predominate in the layer (coverage 75 %) while other herbaceous pants cover 30 %. The herb layer is moderately high – reaches 120 cm. The 2nd level reaches 70 cm, the 3rd – 40, the 4th – 20 cm.

The total species number is rather high – 25 plant species were found. Of these, 24 are vascular plants and 1 – bryophyte species. *Carex disticha* predominate in the herb layer. Rather abundant are *Carex lasiocarpa*, *Lysimachia vulgaris* and *Peucedanum palustre*. The moss cover is very sparse (coverage 2 %) due to considerable water table changes during growing season. Only *Calliergonella cuspidata* occur.

In the phytomass as of the fresh as of the dried samples predominate the sedges (Tables 9 & 10).

The coverages of the layers and plant groups in the 1 m^2 plots (Table 15) show very high mosaicity. Especially variable are the coverages as well as the heights of the 1st and the 2nd levels. In spite of the high variability, the coverages of these levels are the highest.

The total number of species in the 1 m2 plot varies from 7 to 13 (10.4±1.4). Within the similar ranges varies the number of the herbaceous plants – from 7 to 13 (10.2±1.3).

The permanent plot distinguishes with high number of constant species – 5 species (*Carex disticha, C. lasiocarpa, Lysimachia vulgaris, Peucedanum palustre, and Potentilla palustris*) are found in all plots. However, of these only *Carex disticha* and *C. lasiocarpa* are abundant. *Carex disticha* is important as for the 1st as for the 2nd levels while *Carex lasiocarpa* more concentrates in the1st level. *Lysimachia vulgaris* and *Peucedanum palustre* occur in all levels while *Potentilla palustris* is found only in the 3rd and 4th levels. *Eriophorum angustifolium* is frequent (is found in 88 % of the plots) as well and occurs in 1st to 3rd levels. Rather frequent are *Carex panicea*, *Iris pseudacorus*, *Lythrum salicaria*, and *Sanguisorba officinalis*. All these species are not abundant. Two first species usually occur in the highest levels, while other – in the lowest as they are not well developed.

Table 15. Vegetation structure in the 1m^2 plots of the permanent plot No 18

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	0.0±0.0	0	0
	Herbs	87.5±6.3	75	97
	Bryophytes	1.2±2.9	0	10
	Open ground	1.7±2.1	0	6
	Dead phytomass	92.3±3.8	80	95
Coverage (%) of the plant groups	*Phragmites australis*	0.01±0.0	0	0.1
	Carex spp.	74.0±10.1	55	92
	Other herbs	19.8±8.4	5	39
	Brown mosses	1.2±2.9	0	10
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	40±23.7	7	90
	II	47.0±24.5	3	90
	III	8.9±3.5	4	18
	IV	3.2±2.1	0.5	10
Height of the levels of the herb layer	I	114.0±9.3	98	141
	II	68.0±7.3	52	85
	III	40.4±4.0	35	52
	IV	19.8±3.1	12	25
Species number per 1m^2 plot	Shrubs	0.0±0.0	0	0
	Herbs	10.2±1.3	7	13
	Bryophytes	0.2±0.4	0	1
	Total	10.4±1.4	7	13

Table 16. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 18

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis stolonifera	4	0	0	0	1.5±0				15.0±0
Calamagrostis stricta	8	0	0.15±0.07	0	0		73.5±3.5		
Cardamine pratensis	4	0	0	0	0.1±0				22.0±0
Carex disticha	100	21.1±17.3	33.6±19.2	1.0±0.0	0	81.0±7.9	66.3±7.5	42.0±0	
Carex elata	20	6.0±0	10.3±8.7	0	0	74.0±0	67.3±4.2		
Carex lasiocarpa	100	20.2±10.9	1.6±1.3	0	0	109.8±8.8	63.7±4.7		
Carex nigra	28	0	4.8±1.3	0.7±0.5	0		56.2±8.1	41.7±2.5	
Carex panicea	60	0.75±0.4	4.4±4.1	0.6±0.3	0	80.0±7.1	58.9±7.5	35.8±4.3	
Eriophorum angustifolium	88	0.6±0.3	3.6±4.6	0.8±0.4	0	74.3±11.4	61.9±6.2	36.0±5.7	
Filipendula ulmaria	24	0	0	1.3±0.7	0			31.2±5.3	
Galium palustre	24	0	0	0.01±0	0.03±0.04			33.0±7.1	10.6±3.6
Iris pseudacorus	56	1.5±1.1	1.5±2.5	0	0	90.8±7.6	65.0±6.6		
Juncus effusus	4	1.0±0	0	0	0	100.0±0			
Lycopus europaeus	4	0	0	1.0±0	0			36.0±0	
Lysimachia vulgaris	100	0.3±0	2.1±2.4	3.7±2.5	0.1±0	73.0±7.0	57.3±7.4	37.5±5.1	10.0±0
Lythrum salicaria	60	0	0.3±0.06	1.8±1.7	0.5±0		47.3±7.0	35.2±4.7	22.0±0
Mentha arvensis	4	0	0	0	0.2±0				9.0±0
Molinia caerulea	44	1.7±2.0	16.4±11.2	0	0	105.8±18.9	66.2±2.5		
Peucedanum palustre	100	1.1±1.0	2.3±2.0	3.2±2.3	0.6±0.7	90.1±13.9	58.7±8.5	35.6±6.6	16.6±2.8
Potentilla palustris	100	0	0	3.0±4.1	2.5±1.4			29.4±6.1	19.0±3.7
Sanguisorba officinalis	68	0	0	1.0±0.7	1.3±1.7			30.7±4.5	16.8±5.4
Stellaria palustris	8	3.0±0	0	0.05±0	0	123.0±0		45.0±0	
Thalictrum flavum	12	0	1.0±0.6	1.3±1.1	0		55.0±1.4	35.0±2.8	

* – average and STDEV

Vegetation properties in the permanent plot No. 19

The permanent plot is situated on the southern edge of the north-western part of the Tyrai wetland. In spite of the draining by the ditches the water table in the area was at the level of the surface of the dead plant remnants. The area is occupied by helophyte communities. The major part (98 %) of the 100×100 m plot is occupied with *Caricetum distichae* community. The condition of these communities is diverse: in 25 % of the plot shrubs are solitary and *Phragmites australis* is sparse or absent. About 73 % of the plot distinguishes with denser read and more abundant shrubs. The rest of the plot area is occupied with *Acoretum calami* communities situated in the ditch crossing the 100×100 m plot.

The water table in the permanent plot was at the level of the surface of the dead plant remnants. The conductivity of the water was 0.7 S m^{-1}; the reaction – near neutral (Ph – 6.7). The surface was even. Sparse read and *Salix cinerea* shrubs occurred only on the northern edge of the permanent plot. The coverage of the shrubs was 2 %. The herb layer was rather dense (coverage 90 %). The sedges predominate (coverage 80%) while other herbaceous plants cover 10 %. The grass layer is rather high – the height of the 1st level reaches 140 cm. The heights of other levels are: the 2nd – 90 cm, the 3rd – 40 cm, the 4th – 25 cm. The moss cover is absent. The open peat is absent as well – all gaps between plant stems are covered with dead plant remnants.

The total number of species in the plot is high – 36. All these plants are vascular. Of these, 33 species are herbaceous plants and 3 – woody. In the species composition is a large group of tall sedge communities (*Magnocaricion elatae* alliance). *Carex disticha* predominates in the herb layer. In addition to this species there are found other sedge species: *Carex lasiocarpa, C. nigra, C. panicea, C. rostrata*. Of these, only *Carex lasiocarpa* is abundant. This species as well as *Peucedanum palustre* indicates the vegetation succession toward transition mire.

In spite of predominance of *Carex disticha* and abundance of *C. lasiocarpa* sedges make only about a half of the phytomass as in the fresh as in the dried samples (Tables 17 & 18). It is determined by occurrence of *Phragmites australis* in a part of the plot and high species diversity.

The coverage of the herb layer is rather similar in 1 m^2 plots (Table 19). Though, the coverage of the sedges is slightly more variable. Uneven is the distribution of *Phragmites australis* and other herbaceous species.

The 1st and the 2nd levels of the herb layer are the densest. Though, the coverages of all levels of the herb layer are very variable. Very variable is the height of the 1st to 3rd levels. Diverse is also the number of species per 1 m^2 plot. The variability of all these characteristics shows the high mosaicity of the vegetation.

From such high number of species only *Carex disticha* was constant and abundant – it occurred in all 1 m^2 plots and always predominated in the 3 highest levels (Table 20). Very frequent (occurred in more than 90 % of the 1 m^2 plots) were *Carex lasiocarpa*, *Lysimachia vulgaris* and *Peucedanum palustre*. Thou, plants of these species were not abundant. In spite of that, *Lysimachia vulgaris* and *Peucedanum palustre* were found in all levels, while *Carex lasiocarpa* occurred in the highest 3 levels. Frequent (frequency >70 %) were *Carex rostrata, Equisetum fluviatile, Lysimachia thyrsiflora, Potentilla palustris*, and *Sanguisorba officinalis*. Of these, first two species were found in three highest levels, while *Lysimachia thyrsiflora* and *Potentilla palustris* occurred in three lowest levels. Only *Sanguisorba officinalis* participated in all levels.

Table 17. Amount of fresh phytomass (Average and STDEV) of vascular plants in Tyrai wetland (19–20 permanent plots)

Plant group	Amount of phytomass (g/m^2)	
	19	**20**
Shrubs and dwarf shrubs	22.4±50.1	31.8±66.7
Ferns	0.0	0.0
Carex spp.	800.8±333.0	42.0±20.4
Other edificator (*Phragmites australis*)	0.0	0.0
Equisetum spp.	101.6±60.6	0.0
Poaceae (including *Phragmites australis*)	185.2±231.2	484.4±254.2
Phragmites australis	153.6±216.9	0.0
Other herbaceous plants	444.0±184.2	45.2±20.6
Total amount	1553.6±333.1	603.4±235.5
Dead plant remnants	982.4±586.7	615.0±342.2

Table 18. Amount of dry phytomass (Average and STDEV) of vascular plants in Tyrai wetland (19–20 permanent plots)

Plant group	Amount of phytomass (g/m^2)	
	19	**20**
Shrubs and dwarf shrubs	10.9±24.3	17.1±36.0
Ferns	0.0	0.0
Carex spp.	335.9±150.9	18.6±10.1
Other edificator (*Phragmites australis*)	0.0	0.0
Equisetum spp.	21.8±12.7	0.0
Poaceae (including *Phragmites australis*)	75.3±90.3	226.2±115.5
Phragmites australis	62.4±85.2	0.0
Other herbaceous plants	123.6±56.5	17.3±7.5
Total amount	567.4±127.0	279.2±108.3
Dead plant remnants	237.8±103.8	230.3±62.5

Table 19. Vegetation structure in the 1m^2 plots of the permanent plot No 19

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	5.6±12.5	0	45
	Herbs	86.5±6.2	75	95
	Bryophytes	0.0±0.0	0	0
	Open ground	0.0±0.0	0	0
	Dead phytomass	92.8±4.3	80	95
Coverage (%) of the plant groups	*Phragmites australis*	2.4±4.2	0	20
	Carex spp.	78.2±7.4	63	90
	Other herbs	11.4±3.9	5	20
	Brown mosses	0.0±0.0	0	0
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	43.2±37.0	2	90
	II	40.0±38.9	2.5	92
	III	7.3±13.3	0.5	70

	IV	3.6±3.7	0	12.5
Height of the levels of the herb layer	I	126.0±29.8	90	180
	II	78.6±14.6	55	110
	III	50.3±10.6	35	75
	IV	25.9±1.9	25	30
Species number per $1m^2$ plot	Shrubs	0.5±0.5	0	1
	Herbs	12.3±1.5	10	16
	Bryophytes	0.0±0.0	0	0
	Total	12.8±1.5	11	16

Table 20. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 19

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Acorus calamus	8	3.0±2.1	0	0	0	115.5±16.3			
Agrostis canina	4	0	0	0.01±0	0			35.0±0	
Calamagrostis canescens	4	0.5±0	0	0	0	110.0±0			
Calamagrostis stricta	8	0.1±0	0	0	0	75.0±12.7			
Caltha palustris	60	0	0.7±0	2.0±2.3	1.5±1.1		45.0±0	35.5±5.1	24.1±3.9
Carex disticha	100	60.6±29.9	73.2±22.2	10.0±0	0	94.9±9.9	86.7±8.6	62.0±0	
Carex lasiocarpa	92	1.7±1.2	1.8±1.2	0.8±0.4	0	87.4±7.2	77.1±6.8	51.0±1.4	
Carex nigra	8	0	0.1±0	0	0		68.0±0		
Carex panicea	20	0	0.1±0	0.2±0.07	0		49.7±7.8	49.5±2.1	
Carex rostrata	72	1.0±0	0.6±0.6	0.7±0.9	0	67.0±0	60.7±12.0	52.7±8.8	
Dactylorhiza incarnata	4	0	0	2.5±0	0			65.0±0	
Equisetum fluviatile	72	0.2±0.3	0.5±0.3	0.01±0	0	89.7±10.2	85.5±14.7	45.0±0	
Filipendula ulmaria	12	0	0.2±0	0.6±0.6	0		50.0±0	32.5±7.8	
Galium palustre	4	0	0	0	0.01±0				24.0±0
Iris pseudacorus	36	1.2±1.2	0.2±0.07	0	0	91.1±9.2	72.5±17.7		
Lycopus europaeus	16	0	0	0.1±0	0.1±0.06			42.0±0	25.7±3.1
Lysimachia thyrsiflora	84	0	0.3±0.1	0.7±0.6	0.4±0.4		48.6±5.6	41.5±8.6	20.8±5.3
Lysimachia vulgaris	96	3.5±2.2	3.2±2.5	2.2±2.6	0.5±0.4	81.1±13.5	64.4±9.5	45.4±12.4	23.0±2.4
Lythrum salicaria	64	0.9±0.9	1.1±1.0	0.9±1.2	0.1±0	73.5±0.7	55.4±10.0	48.1±11.2	25.0±0
Mentha arvensis	60	0	1.0±0	0.3±0.3	0.3±0.2		56.0±0	37.2±8.0	23.4±2.3
Molinia caerulea	64	0.2±0.1	0.5±0.7	0.1±0	0	88.8±11.0	66.8±17.6	37.5±3.5	
Peucedanum palustre	96	1.2±0.9	2.1±1.9	2.4±1.7	1.2±0.8	86.0±11.5	66.1±12.3	43.4±7.9	21.7±5.8
Phragmites australis	56	4.2±4.9	0.5±0.5	0.01±0	0	147.9±21.1	85.1±10.7	48.0±0	
Potentilla anserina	4	0	0	0	0.1±0				20.0±0
Potentilla palustris	84	0	0.7±0.9	1.6±1.1	3.5±2.9		48.8±7.4	36.5±5.3	20.9±2.2
Sanguisorba officinalis	84	0.1±0.06	0.3±0.3	0.7±0.7	0.4±0.3	75.0±22.1	56.6±12.9	40.0±14.4	21.3±4.3
Sium latifolium	4	0.3±0	0	0	0	83.0±0			
Thalictrum flavum	4	0	1.0±0	0	0		70.0±0		
Vicia cracca	8	0.2±0	0	0	0	67.5±10.6			

* – average and STDEV

Vegetation properties in the permanent plot No. 20

The permanent plot No 20 is situated in south-western part of the Tyrai wetland. Plot is managed – large shrubs and dense shrubberies were removed while small sparse shrubs were left.

The 100×100 m plot is occupied by *Molinietum caeruleae* communities. These communities occur in the permanent plot No 20 as well. The conductivity of the water was 0.2 S m^{-1}. The water reaction was acid (pH – 4.4). Plenty of *Molinia caerulea* tussocks occurred. The water table was close to peat surface – varied from 0 to 2 cm above water surface. The shrub layer consisting of *Salix cinerea* and *Frangula alnus*, was sparse – the coverage 4 %. While the herb layer is very dense (coverage 90 %). Though, the height of the herb layer is not high – the 1st level reach 94 cm, while the 2nd – 50, the 3rd – 32, and the 4th – 15 cm. The mosses were absent. The coverage of the open peat was very low. Though, almost all gaps between *Molinia caerulea* tussocks were covered with dead plant remnants. *Molinia caerulea* predominated in the herb layer. Rather abundant were *Carex panicea*, *Peucedanum palustre*, and *Potentilla palustris*.

In total 25 species were found. All they are vascular plants. Of these, 23 species are herbaceous plants and 2 – shrubs.

The permanent plot No 20 distinguishes with very low amount of the total phytomass as in fresh as in dry samples (Tables 17 & 18). The role as of sedges as of the other herbaceous plants in the phytomass was inconsiderable, while Poaceae made the biggest one. The amount of the dead plant remnants was not high as well.

Shrubs occurred only in a little part (20 %) of the 1 m^2 plots. The coverages of this layer as of herbaceous plants were very variable (Table 21). Very various were the coverages of the different plant groups. The levels of the herb layers differ very much as well. The 2nd level usually was the densest, though in several cases the densest was the 1st level.

The total species number varied from 3 to 11 species per plot. Such differences are due to the abundance of the tussocks.

In spite of the high species number only two species are constant – were found in all 1 m^2 plots. Though, only one of them – *Molinia caerulea* was abundant. This species was the most abundant in the 2nd level, though in spite of the lower coverage it was predominating in the 1st level as well. *Peucedanum palustre* was not abundant, however was found in all levels. In the 4th level this species was the densest. Only two (*Carex panicea* and *Potentilla palustris*) species were more frequent as 70 %. Both they were not abundant, though participated in al levels of the herb layer.

Table 21. Vegetation structure in the 1m^2 plots of the permanent plot No 20

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	1.8±4.9	0	18
	Herbs	91.6±7.2	65	99
	Bryophytes	0±0	0	0
	Open ground	0.1±0.3	0	1
	Dead phytomass	14.4±7.2	5	35
Coverage (%) of the plant groups	*Phragmites australis*	0±0	0	0
	Carex spp.	1.2±2.3	0	10
	Other herbs	90.5±8.5	59	99.0
	Brown mosses	0±0	0	0
	Sphagnum spp.	0±0	0	0
Coverage (%) of the levels of the herb layer	I	12.3±22.1	0.2	90
	II	76.4±23.5	12	97
	III	5.5±4.9	0.2	20
	IV	0.5±0.7	0	3
Height of the levels of the herb layer	I	83.7±7.0	72	95
	II	61.9±6.8	47	75
	III	41.5±9.7	22	58
	IV	18.8±3.3	13	24
Species number per 1m^2 plot	Shrubs	0.2±0.4	0	1
	Herbs	6.7±1.7	3	11
	Bryophytes	0±0	0	0
	Total	6.9±1.9	3	11

Table 22. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 20

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis canina	12	0.01±0	0.5±0	0.01±0	0	77.0±0	37.0±0	43.0±0	
Carex lasiocarpa	20	6.3±8.1	0.8±1.0	0	0	76.0±5.7	58.0±7.9		
Carex nigra	16	0	0	1.3±1.9	0			40.8±9.9	
Carex panicea	72	0.07±0.05	0.5±0.7	1.7±2.1	0.6±0.6	69.0±6.4	54.8±6.1	38.1±6.2	20.0±0
Eriophorum angustifolium	16	0.01±0	0.01±0	0.1±0.1	0	65.0±0	49.0±0	37.0±11.3	
Filipendula ulmaria	16	0.1±0	0	1.1±0.8	0	74.0±0		36.0±8.2	
Frangula alnus juv.	4	0	0	0	1.0±0				12.0±0
Galium palustre	16	0	0	0.01±0	0.04±0.05			26.0±0	15.3±3.1
Galium uliginosum	20	0	0.2±0.2	0	0.2±0.3		36.0±9.9		16.3±6.0
Iris pseudacorus	4	0.5±0	0	0	0	92.0±0			
Lycopus europaeus	4	0	0	0	0.2±0				10.0±0
Lysimachia vulgaris	64	0.1±0	0.1±0.1	0.1±0.2	0.08±0.1	62.0±0	47.8±5.7	36.0±8.3	14.8±2.6
Lythrum salicaria	24	0	0.3±0.3	1.1±1.0	0.5±0		53.5±7.8	35.4±3.4	18.0±0
Molinia caerulea	100	11.5±22.0	74.4±24.7	2.6±1.1	0	82.5±8.7	60.1±7.4	41.8±4.8	
Peucedanum palustre	100	0.6±0.6	2.9±1.6	2.9±2.0	17.9±34.7	74.8±7.4	52.1±8.9	38.4±6.2	22.7±1.5
Potentilla erecta	24	0	0	0.4±0.3				34.5±5.1	
Potentilla palustris	80	1.0±0	1.4±1.1	2.1±1.9	0.6±0.6	62.0±0	48.8±7.4	34.5±8.5	15.4±3.5
Sanguisorba officinalis	36	0	0.01±0	0.7±0.6	0.2±0.2		58.0±0	27.5±1.5	16.4±5.3
Thalictrum flavum	4	0	0.5±0	1.0±0	0		46.0±0	37.0±0	
Vicia cracca	24	0	0.9±0.8	0.5±0	0.1±0		54.6±4.8	48.0±0	23.0±0
Viola palustris	12	0	0	0	0.2±0.2				19.3±2.3

* – average and STDEV

4.3. Monitoring of invertebrates

Locations of monitoring sites of invertebrate animals in project site LT/01-Tyrai are shown in Fig. 5.

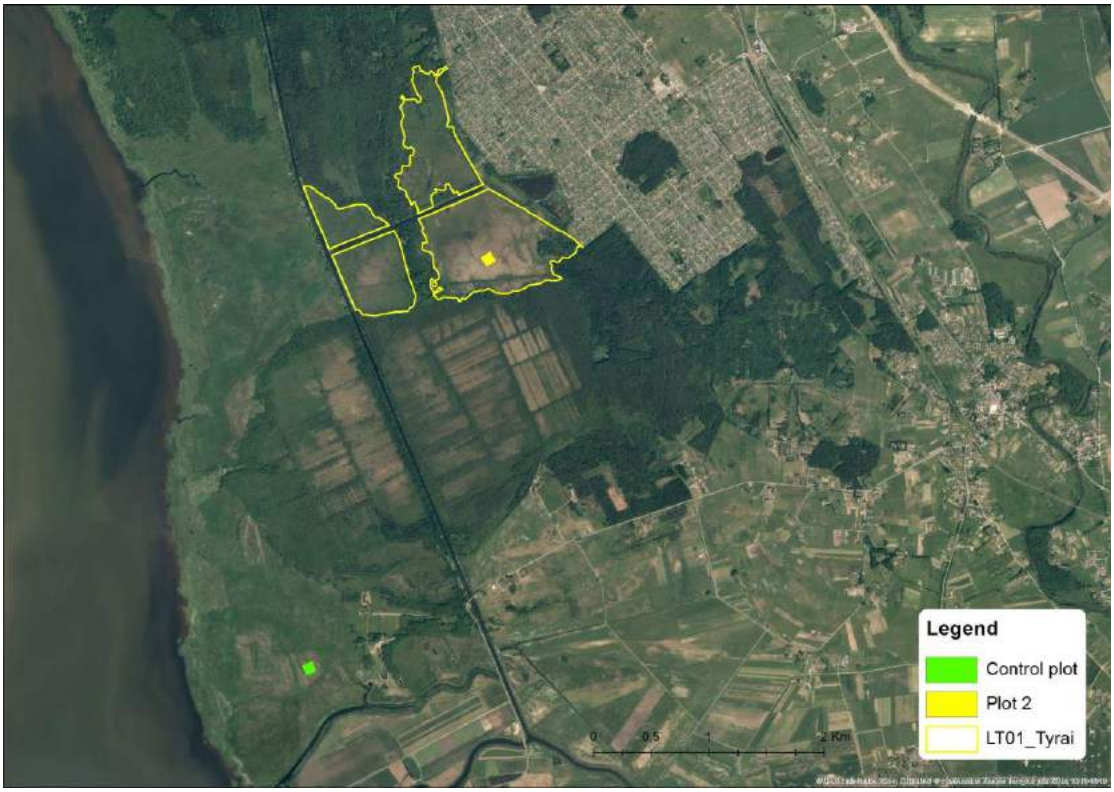

Fig. 5. Location of invertebrate monitoring sites in Tyrai LT/01.

Herpetobiontic invertebrates. Because of the heavy rains at the end of June and beginning of July and the subsequently raised water level (that was too high to place pitfall traps up until the beginning of August), monitoring of the ground beetles was heavily complicated in Tyrai plots. The second sample of the Control plot in Tyrai was lost to the raised water level, but all other samples of both Control and Plot 2 were retrieved, providing in total 212 and 368 specimens of carabid beetles, respectfully (Table 23).

Table 23. Number of speciments of ground beetles, cought with pitfall traps in project site Tyrai.
Indexes: D, dominants – species with abundance more than 5%; Sd, subdominants – abundance from 2 to 5%; R, recendents – abundance from 1 to 2%; Sr, subrecedents – abundance less than 1%

Species	Control plot	Plot 2
Acupalpus parvulus	1 Sr	3 Sr
Agonum sp.	7 Sd	107 D
Badister (Baudia) sp.	1 Sr	
Blethisa multipunctata	125 D	
Carabus clathratus	1 Sr	
Carabus granulatus	18 D	125 D

Chlaenius costulatus		6[R]
Dyschiriodes globosus	1[Sr]	
Loricera pilicornis	5[Sd]	
Notaphus obliquus		
Notaphus semipunctatus	1[Sr]	
Oodes helopioides	27[D]	76[D]
Oxypselaphus obscurus		1[Sr]
Philochthus biguttatus	1[Sr]	
Poecilus versicolor	1[Sr]	
Pseudoophonus rufipes		1[Sr]
Pterostichus diligens	1[Sr]	2[Sr]
Pterostichus gracilis	2[Sr]	1[Sr]
Pterostichus minor	3[R]	15[Sd]
Pterostichus nigrita/rhaeticus	16[D]	31[D]
Stenolophus mixtus	1[Sr]	
Total:	**212**	**368**

Flying invertebrates. In total almost twenty-one thousand of invertebrate specimens were caught with Malaise traps in Tyrai project site (20966 specimens, Table 24). The most numerous group in the traps were Diptera, exceeding the other groups in numbers of specimens (Table 25). The second most-numerous groups were hymenopterans, followed by Hemiptera, Coleoptera, Lepidoptera and others (Table 25).

Table 24 Total number of invertebrates caught in Malaise traps in project site Tyrai

Number of sample	1st sample	2nd sample	3rd sample	4th sample	**TOTAL** (42 days)	**Average number of specimens/day**
Date	2017-07-06	2017-07-17	2017-07-26	2017-08-06		
Number of specimens collected	4218	6141	5368	5239	20966	476,5

The most numerous group of Diptera were Chironomidae. They made up about 59% of all invertebrate specimens caught in Tyrai. Dolichopodidae were also very numerous in Tyrai, making the second most numerous group of Diptera. The third group in numbers of specimens were Muscidae, followed by (in order of abundance) Ceratopogonidae, Tabanidae, Culicidae, Syrphidae, Anthomyiidae, Scathophagidae and others (Table 26).

Table 25 Total number of invertebrates caught in Malaise traps by groups in project site Tyrai

Name of the group	**Number of specimens**
Araneae	19
Coleoptera	173
Diptera	19099
Ephemeroptera	1
Hemiptera	445

Hymenoptera	1032
Lepidoptera	114
Neuroptera	8
Orthoptera	4
Psocoptera	49
Trichoptera	22
GRAND TOTAL:	20966

Table 26 Number of specimens of different Diptera families caught in Malaise traps in project site Tyrai

Family name	Number of specimens
Anthomyiidae	378
Calliphoridae	28
Cecidomyidae	78
Ceratopogonidae	800
Chironomidae	12371
Chloropidae	122
Culicidae	593
Dolichopodidae	1137
Hybotidae	49
Muscidae	827
Mycetophilidae	125
Psychodidae	85
Scathophagidae	264
Sciaridae	26
Sciomyzidae	66
Sepsidae	35
Simuliidae	0
Syrphidae	476
Tabanidae	621

Hortobiontic invertebrates. When invertebrates are grouped into four weight classes (Table 7), the total biomass is found to be higher in all weight groups in Control plots of July and in June for the smaller weight groups of 1–5 mg and 5–10 mg. The Plot 2 plots had higher biomass only of heavier weight groups in June (Table 27). Invertebrates of the lightest group (1–5 mg) were most abundant in all the inspected plots. The dominance of other weight groups varied between the sites. The 5–10 mg group was more abundant in Control plots in Tyrai. The group of 10–20 mg was more abundant in Plot 2 in Tyrai June sample. The heaviest weight group (>20 mg) again was more abundant in Control plot in Tyrai June sample (Table 27).

Table 27 Distribution of invertebrate biomass (mg) per 100 sweeps in different weight classes in project site Tyrai

		Weight classes				
		1–5 mg	**5–10 mg**	**10–20 mg**	**> 20 mg**	**Without 1-5mg group**
Tyrai June	Control	4414,5	44,5	14,8	41,6	457,9
	Plot 2	531,6	13,3	21,6	19,0	
Tyrai July	Control	524,6	65,1	17,6	112,0	

	Plot 2	630,6	23,3	24,6	60,6	

Total invertebrate biomass was highest on Control plot compared to Plot 2 (Table 27, 28), the same tendency is reflected if the biomass is calculated per meter of netting effort (Table 27, 28). Orthoptera formed the highest proportion of biomass in all the sweep net samples (Tables 27, 28). The second most abundant group by total biomass in June was Homoptera, followed by Coleoptera while Orthoptera were second most abundant in July, followed by Homoptera.

Diptera were also the most abundant group by number of specimens per 100 sweeps in all the sweep net samples combined (Tables 28). The second most numerous groups were Homoptera, followed by Heteroptera. Coleoptera were the fourth most numerous group in June and Arachnida – in July (Tables 28). The number of specimens caught in Control plots in Tyrai July sample were higher compared to Plot 2, the same tendency as in biomass of those plots (Table 29).

Table 28 Biomass and number of invertebrates in project site Tyrai

	Biomass, June (mg per 100 sweeps)		**Biomass, July** (mg per 100 sweeps)		**Number of specimens, June**		**Number of specimens, July**	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	27,7	37,3	69,3	46,6	25,25	12,75	23,5	17,25
Mollusca	0,0	2,5	0,0	0,0	0	0,5	0	0
Coleoptera	28,2	2,2	1,7	1,8	24	1,75	2	0,5
Diptera	4003,0	473,6	403,9	75,4	2273,25	177	168,5	36,75
Heteroptera	58,3	4,3	64,5	11,9	42,75	5,5	12,25	9,75
Homoptera	277,1	9,0	73,4	33,5	222,25	9,5	34	28
Hymenoptera	34,0	7,4	2,3	5,1	15	5	1,25	3,75
Hymenoptera larvae	0,0	11,9	0,0	12,3	0	2	0	1
Lepidoptera larvae	37,7	13,5	0,0	0,8	0,5	1	0	0,25
Lepidoptera adults	0,0	7,9	0,6	0,2	0	0,25	0,25	0,25
Orthoptera	49,1	10,6	103,6	78,5	9,5	2	3,25	3
Trichoptera	0,2	5,3	0,0	0,0	0,25	0,25	0	0
Odonata Zygoptera	0,0	0,0	0,0	0,0	0	0	0	0
Odonata Anisoptera	0,0	0,0	0,0	0,0	0	0	0	0
Total:	4515,4	585,5	719,3	266,2	2612,75	217,5	245	100,5
	mg/meter (sweep)		mg/meter (sweep)					
Total:	45,2	5,9	7,2	2,7				

Pollinating insects. The number of pollinator taxa obtained by net sampling in Tyrai was 40, wkile Malaise trapping added 31 extra taxa (Table 29). Tyrai net sample was dominated by Chironomidae (85.5% of the total number of pollinator specimens) with Sciomyzidae (3.3%) and Musidae (2.6%) forming other largest groups. Out of the main pollinator group – Apidae, only single specimens of *Bombus* were caught in Tyrai.

If net sampling and Malaise trap material is combined (Table 29), the total number of pollinator specimens is highest in Tyrai, followed by Žuvintas, Apvardai and Šyša – the same ranking as in the case of net sampling. The pollinator richness (H') in Tyrai was 1.34, and pollinator assemblages were distributed not evenly (1-D=0.48). The equality of the taxa abundance (E) was also quite low here. All the indexes of pollinator biodiversity had the lowest values in Tyrai.

Table 29 Number of taxa, specimens and biodiversity indexes of selected pollinators from the net sampling alone and net sampling with Malaise traps combined, in project site Tyrai

	Net sampling			Net sampling and Malaise traps combined
	Control plot	Plot2	Combined	
Taxa	30	24	40	71
Specimens	9715	899	10580	29748
Shannon (H')	0,67	1,50	0,76	1.43
Simpson (1-D)	0,24	0,58	0,27	0.48
Pielou (E)	0,20	0,47	0,21	0.34

4.4. Hydrological monitoring

Three water level measurement gauges were installed in one of the most important Aquatic Warbler breeding site in Lithuania - the Tyrai fen (Fig. 6.), which is located in the territory of the Kliošiai Landscape Reserve. Two wells are installed in the project areas LT/02-Tyrai, where already in 2016 Habitat management activities (mowing of reeds and shrubs) were implemented. One gauge was installed in the south-eastern part of the swamp, which is adjacent to the Curonian Lagoon, and where the most abundant and most stable local population of Aquatic Warbler in Lithuania is found. The water level measurement in Aquatic Warbler habitats in Lithuania is carried out for the first time, therefore a comparison of the hydrological regime of these sites can help to assess the suitability of the new project territories for the formation of suitable habitats of Aquatic Warbler.

Fig. 6. Locations of Water level measuring gauges in project site LT/01-Tyrai.

Comparing the data of all three observation sites we can see that the water level in these areas varies synchronously, but the hydrological regime in the sites are quite different (Fig. 7.). The synchronicity of changes in the water level indicates that all of the sites are parts of one of the former wetland, which are currently separated from each other by drainage channels and roads. Both the eastern parts of the wetland (Tyrai-1 and Tyrai-2) from the southwest part (Tyrai-3) of the fen, vich is bordering with Curonian Lagoon, are separated by the Klaipėda Channel. The obtained data of dynamics of water level (Fig. 7) showes that, despite the rather rainy season, the water level in the southern part of the project area LT/01 (see "Tyrai-1" in Fig. 7) during the June-September remained below the soil surface, and ranged from -6 to -27 cm (6-27 cm below the soil surface). It should be noted that such a water regime is characteristic only to the southeastern part of the area, where a typical fen vegetation predominates and the flocks of *Myrica gale* are found. The above-ground surface water in this area has rised only after the flood has started. The flood at the end of September 2017 was also observed in other project areas located in the region of the Nemunas Delta.

In the northern part of the site, most of the vegetation period watery level was above the surface of the soil, but in dry periods it fell to -9 cm. Such a hydrological regime is quite common in the AW habitats found in open fens, and therefore the hydrological regime in this area in 2017 formed favorable favourable conditions for ground nesting birds and fen-forming vegetation.

During the whole period of observations, changes in water level in the southeastern part of Tyriai wetland (Tyrai-3) were much more obvious, therefore, it can be stated that the hidrological regime of this territory is significantly affected by the water level in the Curonian Lagoon, which are affected not only by the amount of precipitation but also the prevailing direction of wind. Therefore, in this area even during the summer the water level fluctuated very significantly. On June 23, the level of water in this territory fell to 36 cm below the surface of the soil, and on July 1, has risen to 23 cm above the surface of the soil. However, this lasted only 4 days, meanwhile from 5th to 20th July water level fluctuated from 13 to 9 cm above the surface of the soil.

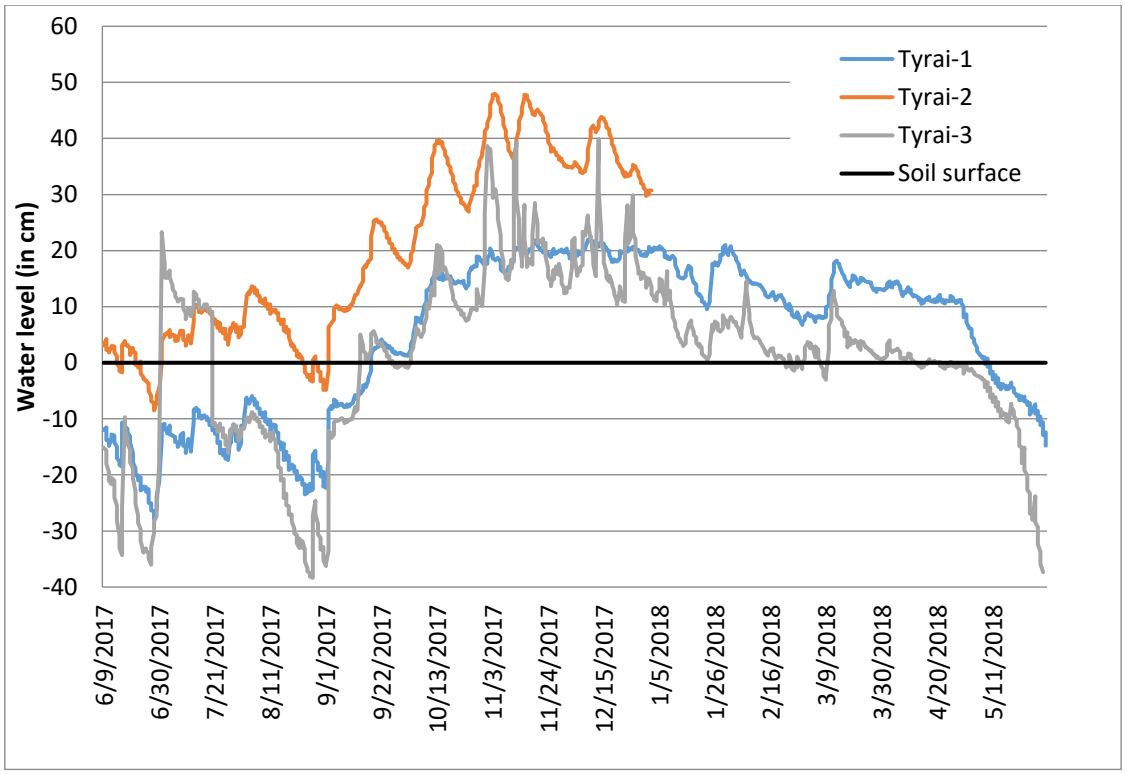

Fig. 7. Water dynamic in project site LT/01-Tyrai.

5. Project site LT/02-Apvardai

5.1. Bird monitoring

The Aquatic Warblers in the area were discovered in 2008, but there is no data on their presence in these project areas during the last decade. The area is important for wetland birds such as Common Redshank (*Tringa totanus*) (1 breeding pair), Black-tailed Godwit (*Limosa limosa*) (1 breeding pair), and Spotted Crake (*Porzana porzana*) (13 calling males). In total, 19 species of birds were found during the bid breeding season in year 2017.

5.2. Vegetation monitoring

Results of vegetation research in Alksnas wetland

General vegetation Characteristics of Alksnas wetland

The major part of the Alksnas wetland is occupied by transition mire. Vegetation in different parts is also different. Open mire occupies almost a half of the wetland area. It is located on the north-western edge, in southern and south-eastern parts of the wetland and also at the middle of borderline with a lake. The north-eastern edge is occupied by transition mire overgrown with sparse *Betula pubescens* trees and rather dense *Betula humilis* shrubbery. The rest of the mire is overgrown with shrubs and reed. Major part of this area was managed in the winter time.

There are some small mineral islands overgrown by deciduous trees. The lakeshore is occupied by *Phragmitetum australis* communities and shrubs.

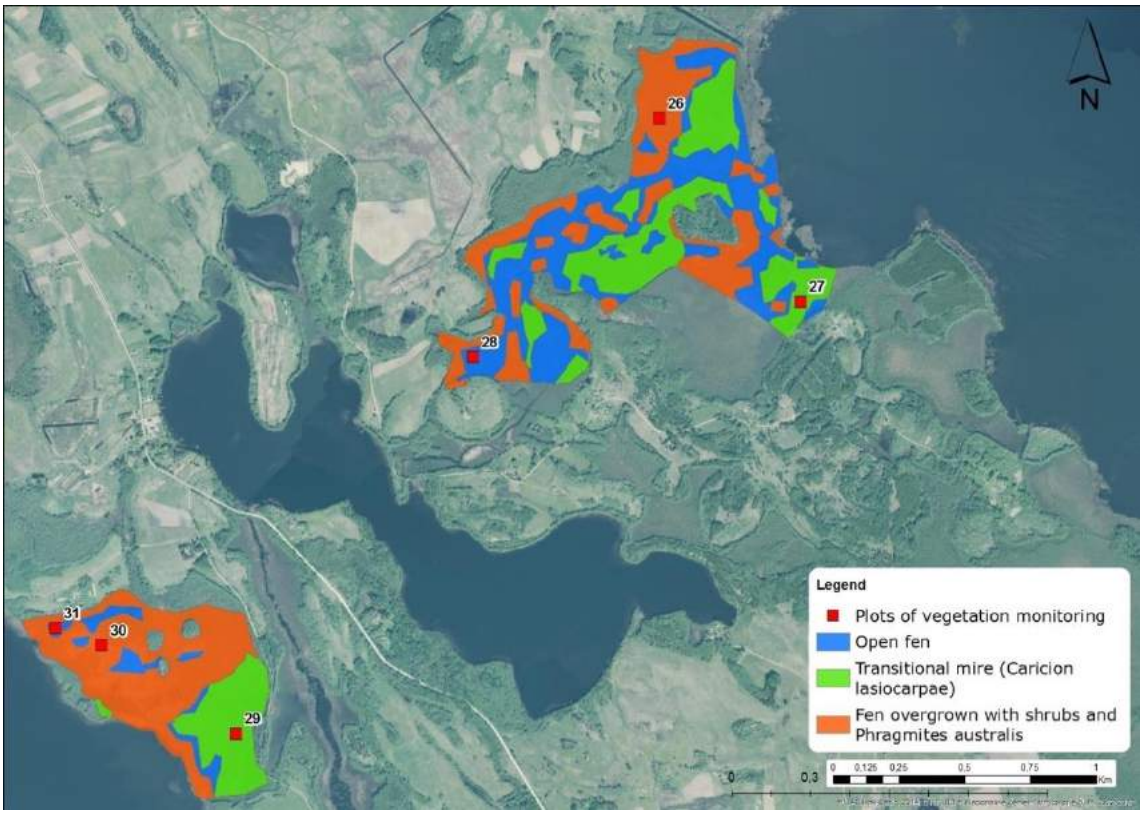

Fig. 8. Distribution of plant communities in Alksnas and Apvardai wetlands in 2017.

In open areas *Caricetum lasiocarpae* communities are developed. The electrical conductivity of the water in different areas was various and the values were rather low – 0.3–0.9 S m^{-1}. Very low conductivity may be determined by dilution with rain water. The pH of the water varied from acidic to slightly acidic (pH – 5.0–6.3). The mire is very young; therefore, *Carex elata* (fen species) still plays an important role in the community. Although, *Carex lasiocarpa* (transition mire species) is less abundant. Other for transition mire specific species can also be found in this area: *Eriophorum angustifolium, Eriophorum gracile, Peucedanum palustre, Potentilla palustris.* Quite few poor shrubs were present. 2 species of them (*Betula humilis, Salix rosmarinifolia*) are specific for transition mire. *Scorpidium scorpioides* – species representative to transitional mire – is found in moss layer. The coverage if the shrub layer reaches 4%, grass layer – 80%, moss layer ~20%. However, the last evaluation can be inaccurate because of high water level after heavy rains (the height of the water table reached 20 cm above soil surface). Furthermore, majority of moss was dead because of the long-term flood. The height of the grass layer reach 80 cm. In general, species richness was low: in 100 m^2 area 27 species were found (shrubs – 5, grasses – 18, moss – 4).

On the northern margin shrubs were removed. Vegetation and the surface of the peat layer in some areas is damaged by dredgers.

In central part of the transition mire scarce (coverage reaches up to 25 %) tree layer consisting of *Betula pubescens* is present. Trees height varies from 440 to 850 cm, diameter at height of 130 cm reaches 4.2–8.2 cm. In the shrubs layer (coverage 45 %) *Betula humilis* predominates. Rather abundant in shrub layer are juvenile *Betula pubescens* trees. *Alnus glutinosa*, *Frangula alnus*, *Salix cinerea*, *Salix rosmarinifolia* also occur. In herb layer distinguish tall (60–70 cm) *Carex appropinquata* and *Carex elata* tussocks. However only *Thelypteris palustris* and *Phragmites australis* are abundant. Mesotrophic conditions determine very diverse species composition – various types of mire plants are found. Scarce reed stems sometimes occur. Their densities do not exceed 1%. Sometimes *Andromeda polifolia* and *Vaccinium oxycoccus,* that are characteristic for raised bog, can be found. Moss grows only on tussocks, because gaps are filled up with water (height above substrate – 15–60 cm). The coverage of the moss cover reaches up to 25 %. *Calliergonella cuspidata* is predominating. *Sphagnum* species were not found. In 100 m^2 area 32 plant species were found: trees – 2, shrub – 4, brushwood – 2, grass plant species – 21, moss – 3.

Part of the mire, which was overgrown with shrubs and reed, in 2016/2017 winter, was managed: shrubs and plant phytomass was removed. In the research time the height of the tillers of the trees (*Alnus glutinosa*, *Betula pubescens*) and shrubs (*Betula humilis*, *Frangula alnus*, *Salix cinerea*, *Salix rosmarinifolia*) varied between 30 and 125 cm. Their coverage varied between 10 and 20 %. For microrelief tall (~60cm) and dense sedge (*Carex elata*, *Carex appropinquata*) tussocks are specific. Although a lot of them are dead. Possible causes of that might be damage of the buds while managing the area and competition of the reed. Grass layer is quite dense (coverage – 80–90 %). Vegetation height is about 200 cm. *Phragmites australis* is dominant. There are not much of sedges. Besides the above tussock forming species there is also *Carex lasiocarpa.* Other dominant of the grass layer is *Thelypteris palustris.* Overall in 100 m^2 area 28–33 species were found: trees – 2, shrubs – 4, brushwood – 1–2, grass – 18–20, moss 3–8. Vegetation and peat layer surface is damaged because of management in some areas.

Protected species of Alksnas wetland

In Alksnas wetland are found 4 protected species listed in Red Data Book of Lithuania: *Betula humilis*, *Dactylorhiza incarnata*, *Eriophorum gracile*, *Liparis loeselii*. The last one is also included into Annex II of the Habitat directive.

Liparis loeselii (L.) Rich.

Included into: Red Data Book of Lithuania, 2(V) category.

Bern Convention I Annex.

EU Habitat directive II Annex (COUNCIL DIRECTIVE 92/43/EEC)

It was found in north-western part of Alksnas wetland (X 655319, Y 6154831), in transition mire. Population is small but viable. 19 generative and 25 vegetative individuals were found. Plants grew solitary or in small (up to 6 individuals) groups.

Eriophorum gracile W. D. J. Koch ex Roth

Included into Red Data Book of Lithuania, 2(V) category.

Three generative individuals were found in north-western part of Alksnas wetland (X 655319, Y 6154831), in transition mire.

Betula humilis Schrank

Included into Red Data Book of Lithuania, 2(V) category.

Species was found in total area of the Alksnas wetland. In some areas it forms dense shrubbery. It grows especially dense in north-eastern margin of the wetland (X 656041, Y 6154772) and in the neighbouring open transition mire. Population is viable and one of the largest in Lithuania.

Dactylorhiza incarnata (L.) Soó

Included into Red Data Book of Lithuania, 5(Rs) category.

Species was found in south-eastern and north-western parts of Alksnas wetland (X 656012, Y 6154411; X 655325, Y 6154812), in open transition mire. Plants were growing solitary. Part of them were in generative stage.

Vegetation features of the permanent plot No 29

Permanent plot No 29 (X 656012, Y 6154411) is located in young transition mire. In the herb layer still present some species with ecological optimum in *Magnocaricion elatae* communities. The high water table is typical for transition mires of Eastern Lithuania. Though, during research time the water table was unnaturally high due to frequent and heavy rains. Major part of bryophytes was dead due to long flood. *Scorpidium scorpioides* growing in this area naturally is one of the species that grows in more wet habitats, though it is not adapted to grow at a water depth of few decimetres. Average water level above peat layer was 20 cm, maximum – 25 cm, minimum – 15 cm. The coverage of grass and moss layers, of dead phytomass and open peat was estimated approximately because of flood and peculiarities of the water: the water was brown and not transparent due to high content of humic acids. Water filled all spaces between plant stems; because of that the coverage of open peat was quite high, reaching 80%. Sedge tussocks (*Carex elata*) covered ~15% of the area, tussock height reached 18 cm.

Table 30. Amount of fresh phytomass (Average and STDEV) of vascular plants in Alksnas wetland (29–31 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	29	30	31
Shrubs and dwarf shrubs	102.6±226.6	142.4±140.7	180.8±153.2
Ferns	0.0±0.0	178.4±152.8	129.6±150.7
Carex spp.	660.2±281.4	61.3±118.2	219.2±98.5
Other edificator (*Phragmites australis*)	0.0±0.0	695.2±151.9	0.0±0.0
Equisetum spp.	1.0±1.7	0.0±0.0	44.0±30.7

Poaceae (including *Phragmites australis*)	0.1±0.2	696.9±150.8	3.36±7.1
Phragmites australis	0.0±0.0	695.2±151.9	0.0±0.0
Other herbaceous plants	238.8±186.0	39.2±53.4	156.8±48.8
Total amount	1002.7±456.9	1118.2±90.5	733.76±331.2
Dead plant remnants	1838.8±878.9	968.0±574.8	1048.8±630.5

Table 31. Amount of dry phytomass (Average and STDEV) of vascular plants in Alksnas wetland (29–31 permanent plots)

Plant group	**Amount of phytomass (g/m^2)**		
	29	**30**	**31**
Shrubs and dwarf shrubs	47.5±101.7	45.2±48.7	77.3±58.8
Ferns	0.0±0.0	63.0±53.3	42.9±51.6
Carex spp.	243.2±25.6	22.0±41.7	70.3±47.3
Other edificator (*Phragmites australis*)	0.0±0.0	309.1±90.3	0.0±0.0
Equisetum spp.	0.5±0.7	0.0±0.0	7.8±8.5
Poaceae (including *Phragmites australis*)	0.2±0.5	309.6±90.2	1.5±3.2
Phragmites australis	0.0±0.0	309.1±90.3	0.0±0.0
Other herbaceous plants	117.7±136.7	11.4±16.5	30.3±18.4
Total amount	409.2±175.6	451.1±84.3	230.1±93.7
Dead plant remnants	290.5±73.9	268.7±173.0	193.7±89.2

The plant community was classified as *Caricetum lasiocarpae*. There were only few shrubs (coverage 4%). The grasses covered 80% (sedges – 25%, other grasses – 65%), bryophytes ~20%. *Phragmites* and *Sphagnum* were absent.

Both green and air-dried phytomass amount was very different (Tables 30 & 31) because of high vegetation mosaicity. Particularly the amounts of shrubs and dwarf shrubs were different. Major part of grass phytomass consisted of *Carex* plants. While *Poaceae* plants make a little part in the amount of phytomass. Other herbaceous plants make considerable part of the phytomass.

In the permanent plot 21 species was registered: herbaceous plants – 15 species, shrubs – 5, bryophytes – 1. *Sphagnum* species were not present. Though in 1 m^2 plots only 18 species occurred: 4 shrub, 13 – herbaceous plant and 1 bryophyte species. Plots were similar in coverage with dead plant remnants (96.3±1.7%), though they were different in the height of the grass levels and coverage of sedges and other herbaceous plants (Table 32). Different was also coverage of shrubs in 1 m^2 plots. These data demonstrate the mosaic structure of the vegetation. The height of grass levels varied slightly as well, except the 1st grass level.

Comparing coverage of the grass levels, differences between 1 m^2 plots in first and third level are evident. It is determined by different abundance of the constant plant species: *Carex elata* and *Carex lasiocarpa* (1st layer) and *Menyanthes trifoliata* (3rd layer). High constancy is also typical for *Utricularia intermedia*, though plants of this species were not numerous. The attention should be paid at the relativity of height data of this species. High values of the height were determined by unusual meteorological conditions – when the water level has raised sharply *Utricularia intermedia* plant distributed throughout all water stratum.

Other moderately frequent species (*Carex chordorrhiza, Lysimachia thyrsiflora, Peucedanum palustre*) were not rich and didn't have impact on the total coverage of the herb layer. However, these species were important for the height of the grass layers.

Among the shrubs, *Salix rosmarinifolia* was the most frequent while *Betula humilis* had the higher coverage (Table 33). Both species are typical for transition mires. All individuals of the shrub were low (maximal height – 113 cm). Part of them was little viable: leaves were smaller as normally, furthermore several branches often were dead. Individuals of *Salix cinerea* and *Salix triandra* whose branches were damaged by roe deer had offsprings.

In moss layer there was only one species (*Scorpidium scorpioides*) was found. Majority of the individuals were dead because of long term flood. Alive moss was found in 24% of researched 1 m^2 plots. The coverage of the moss layer was low – 1.2±1.1%.

Table 32. Vegetation structure in the 1m^2 plots of the permanent plot No 29

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	min	max
Coverage (%) of the layers	Shrubs	3.2±7.0	1	30
	Herbs	69.3±7.7	50	82
	Bryophytes	0.3±0.7	0	3
	Open ground	0.0±0.0	0	0
	Dead phytomass	96.3±1.7	93	97
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	37.4±6.4	30	50
	Other herbs	38.9±8.3	27	60
	Brown mosses	0.3±0.7	0	3
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	32.6±6.3	20	46
	II	4.6±3.3	0.01	15
	III	38.4±6.7	28	50
	IV	1.6±1.0	0.1	4
Height of the levels of the herb layer	I	89.2±19.6	80	106
	II	59.8±4.9	49	66
	III	39.3±4.1	28	46
	IV	20.2±3.4	13	26
Species number per 1m^2 plot	Shrubs	0.5±0.7	0	2
	Herbs	6.6±1.3	4	9
	Bryophytes	0.2±0.4	0	1
	Total	7.3±1.5	4	10

Table 33. The structure of the shrub layer in the 1 m^2 plots of the permanent plot No 29

Species	Frequency (%)	Coverage (%) in the layer *	Height (cm)	Total number of individuals in the 1 m^2 plots and condition of the plants
Betula humilis	12	12.2±15.5	39–113	3 good condition, fertile; 4 little viable
Salix cinerea	12	1.7±0.6	71–77	2 little viable; 1 offspring**
Salix rosmarinifolia	20	7.0±7.7	34–105	17 poor; 1 little viable; 1 offspring
Salix triandra	4	1.0±0.0	24	1 offspring**

* – average and STDEV.

** – plants damaged by roe deers during the winter.

Table 34. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 29

Herb species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Calamagrostis canescens	16	0.03±0.05				88.3±0.6			
Carex chordorrhiza	56			0.1±0.1	0.01±0.04			33.7±6.7	22.5±3.5
Carex elata	100	19.8±12.5	3.8±2.8			85.2±10.5	58.2±5.9		
Carex lasiocarpa	100	11.5±10.9	0.8±1.3			92.4±6.3	57.6±5.9		
Equisetum fluviatile	36	0.02±0.03	0.003±0.01			73.9±6.3	58.7±6.8		
Eriophorum angustifolium	4		0.01±0.0				65.0±0.0		
Eriophorum gracile	8		0.02±0.01				52±1.4		
Lysimachia thyrsiflora	44			0.2±0.4	0.1±0.2			33.3±6.6	22.0±3.3
Lysimachia vulgaris	28		0.06±0.08	0.3±0.5	0.01±0.04		42.3±5.0	37.4±4.0	22.0±0.0
Menyanthes trifoliata	100			36.2±10.2	0.6±1.0			39.3±3.9	19.2±2.9
Peucedanum palustre	52	0.1±0.3	0.1±0.2	0.3±0.4		82.0±8.5	48.7±8.0	32.2±7.7	
Potentilla palustris	16			0.3±0.5	0.3±0.5			24±1.4	20.7±3.8
Utricularia intermedia	96				1.3±0.8				16.5±2.9

* – average and STDEV

Vegetation features of the permanent plot No 30

The permanent plot is situated in the north-eastern part of the Alksnas wetland which is overgrown with *Phragmites australis*. The wetland is in an active succession process: is a fen developing from *Caricetum appropinquatae* community to the transition mire; the recent stage can be identified as *Thelypteridi-Phragmitetum* community.

The area was managed the last winter: the shrubs (*Salix* spp., *Betula humilis* and *Frangula alnus* shrubs, and young *Alnus glutinosa* and *Betula pubescens* trees) and *Phragmites australis* plants were removed. As the management result, the dead stems of the reed were absent in the plot and only solitary offsprings of woody plants were found, major part of the *Carex appropinquata* tussocks were dead due to the damages made by dredgers.

The coverage of the tussocks is 45 %, the height – 50 cm. The gaps between tussocks are filled with water. The height of the water table is about 40 cm above peat surface. The water reaction is acid (pH – 5.5), the conductivity is law – 0.2 S m^{-1}. It can be a consequence of the heavy and long rains.

The peculiarity of the vegetation of the permanent plot is the high thick herb and dwarf shrub layer. The coverage of this layer is 90 % while offspring of the woody plants cover only 15 %, brown mosses – 1%. *Sphagnum* spp. are absent. *Phragmites australis* predominate in the herb and dwarf shrub layer while sedges cover only 6 %. The height of the grass layer is very high – it reaches 218 cm. The 2nd level is much lower – 78 cm. Though, it is a lithe higher than in other plant communities of the Alksnas wetland. Considerably higher is also the 3rd grass level – it reaches 60 cm in the height. While the 4th level is lower than in other plant communities – reaches only 20 cm.

This permanent plot distinguishes from other with high species diversity. In total 31 species in the permanent plot was found. Of these, 25 are the vascular plants: 2 – tree (in the shrub layer), 4 – shrub, 2 – dwarf shrub and 17– herbaceous plant species. The bryophyte species (14) consisted of 12 brown moss and 2 liverwort species. Such high species diversity possibly is determined by occurrence of *Carex appropinquata* tussocks which make a base for establishing of other hygrophyte species. In spite of high diversity, the abundance of major part of the species is low. Only *Phragmites australis* and *Thelypteris palustris* are abundant (3 points according Braun-Blanquet scale). Plants of other species are solitary or sparse.

The great differences in coverages of the layers and the plant groups of the 1m^2 plots (Table 35) demonstrate the high mosaicity of the vegetation. It can be determined by overgrowing of the area with shrubs, which were removed in the winter.

In spite of the low coverage, offshoots of the shrubs and trees were found in all 1 m^2 plots. The height of the offshoots varied markedly in all species (Table 36). The most frequent species were *Frangula alnus* and *Betula humilis*. Among bryophytes the most frequent were *Climacium dendroides, Campylium stellatum,* and *Calliergonella cuspidata* – common species of the fens (Table 37).

Table 35. Vegetation structure in 1m^2 plots of the permanent plot No 30

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	min	max
Coverage (%) of the layers	Shrubs	10.4±11.0	0.3	45.5
	Herbs	60.2±17.9	31.0	89.0
	Bryophytes	3.9±3.7	0.0	14.0
	Open ground	4.2±19.3	0.0	97.0
	Dead phytomass	74.0±19.8	35.0	95.0
	Phragmites australis	26.1±9.0	12.0	45.0

Coverage (%) of the plant groups	*Carex* spp.	2.9±4.0	0.0	15.0
	Other herbs	42.2±22.8	6.0	83.0
	Brown mosses	3.9±3.7	0.0	14.0
	Sphagnum spp.	0.0±0.0	0.0	0.0
Coverage (%) of the levels of the herb layer	I	25.8±9.0	12.0	45.0
	II	22.1±18.8	0.2	62.0
	III	22.0±27.8	0.5	77.0
	IV	3.1±7.2	0.1	37.0
Height of the levels of the herb layer	I	197.6±10.0	177.0	214.0
	II	75.0±24.0	22.0	126.0
	III	40.2±12.1	24.0	66.0
	IV	13.2±5.9	4.0	24.0
Species number per 1m^2 plot	Shrubs	7.0±1.7	4.0	10.0
	Herbs	2.2±0.9	1.0	4.0
	Bryophytes	1.9±1.5	0.0	5.0
	Total	11.0±2.3	7.0	16.0

Table 36. The species composition of the shrub layer in 1m^2 plots of the permanent plot No 30

Species	Frequency (%)	Coverage* (%)	Height range (cm)
Alnus glutinosa	28	8.6±12.8	29–83
Betula humilis	48	2.5±2.4	13–65
Betula pubescens	12	15±11.5	54–131
Frangula alnus	72	3.6±2.7	17–145
Salix cinerea	28	7.1±8.6	30–125
Salix rosmarinifolia	27	1.4±1.4	3–51

* – average and STDEV

Occurrence of the dwarf shrubs (*Andromeda polifolia* and *Vaccinium oxycoccos*) shows the development of the fen to transition mire (Table 38). Thou, it is only the initial stage, as these species are not abundant and *Sphagnum* spp. absent. The most frequent species of the herbaceous plants are *Phragmites australis* and *Thelypteris palustris* – they were found in all 1 m^2 plots. *Potentilla palustris*, *Carex appropinquata* and *Calamagrostis canescens* were rather frequent species as well. Though, plants of these species were not abundant. In spite of the fact, that tussocks of *Carex appropinquata* covered about 40 % of the permanent plot area, plants had a little number of the living shoots.

Table 37. Species composition of the bryophytes in 1m^2 plots of the permanent plot No 30

Species	Frequency (%)	Coverage (%) (average and STDEV)
Brown mosses		
Brachythecium rivulare	16	0.5±0.7
Brachythecium salebrosum	4	0.01±0.0
Bryum pseudotriquetrum	4	0.2±0.0
Calliergon giganteum	4	1±0.0
Calliergonella cuspidata	28	2.5±3.4
Campylium stellatum	48	2.9±6.4

Climacium dendroides	60	3.4±2.7
Drepanocladus aduncus	4	0.2±0.0
Scorpidium cossonii	4	0.8±0.0
Scorpidium scorpioides	4	1±0.0
Fissidens adianthoides	4	0.1±0.0
Thuidium tamariscinum	4	8±0.0
Liverworts		
Lophocolea heterophylla	4	0.01±0.0
Plagiochila major	4	0.01±0.0

The number of the *Phragmites australis* stems in a 1 m2 plot was 28.2±8.6. It varied within the ranges 14 and 53. The diameter of the stems varied from 3 to 8 mm (5.7±1.1 mm). The height of the stems was very variable: the lowest was 43 cm, the highest – 214 cm (163.4±34.7 cm).

The dead stems were found only in 16 % of the plots. The number was 0.5±1.7; it varied from 1 to 8 dead stems per 1 m^2 plot. The major part of the stems from the last growing season was removed during wetland management actions in the winter.

The plot distinguishes among other plots of the Alksnas wetland with very high amount as of the fresh as of dry phytomass of *Phragmites australis* (Tables 32 & 33), which take more than a half of the total plant phytomass. In spite of management, rather high amount of the shrub phytomass was measured. The moderate weight values of the fresh plant remnants were due to removal of the dead *Phragmites australis* stems in the winter time.

Table 38. The structure of the herb and dwarf shrub layer in the 1 m^2 plots of the permanent plot No 30

Species	Frequency (%)	Coverage in the level *				Height in the level *			
		I	II	III	IV	I	II	III	IV
Andromeda polifolia	4	0	0	0	0.7±0.0				14±0.0
Calamagrostis canescens	64	0	3.2±5.2	0.5±1.1	0		51.7±8.0	42.8±14.7	
Carex appropinquata	64	0	2.5±3.4	1.3±3.6	0		58.3±9.6	46.3±16.8	
Carex elata	16	0	0.95±0.6	0	0		54±7.1		
Carex lasiocarpa	40	0	0.5±0.7	0.2±0.3	0		68.1±5.2	54.5±3.5	
Equisetum fluviatile	12	0	0.01±0.0	0.003±0.0	0		60.5±0.7	22±0.0	
Filipendula ulmaria	16	0	0.6±1.3	0.4±0.3	0		108.0±0.0	28.0±10.4	
Galium palustre	20	0	0.2±0.4	0.04±0.1	0.1±0.1		31±0.0	19±0.0	10±2.0
Lycopus europaeus	4	0	0	0.1±0.0	0			43±0.0	
Lysimachia thyrsiflora	8	0	0	0.3±0.4	0.2±0.1			50±0.0	8±1.4
Lysimachia vulgaris	36	0	0.1±0.2	0.5±0.9	0.04±0.1		60.0±13.2	28.8±4.9	14.5±12.0
Lythrum salicaria	12	0	0	0.2±0.1	0			30.3±9.6	
Menyanthes trifoliata	28	0	0	0	0.9±0.7				10.1±3.1
Molinia caerulea	12	0	2.7±3.8	1.3±1.2	0		115.3±11.6	56.0±4.2	
Peucedanum palustre	16	0	0	0.8±0.5	0			38.5±0.6	
Phragmites australis	100	25.8±9.0	0.3±0.7	0	0	197.8±10.2	84.5±21.6		
Potentilla erecta	8	0	0	0	0.8±0.4				30.5±0.7
Potentilla palustris	88	0	0.3±0.6	1.6±2.6	1.0±1.3		37.0±8.4	31.1±5.4	13.5±5.4
Thelypteris palustris	100	0	17.4±18.1	19.3±27.4	1.9±6.4		59.9±9.0	41.6±13.0	14.6±6.6
Vaccinium oxycoccos	48	0	0	0	0.2±0.3				5.4±2.2

* – average and STDEV

Vegetation features of the permanent plot No. 31

The permanent plot is situated on the north-western edge of the Alksnas wetland. The habitat is open transition mire. In several places, the peat surface and vegetation is damaged by dredgers during management activity (cutting of the shrubs and grass) in the winter. The peat surface and vegetation cover in the permanent plot was without damages.

The area is flooded due to heavy and long lasting rains – the water table reach 38 cm above peat surface. The water reaction was acid (pH – 5.0), the conductivity of the water – 0.9 S m^{-1}. The open water occupied about 75 % of the area. The tussocks of sedges occupied about 15 % of the area. Their height was about 40 cm.

In the permanent plot, trees were absent. The low and sparse shrubs occur: the coverage is 12%, the height do not exceed 85 cm. The coverage of the herb layer was rather low – only 70 %. The sedges predominated in the herb layer – they covered about 50 % of the area, while other herbaceous plants – about 22 %. There are found 7 *Carex* species though, among them *Carex appropinquata* is the most abundant. To the most abundant species belong *Equisetum fluviatile, Lysimachia vulgaris, Menyanthes trifoliata, Peucedanum palustre, Potentilla palustris*, *Thelypteris palustris*. *Phragmites australis* was absent. The vertical structure of the herb layer was typical for the transition mire: the height of the 1st level reached 86 cm, 2nd level – 60 cm, 3rd level – 36 cm, 4th – 20 cm.

The coverage of the moss cover was estimated only approximately as the flood water was not transparent. It should be only 10 %. The moss cover consists only of brown mosses.

The total species number in the permanent plot is high – 44. Vascular plants take a major part –37 species (84 % of total species number). This number includes 27 species of herbaceous plants, 2 – tree, 6 – shrub and 2 – dwarf shrub species.

The coverages of the layers in 1 m^2 plots show a high mosaicity of the vegetation (Table 39). In spite of occurrence of the shrubs in 96 % of the plots, the coverage varies within the ranges of 0–85 %. Similar variation was in the coverage values of al other layers and plant groups, and levels as well. Only the height of the levels of the herb layer demonstrated moderate variation.

The total species number varied within the range of 10–21 and was variable in all plant groups.

Among shrubs, the most frequent species were *Salix rosmarinifolia* and *S. cinerea* (Table 40). In spite of high frequency, the abundance of these species was not high. Whereas, *Betula humilis* which was not frequent, demonstrated high coverage (32.3±45.9 %).

Among bryophytes *Calliergonella cuspidata* and *Scorpidium cossonii* were as the most frequent as the most abundant species (Table 41). The distribution of the species was mosaic.

Table 39. Vegetation structure in 1m^2 plots of the permanent plot No 31

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrub	9.7±16.7	0	85
	Herb	53.8±23.6	16	82
	Moss	23.0±19.7	1	70
	Open ground	2.8±7.5	0	30
	Dead phytomass	38.1±25.9	2	80
Coverage (%) of the plant groups	*Phragmites australis*	0.0±0.0	0	0
	Carex spp.	18.4±12.5	5	57
	Other herbs	40.6±21.2	4	75
	Brown mosses	22.1±20.2	0	70
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	12.9±12.6	1	55
	II	10.6±15.5	1	71
	III	29.1±19.0	4	62
	IV	7.0±11.3	0.5	45
Height of the levels of the herb layer	I	73.3±8.5	59	89
	II	48.6±6.0	40	68
	III	27.0±4.8	20	36
	IV	11.8±2.9	9	20
Species number per 1m^2 plot	Shrubs	1.8±1.0	0	5
	Herbs	11.3±1.5	7	15
	Bryophytes	2.2±0.9	1	4
	Total	15.3±2.5	10	21

Table 40. The species composition of the shrub layer in 1m^2 plots of the permanent plot No 30

Species	Frequency (%)	Coverage* (%)	Height range (cm)
Alnus glutinosa	4	5±0.0	45
Betula humilis	12	32.3±45.9	24–84
Betula pubescens	12	2.7±2.9	49–85
Salix aurita	4	1.5±0.0	26
Salix cinerea	60	3.4±3.6	21–78
Salix rosmarinifolia	80	3.8±3.8	18–66
Salix triandra	4	0.5±0.0	16–41

* – average and STDEV

Table 41. Species composition of the bryophytes in 1m^2 plots of the permanent plot No 31

Species	Frequency (%)	Coverage (%) (average and STDEV)
Bryum pseudotriquetrum	24	1.7±1.4
Calliergon giganteum	36	11.6±13.2
Calliergonella cuspidata	64	18.4±18.4
Campylium stellatum	36	2.6±3.8
Cinclidium stygium	16	2.5±3.7
Scorpidium cossonii	40	13.1±20.5
Scorpidium scorpioides	8	1±0.0

The most frequent species of the herb and dwarf shrub layer were *Carex elata*, *Menyanthes trifoliata*, and *Potentilla palustris*. These species were fund in all 1 m^2 plots. Frequent was *Carex lasiocarpa*, *Lysimachia thyrsiflora*, *Peucedanum palustre*, and *Utricularia intermedia*, which occurred in major part of the plots. Though, only *Carex elata*, *C. lasiocarpa*, and *Utricularia intermedia* were abundant. Majority of the species participated in the structure of several levels.

The amount of the phytomass in the plots vas variable (Tables 30 & 31) due to mosaicity of the vegetation. Woody plants and sedges made the highest parts in the total amount of the phytomass. Rather high was amount of the dead plant remnants – in the dry phytomass amount of the dead plant remnants was only a few lower than once of alive plants.

Table 42. The structure of the herb and dwarf shrub layer in the 1 m^2 plots of the permanent plot No 31

Plant species	Frequency (%)	Coverage (%) in the layer *				Height (cm) in the layer *			
		I	II	III	IV	I	II	III	IV
Agrostis canina	4		0.01±0.0				47±0.0		
Andromeda polifolia	8				0.55±0.6				11.5±3.5
Calamagrostis stricta	28	0.2±0.2	2.0±0.0			74.4±10.7	47±0.0		
Carex appropinquata	20	7.5±6.1	0.1±0.0			67.6±9.4	31±0.0		
Carex chordorrhiza	76		0.02±0.1	0.3±0.3	0.01±0.0		26.0±1.4	22.7±4.1	8.0±4.2
Carex diandra	40	2.1±1.5	0.3±0.7	0.03±0.1		63.6±7.0	45.0±7.1	26.0±0.0	
Carex elata	100	6.16±8.8	4.58±5.2	0.04±0.2		58.15.7±	43.1±6.6	26.0±0.0	
Carex lasiocarpa	96	5.2±7.4	0.6±0.6			67.6±8.0	41.8±6.2		
Carex nigra	20		0.3±0.4	0.1±0.2			27.0±2.6	25.0±8.5	
Dactylorhiza incarnata	10		0.3±0.3				48.5±3.5		
Equisetum fluviatile	88	0.1±0.2	0.06±0.1	0.001±0.002		69.7±10.3	43.4±6.4	24.0±0.0	
Galium palustre	4				0.01±0.0				5±0.0
Lycopus europaeus	44		0.02±0.04	0.06±0.1	0.03±0.1		30.0±9.9	19.8±3.6	7.7±3.8
Liparis loeselii	12			0.1±0.01				15.3±3.1	
Lysimachia thyrsiflora	92		0.03±0.1	0.1±0.2	0.1±0.1		30.5±1.0	18.2±4.4	9.5±3.3
Lysimachia vulgaris	68		0.4±0.6	0.4±0.5	0.0±0.1		36.4±9.4	24.5±4.3	9.8±1.0
Lythrum salicaria	4		0.1±0.0				39±0.0		
Menyanthes trifoliata	100		0.04±0.2	19.8±14.5	0.6±0.9		25.0±0.0	23.8±4.0	11.3±3.3
Parnassia palustris	8		0.1±0.1	0.1±0.1			32.5±3.5	22.5±6.4	
Peucedanum palustre	84	0.2±0.3	0.2±0.4	0.2±0.3	0.01±0.03	65.3±10.6	36.7±9.7	22.5±6.3	10.0±0.0
Potentilla palustris	100		0.9±1.4	2.7±4.4	0.6±0.8		37.6±7.7	21.6±5.6	10.4±3.0
Thelypteris palustris	48		9.5±21.3	13.4±17.1	0.3±0.8		52.7±13.3	27.5±5.7	10.0±1.4
Utricularia intermedia	72				8.2±12.6				9.2±2.4

* Average and STDEV

General vegetation characteristics of Apvardai wetland

Apvardai wetland is a transition mire. Major part of research area is occupied by open mire vegetation. Shrub and *Phragmites* thickness mostly occurs in north-western part of wetland also along the riverbed and ditches. There are some small mineral islands overgrown with deciduous trees.

In open areas *Caricetum lasiocarpae* communities are developed. The electric conductivity was ~0.3 S m^{-1}. Such very low conductivity may be determined due to dilution with rain water. The water was acid (pH – 5.0–5.1).

Apvardai wetland occurs in the initial stage of the transition mire. Because of that *Carex elata* which is specific for fens abundantly grows in plant communities. Slightly less abundant is *Carex lasiocarpa* that is specific for transition mire. However, *Menyanthes trifoliata* is the most abundant species. It was counted in 100 m^2 17–20 herbaceous plant species. The coverage of the grass layer reached 70–80%. First level of the grass layer is quite tall – 110–165 cm, though it's coverage was low – 0.3–7%; only rarely it reached 20%. Mostly it was composed of *Peucedanum palustre, Carex elata* inflorescences and taller *Carex lasiocarpa* plants. The height of the 2nd level was 71–110 cm, the coverage varies between 10 to 60 %. In this level *Carex lasiocarpa, Equisetum fluviatile, Lysimachia* genus plants, *Equisetum palustre*, and *Lythrum salicaria* prevail. The height of the 3rd level is 35–71 cm, the coverage usually is low (1–15%). This level usually consisted of *Potentilla palustris, Thelypteris palustris.* The 4th level, which height usually varies between 20 and 30 %, distinguished from other layers with high coverage (10–65 %). Major role has *Menyanthes trifoliata* and not well developed *Potentilla palustris* plants.

Shrub layer in particular parts is developed differently – coverage 10–25 %. Usually shrubs are not tall – do not reach 100 cm, though occurs several young *Betula pubescens* trees reaching 200–400 cm in height. The most frequent are *Salix rosmarinifolia* shrubs, more rarely *Salix cinerea* occurs.

Moss layer was sparse (coverage 15–30 %). It consists of *Calliergon giganteum, Calliergonella cuspidata, Campylium stellatum, and Scorpidium cossonii*. In total there were 7 moss species found.

The amount of the fresh phytomass in 1 m^2 plots varied between 850 to 1750 g. It can be influenced by uneven sedge and grass plants distribution, also presence or absence of the shrubs.

Part of the mire densely overgrown with *Phragmites australis* is classified as *Thelypteridi-Phragmitetum australis.* In this part of the wetland are found large shrubs and solitary trees. Trees and shrubs are distributed very unevenly. The density of the trees in 100 m^2 area varies between 1 to 9 individuals. Their height varies between 256 and 650 cm, the stem diameter in the height of 130 cm was 2.6–11.4 cm. *Betula pubescens* is predominating and *Alnus glutinosa* rarely occurs. Shrubs cover 10–35 %. *Betula humilis* and *Salix rosmarinifolia* are predominating. Several small *Alnus glutinosa* trees, *Frangula alnus and Salix cinerea* occur with the low frequency.

Grass layer coverage is high – 80–85%. Major part (50–60 %) of the area is covered with *Phragmites australis*, which makes a high (190–220 cm) 1st level. Sedges cover 10–12 % of the area. There are two types of them: rhizomatous *Carex lasiocarpa* and tussock forming *Carex appropinquata* and *Carex elata* (tussocks height reach 40 cm). Second grass level (100–125 cm height) is composed of sedges. Other species usually grow in 3rd (35–65 cm in height) and 4th (up to 35 cm height) levels. More abundant species in these levels are *Menyanthes trifoliata, Potentilla palustris, and Thelypteris palustris.* At the lowest level there are some sparse oligotrophic dwarf shrubs (*Andromeda polifolia, Vaccinium oxycoccus*).

There moss layer is sparse (coverage 3–8 %). It consists as of the mosses as the liverworts. Though, the last group is not abundant. The most frequent bryophyte species is *Campylium stellatum*.

The amount of the phytomass in 1 m^2 is not very high, however it varies in the wide range (800–1400 g). It can be determined by uneven distribution of the shrub and sedge tussocks and different height of the Phragmites australis plants.

Protected species in Apvardai wetland

There were found 3 species included in the Red Data Book of Lithuania, found: *Betula humilis, Dactylorhiza incarnata* and *Liparis loeselii*. The last one is also included in to the international Lists of protected species.

Liparis loeselii (L.) Rich.

Included into Red Data Book of Lithuania, 2(V) category.

Bern Convention I Annex.

EU Habitats directive II Annex (COUNCIL DIRECTIVE 92/43/EEC)

Species were found in south-western part (X 656922, Y 6155881) of the Apvardai wetland. Population is small – it consists of 3 generative and 10 vegetative individuals. The habitat type is transition mire.

Betula humilis Schrank

Included into Red Data Book of Lithuania, 2(V) category.

It was found in total area of the Apvardai wetland.

Dactylorhiza incarnata (L.) Soó

Included into Red Data Book of Lithuania, 5(Rs) category.

Several generative individuals were found in open communities of Apvardai wetland.

Vegetation properties in the permanent plot No. 26

The permanent plot is located in northern part of Apvardai wetland. This part is more or less overgrown with reeds; a lot of shrubs and solitary trees or groups of them are found in this part as well. The trees absent in the area of permanent plot, but plenty of shrubs (coverage reaches 35 %) are found. The grass layer is quite dense (coverage reaches 85 %). *Phragmites australis* predominates in the grass layer and covers up to 80 % of the area. The sedges are shaded by the reeds. Therefore, the coverage of the sedges is only about 40 %. The rest of herbaceous species covers only 20 %. There are some dwarf shrubs (*Andromeda polifolia, Vaccinium oxycoccus*) in the herb layer, but these plants are sparse. The vertical structure of the grass layer in this permanent plot differs very obviously from other plots: the height of the 1st first level reaches 218 cm, 2nd – 127 cm, 3dr – 65 cm. Only 4th level is more or less of usual height – 33 cm.

The moss cover is developed poorly. There is no *Sphagnum*. Brown mosses cover about 8 % of the area. There are some small patches overgrown with liverworts. The conditions for the bryophytes are unfavourable because of high water level. The height of the tall sedge tussocks (up to 40 cm) shows the high water table at the beginning of growing season. During the research the water level was about 25 cm (minimum – 15 cm, maximum – 30 cm) above peat surface.

The species number found in the permanent plot is rather high (33). It consists of 3 shrubs, 2 dwarf shrub, 20 herbaceous, 7 brown moss and 1 liverwort species. *Betula humilis* and *Salix rosmarinifolia* are predominating species amongst shrubs. Dwarf shrubs (that are specific for transition mires and raised bogs) were sparse. *Phragmites australis* was a dominant among herbaceous plants. *Carex appropinquata, Menyanthes trifoliata, Potentilla palustris* and *Thelypteris palustris* were abundant as well. *Campylium stellatum* was predominating bryophyte species.

The height of *Phragmites australis* varied greatly (164.9±23.4 cm). Though, the solitary plants reach up to 218 cm in height. Stem diameter at the base was also uneven (5.3±3.0 mm). The number of alive reed stem was 43.0±7.8, while of dead was much higher (102.0±27.2).

Almost 20 % of fresh phytomass consisted of wooden plants – shrubs and dwarf shrubs (Table 43). Differently from other permanent plots of Apvardai wetland, majority of fresh phytomass consisted of edificator of the community – *Phragmites australis*. Sedges made up less than 10 % of fresh phytomass. Remarkably high amount of the dead plant remnants (almost twice as much as fresh phytomass) was received because of high amount of water in it due to high flood in the area. The amount of dry dead plants remnants was just a little higher than dry phytomass of the living plants (Table 44).

Table 43. Amount of fresh phytomass (Average and STDEV) of vascular plants in Apvardai wetland (26–28 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	26	**27**	**28**
Shrubs and dwarf shrubs	186.4±126.8	258.4±388.0	121.6±112.2
Ferns	21.6±18.5	0.0±0.0	35.2±78.7
Carex spp.	81.6±101.6	461.6±118.5	614.4±210.3
Other edificator (*Phragmites australis*)	554±194.6	0.0±0.0	0.0±0.0
Equisetum spp.	1.2±2.7	112.8±33.6	25.6±12.2
Poaceae (including *Phragmites australis*)	557.7±197.4	0.0±0.0	14.8±27.6
Phragmites australis	554±194.6	0.0±0.0	0.0±0.0
Other herbaceous plants	74.2±60.2	496±237.8	162.4±74.2
Total amount	922.7±343.9	1328.8±423.1	974±72.0
Dead plant remnants	2256.4±1002.1	3037.6±478.9	2062.4±1008.0

Table 44. Amount of dry phytomass (Average and STDEV) of vascular plants in Apvardai wetland (26–28 permanent plots)

Plant group	Amount of phytomass (g/m^2)		
	26	**27**	**28**
Shrubs and dwarf shrubs	103.1±73.1	187.4±295.1	82.6±86.1
Ferns	12.9±17.4	0.0±0.0	14.5±32.4
Carex spp.	34.3±37.2	150.6±35.9	213.8±52.1
Other edificator (*Phragmites australis*)	427.2±176.7	0.0±0.0	0.0±0.0
Equisetum spp.	0.7±1.6	38.5±26.1	13.2±17.3
Poaceae (including *Phragmites australis*)	428.2±177.0	0.0±0.0	4.5±7.2
Phragmites australis	427.2±176.7	0.0±0.0	0.0±0.0
Other herbaceous plants	29.8±31.9	205.5±127.6	59.0±60.7
Total amount	609.0±166.7	582.0±212.6	387.5±139.6
Dead plant remnants	732.5±184.7	457.9±107.7	328.6±124.1

The vegetation in the permanent plot is very mosaic. It can be seen in results of vegetation structure study in 1 m^2 – the coverage varied in all layers and levels (Table 45). Analogous differences were observed in the coverage between distinct plant groups.

Exclusive feature in this area was that the coverage of the 1st level was the higher comparing with other permanent plots. The highest were the height values (199.7±10.1 cm) of the 1st level as

well. The 2nd lever is quite far behind (height 109.0±12.9 cm), although it is much denser than lower levels. Tall plants overshadow smaller plants, because of that usually they are poorly developed.

Phragmites australis was a dominant of first grass level. Some sedge species (*Carex appropinquata, C. elata, C. lasiocarpa*) also grows here with some *Molinia caerulea*, but their coverage is quite low here. Mentioned species makes up the majority of plants in the 2nd level. In spite of the fact, that 13 plant species were found in the 2nd level, but majority of them were sparse. The 3rd and 4th levels distinguished with diversity of plant species however the abundance of plants was low (Table 46).

The frequency and abundance of species often were different. *Phragmites australis* was found in all 1 m^2 plots and always predominated. Tall sedges were also frequently found in more than a half of the plots. Though some plants of many frequent species (*Peucedanum palustre, Lysimachia thyrsiflora, Potentilla palustris, Thelypteris palustris, Menyanthes trifoliata, Andromeda polifolia*) were not abundant.

Table 45. Vegetation structure in the 1m^2 plots of the permanent plot No 26

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	Min	Max
Coverage (%) of the layers	Shrubs	13.8±7.4	4	40
	Herbs	73.0±10.0	50	90
	Bryophytes	4.6±4.4	0	16
	Open ground *	–	–	–
	Dead phytomass	89.4±10.5	45	96
Coverage (%) of the plant groups	*Phragmites australis*	62.1±16.5	7.5	86
	Carex spp.	7.9±8.1	0.2	28
	Other herbs	12.1±5.6	3	25
	Brown mosses	4.4±4.5	0	16
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels of the herb layer	I	64.6±12.2	38	88
	II	12.0±8.0	0.6	32
	III	4.7±3.0	0.6	11
	IV	4.3±4.4	0.2	16
Height of the levels of the herb layer	I	199.7±10.1	182	218
	II	109.0±12.9	85	131
	III	66.5±11.0	45	92
	IV	33.9±8.6	19	62
Species number per 1m^2 plot	Shrubs	1.8±0.6	1	3
	Dwarf shrubs	0.6±0.6	0	2
	Herbs	9.0±1.7	7	13
	Bryophytes	1.4±0.8	0	3
	Total	12.9±2.2	10	19

* Due to high water level and intransparecy it was impossible to evaluate what area is covered by open soil

Table 46. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 26

Species	Coverage (%) in the layer *				Height (cm) in the layer *				Frequency
	I	II	III	IV	I	II	III	IV	
Herbaceous plants									
Agrostis stolonifera			0.3±0.3				56±19.8		8
Carex appropinquata		5.7±7.5				104.7±15.4			52
Carex chordorrhiza			0.03±0.03				53.5±12.02		8
Carex elata		6.0±4.8				92.5±14.5			56
Carex lasiocarpa	0.01±0.0	2.4±4.8	0.01±0.0		118.0±0.0	96.5±8.8	67.0±0.0		60
Epilobium palustre		0.1±0.0		0.01±0.0		67±0.0		21±0.0	4
Equisetum fluviatile	0.004±0.01	0.02±0.04	0.04±0.0		128.0±14.8	84.3±8.1	44.0±0.0		28
Filipendula ulmaria	0.9±1.0	0.2±0.4	0.4±0.7		163.3±12.4	89.5±27.6	44.0±7.8		28
Galium palustre		0.003±0.0	0.003±0.0	0.02±0.0		80±0.0	50±0.0	35±0.0	12
Lycopus europaeus			0.3±0.0	0.05±0.0			55±0.0	30±0.0	8
Lysimachia thyrsiflora			0.1±0.1	0.2±0.1			56.0±13.9	28.5±7.7	28
Lysimachia vulgaris	0.02±0.1	0.4±0.5	0.1±0.1	0.03±0.1	102.00±0.0	93.0±15.8	62.8±18.8	20.5±13.4	76
Menyanthes trifoliata			0.1±0.3	4.0±3.8			52.0±4.2	31.1±6.5	88
Molinia caerulea	0.05±0.1	1.8±2.9	0.1±0.4		129.0±32.1	105.6±15.2	75.5±0.7		68
Peucedanum palustre		0.1±0.1	0.4±0.4	0.2±0.4		77.3±15.3	58.4±11.6	23.9±4.5	88
Phragmites australis	64.4±11.9	0.1±0.1			199.7±10.1	95.4±10.5			100
Potentilla palustris			3.5±2.6	0.7±1.0			57.6±7.0	34.9±9.7	88
Scutellaria galericulata		0.03±0.05	0.1±0.1	0.01±0.04		97.0±1.4	55.5±11.1	21.0±0.0	28
Thelypteris palustris	0.03±0.1	3.5±4.0	1.5±1.4	0.2±0.4	138.5±53.0	96.7±12.8	61.1±12.7	39.3±15.6	80
Dwarf shrubs									
Andromeda polifolia			0.2±0.3	0.04±0.1			47.6±15.4	36±15.7	60
Vaccinium oxycoccos				0.1±0.04				26.0±1.4	8

* – average and STDEV

Vegetation properties of the permanent plot No 27

The permanent plot is located in eastern part of Apvardai wetland. This part is almost open: only low and stunted shrubs occur; sparse reeds occur in several places of the mire. Though, the permanent plot is located in the site without *Phragmites australis*.

Plenty of shrubs are growing in the plot –coverage reaches 20%. Grass layer is quite dense – covers 80%. The height of the 1st level is 158 cm, 2nd – 110 cm, 3rd – 60 cm, 4th – 38 cm. The sedges predominate amongst herbaceous plants (coverage of *Carex* plants – 60%).

The moss cover is not closed (30%), though this value is only approximate due to high water level (24–33 cm above peat surface). Furthermore, part of the bryophytes is dead because of long-term flooding.

In total, 33 plant species were found in the permanent plot: 3 of shrubs, 23 of herbaceous and 7 of bryophyte species. *Sphagnum* species were not found. *Salix rosmarinifolia,* that is characteristic to transition mire, was the most abundant among shrub species. *Phragmites australis* is absent. *Carex elata* and *C. lasiocarpa* were the most abundant among 6 identified sedge species. Among other herbaceous species more abundant were *Menyanthes trifoliata, Equisetum fluviatile* and *Utricularia intermedia*. *Calliergonella cuspidata* and *Scorpidium scorpioides* predominated among bryophytes.

About 20% of the fresh phytomass consisted of shrub (table 43). Sedges take up almost a half of total phytomass of the herbaceous plants. Remarkably high amount of dead plant remnants (almost twice as big as amount of the living plant phytomass) was due to high amount of the saturating water, as the area was flooded. The weight of dried plant remnants was even a little less than total dry phytomass of the living plants (Table 44).

The results of the vertical structure of the vegetation in 1m^2 plots shows the high mosaicity of the vegetation – the coverages of all layer varied greatly. A little more similar were the coverages and heights of different plant groups (Table 47).

This permanent plot is particular comparing to other plots due to very high coverage of the 4th level. It is determined by abundant *Menyanthes trifoliata* and *Utricularia intermedia*. The coverage of the 2nd level was a little lower. It is predominated by *Carex elata, C. lasiocarpa* and *Equisetum fluviatile.* The 1st and the 3rd levels were sparse and the coverage varied considerably.

The species constancy was very different (Table 48). Only *Carex elata* and *Peucedanum palustre* occurred in every 1 m^2 plot. A little less frequent were *C. lasiocarpa, Equisetum fluviatile, Menyanthes trifoliata* and *C. chordorrhiza.* Although the last mentioned species was not abundant, though it was found in the majority of plots; while plants of the other frequent species were dominants or codominants of plant community.

Table 47. Vegetation structure in the 1m^2 plots of the permanent plot No 27

Measurement	**Layer / Plant group / Level of the herb layer**	Average & STDEV	MIN	MAX
Coverage (%) of the layers	Shrubs	7.4±7.8	0	25
	Herbs	67.4±13.3	32	90
	Bryophytes	6.6±9.3	0.5	45
	Open ground	*	*	*
	Dead phytomass	83.69.6	60	95
Coverage of the plant groups	*Phragmites*	0.0±0.0	0	0
	Carex spp.	31.9±16.4	8	60
	Other herbs	43.1±15.7	20	75

	Brown mosses	4.3±4.2	0.5	15
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels	I	11.3±11.9	1	47
	II	21.44±17.9	5	62
	III	7.3±10.4	0.5	37
	IV	36.7±18.8	7	70
Height of the levels	I	103.0±10.6	83	126
	II	74.0±9.3	60	90
	III	49.3±9.0	35	69
	IV	33.1±6.1	20	46
Species number	Shrubs	1.0±0.6	0	2
	Herbs	9.18±1.7	6	13
	Bryophytes	2.1±0.9	1	4
	Total	12.2±2.0	9	16

* Due to high water level and intransparecy it was impossible to evaluate what area is covered by open soil

Table 48. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 27

Species	Frequency	Coverage (%) of the layers				Height (cm) of the layers			
		I	II	III	IV	I	II	III	IV
Calamagrostis stricta	4	0.5±0.0				92±0.0			
Carex appropinquata	8	0.3±0.4	32±36.8			107±0.0	78.5±0.7		
Carex chordorrhiza	84.0			0.03±0.1	0.2±0.3			35.0±14.4	25.3±7.8
Carex elata	100.0	4.1±9.1	17.4±16.1	1.6±7.4		84.5±14.8	69.8±8.8	61.0±7.1	
Carex lasiocarpa	92	7.0±7.5	1.0±1.8	0.004±0.0		96.3±9.1	75.7±12.3	55.0±0.0	
Carex limosa	8			0.1±0.1				44.5±13.4	
Carex rostrata	4			0.6±0.0				56±0.0	
Dactylorhiza incarnata	4			0.1±0.0				44±0.0	
Equisetum fluviatile	92.0	0.2±0.3	0.5±0.6	0.04±0.1		81.2±9.0	67.2±10.0	46.8±5.7	
Galium palustre	12				0.01±0				23.0±9.8
Lycopus europaeus	12			0.1±0.1	0.03±0.1			42.0±1.4	19.0±0.0
Lysimachia thyrsiflora	60			0.03±0.1	0.5±0.5			40.5±13.4	19.0±5.0
Lysimachia vulgaris	36		0.03±0.1	1.5±1.5	0.1±0.1		52.0±0.0	42.8±6.1	25.7±6.7
Lythrum salicaria	28			0.2±0.1	0.03±0.1			45.4±9.7	28.0±0.0
Menyanthes trifoliata	92			3.5±8.7	32.8±18.9			42.6±7.0	32.9±6.7
Peucedanum palustre	100	0.6±1.1	0.2±0.4	1.4±1.3	0.1±0.2	104.8±13.9	65.1±13.0	45.7±7.2	26.8±7.6
Potentilla palustris	80		0.1±0.3	0.9±0.9	2.9±2.7		69.3±3.5	46.3±9.7	29.4±6.7
Scutellaria galericulata	8				0.1±0.0				27.0±4.2
Stellaria palustris	8				0.1±0.1				29.0±1.4
Utricularia intermedia	76				1.9±2.0				20.2±3.4

* – average and STDEV

Vegetation properties of the permanent plot No. 28

The permanent plot is located in eastern part of Apvardai wetland, which is almost open: shrubs are present though they are low and stunted; in the shrub layer are some *Betula pubescens* individuals; reed is found only on the edge of the area and spread along the river bed.

In the permanent plot were found quite a lot of shrubs – coverage 25%. Grass layer is relatively dense (coverage – 75%) and tall (the height of the 1st level – 166 cm, 2nd – 108 cm, 3rd – 71 cm, 4th – 52 cm). Amongst herbaceous plants sedges were dominant (coverage – 60 %).

Moss cover is not closed (15 %), however the coverage was estimated only approximately due to very high (20–31 cm above peat surface) water level and dark water colour. Furthermore, part of moss was dead because of long term flooding.

In total, 38 plant species were found in the permanent plot: 3 wooden, 27 herbaceous, and 8 bryophyte species. Amongst shrubs the most abundant was the typical species of transition mires *Salix rosmarinifolia*. Reed was absent. Among herbaceous plants, 5 sedge species were found; though, only 2 of them (*Carex elata* and *Carex lasiocarpa*) grew abundantly. Other abundant herbaceous species were *Menyanthes trifoliata* and *Thelypteris palustris. Calliergonella cuspidata* and *Campylium stellatum* predominated among bryophytes. *Sphagnum* was absent.

Shrubs make up less than 15 % of fresh phytomass (Table 43, while sedges – about 2/3. Exceptionally high (more than two times more than fresh phytomass) was the weight of the dead plant remnants inasmuch as they were very wet because of the flood. The weight of the air dried dead plants remnants was a little less than phytomass of the living plants (Table 44). More than half of the fresh phytomass consisted of sedges.

The vertical structure of 1 m^2 plots showed high mosaicity of the vegetation: coverages of all levels varied greatly, except grass layer. Amongst grass predominated sedges (Table 49).

This area stood out in the high coverage of the second level of the grass layer. It was determined by abundantly growing *Carex elata* and *Carex lasiocarpa.* The relatively small differences in the coverage of mentioned level were observed. A little higher was the average coverage of the 4th level; though the variability was high.

The total species number in 1 m^2 plots were quite similar (15.2±2.2). The number of herbaceous species was particularly similar. The number of bryophyte species varied more distinctly.

In spite of high number of sedge (5) species only two of them (*Carex elata, Carex lasiocarpa*) were abundant and were found in all 1 m^2 plots (Table 50). One more species (*Carex chordorrhiza*) was quite frequent (56 %), although projectile coverage was low. Amongst other herbaceous species *Equisetum fluviatile, Lysimachia thyrsiflora, Utricularia intermedia, Potentilla palustris, Menyanthes trifoliata* and *Thelypteris palustris* were more frequent.

Amongst bryophyte species *Calliergonella cuspidata* and *Campylium stellatum* were growing most frequently. These species were the most abundant as well.

Table 49. Vegetation structure in the 1m^2 plots of the permanent plot No 28

Measurement	Layer / Plant group / Level of the herb layer	Average & STDEV	MIN	MAX
Coverage (%) of the layers	Shrubs	14.1±14.4	0	55
	Herbs	62.3±11.3	40	87
	Bryophytes	13.3±9.3	2	35
	Open ground	*	*	*
	Dead phytomass	81.2±9.5	60	92
Coverage of the plant groups	*Phragmites*	0.0±0.0	0	0
	Carex spp.	42.4±13.4	12	65
	Other herbs	27.6±16.0	5	65
	Brown mosses	10.5±9.8	0	35
	Sphagnum spp.	0.0±0.0	0	0
Coverage (%) of the levels	I	7.9±12.2	0.1	45
	II	39.6±15.2	3	65
	III	7.7±8.9	1	35
	IV	17.9±10.4	1	36
Height of the levels	I	112.1±13.9	89	139
	II	83.8±11.9	57	100
	III	56.1±9.2	38	76
	IV	36.2±5.8	23	44
Species number	Shrubs	1.12±0.3	1	2
	Herbs	11.24±1.7	9	15
	Bryophytes	2.84±1.3	1	6
	Total	15.2±2.2	11	19

* Due to high water level and intransparecy it was impossible to evaluate what area is covered by open soil

Table 50. The structure of the herb layer in the 1 m^2 plots of the permanent plot No 28

Species	Frequency	Coverage (%) of the layers *				Height (cm) of the layers *			
		I	II	III	IV	I	II	III	IV
Agrostis canina	4				0.1±0				35±0
Agrostis stolonifera	44	0.01±0.03	0.01±0.03	0.04±0.1	0.03±0.1	63±0.0	58±0.0	53.3±7.4	24.9±9.9
Calamagrostis stricta	36	0.1±0.1				107.4±9.8			
Cardamine pratensis	8				0.01±0.0				24.5±0.7
Carex appropinquata	4		1±0.0				69±0.0		
Carex chordorrhiza	56			0.02±0.04	0.2±0.5			42.8±6.8	26.1±7.
Carex elata	100	9.7±9.8	34.5±16.2	0.2±0.8		85±16.1	75.5±9.0	49±0.0	
Carex lasiocarpa	100	3.4±6.4	4.1±4.0			97.2±8.1	88.8±8.7		
Carex limosa	4				0.05±0.0				36±0.0
Cicuta virosa	4		1±0.0				57±0.0		
Epilobium palustre	16		0.03±0.05	0.05±0.1	0.02±0.02		63±0.0	66±0.0	26.3±3.2
Equisetum fluviatile	92	0.01±0.03	0.1±0.1	0.003±0.01		84.2±12.6	72.4±9.1	47.5±10.6	
Galium palustre	40			0.05±0.1	0.01±0.02			49.0±5.2	27.0±10.0
Lycopus europaeus	24		0.05±0.1	0.1±0.2	0.1±0.1		49±0.0	55.0±4.2	33.2±8.0
Liparis loeselii	4				0.1±0.0				37±0.0
Lysimachia thyrsiflora	80			0.1±0.1	0.1±0.1			41.8±5.7	23.1±7.3
Lysimachia vulgaris	4		0.2±0.0				69±0.0		
Lythrum salicaria	20		0.3±0.4	0.3±0.4	0.02±0.04		69±5.7	54.3±2.9	30±0.0
Menyanthes trifoliata	96			1.4±4.6	15.0±10.6			42.3±9.2	35.1±5.5
Parnassia palustris	24		0.03±0.04	0.02±0.04	0.03±0.04		66.5±4.9	62.3±7.1	26.3±3.1
Peucedanum palustre	100	1.1±1.2	1.0±1.3	1.3±1.6	0.3±0.4	111.6±14.8	68.8±13.3	52.4±9.4	31.4±5.9
Potamogeton natans	4				0.5±0.0				18±0.0
Potentilla palustris	88	0.001±0.004	0.1±0.3	0.9±1.0	2.8±2.8	65±0.0	79±0.0	53.1±7.6	31.3±5.4
Ranunculus lingua	8			0.1±0.1	0.03±0.04			44±0.0	27±0.0
Scutellaria galericulata	8			0.6±0.6				46.5±10.6	
Stellaria palustris	16			0.01±0.01	0.01±0.01			45.5±0.7	25±8.9
Thelypteris palustris	68		2.3±4.9	6.5±9.5	0.5±1.1		64.2±10.8	51.5±9.5	33.8±7.4
Utricularia intermedia	68				0.7±0.8				16.3±3.2

* – average and STDEV

5.3. Monitoring of invertebrates

Locations of monitoring sites of invertebrate animals in project site LT/02-Apvardai are shown in Fig. 9.

Herpetobiontic invertebrates. Because of the heavy rains at the end of June and beginning of July and the subsequently raised water level (that was too high to place pitfall traps up until the beginning of August), monitoring of the ground beetles (and other herpethobiontic invertebrates) was heavily complicated in Apvardai plots. Although some of the traps were put into tussocks above the water level in Apvardai, only sixteen specimens of beetles from four taxa were caught (Table 51). Only the first sample in Apvardai site (although traps were already submerged under water when they were checked) was successful.

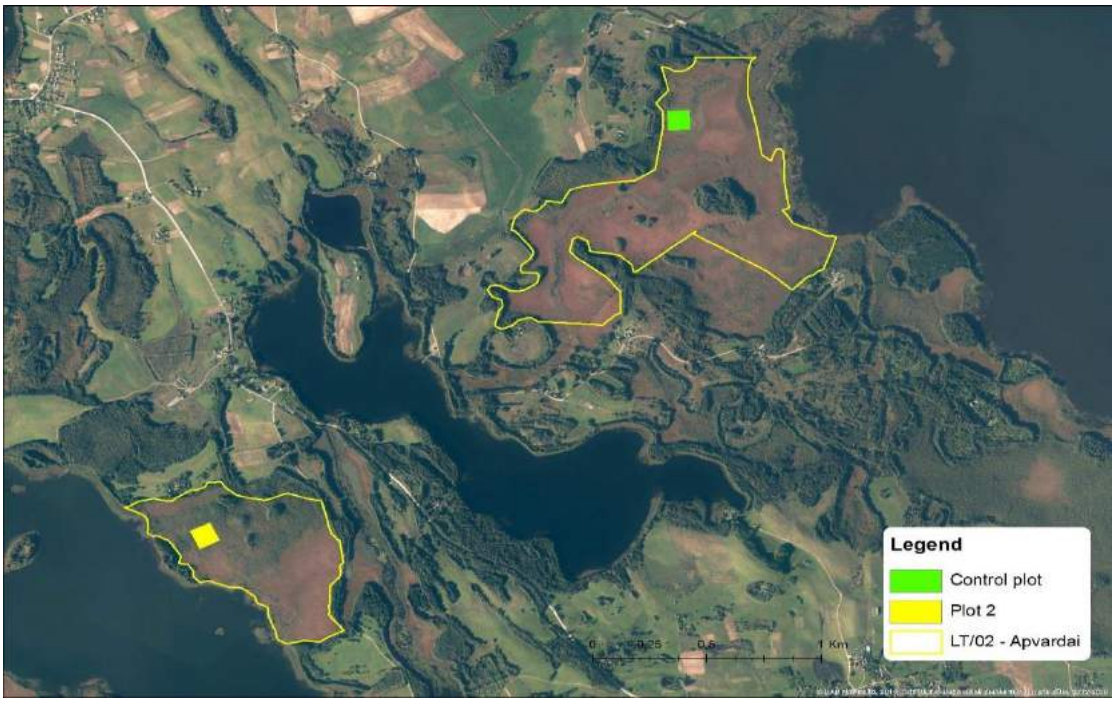

Fig. 9. Location of invertebrate monitoring sites in Apvardai LT/02.

Table 51. Number of speciments of ground beetles, cought with pitfall traps in project site Apvardai
Indexes: D, dominants – species with abundance more than 5%; Sd, subdominants – abundance from 2 to 5%; R, recendents – abundance from 1 to 2%; Sr, subrecedents – abundance less than 1%

Species	Control plot	Plot 2
Agonum sp.	8 D	1 D
Oodes helopioides	5 D	
Pterostichus minor	1 D	
Pterostichus oblongopunctatus		1 D
Total:	**14**	**2**

Flying invertebrates. In total almost fourteen thousand invertebrate specimens were caught with Malaise traps in Apvardai project site (13995 specimens, Table 52). The most numerous group in the traps were Diptera, exceeding the other groups in numbers of specimens many times (Table

55). The second most-numerous group ewas hymenopterans, followed by Lepidoptera, Trichoptera, Hemiptera, Coleoptera and others (Table 53).

Table 52. Total number of invertebrates caught in Malaise traps in project site Apvardai

Number of sample	1st sample	2nd sample	3rd sample	4th sample	**TOTAL** (44days)	**Average number of specimens/day**
Date	2017-07-07	2017-07-20	2017-08-01	2017-08-11		
Number of specimens collected	4288	4241	3059	2407	13995	318,1

Table 53. Total number of invertebrates caught in Malaise traps in project site Apvardai by groups

Name of the group	Number of specimens
Coleoptera	113
Diptera	12405
Ephemeroptera	3
Hemiptera	244
Hymenoptera	576
Lepidoptera	373
Neuroptera	1
Odonata	22
Psocoptera	12
Trichoptera	246
TOTAL:	13995

Most numerous group of Diptera combined were Chironomidae. They made up about 51% in Apvardai. Ceratopogonidae were also very numerous in Apvardai, making the second most numerous group of Diptera. The third group in numbers of specimens were Muscidae, and Mycetophilidae were the third most-numerous group there (Table 54).

Table 54. Number of specimens of main Diptera families caught in Malaise traps in project site Apvardai

Diptera families	Number of specimens
Anthomyiidae	295
Calliphoridae	45
Cecidomyidae	231
Ceratopogonidae	1273
Chironomidae	7208
Chloropidae	30
Culicidae	189
Dolichopodidae	109
Hybotidae	61
Muscidae	628
Mycetophilidae	552
Psychodidae	186
Scathophagidae	36
Sciaridae	91
Sciomyzidae	13

Sepsidae	64
Simuliidae	7
Syrphidae	377
Tabanidae	350

Hortobiontic invertebrates. Total invertebrate biomass was highest on Plot 2 compared to Control plot. The Plot 2 had higher biomass only of heavier weight groups in June (Table 57). Invertebrates of the lightest group (1–5 mg) were most abundant in all the inspected plots. The dominance of other weight groups varied between the sites. The 5–10 mg group was more abundant in Plot 2 in Apvardai. The group of 10–20 mg was more abundant in Plot 2 in Apvardai June sample. The heaviest weight group (>20 mg) again was more abundant in Control plot in Apvardai June sample (Table 55).

Table 55. Distribution of hortobiontic invertebrate biomass (mg) per 100 sweeps in different weight classes in project site Apvardai

		Weight classes				
		1–5 mg	**5–10 mg**	**10–20 mg**	**> 20 mg**	**Without 1-5 mg group**
Apvardai June	Control	217,1	13,0	5,8	14,0	207,4
	Plot 2	273,2	55,0	66,1	0,0	
Apvardai July	Control	172,1	5,2	0,0	8,5	
	Plot 2	291,8	20,1	11,2	8,5	

Diptera formed the highest proportion of biomass in all the sweep net samples (Tables 56, 57). The second most abundant group by total biomass in June was Homoptera, followed by Coleoptera while Orthoptera were second most abundant in July, followed by Homoptera. Diptera were also the most abundant group by number of specimens per 100 sweeps in all the sweep net samples combined. The second most numerous groups were Homoptera, followed by Heteroptera. Coleoptera were the fourth most numerous group in June and Arachnida – in July. The number of specimens caught in Plot 2 in Apvardai July sample were higher compared to Control plot.

Table 56. Biomass and number of invertebrates in project site Apvardai

	Biomass, June (mg per 100 sweeps)		**Biomass, July** (mg per 100 sweeps)		**Number of specimens, June**		**Number of specimens, July**	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	14,6	20,3	8,9	31,1	8	4,25	3,75	11,5
Mollusca	0,0	0,0	0,0	3,0	0	0	0	0,75
Coleoptera	4,1	9,8	10,5	18,5	1,5	1,75	2	5,75
Diptera	165,7	195,3	128,8	158,8	140	83,25	95,25	138,25
Heteroptera	1,1	54,9	5,6	40,7	1	53	3,25	30,5
Homoptera	25,8	45,6	14,8	36,7	20,25	32,5	7,5	25,25
Hymenoptera	23,8	18,1	27,8	25,4	13	6	11	15,75
Hymenoptera larvae	0,8	0,0	0,0	1,3	0,25	0	0	0,25

Lepidoptera larvae	0,0	0,0	0,0	8,5	0	0	0	0,25
Lepidoptera adults	0,0	0,0	6,1	0,0	0	0	0,25	0
Orthoptera	0,0	0,0	0,0	3,5	0	0	0	1
Trichoptera	0,0	36,5	0,0	4,2	0	2,75	0	0,25
Odonata Zygoptera	0,0	13,8	5,5	0,0	0	1,25	0,5	0
Odonata Anisoptera	14,0	0,0	0,0	0,0	0,25	0	0	0
Total:	249,9	394,3	208,1	331,6	184,25	184,75	123,5	229,5
	mg/meter (sweep)		mg/meter (sweep)					
Total:	2,5	3,9	2,1	3,3				

Pollinating insects. The total number of pollinator taxa in Apvardai plots was 73, while combaine net sampling and Malaise trap data were used.

Table 57. Number of taxa, specimens and biodiversity indexes of selected pollinators from the net sampling alone and net sampling with Malaise traps combined, in project site Apvardai

	Net sampling			**Net sampling and Malaise traps combined**
	Control plot	Plot2	Combined	
Taxa	34	35	45	73
Specimens	956	931	1850	14255
Shannon	1,67	2,36	2,06	2.01
Simpson	0,65	0,83	0,74	0.66
Pielou	0,47	0,66	0,54	0.47

The most numerous group in Apvardai were also Chironomidae (47.7%), followed by a group of unidentified to the family level small Cyclorhapha flies (13.8%) and Hybotidae (9.0%). Out of the main pollinator group – Apidae, only single specimens of *Bombus* were caught and several specimens of solitary bees (Apidae) – 6 in Apvardai. If net sampling and Malaise trap material is combined, in Apvardai project site the total number of pollinator taxa was comparatively high. Only in Žuvintas number of pollinators was higher.

5.4. Hydrological monitoring

Two water level measuring gauges were installed in the Project Area LT/02-Apvardai. The performed measurements have shown that the water level in these areas is rather constant, always remains above the surface of the soil and varies, most likelly, depending on the amount of precipitation (Fig. 10). Territories are of different size, and are interconnected through Lake Žilmas. The water from the site near Lake Alksnas (the gauge "29 Alksnas") reaches Žilma Lake through the River Ružas, and flows through the Lake Žilmas to the Apvardai fen (gauge “27 Apvardai"), and finally flows to Lake Apvardai. In both territories, the water level during the vegetation season remains above the surface of the soil and fluctuates in the range of 2-6 cm rarely exceeding 10 cm of depht. Since water level measurements in both areas were started at the end of summer, fluctuations in water level throughout the vegetation period will be determined in 2018.

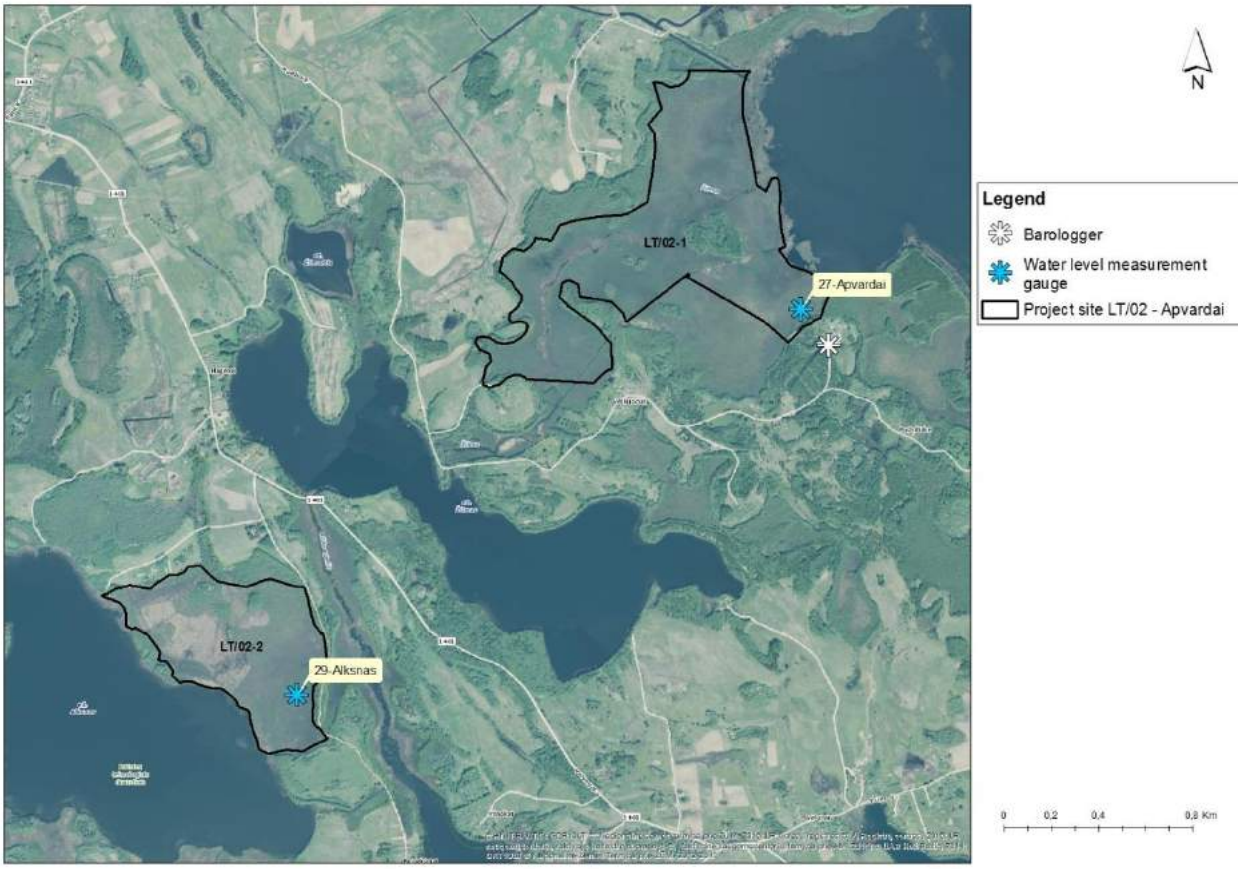

Fig. 10. Locations of water level measuring gauges in project site LT/02-Apvardai.

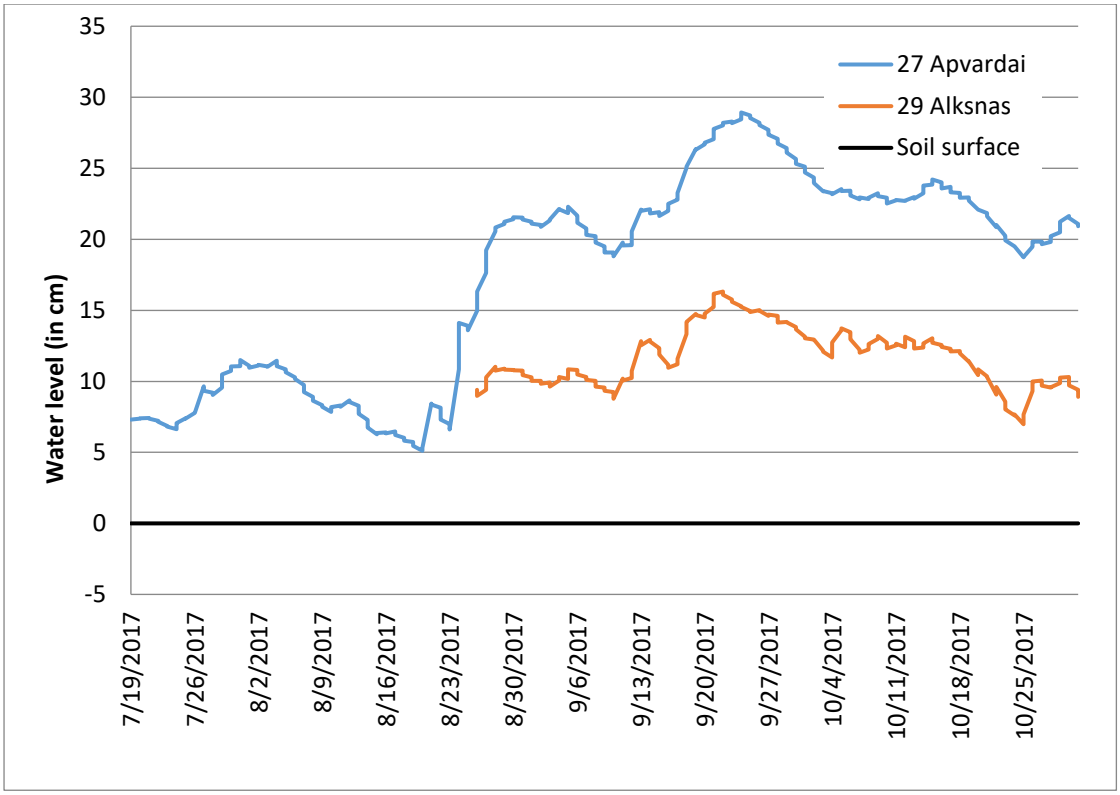

Fig. 11. Water dynamic in project site LT/02-Apvardai.

6. Project site LT/03-Zuvintas

6.1. Bird monitoring

There were 2-3 singing males found in the Project sites LT/03-Zuvintas (Fig. 2), while the rest individuals of local population were found in Grebelė meadows – site managed during the former project. Two singing Aquatic Warbler males were found at Dambavaragis meadows, and one individual was obtained in Liepakojai meadows, on the border of Project site. There were in total 7 calling males of Aquatic Warbler found in 2017 in the meadows of Žuvintas Biosphere Reserve, and this figure indicates that in recent years the bird population in this place is quite stable. During the period of last 10 years, numbers of counted Aquatic Warbler males fluctuated from 1 to 7, while the maximum number were recorded only in years 2007, 2015, and 2017. The number of birds in the project sites is likely to increase due to ongoing implementation of habitat management activities and implementation of the Aquatic Warbler translocation programme, that will be held in 2018-2019.

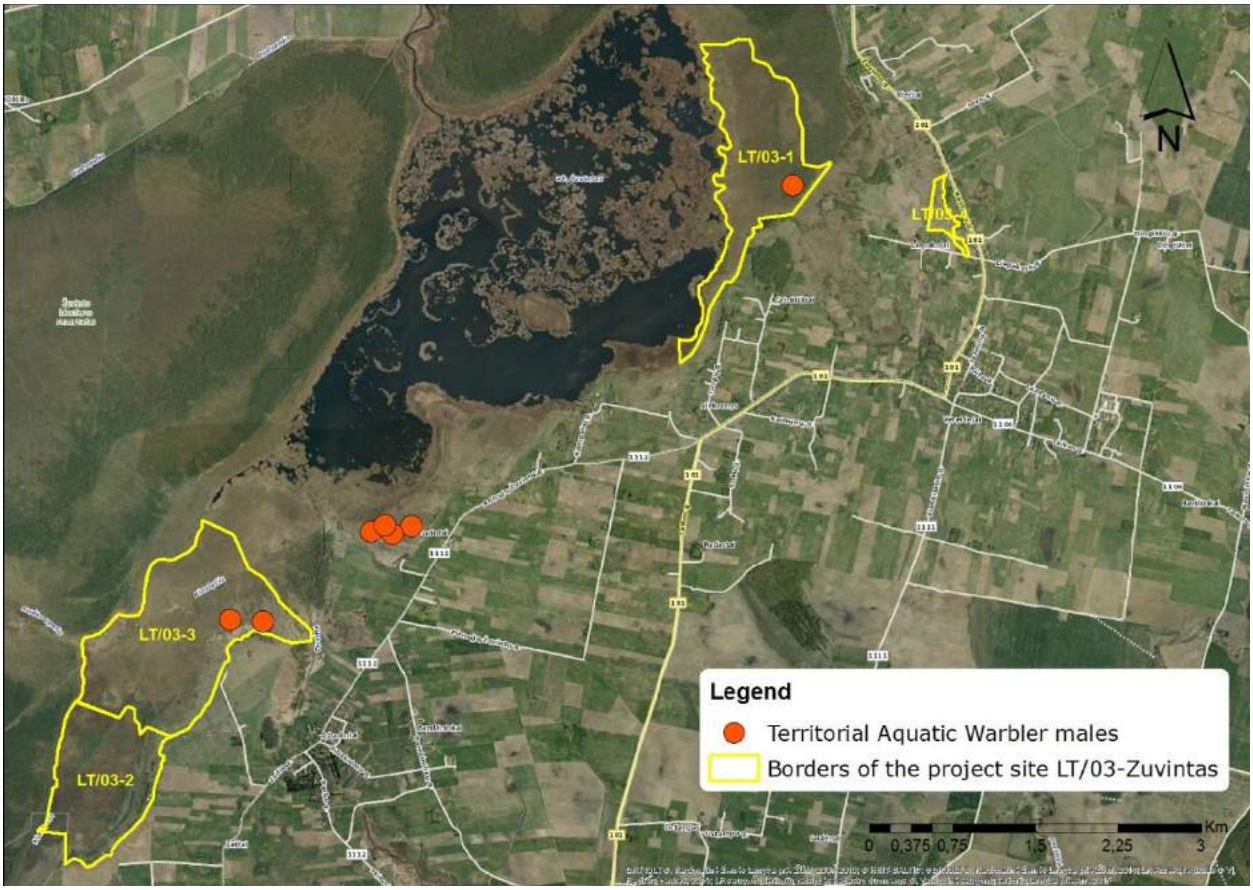

Fig. 12. Results of Aquatic Warbler census in Žuvintas Biosphere reserve (LT/03-Zuvintas) in 2017. Locations of singing males are marked with orange dots.

The area is important because there is a small local AW population that was near the extinction in 2011-2013. This isolated population is more than 150 kilometers away from other Aquatic Warbler breeding places in Lithuania. During the period of 2014-2017, the numbers of recorded Aquatic Warbler calling males ranged from 4 to 7. The area is also important for such wetland birds as Citrine Wagtail *(Motacilla citreola*) (2 breeding pairs), Common redshank (*Tringa totanus*) (2 breeding pairs),

Black-tailed Godwit (*Limosa limosa*) (2 breeding pairs), Spotted Crake (*Porzana porzana*) (4 calling males) and Corncrake (*Crex crex*) (3 calling males). In total, 19 species of birds were found during the breeding season 2017.

6.2. Monitoring of invertebrates

Locations of monitoring sites of invertebrate in project sites LT/03-Žuvintas are shown in Fig. 13. Because of the heavy rains at the end of June and beginning of July and the subsequently raised water level (that was too high to place pitfall traps up until the beginning of August), monitoring of the *Herpetobiontic invertebrates* (mainly ground beetles) was heavily complicated in Žuvintas plots. Only the first sample in control plot (although traps were already submerged under water when they were checked) and only the last sample of Plot 2 were successful in Žuvintas, providing 175 beetle specimens in total (Table 58).

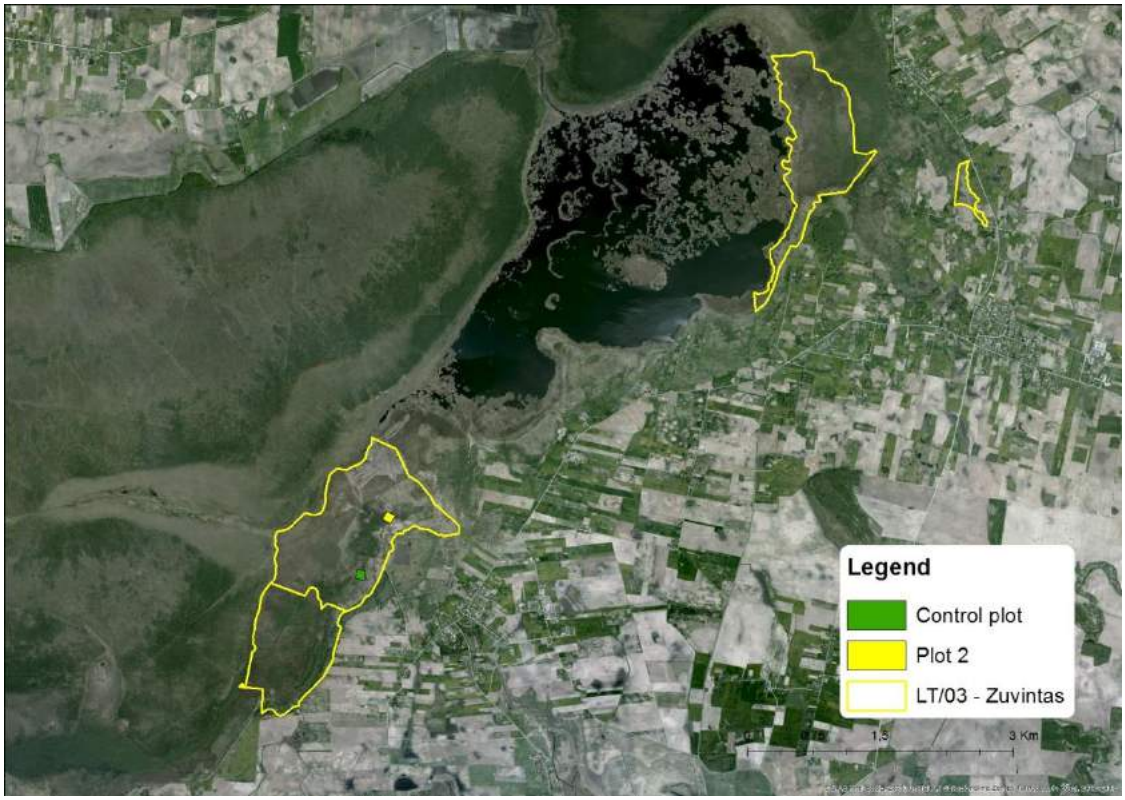

Fig. 13. Location of invertebrate monitoring sites in Žuvintas LT/03.

Table 58. Number of speciments of ground beetles, cought with pitfall traps in project site Žuvintas.
Indexes: D, dominants – species with abundance more than 5%; Sd, subdominants – abundance from 2 to 5%; R, recendents – abundance from 1 to 2%; Sr, subrecedents – abundance less than 1%

Species	Control plot	Plot 2
Agonum sp.	23^{D}	9^{D}
Badister (Baudia) sp.	1^{R}	1^{R}
Carabus clathratus	2^{Sd}	13^{D}

Carabus granulatus	2 Sd	6D
Chlaenius costulatus	2 Sd	1R
Chlaenius tristis		7 D
Elaphrus aureus	1R	1R
Oodes helopioides	20D	25D
Pterostichus aterrimus	17D	21D
Pterostichus diligens		1R
Pterostichus minor	2 Sd	3 Sd
Pterostichus nigrita/rhaeticus	10D	6D
Trepanes doris		1R
Total:	**80**	**95**

Flying invertebrates. In total almost twenty-two thousand of invertebrate specimens were caught with Malaise traps in Žuvintas project sites (21889 specimens, Table 59). The most numerous group in the traps were Diptera, greatly exceeding the other groups in numbers of specimens (Table 60). The second most-numerous group was hymenopterans, followed by Hemiptera, Coleoptera, Lepidoptera and others (Table 60).

Table 59. Total number of invertebrates caught in Malaise traps in project site Apvardai

Number of sample	1st sample	2nd sample	3rd sample	4th sample	**TOTAL** (44 days)	**Average number of specimens/day**
Date	2017-07-02	2017-07-14	2017-07-22	2017-08-03		
Number of specimens collected	5953	4553	3460	7923	21889	497,5

Table 60. Total number of invertebrates caught in Malaise traps in project site Žuvintas by groups

Groups	**Number of specimens**
Araneae	10
Blattodea	1
Coleoptera	747
Diptera	18095
Ephemeroptera	6
Hemiptera	444
Hymenoptera	1929
Lepidoptera	416
Mecoptera	2
Neuroptera	5
Odonata	1
Psocoptera	31
Trichoptera	201
TOTAL:	21888

The most numerous group of Diptera in Žuvintas was Chironomidae, where they made up to 19%. Dolichopodidae were also very numerous in Žuvintas, making the second most numerous group of Diptera. The third group in numbers of specimens were Muscidae, followed by Syrphidae,

Ceratopogonidae, Anthomyiidae, Psychodidae, Simuliidae, Hybotidae, Calliphoridae, Chloropidae, Cecidomyidae and others (Table 61).

Table 61. Total number of specimens of main diptera families caught in Malaise traps in project site Žuvintas

Family name	Number of specimens
Anthomyiidae	947
Calliphoridae	293
Cecidomyidae	255
Ceratopogonidae	1060
Chironomidae	4126
Chloropidae	270
Culicidae	432
Dolichopodidae	2658
Hybotidae	317
Muscidae	1931
Mycetophilidae	71
Psychodidae	497
Scathophagidae	130
Sciaridae	211
Sciomyzidae	194
Sepsidae	215
Simuliidae	403
Syrphidae	1860
Tabanidae	649

Hortobiontic invertebrates. When invertebrates are grouped into four weight classes (Table 62), the total biomass is found to be higher in all weight groups in Control plots of July and in June for the smaller weight groups of 1–5 mg and 5–10 mg. The Plot 2 plots had higher biomass only of heavier weight groups in June (Table 62). Invertebrates of the lightest group (1–5 mg) were most abundant in all the inspected plots. The dominance of other weight groups varied between the sites. The 5–10 mg group was more abundant in Plot 2 in Žuvintas. (Table 62).

Table 62. Distribution of invertebrate biomass (mg) per 100 sweeps in different weight classes in project site Žuvintas

		Weight classes				
		1–5 mg	**5–10 mg**	**10–20 mg**	**> 20 mg**	**Without 1-5mg group**
Tyrai June	Control	117,5	8,1	8,0	45,5	611,4
	Plot 2	301,4	25,9	2,8	13,1	
Tyrai July	Control	547,9	63,7	75,6	92,7	
	Plot 2	531,0	84,2	53,3	143,2	

For all monitoring sites the total invertebrate biomass was highest on Plots 2 compared to Control plots (Table 63, 64), the same tendency is reflected if the biomass is calculated per meter of netting effort (Table 63, 64). Diptera formed the highest proportion of biomass in all the sweep net samples (Tables 63, 64). The second most abundant group by total biomass in June was Homoptera, followed by Coleoptera while Orthoptera were second most abundant in July, followed by

Homoptera. Diptera were also the most abundant group by number of specimens per 100 sweeps in all the sweep net samples combined. The second most numerous groups were Homoptera, followed by Heteroptera. Coleoptera were the fourth most numerous group in June and Arachnida – in July.

The number of specimens caught in Control plots in Žuvintas June sample were higher compared to Plot 2, the same tendency as in biomass of those plots. Žuvintas July sample had the number of invertebrates higher in Control plot compared to the biomass that was higher in Plot 2 plots. This can be explained by the several Lepidoptera adults that added to the biomass rather significantly.

Table 63. Biomass and number of invertebrates in project site Žuvintas

	Biomass, June (mg per 100 sweeps)		**Biomass, July** (mg per 100 sweeps)		**Number of specimens, June**		**Number of specimens, July**	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	9,6	8,2	90,4	55,8	2,5	3	19,5	18,25
Mollusca	0,9	11,9	103,3	69,5	0,25	2	24,5	4,75
Coleoptera	17,5	21,8	53,7	24,7	11,25	9,75	40,25	7,5
Diptera	88,1	177,7	239,4	348,7	84,5	165,75	182,25	215
Heteroptera	1,4	37,9	45,3	52,7	1,5	45,5	31	25,75
Homoptera	8,0	38,8	96,7	62,3	7	34,5	61	44,25
Hymenoptera	5,1	19,5	42,9	24,1	4	9,25	22,5	11,25
Hymenoptera larvae	0,0	8,8	42,5	74,9	0	1,5	5,75	14
Lepidoptera larvae	44,7	0,0	7,1	0,0	0,75	0	0,25	0
Lepidoptera adults	0,0	1,0	2,9	0,8	0	0,25	1,5	0,75
Orthoptera	0,0	7,8	41,3	82,1	0	0,25	1,75	2,5
Trichoptera	3,7	7,0	10,2	15,9	0,25	0,5	1,25	1,5
Odonata Zygoptera	0,0	2,8	0,0	0,0	0	0,25	0	0
Odonata Anisoptera	0,0	0,0	0,0	0,0	0	0	0	0
Total:	179,1	343,1	779,6	811,7	112	272,5	391,5	345,5
	mg/meter (sweep)		mg/meter (sweep)					
Total:	1,8	3,4	7,8	8,1				

Pollinating insects. The number of pollinator taxa obtained from net sampling in Žuvintas was 40, while Malaise trapping added 59 taxa (Table 13). Chironomidae (22.5%) were the most numerous pollinator group in Žuvintas, followed by Scatopsidae (20.4%) and Cyclorhapha (19.5%). Out of the main pollinator group – Apidae, only single specimens of *Bombus* were caught and 1 specimen of solitary bees (Apidaewas cought in Žuvintas. If net sampling and Malaise trap material is combined (Table 14), the total number of pollinator taxa in Žuvintas is highest. High number of specimens in combined material was also found here. In Žuvintas project site the pollinator richness (H'=3.01) was highest, and pollinator assemblages were distributed most evenly (1-D=0.91) there as well. Equality of the taxa abundance was almost the same as in Šyša (E=0.65).

Table 64. Number of taxa, specimens and biodiversity indexes of selected pollinators from the net sampling alone and net sampling with Malaise traps combined, in project site Žuvintas

	Net sampling	

	Control plot	Plot2	Combined	**Net sampling and Malaise traps combined**
Taxa	37	34	40	99
Specimens	1123	1588	2676	20908
Shannon (H')	2,24	2,22	2,23	3.01
Simpson (1-D)	0,84	0,85	0,84	0.91
Pielou (E)	0,62	0,63	0,61	0.65

6.3. Hydrological monitoring

In the project area LT/03-Zuvintas one water level measuring gauge was installed in Kiaulyčia fen. The measurements here began on June 22, 2017, when the water level was 17 cm below the surface of the soil. Subsequently, due to a prolonged rainy period, the water level rose a few centimeters above the surface of the soil and remained within the 9 cm range until the end of October. Taking into account the fact that in 2017 the summer was exceptionally rainy, we can not say that this water level is characteristic of this area every year. However, the data obtained suggest that in the rainy season, when water rises above the surface of the soil, part of the ground-nesting birds can have lost their nestlings. This circumstance must be taken into account in the assessment of the success of productivity of local Aquatic Warbler population.

Fig. 14. Locations of water level measuring gauges in project site LT/03-Žuvintas.

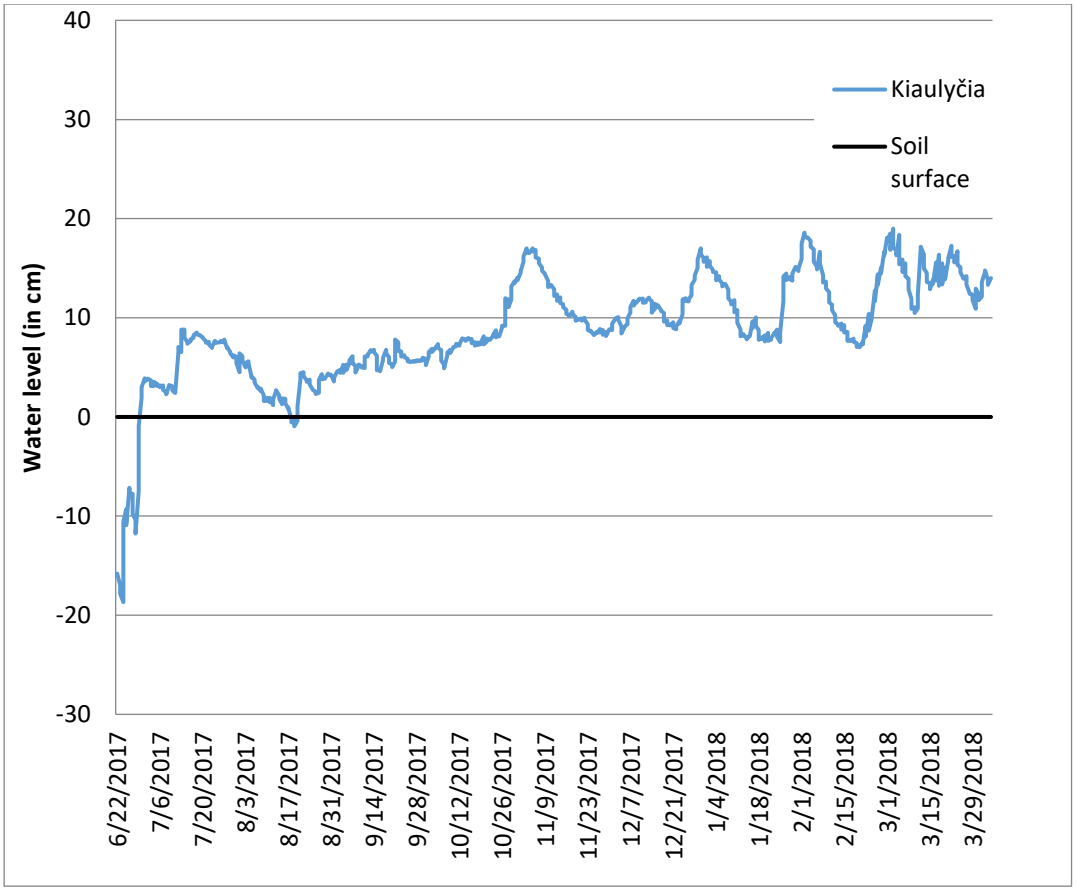

Fig. 15. Water dynamic in project site LT/03-Žuvintas.

7. Project site LT/04-Sysa/Sausgalviai

7.1. Bird monitoring

With the total population ranging from 22 to 43 males of Aquatic Warbler males in the period 2014-2017 these areas remain important species breeding places in Lithuania. The distribution of Aquatic Warbler males in project areas is shown in Figures 16 and 17. The area is also important for wetland birds such as Great Snipe (*Galinago media*) (9 calling males), Common redshank (*Tringa totanus*) (5 breeding pairs) and Corncrake (*Crex crex*) (129-136 calling males). In total, 14 species of birds were found during the breeding season 2017.

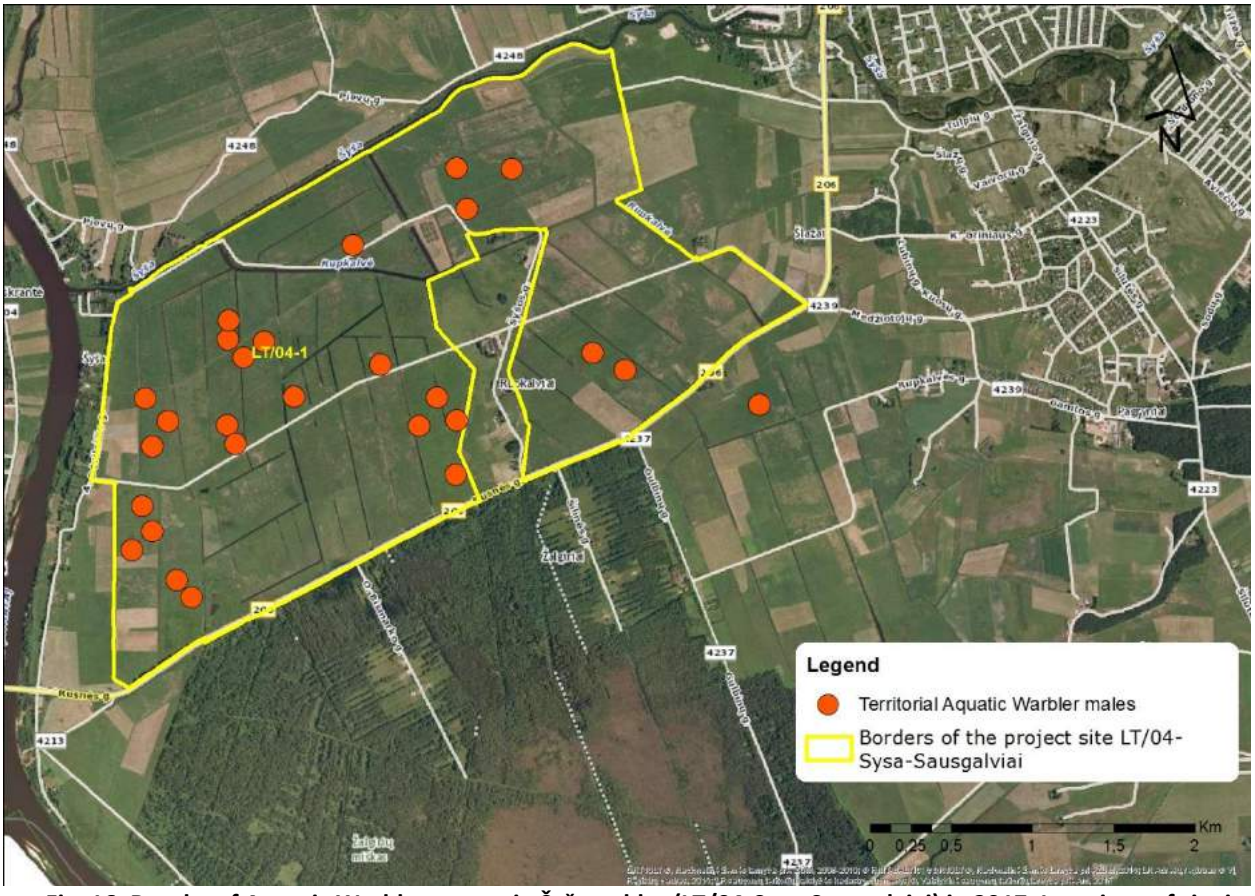

Fig. 16. Results of Aquatic Warbler census in Šyša polder (LT/04-Sysa-Sausgalviai) in 2017. Locations of singing males are marked with orange dots.

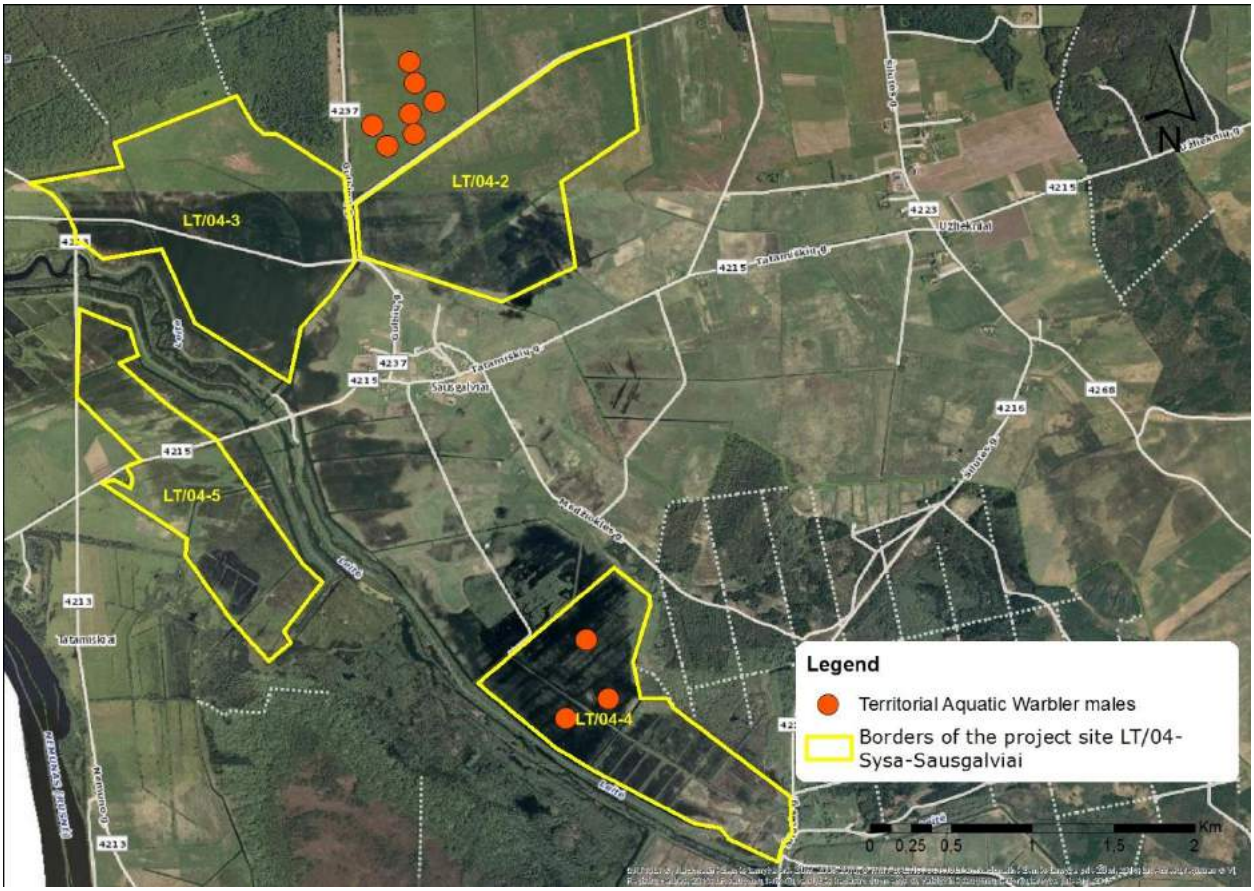

Fig. 17. Results of Aquatic Warbler census in Sausgalviai polder (LT/04-Sysa/Sausgalviai) in 2017. Locations of singing males are marked with orange dots.

7.2. Vegetation monitoring

Vegetation characteristics of Sausgalviai Summer polder

The vegetation of Sausgalviai summer polder depending on site's conditions is composed of plant communities with various ecological requirements (helophyte and hygrophyte, also mesophyte communities). Plant communities are different in number of species: vascular plant species vary between 10 and 34 species; there was only 1 moss species that was found rarely – only in 11.8% of described communities. Woody plants are rare in the territory because of wetland management and regular mowing during past few years. Grass layer is very dense (coverage – 95–100%), height varies within the range of 80–260 cm. The amount of freshly phytomass varies between 1440 and 4720 g/1m^2.

Helophyte communities

Helophyte communities predominate in the area. In the depressions flooded until mid-July on the mineral soil which sometimes is covered by thin layer of the peat occur *Phragmitetum australis, Glycerietum maximae and Caricetum gracilis* var. *Phragmites australis* plant communities. In the areas with slightly shorter flood *Caricetum gracilis* communities are common. Higher relief areas are occupied by *Phalaridetum arundinaceae* communities.

Majority of communities' parameters vary in wide range. Dense grass layer was found in almost all plant communities (98.6±1.5%) (1 table). The height of the grass layer varied between 109 and 260 cm (157.4±36.4 cm). Lowest height was measured in *Caricetum gracilis* communities, while in *Phragmites australis* communities it was highest. Big difference was found in height of second and third levels of the layer: 75–190 cm (114.9±27.4 cm) in second and 54–120 cm (70.7±19.6 cm) in third level. Great height differences are common even in communities that can be assigned for the same association (*Caricetum gracilis*), that developed in different hydrological conditions. Only fourth level in various helophyte communities was similar in height – 30.3±5.6 cm.

The amount of the fresh phytomass in $1m^2$ varied greatly (3185.7±782.0 g/m^2). The highest amount (4720 g) was in *Phragmites australis* community and the lowest (1920 g) in *Phalaridetum arundinaceae* community that developed in high water level conditions. Great variation was determined between communities that were assigned for same associations but developed in different conditions: in *Caricetum gracilis* communities amount of the fresh phytomass in $1m^2$ was between 2400 g and 3760 g, while in *Phalaridetum arundinaceae* community it ranged between 1920 g and 4000 g.

Number of vascular plant species in different communities varied within the range 10–34 species (17.8±6.1). The lowest number (10) of species was found in *Phragmites australis* community, while the highest (34) – in *Caricetum gracilis* community, where because of favourable hydrological conditions not only helophytes but also higrophytes and mesophytes grow. Bryophytes were absent or rare (coverage 0.1%).

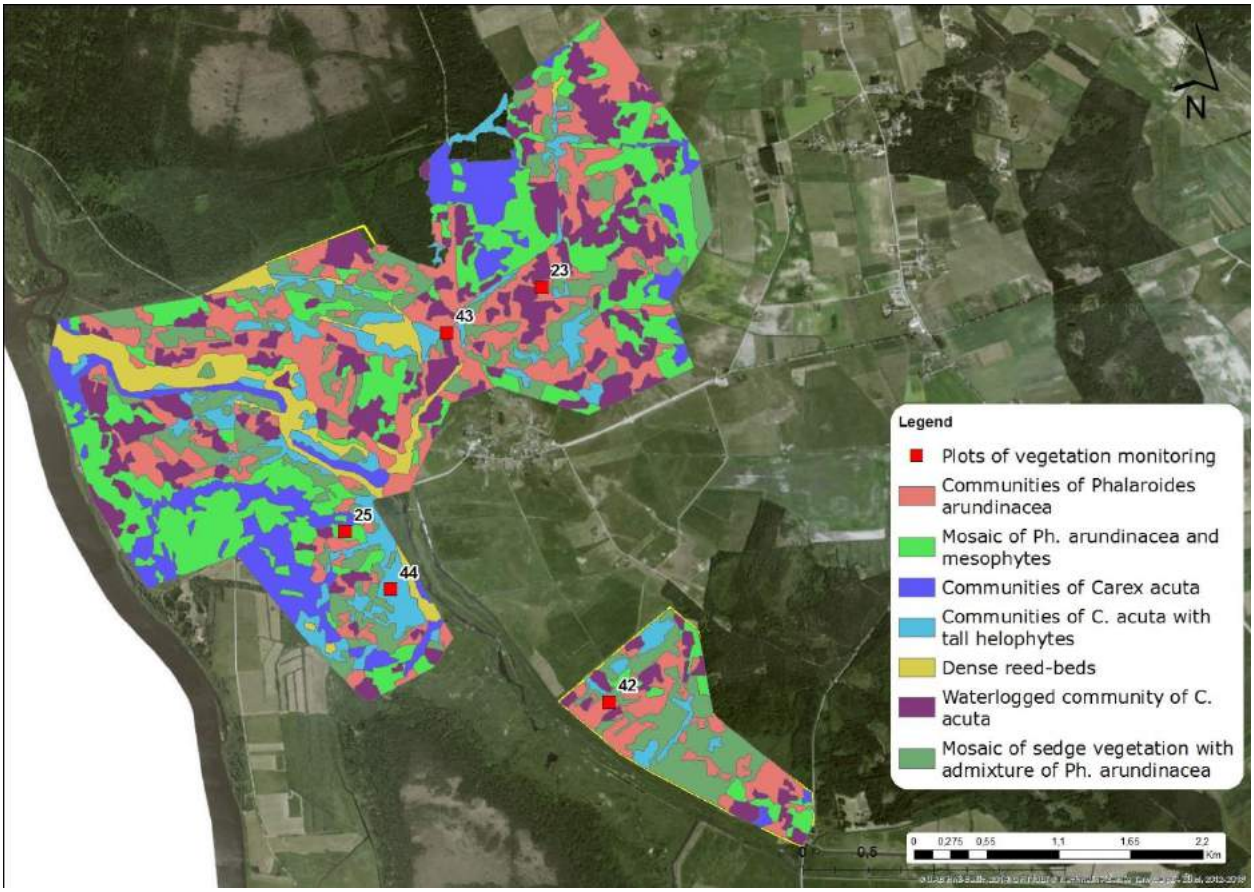

Fig. 18. Distribution of plant communities in Sausgalviai polder in 2017.

Hygrophyte and mesophyte communities

Hygrophyte and mesophyte communities usually develop in areas flooded for shorter period. *Deschampsietum cespitosae* communities are found in areas with always or almost always moist soil. In areas, where vegetation is stunted due to longer periods of high water levels, hygrophyte and mesophyte communities develop with *Potentilla anserina* as a dominant species.

Table 65. Results of the vegetation measurements (average and STDEV) in Sausgalviai summer polder

Measurements	Helophyte communities	Mesophyte & hygrophyte communities
Weight of the fresh phytomass (g/m^2)	3185.7±782.0	2906.7±1320.2
Height of the 1st grass layer (cm)	157.4±36.4	156.8±45.0
Height of the 2nd grass layer (cm)	114.9±27.4	109.3±45.8
Height of the 3rd grass layer (cm)	70.7±19.6	67.3±32.3
Height of the 4th grass layer (cm)	30.3±5.6	28.8±15.3
Coverage of the shrub layer (%)	0.0±0.0	0.0±0.1
Coverage of the herb layer (%)	98.6±1.5	98.5±2.1
Coverage of sedges (%)	36.3±36.5	1.7±2.9
Coverage of other grasses (%)	62.5±37.4	95.3±4.6
Coverage of brown mosses (%)	0.0±0.0	0.0±0.0
Species number of the vascular plants	17.8±6.1	18.6±10.8
Species number of the bryophytes	0.1±0.3	0.0±0.0

Shrubs are absent or rare because of constant usage of grasslands. Grass layer is dense – 98.5±2.1%. Because of unfavourable hydrological conditions moss layer is not developed.

Despite the similar density of grass layer, hygrophyte and communities mesophyte depending on hydrological conditions were different in their grass layers height, green phytomass amount, number of species (Table 65) and species composition. The height of grass layer varies between 80 and 170 cm (average 156.8±45.0 cm). Lowest grass layer, characterized by pioneer hygrophyte and mesophyte communities with *Potentilla anserina* as a dominant species, was observed. Other grass levels also greatly varied in height: second level – 50–140 cm, third – 26–90 cm and fourth – 15–45 cm. The amount of fresh phytomass in 1 m^2 varied between 1440 and 4000 g (average 2906.7±1320.2 g). Minimum amount of fresh phytomass was in communities of pioneer hygrophyte and mesophyte with *Potentilla anserine* as a dominant species.

In 100 m^2 number of vascular plant species was very different – 17–38 species (average 18.6±10.8). In particular number of species varied greatly in *Deschampsietum cespitosae* communities. It is determined by different hydrological regime.

The genus *Carex* had a little importance in these hygrophyte and mesophyte communities. The coverage of sedges was only 0.01–5% (average 1.7±2.9%). Edificators of the communities were diverse: *Deschampsia cespitosa, Thalictrum flavum, Potentilla anserina.*

Communities that were similar to helophyte communities (*Deschampsietum cespitosae* var. *Thalictrum flavum*) may be suitable for aquatic warbler because of comparable grass layers height and density.

Protected species in area

Such species were not found in this area.

Alien species found in area

In Sausgalviai summer polder 2 alien species were found: *Echinocystis lobata* (Michx.) Torr. et A. Gray and *Acer negundo* L. Both species are included in the list of invasive species of Lithuania (MASTER OF ENVIRONMENT OF LITHUANIA, 2016).

Acer negundo in Sausgalviai summer polder was found only in one place (X 338687, Y 6130972). One individual smaller than 1m was found in *Deschampsietum cespitosae* plant community.

Echinocystis lobata in Sausgalviai summer polder was found in four places: X 338687, Y 6130972 in *Deschampsietum cespitosae* community, X 339000, Y6130000 and X 339946, Y 6127057 in *Caricetum gracilis* community; X 338768, Y 6129907 in *Glycerietum maximae* plant community. Plants of alien species were not abundant: individuals were single, but all they already reached reproductive stage.

Vegetation characteristics of Šyša Summer polder

The vegetation of Šyša summer polder is influenced by seasonal floods, which duration, amount and type of sediments determines the vegetation type. Tall helophytes grow in lowest places where flood stays longest and finest sediments accumulate. In places where flood stays for shorter periods and they are less fertilized develop helophyte communities with admixture of hygrophytes. Mesophytes can be found in highest places. Dense grass layer is characteristic for the vegetation of Šyša polder (coverage 95–100%). However other features vary greatly: height – 74–244 cm, phytomass – 1240–4640 g, number of species – 9–32. Vegetation is characterized by poor woody plants and sparse moss cover. Regular usage of the meadow prevents the overgrowing with woody plants and long-term floods are unfavourable for moss development.

Helophyte communities.

The diversity of helophyte communities variety in Šyša polder is not high – only three associations are identified (*Caricetum distichae, Caricetum gracilis, Phalaridetum arundinaceae*). Although because of different hydrological conditions there is a considerable variation between studied plots (2 table). The height of the 1st grass level varies between 78 and 244 cm (average 153.3±35.1 cm). The differences in other levels are less: the height of the 2nd level is 56–128 cm (average 101.9±17.7 cm), 3rd – 35–89 cm (average 65.8±14.4 cm), 4th – 17–50 cm (26.9±8.6 cm). The tallest grass was in *Caricetum gracilis* community that developed in the conditions of high ground water table. The highest differences in the height of the grass layer was observed in *Phalaridetum arundinaceae* communities (the height of the 1st level varies between 70 and 179 cm).

The amount of the fresh phytomass in 1 m^2 is highly variable – from 1360 to 4640 g (average 2725.3±858.6 g). The lowest amounts of phytomass was determined in *Caricetum distichae* and *Phalaridetum arundinaceae* communities. In general, the amount of the fresh phytomass in these communities is often near to average. The largest amount of fresh phytomass was found in *Caricetum gracilis* communities.

The number of species in the 100 ^{m2} plot varies greatly – from 9 to 25 species (average 15.5±4.4). Species number is very different because of different water regime, even in areas that belong to the same association.

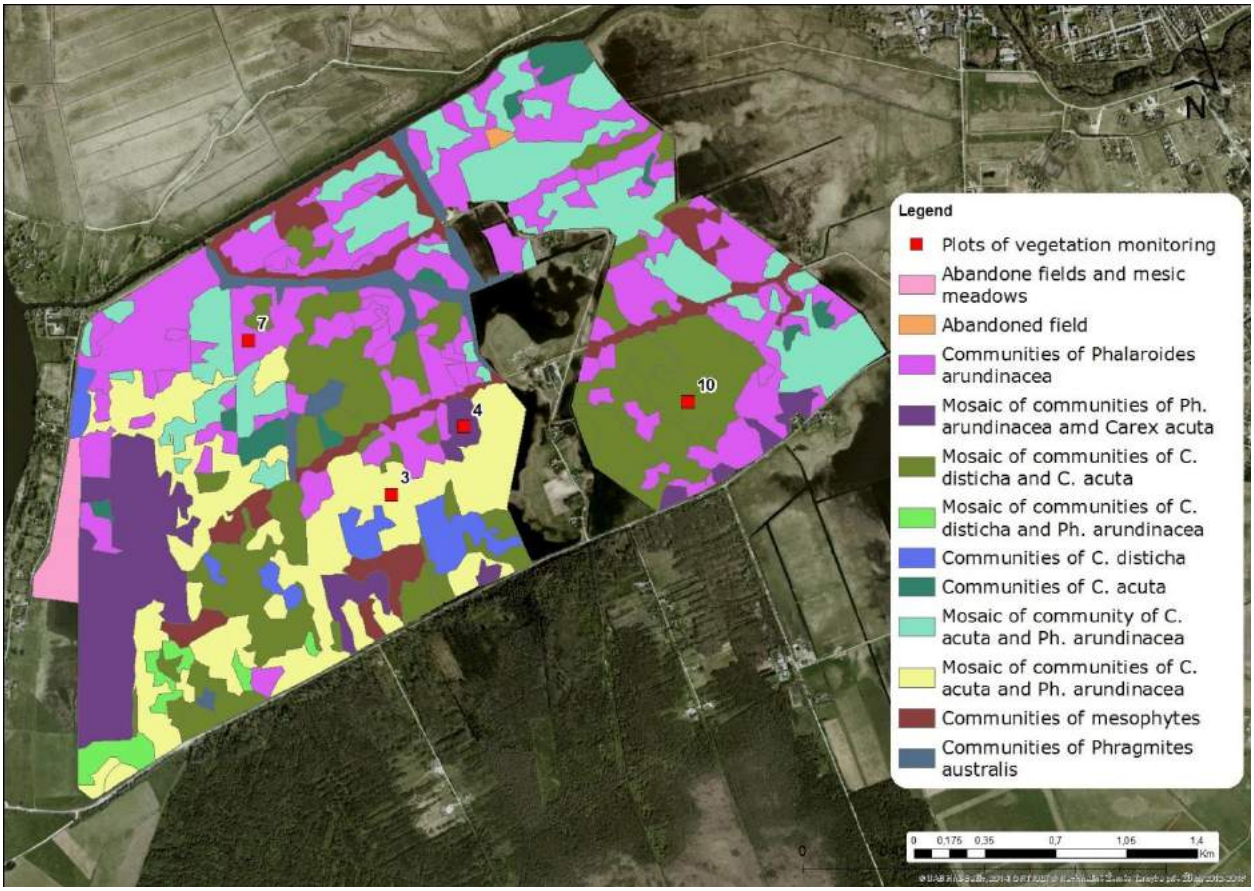

Fig. 19. Distribution of plant communities in Šyša polder in 2017.

Mesophyte meadow.

Mesophyte communities differ depending on hydrological conditions. In moist poorly aerated soil *Deschampsietum cespitosae* communities are developed. Near ditches and riverbed pioneer communities with predominating *Elytrigia repens* are developed, a bit further *Alopecuretum pratensis* communities can be found.

Table 66 Results of the vegetation measurements (average and STDEV) in Šyša summer polder

Measurements	Helophyte communities	Mesophyte & helophyte communities
Weight of the fresh phytomass (g/1m^2)	2725.3±858.6	1996.0±504.0
Height of the 1st grass layer (cm)	153.3±35.1	104.6±20.5
Height of the 2nd grass layer (cm)	101.9±17.7	66.2±13.8
Height of the 3rd grass layer (cm)	65.8±14.4	47.4±14.6
Height of the 4th grass layer (cm)	26.9±8.6	20.0±5.1
Coverage of the shrub layer (%)	0.0±0.0	0.0±0.0
Coverage of the herb layer (%)	98.2±1.3	98.2±1.1
Coverage of sedges (%)	53.9±41.1	7.4±10.3
Coverage of other grasses (%)	46.1±39.6	90.8±11.1
Coverage of brown mosses (%)	1.5±5.7	0.0±0.0
Species number of the vascular plants	15.5±4.4	27.4±4.7
Species number of the bryophytes	0.1±0.3	0.0±0.0

All plant communities have dense grass layer – the coverage reached 97–100% (98.2±1.1%). The 1st grass level is quite low (average 104.6±20.5 cm)., but the variation is high (74–125 cm). The differences levels less: 2nd level – 43–77 cm, the 3rd – 30–62 cm, 4th – 13–24 cm (respectively average heights and standard deviations are 66.2±13.8 cm, 47.4±14.6 cm and 20.0±5.1 cm) (Tble 65). Communities with predominating *Elytrigia repens* distinguished with the low height of all levels. Though, the amounts of the fresh phytomass in these communities are a little above average. The amount of the fresh phytomass in mesophyte communities varies less than in helophyte ones: 1240–2360 g (1996.0±504.0 g).

The species number in mesophyte communities is quite high and rather similar in different communities: 20–32 (27.4±4.7).

Protected species in Šyša polder.

Two rare species (*Scutellaria hastifolia, Viola persicifolia*) that are included in Red Data Book of Lithuania were found in Šyša polder.

Scutellaria hastifolia L. – 2(V) category.

In Šyša summer polder *S. hastifolia* was found in two localities occupied by different plant communities: mesophyte meadow (X 334805, Y 6133901) and in pioneer community with predominating *Elytrigia repens* (X 334848, Y 6133907). In first locality there were about 10 individuals of *S. hastifolia* and in second area – more than 200. In both plant communities plants of *S. hastifolia* have already reached their generative stage.

Viola persicifolia Schreb. – 1(E) category.

In Šyša, summer polder *V. persicifolia* was found in one locality (X 335364, Y 6133455) in *Caricetum distichae* plant community. Part of the population was found in the habitat of aquatic warbler. In this area there were found 2 individuals of *V. persicifolia*; one of these was already with fruits. In a distance from aquatic warbler habitat cut of *V. persicifolia* plants were found in the mowed meadow; in several places lower stems with leaves and somewhere even with fruits were present. In mowed areas there were about 30 individuals and almost all of them have been reached generative stage.

Alien species in the area.

In Šyša summer polder 3 alien species were discovered: *Echinocystis lobata* (Michx.) Torr. et A. Gray, *Lactuca tatarica* (L.) C. A. Mey., *Rumex confertus* Willd. One of them (*Echinocystis lobata*) is included into the list of Lithuania's invasive species (MINISTER OF ENVIRONMENT OF LITHUANIA, 2016).

E. lobata was found in two places of Šyša summer polder: X 334805, Y 6133901 and X 334368, Y 6134187, both in mesophyte meadows. In both sites individuals were already reached their reproductive stage.

L. tatarica was found in one site (X 334368, Y 6134187) in mesophyte meadow. There was only one individual that have been reached thes reproductive stage.

R. confertus was found in one area (X 334805, Y 6133901), also in mesophyte meadow. There were 6 individuals, all they were in the reproductive stage.

7.3. Monitoring of invertebrates

Locations of monitoring sites of invertebrate animals in project site LT/01-Tyrai are shown in Fig. 20.

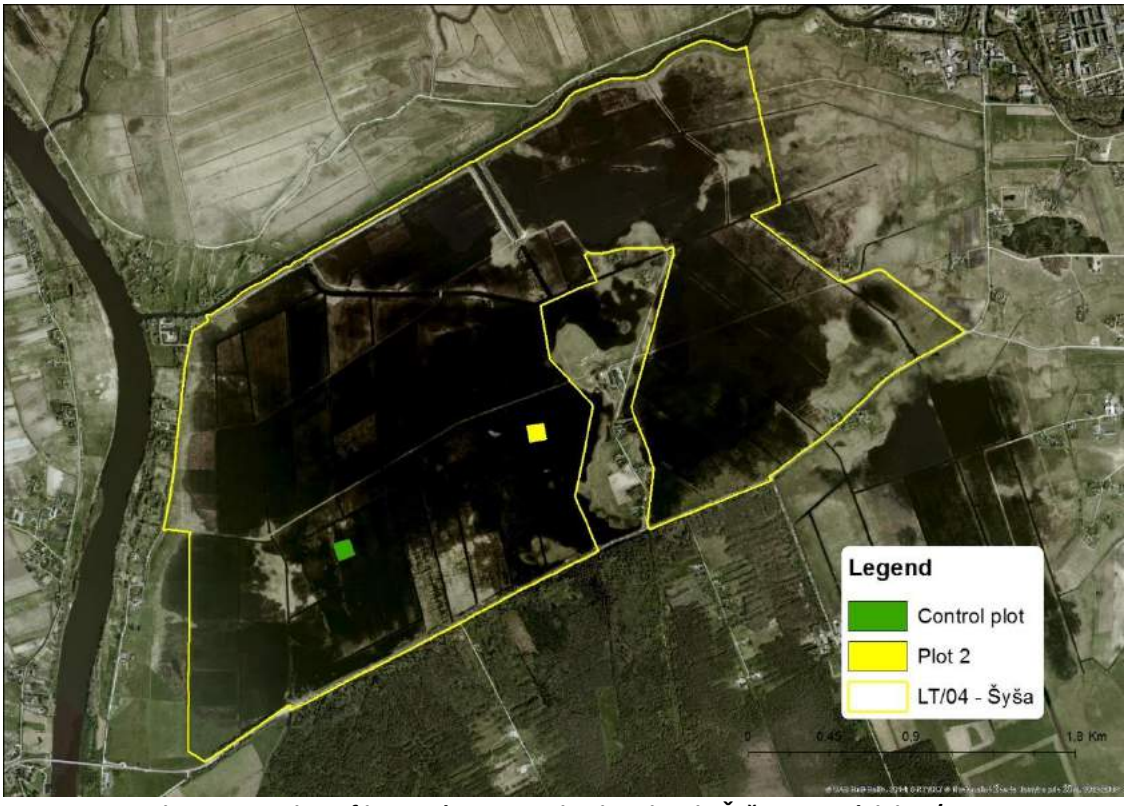

Fig. 20. Location of invertebrate monitoring sites in Šyša-Sausgalviai LT/03.

Monitoring of *Herpetobiontic invertebrates* was performed in two sampling plots in Šyša summer polder. All pitfall samples were successfully retrieved from Šyša, where 502 carabids were caught in Control plot and 603 beetles in Plot 2 (Table 66).

Table 66 Number of speciments of ground beetles, cought with pitfall traps in project site Šyša/Sausgalviai.
Indexes: D, dominants – species with abundance more than 5%; Sd, subdominants – abundance from 2 to 5%; R, recendents – abundance from 1 to 2%; Sr, subrecedents – abundance less than 1%

Species	Control plot	Plot 2
Agonum sp.	68^{D}	67^{D}
Anisodactylus binotatus	1^{Sr}	9^{R}
Bembidion quadrimaculatum	1 ^{Sr}	
Blethisa multipunctata	33^{D}	24^{Sd}
Carabus granulatus	172^{D}	43^{D}
Chlaenius costulatus		
Chlaenius nigricornis	17^{Sd}	9^{R}
Clivina fossor	17 ^{Sd}	6^{R}
Dyschiriodes globosus	1 ^{Sr}	
Harpalus sp.	24^{D}	
Loricera pilicornis	33^{D}	60^{D}
Notaphus obliquus	1 ^{Sr}	

Oodes helopioides	2 Sr	11R
Philochthus biguttatus	4 Sr	5 Sr
Poecilus cupreus	10R	2 Sr
Poecilus versicolor	19Sd	
Pseudoophonus rufipes	28D	7R
Pterostichus anthracinus	47D	199D
Pterostichus gracilis	11Sd	37D
Pterostichus minor	2 Sr	8R
Pterostichus nigrita/rhaeticus	11Sd	116D
Total:	**502**	**603**

During the monitoring of *Flying invertebrates* in total almost thirteen thousand invertebrate specimens were caught with Malaise traps (12989 specimens; Table 67). The most numerous group of flying invertebretes were Diptera, exceeding the other groups in numbers of specimens many times (Table 68). The second most-numerous group were hymenopterans, followed by Trichoptera, Hemiptera and Coleoptera (Table 68).

Table 67 Total number of invertebrates caught in Malaise traps in project site Šyša/Sausgalviai

Number of sample	1st sample	2nd sample	3rd sample	4th sample	**TOTAL** (42 days)	**Average number of specimens/day**
Date	2017-07-06	2017-07-17	2017-07-26	2017-08-06		
Number of specimens collected	2326	2545	3597	4521	12989	295,2

Table 68 Total number of invertebrates caught in Malaise traps by goups in project site Šyša/Sausgalviai

Group	**Number of specimens**
Coleoptera	113
Diptera	12405
Ephemeroptera	3
Hemiptera	244
Hymenoptera	576
Lepidoptera	373
Neuroptera	1
Odonata	22
Psocoptera	12
Trichoptera	246
TOTAL:	13995

Most abundant group of Diptera were Dolichopodidae. They made up about 25% of all the specimens in Šyša/Sausgalviai project site. Chironomidae were also very numerous, making the second most numerous group of Diptera. The third group in numbers of specimens in Šyša were Hybotidae, Syrphidae, Anthomyiidae, Muscidae and Calliphoridae (Table 69).

Table 69 Number of specimens of main Diptera families caught in Malaise traps in project site Šyša/Sausgalviai

Diptera families	Number of specimens
Anthomyiidae	787
Calliphoridae	561
Cecidomyidae	62
Ceratopogonidae	85
Chironomidae	1292
Chloropidae	263
Culicidae	147
Dolichopodidae	3241
Hybotidae	954
Muscidae	640
Mycetophilidae	271
Psychodidae	15
Scathophagidae	58
Sciaridae	76
Sciomyzidae	3
Sepsidae	44
Simuliidae	8
Syrphidae	860
Tabanidae	311

Hortobiontic invertebrates. When invertebrates are grouped into four weight classes (Table 7), the total biomass is found to be higher in all weight groups in Control plots of July and in June for the smaller weight groups of 1–5 mg and 5–10 mg. The Plot 2 plots had higher biomass only of heavier weight groups in June (Table 70). Invertebrates of the lightest group (1–5 mg) were most abundant in all the inspected plots. The dominance of other weight groups varied between the sites. The 5–10 mg group was more abundant in Control plots in Šyša. The group of 10–20 mg was more abundant in Plots 2 Šyša June sample, but in Control plot in Šyša July sample. The heaviest weight group (>20 mg) again was more abundant in Šyša July sample (Table 70).

Table 70 Distribution of invertebrate biomass (mg) per 100 sweeps in different weight classes in project site Šyša/Sausgalviai

		Weight classes				
		1–5 mg	**5–10 mg**	**10–20 mg**	**> 20 mg**	**Without 1-5mg group**
Šyša June	Control	200,2	61,7	58,6	0,0	515,6
	Plot 2	177,1	21,8	69,9	119,2	
Šyša July	Control	357,8	19,4	47,6	88,7	
	Plot 2	133,4	9,5	13,2	5,9	

Ttotal invertebrate biomass was highest on Control plot compared to Plot 2 in Šyša July sample. The same tendency is reflected if the biomass is calculated per meter of netting effort (Table 71, 72). Diptera formed the highest proportion of biomass in all the sweep net samples (Tables 71, 72). The second most abundant group by total biomass in June was Homoptera, followed by Coleoptera while Orthoptera were second most abundant in July, followed by Homoptera.

Diptera were also the most abundant group by number of specimens per 100 sweeps in all the sweep net samples combined. The second most numerous groups were Homoptera, followed by Heteroptera. Coleoptera were the fourth most numerous group in June and Arachnida – in July.

The number of specimens caught in Control plots in Šyša July sample were higher compared to Plot 2, the same tendency as in biomass of those plots. Šyša June sample had the number of invertebrates higher in Control plot compared to the biomass that was higher in Plot 2 plots. This can be explained by the several Lepidoptera adults in Šyša that added to the biomass rather significantly.

Table 71 Biomass and number of invertebrates in project site Šyša/Sausgalviai

	Biomass, June (mg per 100 sweeps)		**Biomass, July** (mg per 100 sweeps)		**Number of specimens, June**		**Number of specimens, July**	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	0,4	0,0	1,0	0,0	0,25	0	1	0
Mollusca	0,0	0,0	0,0	0,0	0	0	0	0
Coleoptera	101,4	50,8	46,3	10,6	20	7,5	20,75	3,5
Diptera	115,7	142,5	225,8	116,7	79,25	77,25	144	45,75
Heteroptera	10,5	2,0	21,8	1,8	7	1,5	21,75	1
Homoptera	18,6	14,0	58,5	6,6	15,5	10	32,25	3,75
Hymenoptera	13,9	4,1	18,7	4,8	8,25	4,25	10,75	2,75
Hymenoptera larvae	51,4	37,8	15,4	13,9	13,25	4,25	2	1,5
Lepidoptera larvae	0,0	0,0	0,4	0,0	0	0	0,25	0
Lepidoptera adults	1,1	114,2	2,6	0,0	0,5	2	1,25	0
Orthoptera	7,6	22,6	123,2	7,6	1,5	1,5	4,25	0,5
Trichoptera	0,0	0,0	0,0	0,0	0	0	0	0
Odonata Zygoptera	0,0	0,0	0,0	0,0	0	0	0	0
Odonata Anisoptera	0,0	0,0	0,0	0,0	0	0	0	0
Total:	320,6	388,0	513,5	161,9	145,5	108,25	238,25	58,75
	mg/meter (sweep)		mg/meter (sweep)					
Total:	3,2	3,9	5,1	1,6				

Pollinating insects. The total number of pollinator taxa in project site Šyša/Saugalviai using net sampling data was 33, and 66, when combained data of net sampling and Malaise trapping were used. most numerous group in Šyša were Syrphidae (19.8%), followed by Dolichopodidae (16.4%) and Calliphoridae (12.4%). Out of the main pollinator group – Apidae, only single specimens of *Bombus* were caught, and several specimens of solitary bees (Apidae) – 5, in Šyša were cought.

The pollinator richness (H') in Šyša/Saugalviai project site was comparatively high and pollinator assemblages were distributed quite evenly (1-D=0.89) there as well. The equality of the taxa abundance (E) was 0.66.

Table 72 Number of taxa, specimens and biodiversity indexes of selected pollinators from the net sampling alone and net sampling with Malaise traps combined, in project site Šyša/Sausgalviai

	Net sampling			**Net sampling and Malaise traps combined**
	Control plot	Plot2	Combined	
Taxa	26	25	33	66
Specimens	918	527	1418	12158

Shannon (H')	2,33	2,38	2,46	2.75
Simpson (1-D)	0,87	0,87	0,89	0.88
Pielou (E)	0,72	0,74	0,70	0.66

7.4. Hydrological monitoring

The project areas located in the polder meadows in the Nemunas Delta region are one of the most important Aquatic Warbler breeding sites in Lithuania. These areas are regularly flooded during the spring flood of the Nemunas River, but in 2017, the flood began on the 25th of September, when the water in Sausgalviai polder (gauge "Sausgalviai") rose above the surface of the soil, and at the end of October it reached 133 centimeters. Water was fluctuating almost simultaneously in the Šyša polder (gauge "Šyša"), but the flooding there began several days later, and in the spring it ended several days earlier. During the vegetation period, the water in both territories most of the time remained below the surface of the soil, but in the beginning of July it rose for a short time above the surface of the soil: On July 1-6th, the water raised up to 13 cm above the soil surface at Šyša polder. In Sausgalviai polder almost at the same time water rised 5 cm above the surface of the soil and the flood there last for one day only. The diagram also indicates period of intensive pumping of flood water from the polders. In the end of May water significantly droped below the soil surface: to roughly 50 cm (Šyša polder) or 70 cm (Sausgalviai polder) below the surface of the soil.

Fig. 21. Location of water level monitoring gauges in Šyša-Sausgalviai LT/03.

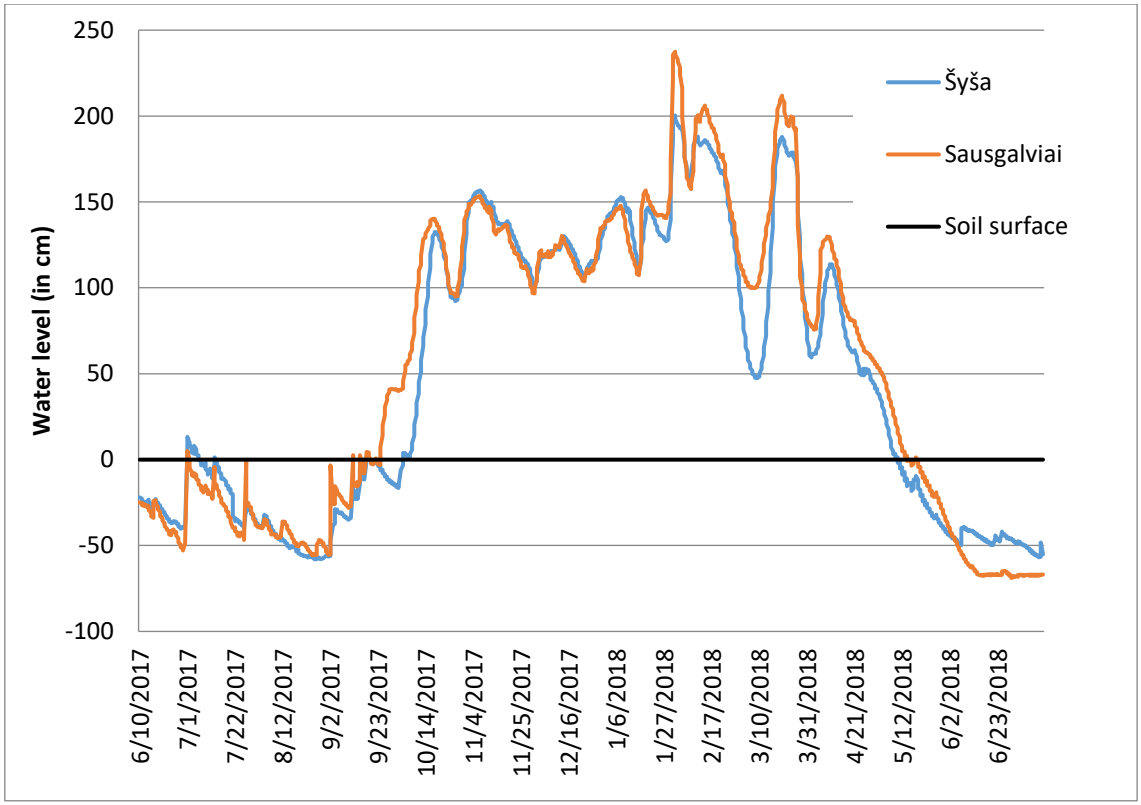

Fig. 22. Water dynamic in project site LT/04-Sysa/Sausgalviai.

8. BY/05-Dokudovskoe

8.1. Bird monitoring

On the territory of the project site BY/05-Dokudovskoe three line transects with a total length of 4,2 km were established for conducting of bird censuses along them. Great Reed Warbler, Sedge Warbler and Common Whitethroat were the most common bird species for the highly waterlogged route. Common species for the route, partly overgrown with shrubs, were Common Whitethroat, Willow Warbler, and in almost open peat extraction grounds – Citrine Wagtail and Whinchat. These routes will be used as control ones to compare processes, which will take place after rewetting of the extracted peatland.

9. BY/06-Servech

9.1. Bird monitoring

Absolute counts of singing males of Aquatic Warbler in project site BY/06-Servech were conducted in the period from the middle to the end of June 2018. The total number counted was 48 birds, which is a bit lower than in previous years (Fig. 23). Perhaps, this number was affected by abrupt changes in the groundwater table during the breeding season.

Only 2 pairs of the Citrine Wagtail were registered along the monitoring routes with a total length of 2,4 km. Common Redshank, Great Snipe, Corncrake, Montagu's Harrier, Short-eared Owl and Black-tailed Godwit were not detected on the whole territory of the sedge mire adjacent to the lake Servech. Two singing males of the Spotted Crake were observed in the coastal zone of the lake. Eurasian Curlew was irregularly registered within the mire Servech as a visitor.

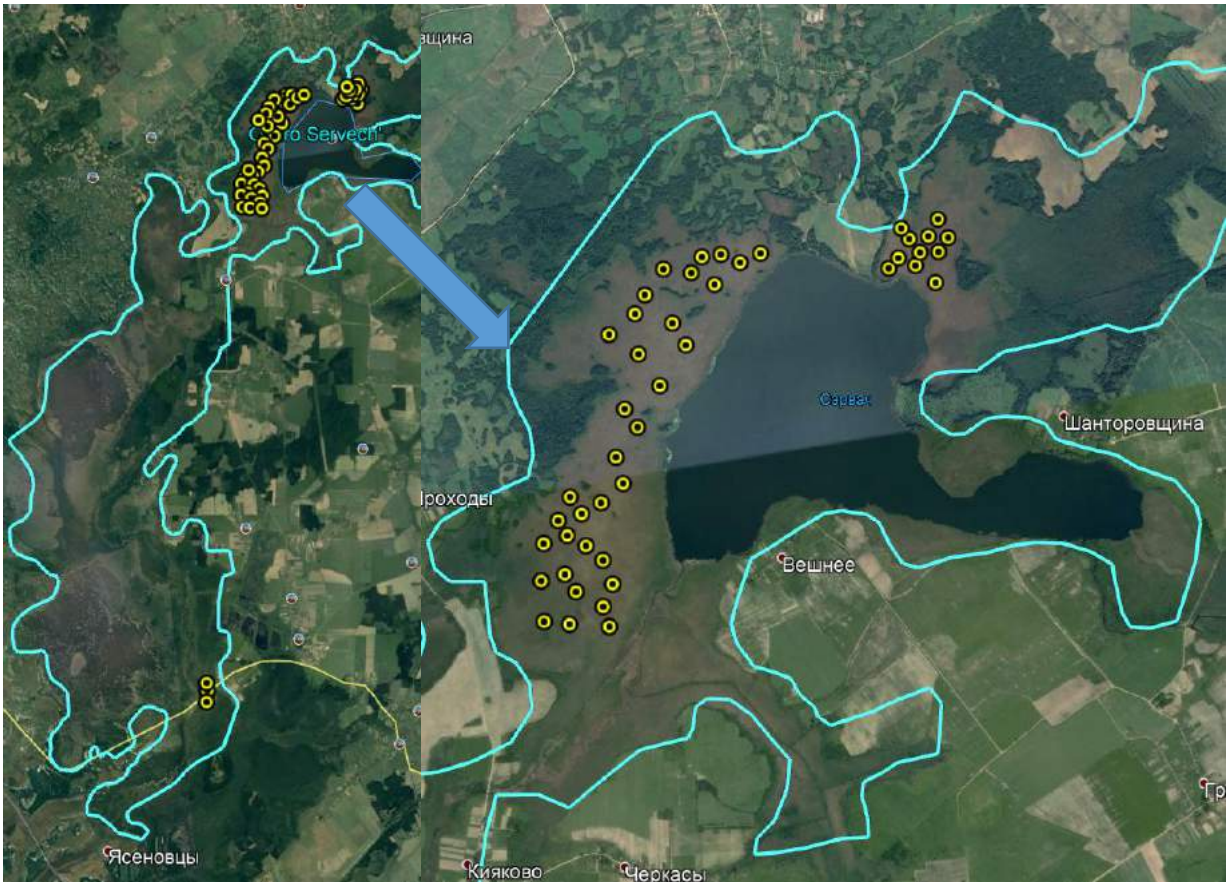

Fig. 23. Distribution of singing males of the Aquatic Warbler throughout the territory of the protected area Servech in 2018.

9.2. Vegetation monitoring

In the current vegetation structure of the Servech site (Table 73, Picture 24) forests occupy 83.4 ha (13.6% of the site's area), mires - 464.7 ha (76%), small forest and shrubs – 63.3 ha (10.4%).

The core of the project site is large sedge fen mire that occupies 382.3 ha (62.5%). Background communities of the fen mire are phytocenoses with domination of the Slender sedge (*Carex lasiocarpa*), Bottle sedge (*C. rostrata*), Tussock sedge (*C. elata*), less often - *Carex appropinquata.*

Communities *Caricetum elatae* (Fig. 24) are among the ecosystem-forming associations of the vegetation cover of the project site (№7a, Fig. 24). They are characterized by a high sedge layer (0.6–0.7 m), formed solely by the Tussock sedge *Carex elata*, sometimes with a share of co-dominant Slender sedge (*C. lasiocarpa*), less often – Bottle sedge (*C. rostrate*). The mire's herb layer (*Comarum palustre*, *Equisetum fluviatile*, *Menyanthes trifoliata*) is present not in all communities. Moss cover is poor (total projective coverage rarely exceeds 15%), includes *Calliergonella cuspudata*, *Hamatocaulis vernicosus*, *Helodium blandowii* and *Aulacomnium palustre*.

The second ecosystem-forming association of the project site is *Betulo humilis-Salicetum repentis* (№ 7c, Fig. 24), which occupies rich habitats (mire water's pH is 6.5–6.9, conductivity (EC) – 420–550 µS/cm) with water level from -5 to -15 cm. The communities have 3 storeys. Tree-shrub storey has 2 sub-layers: the upper one (canopy density is 0.1–0.2) is dominated by the Downy birch (*Betula pubescens*), less often - pine (*Pinus sylvestris* f. *uligonosa* and f. *Litwinowii*); the lower layer is formed by *Betula humilis*, willows – *Salix cinerea*, *S. lapponum*, *S. rosmarinifolia*, and by Juniper *Juniperus communis*. The grass layer consists of sedges (*Carex lasiocarpa*, *C. rostrata*, *C. diandra*, *C. dioica*), cottongrass *(Eriophorum vaginatum*, *E. polystachyon*), horsetail (*Equisetum fluviatile*) and mire herbs (*Menyanthes trifoliata*, *Comarum palustre*). The characteristic feature of this community is quite high share of rare and protected plant species in the grass stands (*Betula humilis*, *Salix lapponum*, *Eriophorum gracile*, *Liparis loeselii*, *Baeothryon alpinum*, *Dactylorhiza ochroleuca* and other). The moss cover often includes Sphagnum eutrophic species (projective coverage up to 20–40%) - *Sphagnum warnstorfii*, *Sph. teres, Sph. contorum*, meso- and oligomesothrophic (*Sph. centrale*, *Sph. fallax*) and Bryidae mosses (*Bryum* sp., *Drepanocladus aduncus*), not forming the dense cover and with the projective coverage up to 25–40% in total.

There is a complex of hygrophyte large sedge communities MAGNO-CARICION ELATAE in the center of the western part of the project area, which are dominated by ass. *Peucedano palustris-Caricetum lasiocarpae*, ass. *Caricetum elatae*, ass. *Equiseto fluviatilis-Caricetum rostratae* (№ 7b, Fig. 24). These are characterized by the grass cover consisting of hydromesophilic and mesohydrophilic species with domination of sedges (*Carex lasiocarpa*, *C. rostrata*, *C. elata,* less often *Carex appropinquata*).

The significant part of the mire is at the succession stage of overgrowing with reeds (mapped taxon № 7d, Fig. 24) and (or) trees and shrubs (№ 7d, Fig. 24). As a rule, these parts are situated along the periphery of the project area, as well as in the coastal area (up to 220-270 m) of Servech Lake. Area of the sedge fen mire in stage of overgrowing is 144.7 ha, or 23.7% of the project site.

Monodominant reed stands occupy the coastal zone of Servech Lake. The grass layer has medium density, its projective coverage is 10-50%; reed *Phragmites australis* dominates, sometimes other species co-dominate: Purple loosestrife *Lythrum salicaria*, Marsh fen *Thelypteris palustris*, Great water-parsnip *Sium latifolium*, Broadleaf cattail *Typha latifolia*, Acute sedge *Carex acuta* can be found quite often.

Table 73 Structure of the vegetation cover and legend of the geobotanical map of the project area Servech

Number on the map	Vegetation communities and groups	Syntaxons, types of vegetation cover structures	Dominant and diagnostic species	Area	
				ha	%
1	2	3	4	5	6
		FOREST VEGETATION			
1	Oak, spruce-oak blueberry with boreal and nemoral grasses	ass. ***Vaccinio 104yrtillis-Quercetum roboris***	*Quercus robur, Corylus avellana, Calamagrostis arundinacea, Convallaria majalis, Melampyrum nemorosum, Pteridium aquilinum, Rubus saxatilis, Vaccinium myrtillus*	1.3	0.2
2	Birch with aspen, spruce, cereals – bracken with taiga species and spots of green mosses	ass. ***Querco roboris – Piceetum abietis*** (fac. *Betula pendula*)	*Betula pendula, Populus tremula, Calamagrostis arundinacea*, *Convallaria majalis*, *Pteridium aquilinum*, *Maianthemum bifolium*, *Rubus saxatilis*, *Hylocomium splendens*, *Pleurozium schreberi*	11.7	1.9
3	Birch-black alder with aspen and grey alder, ground elder	ass. ***Mercurialo perrenis-Quercetum roboris***	*Betula pendula, Alnus glutinosa, Alnus incana, Populus tremula, Aegopodium podagraria*, *Asarum europaeum*, *Mercurialis perennis*, *Urtica dioica*	6.8	1.1
4	Downy birch and black alder - downy birch hygrophilic-grass-sedge	ass. ***Thelypterido palustris-Betuletum pubescentis***	*Alnus glutinosa, Betula pubescens, Carex acutiformis*, *C. canescens*, *Comarum palustre*, *Filipendula ulmaria*, *Equisetum fluviatile*, *Menyanthes trifoliata*, *Peucedanum palustre*, *Phragmites australis*, *Thelypteris palustris*	35.6	5.8
5	Black alder and downy birch – black alder hygrophilic-grass-sedge, often with dense shrub layer	ass. ***Carici elongatae-Alnetum glutinosae***	*Alnus glutinosa, Betula pubescens, Frangula alnus, Salix cinerea, S. triandra, S.pentandra, Athyrium filix-femina, Calla palustris, Carex acutiformis, C. elongata, C. pseudocyperus, Comarum palustre, Equisetum fluviatile, Iris*	28.0	4.6

Number on the map	Vegetation communities and groups	Syntaxons, types of vegetation cover structures	Dominant and diagnostic species	Area	
				ha	%
1	2	3	4	5	6
			pseudacorus, Menyanthes trifoliata, Phragmites australis, Solanum dulcamara, Thelypteris palustris		
	SEDGE AND GRASS VEGETATION OF FEN MIRES AND LITTORAL ZONE OF WATERBODIES				
6	Reed stands	ass. ***Phragmitetum australis***	*Phragmites australis, Lythrum salicaria*, *Sium latifolium, Typha latifolia, Carex acuta*	19.7	3.2
	Sedge fen mire				
7a	Hygrophyte communities with prevalence of the Tussock sedge	ass. ***Caricetum elatae***	*Carex elata*	62.7	10.3
7b	Grass-sedge-hypnum	Complex of hygrophyte large sedge communities MAGNO-CARICION ELATAE (dominating are: ass. ***Peucedano palustris-Caricetum lasiocarpae*** + ass. ***Caricetum elatae*** + ass. ***Caricetum appropinquatae***)	*Carex lasiocarpa*, *C. rostrata*, *C. elata, Equisetum fluviatile*, *Thelypteris palustris*, *Peucedanum palustre*, *Comarum palustre*, species of the genus *Drepanocladus*, *Aulacomium palustre*, *Calliergonella cuspidata*	157.4	25.7
7c	Sedge-Menyanthes with thickets (up to 10–25%) of the Salix rozmarinifolia and Betula humilis on mires of rich mineral nutrition	ass. ***Betulo humilis-Salicetum repentis***	*S. rosmarinifolia*, *S. lapponum, Carex lasiocarpa*, *C. chordorrhiza*, *C. limosa*, *C. diandra*, *C. dioica*, *Eriophorum polystachyon*, Menyanthes *trifoliata*, *Dactylorhiza* sp., *Baeothryon alpinum; Bryum sp., Drepanocladus aduncus*, *Tomentypnum nitens*, *Campylium stellatum*, *Sphagnum warnstorfii*, *Sph. teres*	80.2	13.1
7d	Sedge fen mire overgrown with trees and shrubs (up to 30–40%)	Complex of hygrophyte large sedge communities MAGNO-CARICION ELATAE	*Salix cinerea*, *S. rosmarinifolia*, *S. lapponum, S. rosmarinifolia, Betula pubescens*, *B. humilis*,	58.1	9.5

Number on the map	Vegetation communities and groups	Syntaxons, types of vegetation cover structures	Dominant and diagnostic species	Area	
				ha	%
1	2	3	4	5	6
		overgrowing with *Salix* spp., *Betula pubescens*	*Pinus sylvestris, Juniperus communis, Carex lasiocarpa*, *C. rostrata*, *C. elata*		
7e	Sedge-reed thickets, often with willows	Complex of hygrophyte large sedge communities MAGNO-CARICION ELATAE overgrowing with *Phragmites australis*, sometimes in combination with *Salix* spp., *Betula pubescens*	*Salix cinerea*, *Phragmites australis, Thelypteris palustris, Carex lasiocarpa, C. elata,*,	86.6	14.2
		SHRUB VEGETATION			
8	Willow thickets on fen mire	Ass. ***Salicetum auritae***	*Betula pubescens, Frangula alnus, Salix cinerea, S. aurita, Carex acuta, Phragmites australis, Thelypteris palustris, Lysimachia vulgaris, Galium palustre, Equisetum fluviatile*	58.1	9.5
9	Deciduous Calamagrostis-Molinia-sedge low forest	com. ***Betula pendula – Salix cinerea – Molinia caerulea***	*Betula pendula*, *B. pubescens*, *Alnus glutinosa, Frangula alnus, Salix cinerea*, *Calamagrostis arundinacea*, *C. canescens*, *Carex nigra*, *Geum rivale, Lysimachia vulgaris, Molinia caerulea*, *Pteridium aquilinum*	5.2	0.9

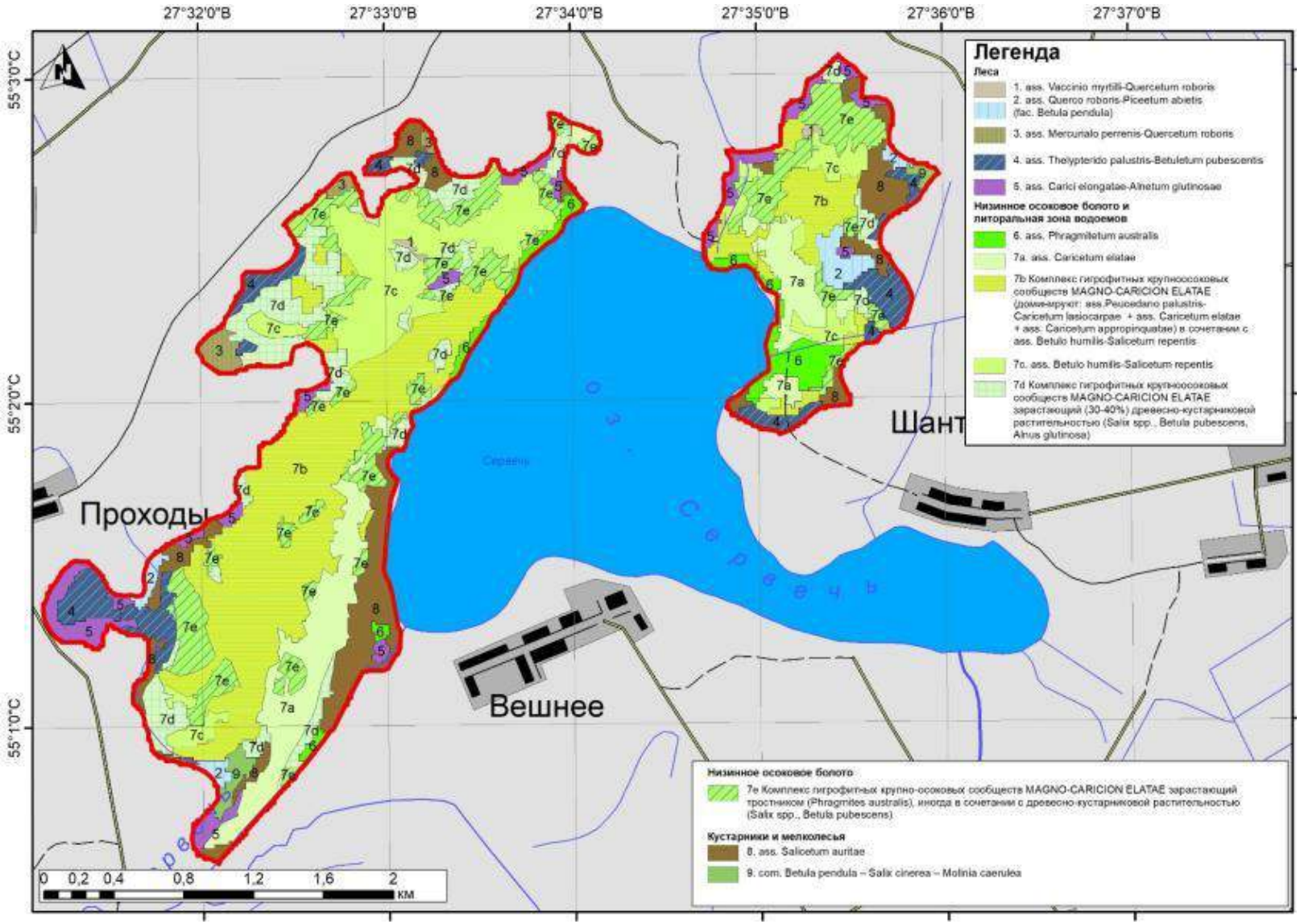

Fig. 24. Current vegetation map of the project site Servech (as of 2018)

Fig. 25. Hygrophyte communities with prevalence of the Tussock sedge (ass. *Caricetum elatae*) – ecosystem-forming association of the vegetation cover of the project area Servech

Fig. 26. Phytocenotic appearance of the sedge-Menyanthes-Hypnum-Sphagnum communities on fen mires of rich mineral nutrition, important for conservation of the biological diversity in the region

Along the periphery and on the mineral islands forest vegetation dominates, represented by communities, which are formed on both mineral (ass. *Vaccinio myrtillis-Quercetum roboris* (mapped taxon № 1, Fig. 24), ass. *Querco roboris – Piceetum abietis* (mapped taxon № 2, Fig. 24), ass. *Mercurialo perrenis-Quercetum roboris* (mapped taxon № 3, Fig. 24)) and peat-mire soils (ass. *Thelypterido palustris-Betuletum pubescentis* (mapped taxon № 4, Fig. 24) and ass. *Carici elongatae-Alnetum glutinosae* (mapped taxon № 5, Fig. 24).

Shrub vegetation within the project area occupies 58.1 ha (9.5%) (Table 73). Its genesis is due to various types of succession processes and is primarily associated with the active overgrowing of the mire. These communities occupy closed depressions and hollows with groundwater level from -80 to +15 cm; prefer conditions of more or less pronounced flowage of soil-ground water, but often with a trend to stagnation in some extent. Within the site the communities form clump monodominant thickets of middle density. Grey willow *Salix cinerea* dominating the shrub layer quite often is joined by the Almond Willow *S. triandra* and *S. rosmarinifolia*, Downy birch, Black alder, Alder buckthorn *Frangula alnus*. The following species dominate the grass layer: reed (*Phragmites australis*), Acute sedge (*Carex acuta*), Marsh fen (*Thelypteris palustris*); as a constant species present Garden loosestrife (*Lysimachia vulgaris*), Marsh bedstraw (*Galium palustre*), Purple loosestrife (*Lythrum salicaria*).

BIOTOPES

Within the project site Servech according to the habitat (biotope) classification system EUNIS there were identified 10 units of 4-6 hierarchical levels, including 7 forest ones, 1 – shrub, 2 – mire (Table 74). Share of highly waterlogged biotopes is 97.8% of the total area of the project site.

Table 74 – Biotopes of the project site Servech

№	Biotopes EUNIS		Area	
	Code	Name	ha	%
1	D5.11	Common reed [Phragmites] beds normally without free-standing water /	19.7	3.2
2	D5.21	Beds of large [Carex] species	300.3	49.1
3	D5.21(Phg)	D5.21 in the phase of overgrowing with reed [Phragmites]	58.1	9.5
4	D5.21 (Slx)	D5.21 in the phase of overgrowing with reed [Phragmites] and tree-shrub vegetation [Salix spp., Betula]	86.6	14.2
5	F9.21	Grey willow carrs [Salix cinerea]	58.1	9.5
6	G1.411	Meso-eutrophic swamp alder woods [Alnus glutinosa]	28.0	4.6
7	G1.513	Meso-acidophilous birch swamp woods [Betula pubescens]	35.6	5.8
8	G1.918	Eurasian boreal birch woods [Betula pendula]	11.7	1.9
	Complex of biotopes			
9	G1.922	Lowland nemoral Populus tremula woods	6.8	1.1
	G1.B23	Sarmatic dry alder woods		
10	G1.A163	Boreonemoral spruce-lime-oak-hornbeam forests	1.3	0.2
11	G4.4	Mixed Scots pine - birch woodland [Pinus sylvestris, Betula pendula]	5.2	0.9
		IN TOTAL:	**611.4**	**100.0**

Further is a description of biotopes that dominate within the project area.

D5.11 Common reeds [Phragmites] beds normally without free-standing water

D i s t r i b u t i o n . In the littoral zone of Servech Lake at overall area of 19.7 ha (3.2% of the project site's area).

E c o l o g y . Occur in littoral zone of waterbodies (including artificial ones), disturbed mire parts with slowly flowing water, young mires which are forming at the place of overgrowing highly waterlogged depressions. Water level is over the peat surface (+5 ÷ +11 cm); pH of unfiltered mire water is 5.2–5.89; depth of the peat layer is 0.4–0.8 m.

S y n t a x o n o m y . PHRAGMITION AUSTRALIS: *Phragmitetum australis*

C h a r a c t e r i s t i c p l a n t s p e c i e s . *Phragmites australis*

S t r u c t u r e . There is only one, but quite dense layer of *Phragmites australis* of 1.5–2.5 m high. Species of mire herbs (*Thelypteris palustris, Menyanthes trifoliata*, *Comarum palustre, Peucedanum palustre* and other) do not form closed layer; the moss cover is absent.

D5.21 Beds of large [Carex] species

D i s t r i b u t i o n . Occupy the central part of the project area. Are represented by the complex of biotopes (D5.2121, D5.2141, D5.2143, D5.2151, D5.2152, D5.217) with the total area of 445.0 ha (72.8%).

E c o l o g y . The water level in the mire greatly varies (June-July): from -15 to -6 cm (on the average -8±1 cm). The depth of the peat layer varies from 1.2 to 3.8 m, prevailing range is 1.2–1.6 m. The mire water (unfiltered) in this type of habitats is characterized by the following physical and chemical properties: average pH is 6.36±0.05 (range is 6.0–6.79); electroconductivity (EC) – 434.9±23.0 µS/cm (310–606 µS/cm).

S y n t a x o n o m y . MAGNO-CARICION ELATAE, MAGNO-CARICION GRACILIS.

Fig. 27. Biotope D5.21 (Beds of large [Carex] species) – the core of the project area

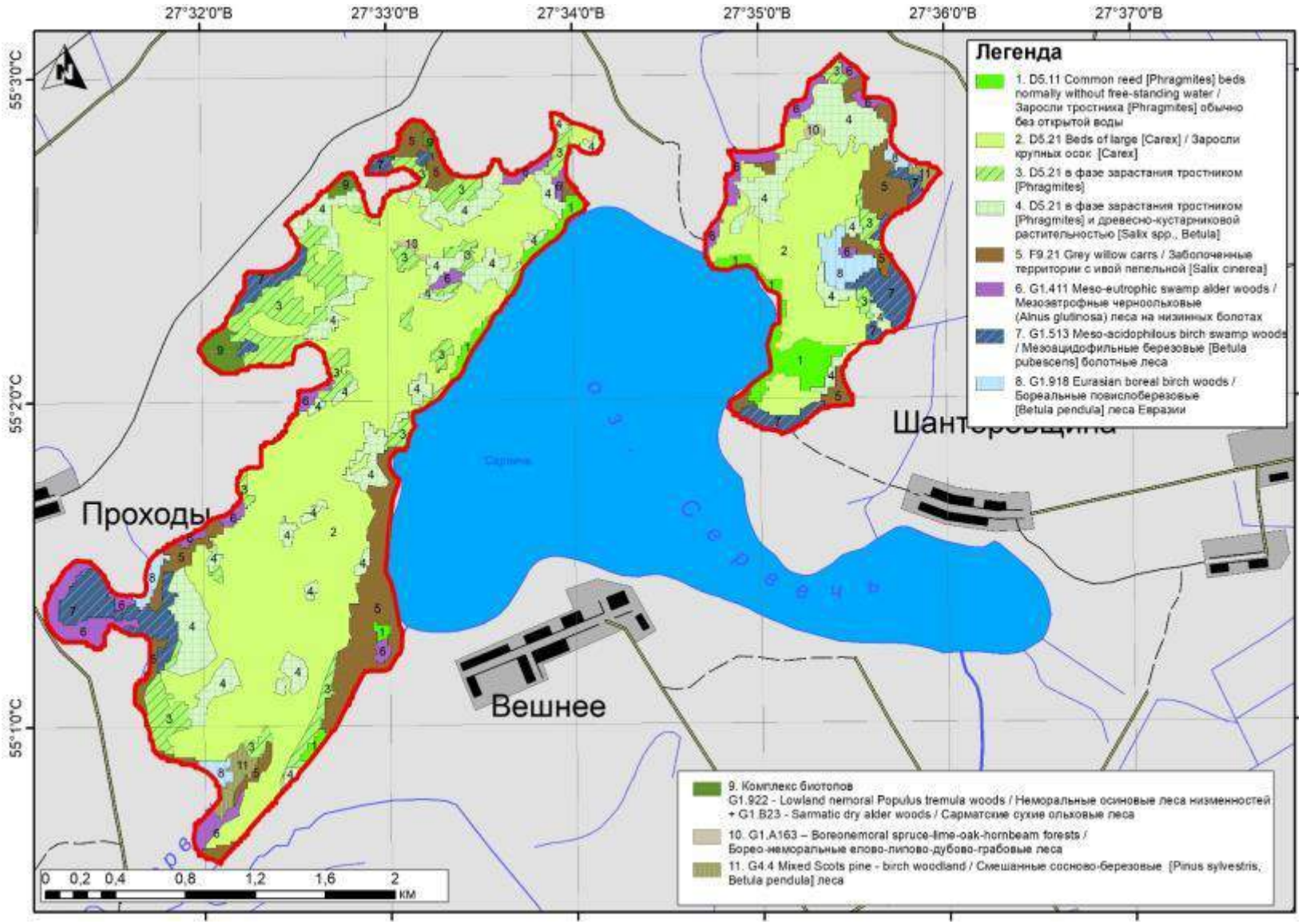

Fig. 28. Map of habitats (biotopes) of the project area Servech (according to the EUNIS system)

Characteristic plant species. *Carex acuta*, *C. rostrata*, *C. cespitosa, C. lasiocarpa*, *C. elata*, *C. appropinquata*.

Structure. Include communities (Picture 5), which main forming species are large sedges; characterized by high (0.6–0.7 m) layer of middle density, as a rule, mono species (with domination of one of the Carex species - *Carex acuta*, *C. rostrata*, *C. lasiocarpa*, *C. elata*, *C. cespitosa* or *C. appropinquata*).

F9.21 Grey willow carrs [Salix cinerea]

Distribution. By small plots throughout the whole territory, the total area is 6.8 ha (1.1%).

Ecology. The water level is high (+1 cm); average pH of the mire water is 5.96±0.01 (range – 5.75–6.44); EC – 436.5±7.6 µS/cm (321–546 µS/cm); depth of the peat layer is 0.8–1.2 m.

Syntaxonomy. SALICION CINEREAE: *Salicetum auritae*

Characteristic plant species. *Betula pubescens, Frangula alnus, Salix cinerea, S. aurita, Carex acuta, Phragmites australis, Thelypteris palustris, Lysimachia vulgaris, Galium palustre, Equisetum fluviatile*

Structure. The main layer of these communities is 1.5-3 m high and is formed by willow shrubs, mainly *Salix cinerea*, but regularly occur *S. aurita* and *S. rosmarinifolia*. The dominant species in the grass stands are reed (*Phragmites australis*), Acute sedge (*Carex acuta*), Marsh fern (*Thelypteris palustris*), constant species are Garden loosestrife (*Lysimachia vulgaris*), Marsh bedstraw (*Galium palustre*), Purple loosestrife (*Lythrum salicaria*).

G1.411 Meso-eutrophic swamp alder [Alnus glutinosa] woods

Distribution. The total area is 28.0 ra (4.6%), form a narrow ribbon strip along the periphery of the fen mire (Picture 6).

Ecology. Mesotrophic forest mires with pronounced microrelief, forming in conditions of significant waterlogging and poor water flowage. The water level during the habitat study (June-July) was within -10 ÷ -20 cm range (on the average -11±2 cm). Average pH value of the mire unfiltered water is 5.93±0.06 (the range 5.47–6.27); EC – 345.0±7.7 µS/cm (302–385 µS/cm). Soils are peat-mire, depth of the peat layer is 1.5 – 2.0 m. Type of habitat conditions is C_4 (humid relatively rich subor), C_5 (wet relatively rich subor).

Syntaxonomy. ALNION GLUTINOSAE: *Carici elongatae-Alnetum glutinosae*.

Characteristic plant species. *Alnus glutinosa, Betula pubescens, Frangula alnus, Salix cinerea, S. triandra, S. pentandra, Athyrium filix-femina, Calla palustris, Carex acutiformis, C. elongata, C. pseudocyperus, Comarum palustre, Equisetum fluviatile, Iris pseudacorus, Menyanthes trifoliata, Phragmites australis, Solanum dulcamara, Thelypteris palustris.*

Structure. The tree storey is formed by *Alnus glutinosa* and *Betula pubescens*, also includes *Picea abies и Fraxinus excelsior*. The shrub layer (*Frangula alnus*, *Viburnum opulus*, *Ribes nigrum*, *R. spicatum*, *Padus avium*) is formed at near-trunk micro elevations. In the grass layer prevail large ferns (*Athyrium filix-femina, Thelypteris palustris*), sedges (*Carex elongata*, *C. acutiformis*) and mire herbs (*Caltha palustris, Filipendula ulmaria*, *Impatiens noli-tangere*, *Scirpus sylvaticus*, *Solanum dulcamara*). The moss cover is poorly developed, mosses (*Calliergonella cuspidata*, *Calliergon cordifolium*, *Climacium dendroides*, *Sphagnum squarrosum*, *Brachythecium* and *Plagiomnium spp.*) grow on deadwood and as separate spots on the soil.

Fig. 29. Biotope G1.411 Meso-eutrophic swamp alder woods (*Alnus glutinosa*)

G1.513 Meso-acidophilous birch [Betula pubescens] swamp woods

D i s t r i b u t i o n . Are found in small areas along the periphery of the open fen mire and occupy an area of 35.6 ha (5.8%).

E c o l o g y . Mesotrophic forest mires under conditions of high waterlogging and poor water flowage. The water level during the vegetation period is usually from -20 to -10 cm. Average pH value of unfiltered mire water is 5.41±0.04 (4.65–5.89); EC – 304.2±6.4 µS/cm (282–227 µS/cm). Type of habitat conditions – B_5 (wet relatively poor subor).

S y n t a x o n o m y . ALNION GLUTINOSAE: *Thelypterido palustris-Betuletum pubescentis*.

C h a r a c t e r i s t i c p l a n t s p e c i e s . *Alnus glutinosa, Betula pubescens, Carex acutiformis*, *C. canescens*, *Comarum palustre*, *Filipendula ulmaria*, *Equisetum fluviatile*, *Menyanthes trifoliata*, *Peucedanum palustre*, *Phragmites australis*, *Thelypteris palustris*

S t r u c t u r e . *Betula pubescens* dominates in the tree layer. Natural renewal is usually of vegetative origin. Undergrowth (*Salix cinerea, Frangula alnus* dominate) is well developed (Picture 7). The grass layer is formed by sedges (*Carex acutiformis*, *C. canescens*) and hygrophylic mire herbs (*Comarum palustre*, *Filipendula ulmaria*, *Equisetum fluviatile*, *Menyanthes trifoliata*, *Peucedanum palustre*, *Phragmites australis*). The moss cover is usually fragmented, Sphagnum mosses prevail (*Sphagnum centrale*, *Sph. fallax, Sph.teres*).

Fig. 30. Biotope G1.513 Meso-acidophilous birch (*Betula pubescens*) swamp woods

VEGETATION SUCCESSIONS AS INDICATOR OF CURRENT PROCESSES IN WETLAND ECOSYSTEMS: MAIN DYNAMICS TRENDS, THEIR QИХ QUALITATIVE AND QUANTITATIVE ASSESSMENT, THREATS TO BIODIVERSITY

Investigations have shown that negative for biodiversity processes occur at an area of 299.1 ha (48.9% of the project site's area) (Table 75, Fig. 31, 32). The main threats include overgrowth of the fen mire (up to 30–40%) with trees, shrubs and reeds. These processes occur at an area of 222.5 ha (36.4%). Picture 8 shows location of threats and their qualitative assessment.

To restrict the mire overgrowing the plan of mowing of the project area is developed and the impact is assessed taking into account rare and protected plant species (Fig. 33).

Table 75 – Succession processes in ecosystems of the project site Servech

№	Process	ha	%*
1	Forests, formed at formerly (before 1990) non-forest lands	76.6	12.5
2	Overgrowing of the fen mire (up to 30–40%) with trees and shrubs (*Salix* spp., *Betula pubescens*)	64.8	10.6
3	Overgrowing of the fen mire (up to 30–40%) with trees and shrubs (*Salix* spp., *Betula pubescens*) and reeds (h=1.5-2.0; projective coverage = 20-35%)	59.4	9.7
Overgrowing of the fen mire with reed		98.3	16.1
4	1.3 – 1.8 m high; projective coverage = 15-30%	74.3	12.2
5	1.5 – 2 m high; projective coverage = 30-45%	3.7	0.6
6	2 – 3 m high; projective coverage = 30-45%	20.3	3.3
IN TOTAL		**299.1**	**48.9**

*of the area of the project site Servech

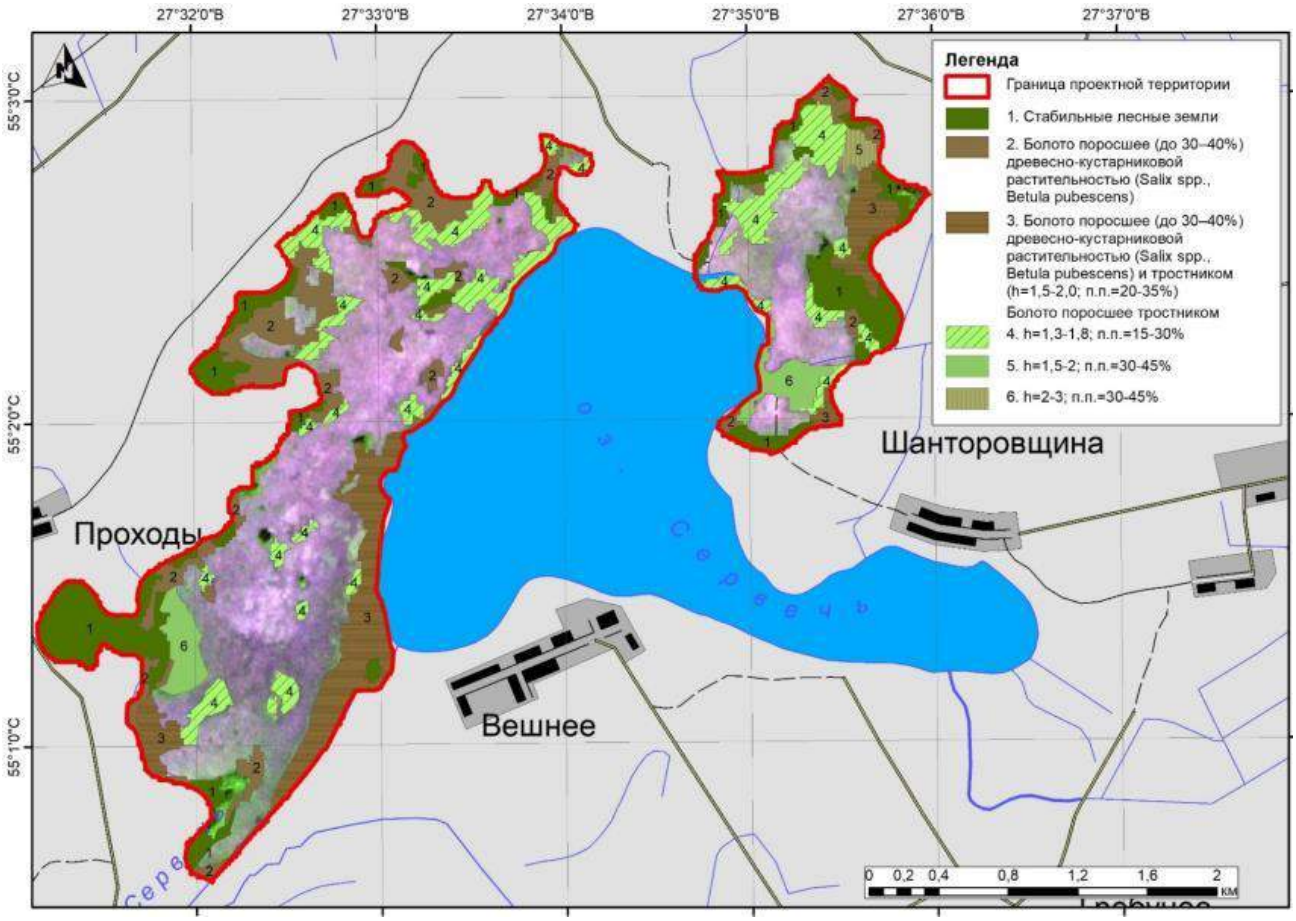

Fig. 31. Processes of degradation of mire ecosystems in the project site Servech

A

B

Fig. 32. Overgrowing with reeds (A) and trees and shrubs (B) – the main threats to the fen mire of the project site

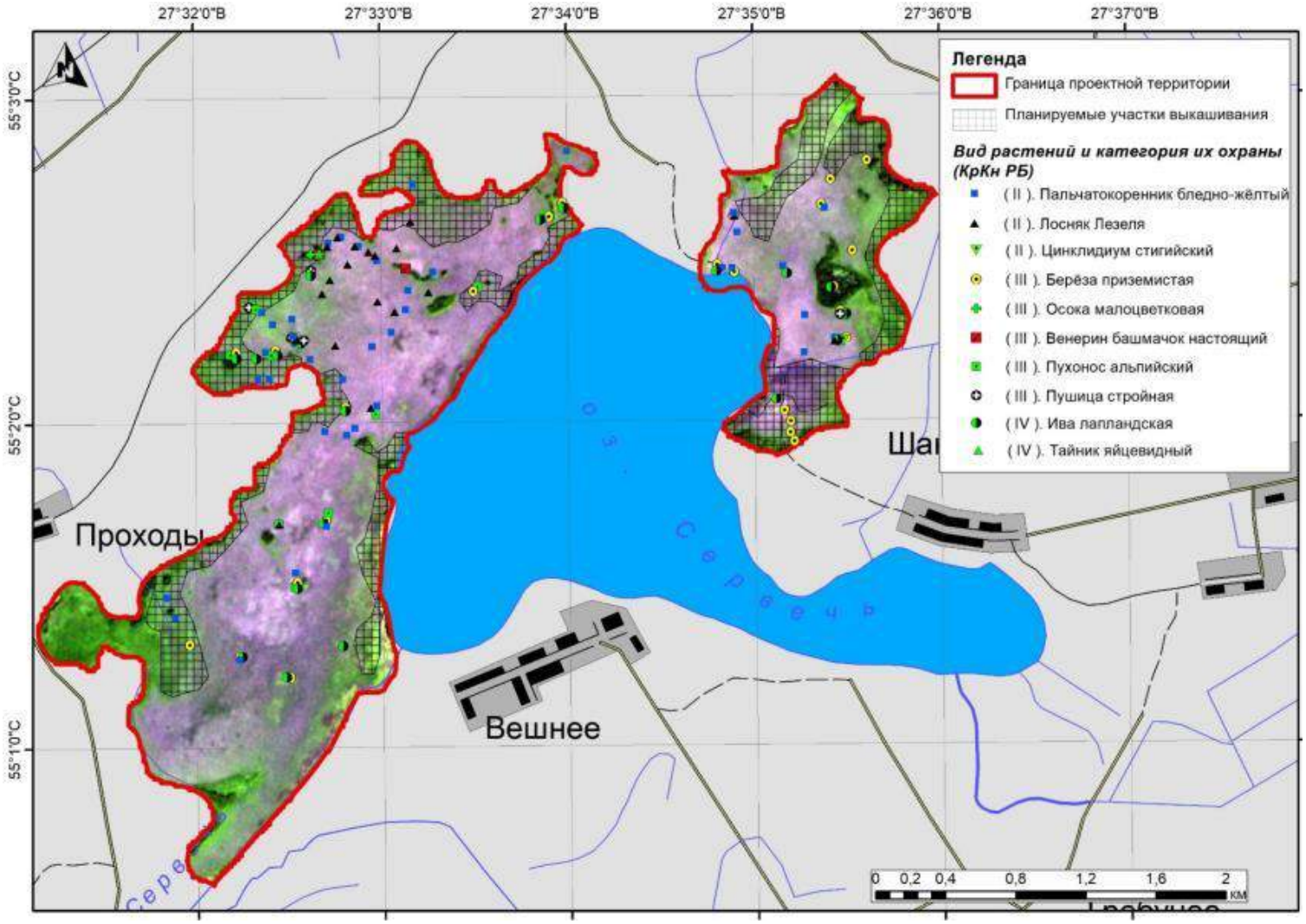

Fig. 33. Plan of mowing in the project site Servech

9.3. Monitoring of invertebrates in the protected areas Servech and Zvanets

According to the project's aims and tasks, monitoring plots were established to study the impact of the project's measures (mowing and fire management) on the population size and variety of the main groups of invertebrate animals, which, in its turn, are trophic objects for indicator meadow-mire bird species.

On the territory of the protected area Servech (project measures have not been conducted currently) a constant monitoring plot №1 has been established (2.5 km south of the village Derkovstchina - N52°02.550' E27°33.732') – see Fig. 34.

Fig. 34. Location of the constant monitoring plot on the territory of the protected area Servech

4 constant monitoring plots have been established in the protected area Zvanets: plot № 2 – "control" plot (no project activities), located 6 km northeast of the village Povitie (N52°01.857' E24°49.841'); plot № 3 – "mowed" plot, where the mowing of mire vegetation has been conducted (4 km south of the village Novosiolki – N52°03.113' E24°49.012'); monitoring plot № 4 – "burned" plot, where the fire management has been conducted (5.5 km south of the village Novosiolki, N52°03.940' E24°49.879'); monitoring plot № 5 – direct border of the burned territory (burned and unburned sides) (6.5 km south of the village Novosiolki, N52°03.377' E24°50.052') – see Fig. 35.

Population structure of the hortobiontic invertebrates at the constant monitoring plot in the protected area Servech, and at the "mowed", "control" and "burned" plots in the protected area Zvanets.

Collection and study of invertebrates were conducted during the vegetation period (May-July). Material for study of the fauna and structure of grass invertebrates, and for subsequent calculation of the biomass of potential trophic objects of indicator bird species, were collected by means of "sweeping" through the grass layer by standard entomological sweep-net (hoop diameter – 35 cm, net length – 70 cm, sweep-net's handle length – 80 cm). Each survey was conducted in 4 replications of 50 double sweeps of the net in four directions from the center of the monitoring plot (Fig. 36).

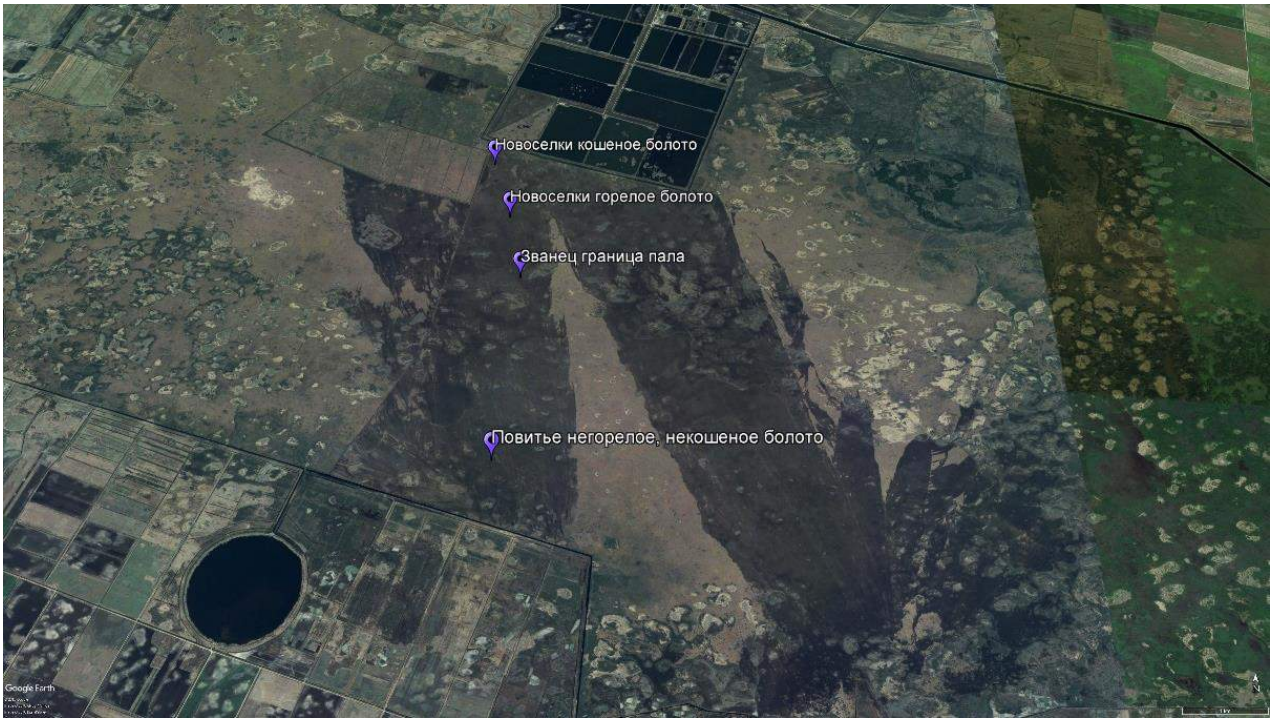

Fig. 35. Location of the control monitoring plots on the territory of the protected area Zvanets

Fig. 36. Collection of the material by means of “sweeping” through the grass layer by standard entomological sweep-net (monitoring plot №3, protected area Zvanets)

Material in the protected area Servech was collected by means of “sweeping” in May (2018-05-09), June (20.06.2018), July (24.07.2018). In total, 5040 invertebrate specimens were collected by sweeping method during the monitoring period in the Servech site.

16972 specimens of invertebrates were collected by sweep-net method at constant monitoring plots of the protected area Zvanets in May (10-12.05.2018), June (21-22.06.2018) and July (25-26.07.2018). All collected material was fixed in 70% ethanol or placed on wadded mattresses for further taxonomic processing - species identification.

Study of the grass layer invertebrates at monitoring plots of the fen mire Zvanets (“control” plot Povitie, “mowed” plot Novosiolki, “burned” plot Novosiolki and border of the burned area) has shown that the population structure of invertebrates of the grass layer is mostly represented by 11 taxonomic groups - Arachnida, Mollusca, Coleoptera, Diptera, Heteroptera, Homoptera, Hymenoptera, Lepidoptera (imago, larvae), Odonata, Orthoptera, Trichoptera; also there were individual representatives of Thysanoptera, Neuroptera, Aphidoidea and other taxa present in some samples, but these groups do not make up a significant part of the diet of meadow and mire bird species, so they were not counted.

The following features were discovered when comparing the values of relative abundance and population size of the main taxa of invertebrates at monitoring plots:

Table 76 – Population structure of invertebrates of the grass layer at the monitoring plots Povitie and Novosiolki in the Zvanets mire, studied by sweep-net method.

Taxonomic group	Relative abundance, %								
	May			June			July		
	“control”	“mowed”	“burned”	“control”	“mowed”	“burned”	“control”	“mowed”	“burned”
Arachnida	13.42	12.06	12.34	2.35	3.49	3.80	12.34	11.52	6.09
Mollusca	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.19	0.00
Coleoptera	4.12	6.86	8.74	1.65	3.87	2.62	8.29	4.91	1.95
Diptera	**48.67**	**45.10**	**45.50**	**63.27**	**46.98**	**75.49**	**35.17**	**48.49**	**71.31**
Heteroptera	16.01	2.16	27.16	2.70	5.94	6.42	7.37	4.79	3.52
Homoptera	3.40	1.27	2.57	15.75	24.72	6.68	23.76	21.85	12.24
Hymenoptera	9.86	16.18	3.08	12.36	11.79	3.34	11.23	4.22	2.39
Lepidoptera larvae	2.83	0.29	0.00	0.44	0.00	0.52	0.37	0.13	0.75
Lepidoptera imago	0.00	0.10	0.00	0.00	0.47	0.26	0.18	0.38	0.06
Odonata	0.00	0.00	0.26	0.00	0.09	0.00	0.18	0.06	0.06
Orthoptera	1.62	0.59	0.09	1.48	2.55	0.85	1.10	2.64	1.63
Trichoptera	0.08	15.39	0.26	0.00	0.00	0.00	0.00	0.82	0.00
IN TOTAL:	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Diptera dominate in the grass layer during the vegetation season, their relative abundance and population size at different plots during the monitoring period was as follows:

- at the monitoring plot Povitie (“control”) from May til July: relative abundance was 48.67 – 35.17%, population size was 150 - 48 ind/100 sweeps;
- at the monitoring plot Novosiolki (“mowed” site): relative abundance was 45.10 – 48.49%, population size was 115 - 192 ind/100 sweeps;

- at the monitoring plot Novosiolki ("burned"): relative abundance was 45.50 – 71.31%, population size was 133 - 284 ind/100 sweeps;

Cicadas, Hemiptera and Arachnida were also among dominating groups of invertebrates at the monitoring plots.

Comparison of the relative size of the main taxonomic groups has shown that there is no significant difference in this indicator between monitoring plots of the protected area Zvanets (Table 76).

Table 77 – Population size of taxonomic groups of the grass layer invertebrates at the monitoring plots Povitie, Novosiolki in the Zvanets mire, studied by sweep-net method.

Taxonomic group	Population size, individuals per 100 sweeps in 4 replications								
	May			June			July		
	"control"	"mowed"	"burned"	"control"	"mowed"	"burned"	"control"	"mowed"	"burned"
Arachnida	166	123	144	27	37	58	67	183	97
Mollusca	0	0	0	0	1	0	0	3	0
Coleoptera	51	70	102	19	41	40	45	78	31
Diptera	**602**	**460**	**531**	**727**	**498**	**1152**	**191**	**770**	**1136**
Heteroptera	198	22	317	31	63	98	40	76	56
Homoptera	42	13	30	181	262	102	129	347	195
Hymenoptera	122	165	36	142	125	51	61	67	38
Lepidoptera larvae	35	3	0	5	0	8	2	2	12
Lepidoptera imago	0	1	0	0	5	4	1	6	1
Odonata	0	0	3	0	1	0	1	1	1
Orthoptera	20	6	1	17	27	13	6	42	26
Trichoptera	1	157	3	0	0	0	0	13	0
IN TOTAL:	1237	1020	1167	1149	1060	1526	543	1588	1593

Quite high population size of some of above-mentioned taxonomic groups at plots, where the project's measures were conducted, is possibly explained by the higher species diversity in vegetation communities, which are trophic objects for above-mentioned taxa. Based on the data of the relative population sizes obtained during the vegetation season of 2018, we constructed a dendrogram of the similarity of the taxonomic composition and the number of invertebrates on 3 constant monitoring plots (control, mowed and burned) of the fen mire Zvanets (Fig. 38).

As it can be seen on the dendrogram, the qualitative and quantitative composition of the grass layer invertebrates in the mowed and control areas match more than 80%, and both these areas for the same indicators are 70% similar to the site where the burning was carried out.

Analysis of values of the relative abundance and population size of the registered taxa at the border of the fire management area (from burned and unburned sides) has shown, that there is no statistically significant difference between both sides, similarity percentage reaches 90 (Fig. 39, Table 78).

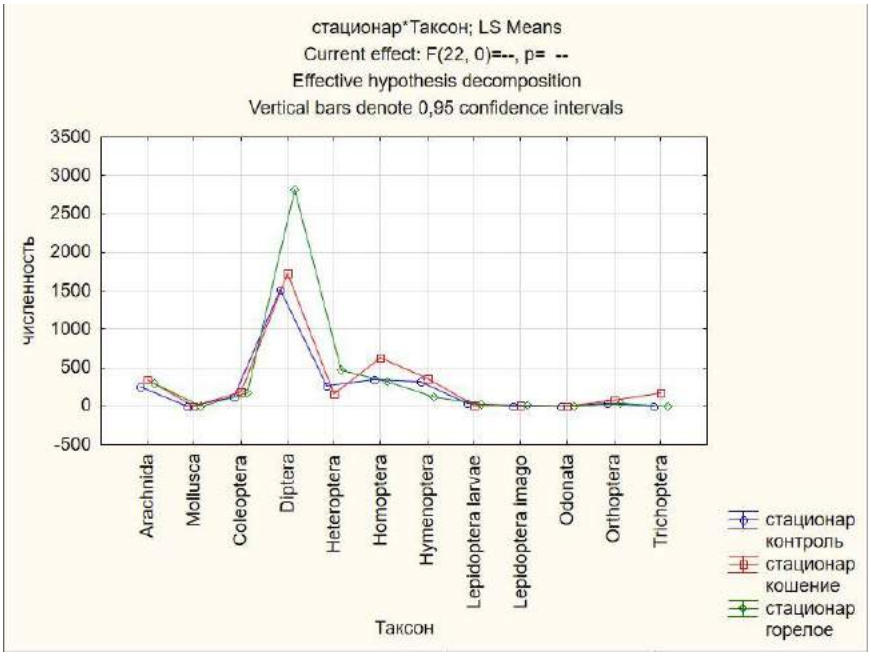

Fig. 37. Comparison of the relative population size between monitoring plots in the protected area Zvanets

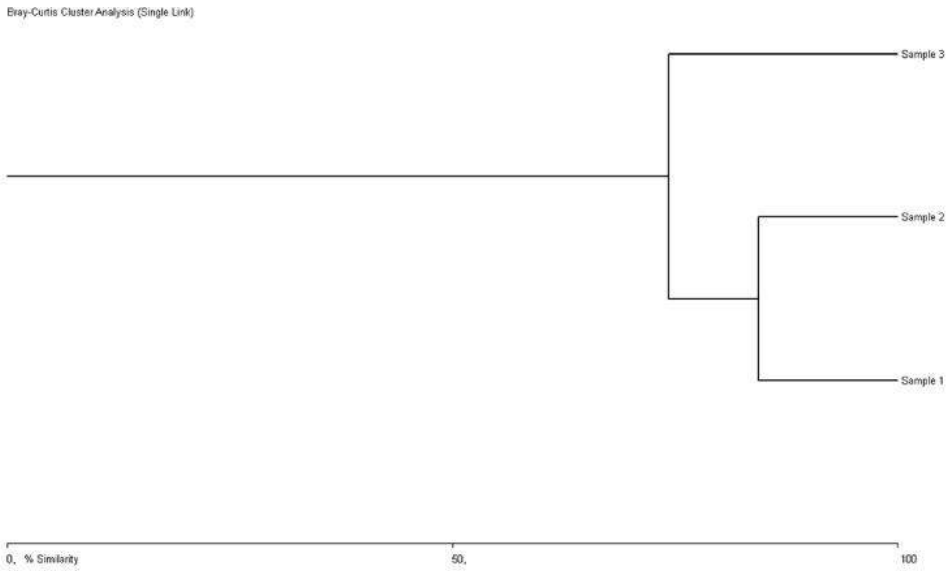

Fig. 38. Dendrogram of the similarity of the taxonomic composition and the number of invertebrates at 3 constant monitoring plots of the fen mire Zvanets (May-July 2018) Sample 1 – "Control"; Sample 2 – "Mowed", Sample 3 – "Burned"

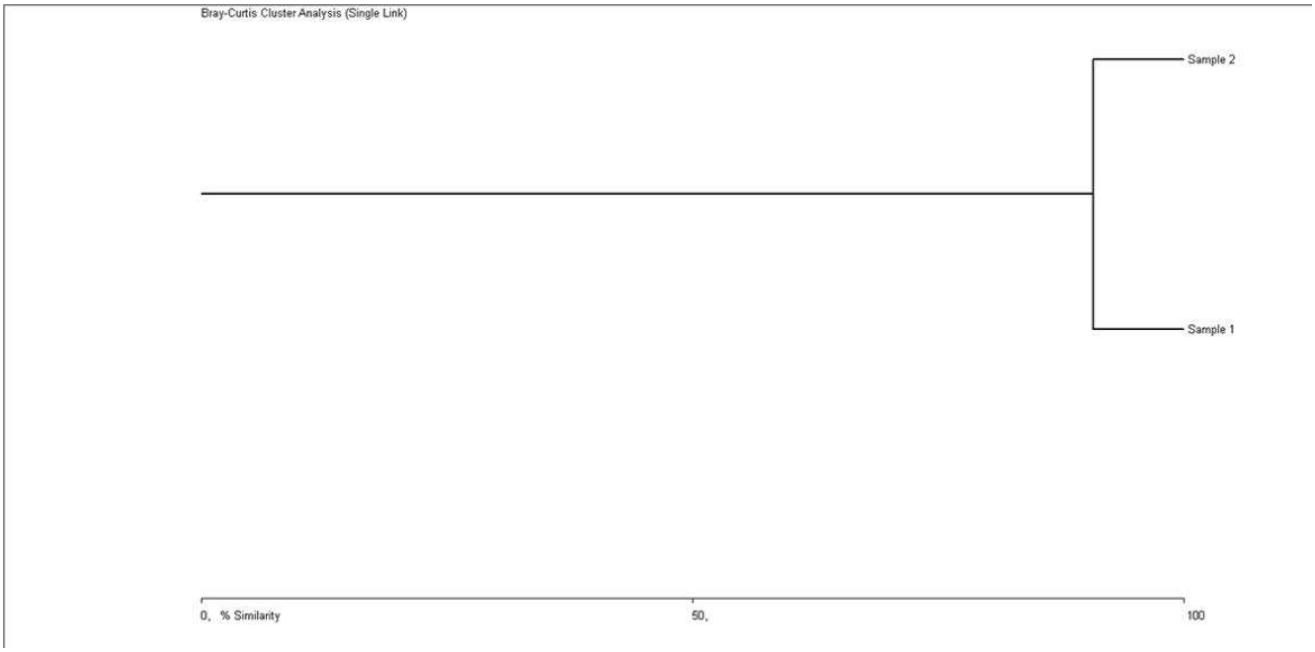

Fig. 39. Dendrogram of the similarity of the taxonomic composition and the number of invertebrates at the border of the fire management area in the Zvanets mire (May-July 2018). Sample 1 – "burned side"; Sample 2 – "unburned side"

Table 78 – Population structure of invertebrates of the grass layer at the monitoring plot Novosiolki in the mire Zvanets at the border of fire management area (from the burned and unburned sides) by sweep-net method

Taxonomic group	Relative abundance, %					
	May		**June**		**July**	
	"burned side"	**"unburned side"**	**"burned side"**	**"unburned side"**	**"burned side"**	**"unburned side"**
Arachnida	2.63	5.11	4.85	8.99	7.82	10.41
Mollusca	0.00	0.00	0.00	0.00	0.00	0.00
Coleoptera	30.98	19.54	4.59	4.16	4.40	5.53
Diptera	**31.16**	**38.66**	**67.24**	**64.60**	**49.39**	**53.75**
Heteroptera	2.63	4.37	3.99	2.71	4.16	4.74
Homoptera	21.92	14.67	10.40	6.96	25.06	16.60
Hymenoptera	8.88	15.33	5.63	9.48	4.03	5.53
Lepidoptera larvae	0.27	0.33	0.00	0.58	2.57	1.58
Lepidoptera imago	0.09	0.00	0.78	0.39	0.12	0.26
Odonata	0.18	0.00	0.00	0.00	0.00	0.00
Orthoptera	1.09	1.73	2.51	2.13	2.44	1.45
Trichoptera	0.18	0.25	0.00	0.00	0.00	0.13
IN TOTAL:	100.00	100.00	100.00	100.00	100.00	100.00

Study has shown, that population structure of invertebrates of the grass layer in the protected area Servech is represented mostly by 11 taxonomic groups: Arachnida, Mollusca, Coleoptera,

Diptera, Heteroptera, Homoptrera, Hymenoptera, Lepidoptera (imago, larvae), Odonata, Orthoptera, Trichoptera.

Comparison of values of the relative abundance and population size of the main taxa of invertebrates at the monitoring plot in Servech reserve has shown, that Diptera dominate in the grass layer during the vegetation season; their relative abundance varies from 32.54 to 25.48 % from May to July and population size is 494 – 631 ind/100 sweeps. In May Arachnida also are among the dominant groups; their relative abundance in this period reaches 35.48 % and the population size - 544 ind/100 sweeps. Among subdominant groups in May there is also Coleoptera, which relative abundance reaches 18.91 % and population size - 287 ind/100 sweeps. From May to July, there is a rising trend in the presence of cicadas and Heteroptera in the sweep-net harvest; their relative abundance and population size in July reach 35.50% and 879 ind/100 sweeps and 10.58 % and 262 ind/100 sweeps accordingly (Table 79).

The claster analysis was carried out to compare the values of the relative population size of the main taxa of invertebrates at three monitoring plots in the mire Zvanets and at the monitoring plot in the Servech mire during the monitoring period in 2018 (Fig. 40). 3 clasters are marked on the dendrogram. The greatest similarity in the population size is observed between the “control” and “mowed” plots of the Zvanets reserve – over 80%; another claster shows the similarity of the population size of invertebrates between the monitoring plots “control”, “mowed” in the mire Zvanets and the monitoring plot in the Servech reserve, which is 75%. Separate claster represents the monitoring plot “burned” in the protected area Zvanets (about 73% of the similarity). In overall, there is no significant difference in the population size of the main taxonomic groups of invertebrates between monitoring plots of the both protected areas.

Table 79 – Comparative population structure of the grass layer invertebrates in the protected areas Servech and Zvanets, studied by sweep-net method

Taxonomic group	Relative abundance, %					
	May		**June**		**July**	
	“Zvanets control”	**“Servech”**	**“Zvanets control”**	**“Servech”**	**“Zvanets control”**	**“Servech”**
Arachnida	13.42	35.84	2.35	15.01	12.34	8.48
Mollusca	0.00	0.79	0.00	1.63	0.00	2.14
Coleoptera	4.12	18.91	1.65	4.49	8.29	2.30
Diptera	**48.67**	**32.54**	**63.27**	**38.62**	**35.17**	**25.48**
Heteroptera	16.01	1.38	2.70	12.05	7.37	10.58
Homoptera	3.40	0.20	15.75	11.76	23.76	35.50
Hymenoptera	9.86	6.79	12.36	13.38	11.23	4.73
Lepidoptera larvae	2.83	2.77	0.44	2.01	0.37	9.29
Lepidoptera imago	0.00	0.00	0.00	0.38	0.18	0.73
Odonata	0.00	0.13	0.00	0.10	0.18	0.00
Orthoptera	1.62	0.00	1.48	0.48	1.10	0.69
Trichoptera	0.08	0.66	0.00	0.10	0.00	0.08
IN TOTAL:	100.00	100.00	100.00	100.00	100.00	100.00

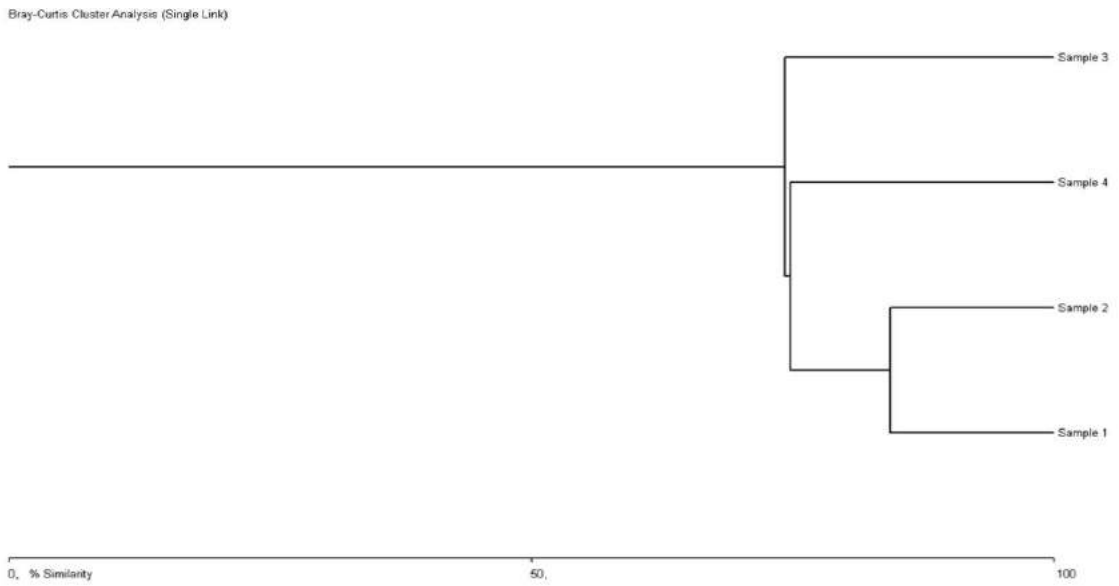

Fig. 40. Dendrogram of the similarity of the taxonomic composition and the number of invertebrates at constant monitoring plots of the fen mires Zvanets and Servech (May-July 2018) Sample 1 – "Control"; Sample 2 – "Mowed", Sample 3 – "Burned", and Sample 4 – fen mire Servech

Material for studying the fauna of flying insects was collected by means of enthomological malaise traps (the height is 120 cm, length - 100 cm, width - 150 cm), which collector tanks contained isopropyl alcohol as a fixator. Traps were established directly in the centre of the monitoring plots on the following dates: plot № 1 – 20.06.2018, plot № 2 – established on 10.05.2018, collector tanks changed on 30.05.2018, 21.06.2018, plot № 3 – established on 11.05.2018, collector tanks changed on 31.05.2018, 22.06.2018.

Claster analysis of the difference of number of flying insects at monitoring plots "control", "mowed" of the Zvanets reserve and the monitoring plot of the Servech reserve has shown, that the greatest similarity in population size of the main taxa of flying insects is between the "control" plot of the Zvanets mire and the monitoring plot Servech – 67% (project measures were not conducted on both plots), and these plots 55% similar to the plot, which was mowed. (Fig. 41)

Analysis of the amount of dry invertebrate biomass at monitoring plots in the Zvanets and Servech protected areas

The amount of dry invertebrate biomass was calculated using the material obtained during the monitoring period (May-July) by means of sweeping through the grass layer (100 sweeps by the standard entomological sweep-net in 4 replications) at each of the monitoring plots in both protected areas. All the collected material was measured and counted with use of the coefficients for dry biomass. Weight values of the biomass are grouped in 4 weight classes (0–5 mg, 6–10 mg, 11–20, >20 mg).

Weight values of the biomass at different monitoring plots were compared pairwise using the non-parametric test for two independent samples Mann-Whitney (U-criterion). (Table 80).

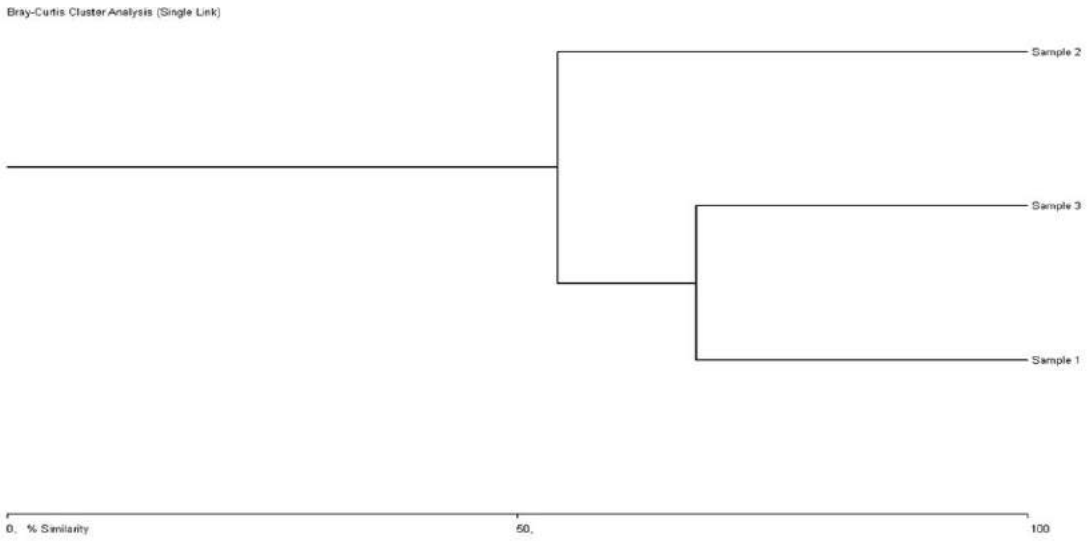

Fig. 41. Dendrogram of the similarity of the taxonomic composition and population size of flying insects at monitoring plots of the fen mires Zvanets and Servech (May-July 2018), Sample 1 – "control", Sample 2 – "mowed", Sample 3 - Servech

Pairwise comparison of the weight values between monitoring plots "control" and "mowed" of the Zvanets mire in May, using the U-criterion, has shown, that there is no statistically significant difference between them in that period (Z = -1,639; p = 0.101). The same picture is observed when comparing monitoring plots "control" and "burned" (Z = 0.018; p = 0.984). But monitoring plots "burned" and "mowed" in May differ from each other by the value of the dry invertebrate biomass $p < 0.05$ (Z = 2.167; p = 0.03). Figure 42 shows the results of the comparison of values of the dry invertebrate biomass in May.

Comparison of the monitoring plots "control" and "mowed" (Z = -1.074; p = 0.283), "control" and "burned" (Z = 0.961; p = 0.337), "mowed" and "burned" (Z = 0.886; p = 0.376) of the Zvanets reserve in June has not revealed any statistically significant differences between compared pairs of monitoring plots in the weight of the dry invertebrate biomass.

Figure 43 shows the results of comparing the values of dry invertebrate biomass in June.

Weight class	May				June				July			
	Zvanets			Servech	Zvanets			Servech	Zvanets			Servech
	"control"	"mowed"	"burned"		"control"	"mowed"	"burned"		"control"	"mowed"	"burned"	
0–5 mg	325.00 (319.58–389.26)	309.65 (258.65–367.15)	339.08 (333.33–342.70)	580.91 (469.96–705.86)	399.03 (378.98–410.35)	424.38 (397.01–500.08)	546.86 (511.65–594.93)	333.72 (310.01–365.86)	189.06 (188.42–194.01)	699.03 (612.65–783.32)	588.07 (419.15–818.18)	941.95 (914.96–993.93)
6–10 mg	12.92 (10.97–17.67)	313.51 (281.90–344.17)	24.08 (18.84–34.81)	59.57 (54.09–70.62)	15.21 (12.92–19.16)	47.42 (43.00–50.86)	27.21 (23.17–38.62)	72.04 (54.53–85.90)	35.98 (31.22–39.52)	78.68 (66.09–85.41)	48.58 (44.74–61.58)	139.66 (121.68–174.51)
11–20 mg	6.62 (0–21.84)	42.39 (33.76–49.02)	43.81 (21.02–63.44)	13.25 (9.94–25.96)	26.22 (8.33–53.23)	32.56 (20.25–43.16)	41.41 (30.33–42.90)	41.26 (21.04–58.74)	35.64 (20.11–48.17)	114.92 (98.10–121.93)	102.23 (76.81–123.96)	154.75 (136.99–263.90)
>20 mg	130.26 (63.20–238.86)	163.72 (136.91–195.49)	13.05 (0–32.42)	10.57 (0-43.86)	60.46 (0–190.41)	147.12 (36.67–386.38)	36.71 (24.40–55.07)	91.22 (31.71–147.59)	123.50 (40.30–235.59)	789.12 (492.34–1067.42)	169.69 (119.08–436.17)	342.13 (273.54–400.53)

Table 80 – Weighted mean values of the dry invertebrate biomass, mg, and quartile values (in brackets) for monitoring plots in the reserves Zvanets and Servech for each 100 sweeps of the entomological sweep-net

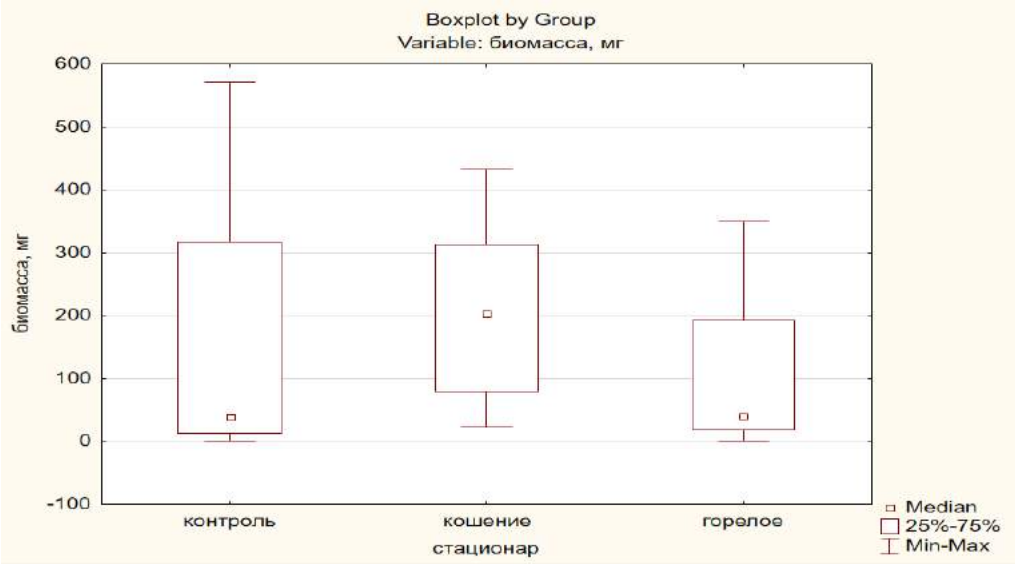

Fig. 42. Comparison of values of the dry invertebrate biomass at the monitoring plots of the Zvanets reserve in May

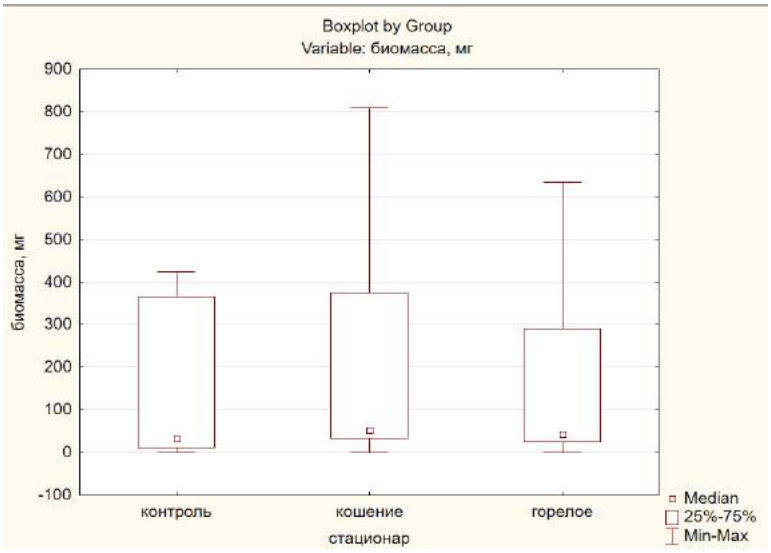

Fig. 43. Comparison of values of the dry invertebrate biomass at monitoring plots of the Zvanets reserve in June

Differences in the values of dry invertebrate biomass between pairs of the monitoring plots of the Zvanets mire in July are as follows: “control” – “mowed” (Z = -2.732; p = 0.006), “control” – “burned” (Z = -1.865; p = 0.062), “mowed” – “burned” (Z = 0.875; p = 0.376).

Figure 44 shows the results of comparing the values of dry invertebrate biomass in July.

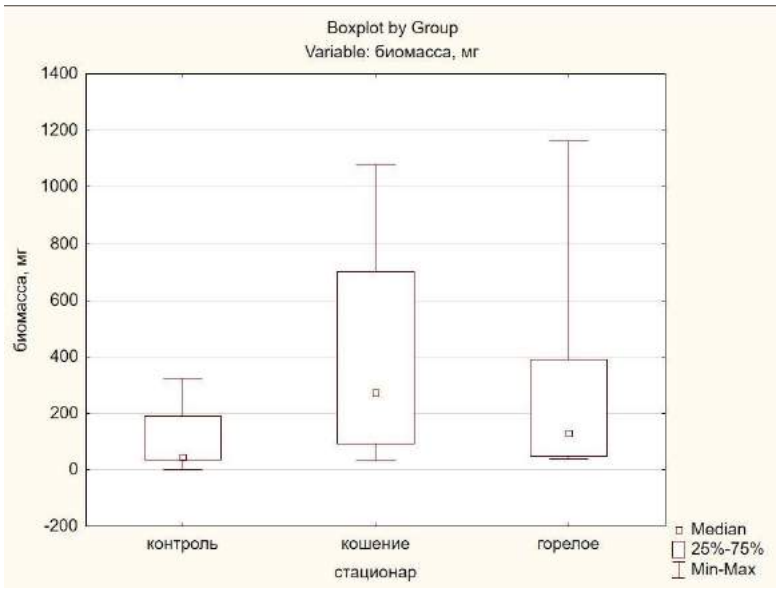

Fig 44. Comparison of the values of dry invertebrate biomass at monitoring plots of the Zvanets reserve in July

Thus, during the monitoring period (May-July) there is a decrease in the dry biomass values at the monitoring plot “control” and an increase at monitoring plots “mowed” and “burned”.

Also, we compared the monitoring plot “control” of the Zvanets reserve and the monitoring plot of the Servech reserve (no project measures were conducted at both plots). Difference in values of the dry invertebrate biomass was registered only in July (Z = -3.185; p = 0.001).

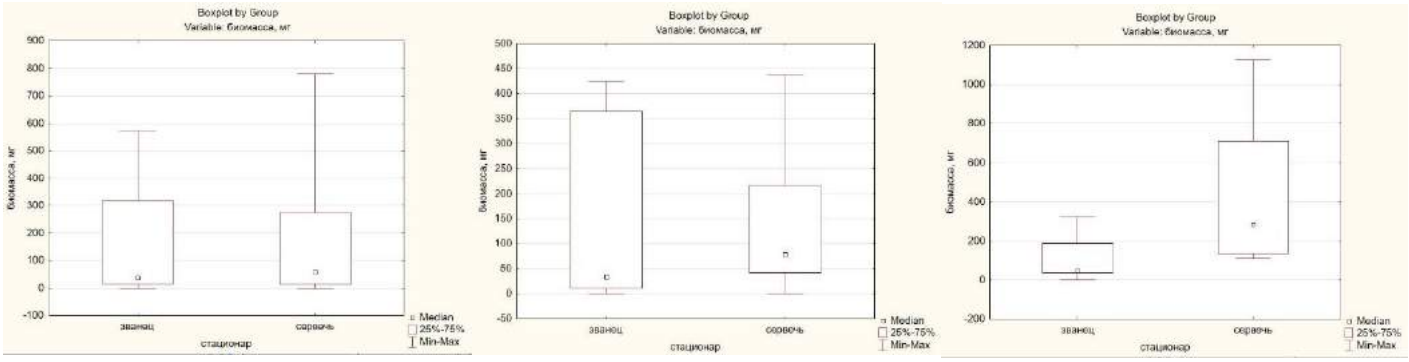

Fig. 45. Comparison of the dry invertebrate biomass values in the protected areas Zvanets and Servech in May (the left boxplot), June (the middle boxplot) and July (the right boxplot)

As can be seen from the Figure 45, during the monitoring period at monitoring plots of the both protected areas the values of dry invertebrate biomass are comparable in May and June, and decline at the "control" monitoring plot of the Zvanets mire in July, which is possibly connected with overgrowth of this site with reeds, and thus decrease in invertebrate number.

Summary: Study of the grass layer invertebrates at monitoring plots of the fen mires Zvanets and Servech has shown, that the population structure of invertebrates of the grass layer is mostly represented by 11 taxonomic groups - Arachnida, Mollusca, Coleoptera, Diptera, Heteroptera, Homoptrera, Hymenoptera, Lepidoptera (imago, larvae), Odonata, Orthoptera, Trichoptera.

During the vegetation season in both protected areas the following groups dominate in the grass layer: Diptera, cicadas, Hemiptera, Arachnida.

It is noted, that there is an increase in number of Diptera, represented mainly by Brachycera (531-1136 ind/100 sweeps), from May to July at monitoring plots of the Zvanets mire, where the project measure was conducted ("burned" plot). A high number of Cicadellidae (347 ind/100 sweeps) was registered at the "mowed" plot in June and July; at the same plot in May the highest numbers of Orthoptera (42 ind/100 sweeps) and Trichoptera (157 ind/100 sweeps) were registered. Quite high population size of some of above-mentioned taxonomic groups at plots, where the project's measures were conducted, is possibly explained by the higher species diversity in vegetation communities, which are trophic objects for above-mentioned taxa.

It is confirmed, that the qualitative and quantitative composition of the grass layer invertebrates at monitoring plots of the Zvanets and Servech mires do not differ significantly: the similarity is more than 70%. The highest similarity percent (over 80%) is between monitoring plots "control" and "mowed" of the Zvanets reserve.

Analysis of the dry invertebrate biomass values at the monitoring plots of the Zvanets mire using the Mann-Whitney U-criterion has shown the difference in this indicator between the monitoring plots "mowed" and "burned" in May ($Z = 2.167$; $p = 0.03$), and between "control" and "mowed" in July ($Z = -2.732$; $p = 0.006$). Thus, during the monitoring period (May-July) there is a decrease in the dry biomass values at the monitoring plot "control" and an increase at monitoring plots "mowed" and "burned". Monitoring plot "control" of the Zvanets reserve and the monitoring plot of the Servech reserve (no project measures were conducted at both plots) differ between each other in the dry invertebrate biomass values only in July ($Z=-3,185$; $p=0,001$). These differences, perhaps, are connected with overgrowth of the plot "control" of the Zvanets mire with reeds, and thus decrease in invertebrate number.

Impact of mowing and fire management on the composition and structure of the communities of ground beetles (Coleoptera: Carabidae) in the Zvanets mire

Monitoring of soil surface invertebrate fauna (herpetobions) was conducted in the period from 11.05.2018 to 27.07.2018 at monitoring plots of the Zvanets mire to assess the impact of the project measures (mowing and controlled burning of dry vegetation – fire management) on the state and number dynamics of the herpetobion fauna. 2 monitoring plots are situated in the northern part of the Zvanets mire (near the village Novosiolki): one plot was subject to fire management, at another one mowing of reeds and sedges was conducted in spring 2018. The "control" plot was established in the southern part of the mire (near the village Povitie), where these measures were not carried out.

Material for studying the fauna of insects-herpetobions was collected by the Barber pitfall traps, which are 200 ml polystyrene containers, 75 mm in diameter, 85 mm high, installed in a line of 15 cups with an interval of 5 m. 4% formalin solution was used as a fixator in the traps. Lines of traps were installed in the central part of the monitoring plots from north to south.

Dominance indices are calculated on Renconen scale (Renkonen, 1938). The dominant species are those whose numerical abundance was 5% or more of all caught specimens of ground beetles within each plot; subdominant species – whose abundance was from 2 to 5%, recedent species (less abundant) – abundance from 1 to 2%; subrecedents (the least abundant) – species with abundance less than 1%.

During the study 1226 specimens of ground beetles were caught at monitoring plots of the Zvanets mire, belonging to 31 species (Table 81) and 16 genera. The richest in species are genera *Pterostichus* (7 species), *Agonum* (5 species), *Badister* (5 species).

At the control plot 79 specimens of ground beetles were caught, belonging to 13 species. Dominant species at this plot are *Agonum emarginatum* (24.05%), *Carabus menetriesi* (26.58%), *Pterostichus diligens* (15.19%), *Pterostichus minor* (5.06%), *Carabus granulatus* (6.33%), *Oodes helopioides* (5.06%).

Reed mowing led to higher species diversity and increase in number of ground beetles at the "mowed" plot in comparison with the control plot. At the "mowed" plot the following species are the dominant: *Agonum emarginatum* (6.25%), *Carabus menetriesi* (20.70%), *Oxypselaphus obscurus* (5.08%), *Pterostichus diligens* (21.88%), *Pterostichus minor* (17.19%), *Pterostichus strenuus* (5.08%).

At the plot, where the fire management was conducted, the species diversity is not high. In total, 832 specimens of ground beetles were caught (according to the data from 14.06-25.07.2018), belonging to 23 species. Dominant species are *Agonum emarginatum* (18.75%), *Agonum hypocrita* (11.66%), *Carabus menetriesi* (21.51%), *Oodes helopioides* (8.77%), *Pterostichus atterimus* (8.53%), *Pterostichus diligens* (8.89%), *Pterostichus minor* (6.01%).

Taxonomic structure of the soil surface insects at the studied plots in the Zvanets mire includes 31 species, belonging to 16 genera (Table 81).

Table 81 – Species composition and dominance structure of ground beetles at monitoring plots of the Zvanets mire

Species	North, mowed mire		North, burned mire		South, control part of the mire	
	Number of specimens	Relative abundance	Number of specimens	Relative abundance	Number of specimens	Relative abundance
Agonum emarginatum	16	**6.25%**	156	**18.75%**	19	**24.05%**
Agonum fuliginosum	0	0.00%	4	0.48%	1	1.27%

Agonum gracile	3	1.17%	0	0.00%	0	0.00%
Agonum hypocrita	7	2.73%	97	**11.66%**	6	7.59%
Agonum versutum	3	1.17%	10	1.20%	0	0.00%
Amara comunis	1	0.39%	0	0.00%	0	0.00%
Badister dillatatus	2	0.78%	4	0.48%	0	0.00%
Badister dorsiger	11	4.30%	0	0.00%	0	0.00%
Badister peltatus	0	0.00%	17	2.04%	1	1.27%
Badister sodalis	0	0.00%	1	0.12%	0	0.00%
Badister unipustulatus	0	0.00%	1	0.12%	0	0.00%
Bembidion assimile	0	0.00%	1	0.12%	0	0.00%
Calathus fuscipes	1	0.39%	0	0.00%	0	0.00%
Calathus melanocephalus	1	0.39%	1	0.12%	0	0.00%
Carabus granulatus	11	4.30%	29	3.49%	5	**6.33%**
Carabus menetriesi	53	**20.70%**	179	**21.51%**	21	**26.58%**
Chlaenius costulatus	0	0.00%	1	0.12%	0	0.00%
Dyschirius globosus	1	0.39%	0	0.00%	0	0.00%
Harpalus rufipes	0	0.00%	1	0.12%	0	0.00%
Oodes helopioides	8	3.13%	73	**8.77%**	4	**5.06%**
Oxypselaphus obscurus	13	**5.08%**	0	0.00%	0	0.00%
Platynus krynickii	1	0.39%	0	0.00%	0	0.00%
Poecilus versicolor	9	3.52%	0	0.00%	1	1.27%
Pterostichus atterimus	1	0.39%	71	**8.53%**	2	2.53%
Pterostichus diligens	56	**21.88%**	74	**8.89%**	12	**15.19%**
Pterostichus minor	44	**17.19%**	50	**6.01%**	4	**5.06%**
Pterostichus niger	0	0.00%	0	0.11%	0	0.00%
Pterostichus nigrita	1	0.39%	24	2.88%	2	2.53%
Pterostichus strenuus	13	**5.08%**	8	0.96%	1	1.27%
Pterostichus vernalis	0	0.00%	28	3.37%	0	0.00%
Stenolopus mixtus	0	0.00%	1	0.12%	0	0.00%
Trechus rivularis	0	0.00%	1	0.12%	0	0.00%
Number of species	21		23		13	
Total, specimens	256		832		79	

Summary: During the study 1226 specimens of ground beetles were caught at monitoring plots of the Zvanets mire, belonging to 31 species (Table 6) and 16 genera. The richest in species are genera *Pterostichus* (7 species), *Agonum* (5 species), *Badister* (5 species).

At the control plot 79 specimens of ground beetles were caught, belonging to 13 species. Dominant species at this plot are *Agonum emarginatum* (24.05%), *Carabus menetriesi* (26.58%), *Pterostichus diligens* (15.19%), *Pterostichus minor* (5.06%), *Carabus granulatus* (6.33%), *Oodes helopioides* (5.06%).

Reed mowing led to higher species diversity and increase in number of ground beetles at the "mowed" plot in comparison with the control plot. At the "mowed" plot the following species are the

dominant: *Agonum emarginatum* (6.25%), *Carabus menetriesi* (20.70%), *Oxypselaphus obscurus* (5.08%), *Pterostichus diligens* (21.88%), *Pterostichus minor* (17.19%), *Pterostichus strenuus* (5.08%).

At the plot, where the fre management was conducted, the species diversity is not high. In total, 832 specimens of ground beetles were caught (according to the data from 14.06-25.07.2018), belonging to 23 species. Dominant species are *Agonum emarginatum* (18.75%), *Agonum hypocrita* (11.66%), *Carabus menetriesi* (21.51%), *Oodes helopioides* (8.77%), *Pterostichus atterimus* (8.53%), *Pterostichus diligens* (8.89%), *Pterostichus minor* (6.01%).

The results received when comparing communities of ground beetles of the control plot and plots, subject to the project measures (burning and mowing) show the increase of species abundance and change in dominance structure of ground beetle communities, inhabiting parts of the mire, where the project measures were conducted. Herewith, mowing of vegetation is more effective for increasing of species abundance in comparison with the fire management.

Assessment of the composition of soil surface invertebrate fauna of the fen mire Servech

Monitoring of soil surface invertebrate fauna (herpetobions) was conducted in the period from 09.05.2018 to 24.07.2018 at the monitoring plot of the fen mire Servech to assess the state of the herpetobion fauna and its taxonomic structure. The monitoring plot was established in the distance of 1200 m from Lake Servech, where no project measures (mowing and burning) were conducted.

Material for studying the fauna of insects-herpetobions was collected by the Barber pitfall traps, which are 200 ml polystyrene containers, 75 mm in diameter, 85 mm high, installed in a line of 15 cups with an interval of 5 m. 4% formalin solution was used as a fixator in the traps. Lines of traps were installed in the central part of the monitoring plot from north to south.

Dominance indices are calculated on Renconen scale (Renkonen, 1938). The dominant species are those whose numerical abundance was 5% or more of all caught specimens of ground beetles within each plot; subdominant species – whose abundance was from 2 to 5%, recedent species (less abundant) – abundance from 1 to 2%; subrecedents (the least abundant) – species with abundance less than 1%.

During the study 162 specimens of ground beetles were caught at the monitoring plot of the Servech mire (from 14.06. – 23.07.2018), belonging to 20 species (Table 7). The richest in species are genera *Agonum* (6 species), *Pterostichus* (4 species), *Chlaenius* (4 species). The dominant species are *Agonum emarginatum* (49 specimens, or 30.25% of all specimens), *Carabus menetriesi* (35 specimens, 21.60%) and *Agonum hypocrita* (19 specimens, 11.73%); subdominant species are *Carabus granulatus* (4.94%), *Pterostichus atterimus* (4.94%), *Agonum gracile* (3.70%), *Oodes helopioides* (3.09%), *Chlaenius quadrisulcatus* (3.09%), *Chlaenius sulcicolis* (3.09%), *Chlaenius tristis* (3.09%). Less abundant species are *Agonum versutum* (1.85%), *Carabus clathratus* (1.85%), *Badister peltatus* (1.23%), *Chlaenius costulatus* (1.23%), *Harpalus rufipes* (1.23%), and the least abundant are *Agonum fuliginosum* (0.62%), *Agonum thorey* (0.62%), *Pterostichus minor* (0.62%), *Pterostichus niger* (0.62%), *Pterostichus nigrita* (0.62%).

Taxonomic structure of soil surface invertebrates at the monitorin plot of the Servech mire includes 22 species, belonging to 8 genera (Table 82).

Table 82 – Species composition and dominance structure of ground beetles at the monitoring plot of the Servech mire.

Species	Servech, monitoring plot	
	Number of specimens	Relative abundance
Agonum emarginatum	49	**30.25%**
Agonum fuliginosum	1	0.62%
Agonum gracile	6	3.70%
Agonum hypocrita	19	**11.73%**
Agonum thorey	1	0.62%
Agonum versutum	3	1.85%
Badister peltatus	2	1.23%
Carabus clathratus	3	1.85%
Carabus granulatus	8	4.94%
Carabus menetriesi	35	**21.60%**
Chlaenius costulatus	2	1.23%
Chlaenius quadrisulcatus	5	3.09%
Chlaenius sulcicolis	5	3.09%
Chlaenius tristis	5	3.09%
Harpalus rufipes	2	1.23%
Oodes helopioides	5	3.09%
Pterostichus atterimus	8	4.94%
Pterostichus minor	1	0.62%
Pterostichus niger	1	0.62%
Pterostichus nigrita	1	0.62%
Number of species	20	
Total	162	

Summary: The study shows, that population structure of ground beetles at the monitoring plot of the Servech mire is represented by 20 species of 7 genera. 162 specimens of ground beetles were caught at the monitoring plot of the Servech mire. The reachest in species are genera *Agonum* (6 species), *Pterostichus* (4 species), *Chlaenius* (4 species). The dominant species are *Agonum emarginatum* (49 specimens, or 30.25% of all specimens), *Carabus menetriesi* (35 specimens, 21.60%) and *Agonum hypocrita* (19 specimens, 11.73%).

10. BY/07-Zvanets

10.1. Bird monitoring

Density of the Aquatic Warbler in optimal biotopes during the first clutch period in 2018 varied from 5,00 to 11,11 males per 10 ha (see Table 1), which are high values. The density on "overgrowing" routes varied from 0,14 to 3,13 males/10 ha during the period of first clutch. Below are the comparative data for years 2017-2018 at different parts of the Aquatic Warbler census routes (Fig. 46, Table 83). Attention is drawn to the fact that in 2018 during the second clutch period the density of singing males has strongly increased in the northern part of the reserve. One of the possible reasons of such increase could be burning of vegetation (upper fire) occurred in the southern part of the reserve in early spring. Due to this fire the optimal conditions for the Aquatic Warbler's breeding were created here during the first clutch period: lack of the old reeds, weak willow shrubs. In July with increased density and height of reeds, the density of Aquatic Warbler males in this southern part has declined, and respectively, it has risen in the northern part, where reeds remain low during the entire vegetation period. Thus, these changes of the Aquatic Warbler density in the north and south from May till July are explained by redistribution of birds within the mire due to impact of the project's measures.

Fig. 46. Location scheme of monitoring routes and plots for census of the Aquatic Warbler in 2017-2018 in the Zvanets protected area. Legend: monitoring routes for the Aquatic Warbler census; counts of singing males were conducted on the constant monitoring plots "Novosiolki" and "Povitie". Each monitoring plot was divided on parts according to the projective coverage of reeds and shrubs (over 50% - part A, less than 30% - Povitie B and C, and less than 10% - Novosiolki B).

Table 83. Density of singing males of the Aquatic Warbler (males per 10 ha) during the first and second clutch period in 2017-2018 in the Zvanets protected area.

	2017		2018	
Monitoring route	I clutch	II clutch	I clutch	II clutch
Novosiolki "A"	1.89	0.63	1.25	3.13
Novosiolki "B"	9.38	12.86	8.33	22.78
Povitie "A"	1.88	1.25	0.71	0.14
Povitie "B"	5.5	6.86	11.11	8.89
Povitie "C"	5	6.38	5	4.29

Maximal density of the Citrine Wagtail on the territory of the Zvanets site was 10 birds per 10 ha. Only one pair of the Montagu's Harrier was registered within the monitoring plot. Short-eared Owl was not observed during the spring period. 3 colonies of the Black-tailed Godwit and Common Redshank were found on the monitoring plot in 2018. The total population size of the Black-tailed Godwit was 23 pairs, of the Common Redshank – 3 pairs. It should be noted that colonies were formed on plots, where mowing and burning of the vegetation were conducted. In 2018 only one worrying individual bird of the Eurasian Curlew was registered on the monitoring plot in early spring period. There were no later observations of this species. The same situation was observed and in previous years. Only one male of the Great Snipe was registered on the known displaying ground during the counts. Comparing with previous years, we can say that at this displaying ground there is a constant fluctuation in the number of the Great Snipe. However, male and female (later – with a brood) of this species were present on the mowed part of the monitoring plot during the entire spring period. This indicates a positive effect of mowing on population of the Great Snipe in the sedge mire. Such positive effect is also confirmed in other project areas. There were registered 3 displaying males of the Corncrake and 2 spotted crakes within the monitoring plot with a total area of 2 km^2. Such population size of these species is usual for open sedge fen mires.

Table 2 presents comparative data for years 2017-2018 in the project area Zvanets for monitored bird species.

Table 84 Density of bird species monitored under the LIFE project on the territory of the Zvanets mire in 2017-2018.

Species	Density on the monitoring plots	
	2017	2018
Aquatic Warbler *(Acrocephalus paludicola)*	In optimal biotopes 5.00 – 9.38 males/10 ha	In optimal biotopes 5.00 - 11.11 males/10 ha
Citrine Wagtail *(Motacilla citreola)*	In optimal biotopes 1.75 – 3.75 ind./10 ha	In optimal biotopes 1.11 – 10.0 ind./10 ha
Montagu's Harrier *(Circus pygargus)*	0.01 pairs/km^2	0.01 pairs/km^2
Short-eared Owl (*Asio flammeus*)	0.15 pairs/km^2	0
Black-tailed Godwit *(Limosa limosa)*	0	2.19 pairs/10 km^2
Common Redshank (*Tringa totanus)*	0	0.29 pairs/10 km^2
Eurasian Curlew (*Numenius arquata*)	0.10 pairs/km^2	0.10 pairs/km^2
Great Snipe *(Galinago media)*	0.29 males/km^2	0.57 males/km^2

Corncrake *(Crex crex)*	No data	0.29 males/km^2
Spotted Crake *(Porzana porzana)*	No data	0.19 males/km^2

10.2. Vegetation monitoring

The project site Zvanets is located between N 58^{0}0′–52^{0}70′ and E 24^{0}42′–25^{0}30′. The total area is 16221.1 ha. The central part of the project site is occupied by sedge mires (34.4%) which are overgrowth with reeds and tree-shrub vegetation. Significant area (Table 85, Fig. 47.) is occupied by derivative reed, reed-willow and willow communities (25.9% of the territory). Meadow and agricultural lands (arable land, vegetable gardens) occupy 15.6%; forest – 24.1%.

Table 85 – The map's legend and structure of the modern vegetation cover of the project site Zvanets (as of 2018)

№ on the map	*The legend units*	*Area*	
		ha	*%*
MEADOW AND AGRICULTURAL LANDS		**2518.4**	**15.6**
1.	Xero- and mesophytic cereal (*Briza media, Dactylis glomerata, Festuca pratensis, F. rubra, Helictotrichon pubescens, Holcus lanatus, Phleum pratense*) and herb-cereal (*Achillea millefolium, Campanula glomerata, Centaurea jacea, Galium mollugo, G. verum, Lathyrus pratensis, Potentilla anserine, Thymus serpyllum, Trifolium pretense, T. repens, Vicia cracca*) meadows on calcareous soils	951.3	5.9
2.	True hygromesophytic herb-cereal (*Molinia caerulea, Phalaroides arundinacea, Poa palustris, Galium mollugo, Inula salicina, Lathyrus pratensis, Origanum vulgare, Symphytum officinale*) meadows with plots of agrocoenoses (vegetable gardens)	1567.1	9.7
MIRES		**7366.9**	**45.3**
3.	Large sedge mires (with dominant *Carex elata*), which parts are under overgrowth with tree-shrub vegetation (*Alnus glutinosa, Betula pubescens, Salix* spp.) and reed (*Phragmites australis*)	1950.7	12.0
4.	Reed-sedge mires (*Phragmites australis, Carex elata, C.lasiocarpa*) with parts, overgrown by willow (*Salix cinerea, S. myrsinifolia, S. pentandra, S. rosmarinifolia*)	2502	15.4
5.	Calamagrostis-sedge mires (with dominant *Carex lasiocarpa, C. diandra, C. elata, Calamagrostis canescens*), locally under active encroachment of reed (*Phragmites australis*) and willow (*Salix* spp.)	1142.7	7.0
6.	Reed (*Phragmites australis*) thickets, often with shrubs (*Salix cinerea*, *S. lapponum*, *S. pentandra*, *S. rosmarinifolia*)	1771.5	10.9
SHRUBS		**2428.7**	**15.0**
7.	Willow stands (*Salix cinerea, S. pentandra, S. rosmarinifolia*) of reed-Calamagrostis-sedge type (*Phragmites australis, Calamagrostis canescens, Carex lasiocarpa, C. elata, C. appropinquata*), sometimes in combination with deciduous (*Betula pubescens, B. pendula, Alnus glutinosa*) hygrophytic-grass-sedge light forest	2428.7	15.0
FORESTS		**3907.1**	**24.1**
8.	Forested lands	3907.1	24.1

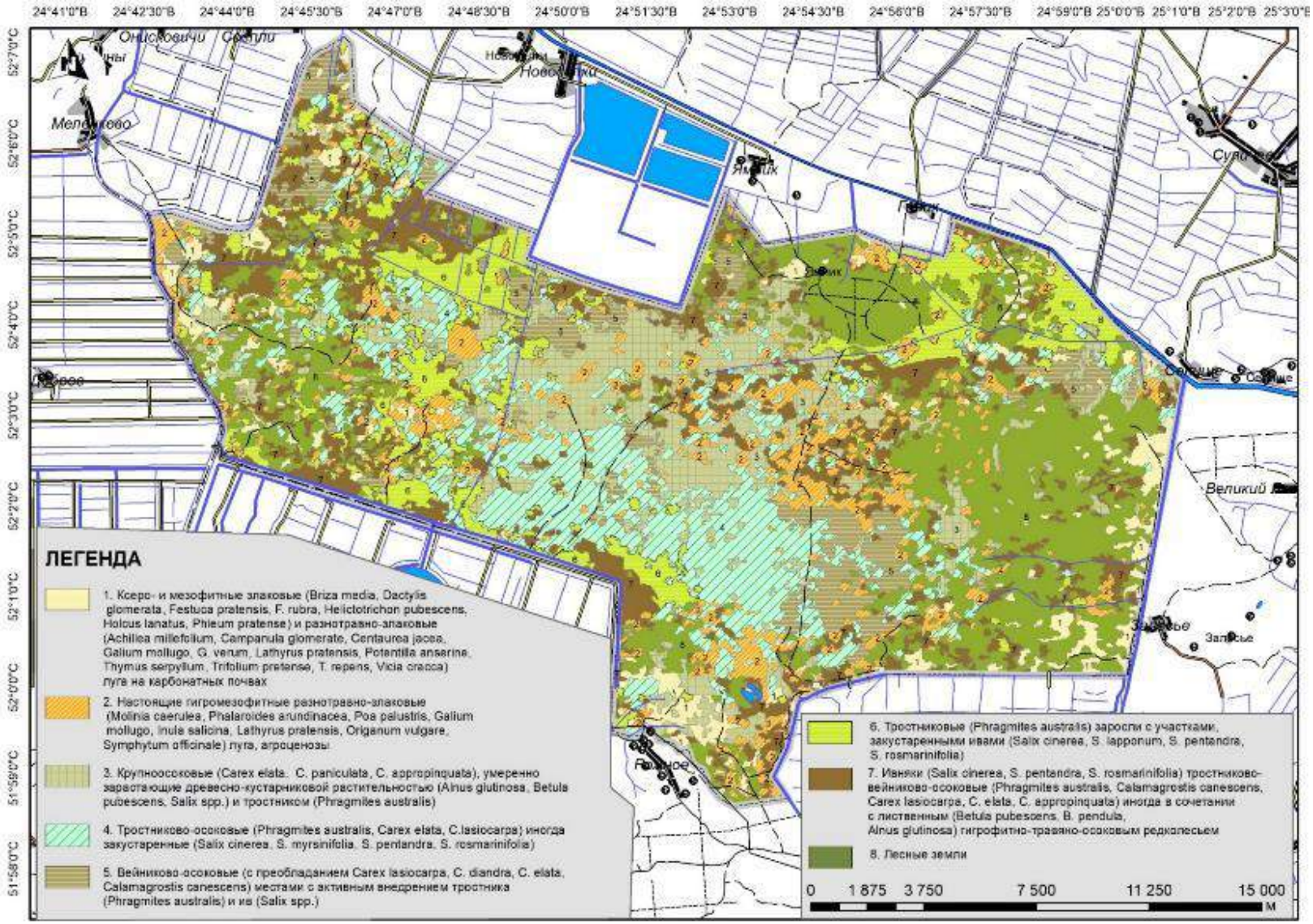

Fig. 47. Vegetation map of the project site Zvanets (as of 2017-2018)

1. Xero- and mesophytic cereal and herb-cereal meadows with plots of agrocoenoses.

Communities of xero- and mesophytic cereal meadows are located at ridges of different height (Fig. 48.), in sod-calcareous leached and podzolized soils; they occupy 951.3 ha, or 5.9% of the site's territory and located mainly at the periphery of the mire, especially in the western, eastern and southern parts. Phytocoenotic feature of such communities is polydominance of the grass stand. The following species prevail: Quaking-grass (*Briza media*), Cat grass (*Dactylis glomerata*), Meadow fescue and red fescue (*Festuca pratensis, F. rubra*), Downy oat-grass (*Helictotrichon pubescens*), Yorkshire fog (*Holcus lanatus*), Timothy-grass (*Phleum pratense*), Yarrow (*Achillea millefolium*), Clustered bellflower (*Campanula glomerata*), Brown knapweed (*Centaurea jacea*), Hedge bedstraw and Lady's bedstraw (*Galium mollugo, G. verum*), Meadow vetchling (*Lathyrus pratensis*), Silverweed (*Potentilla anserine*), Breckland thyme (*Thymus serpyllum*), Red clover and White clover (*Trifolium pratense, T. repens*), Bird vetch (*Vicia cracca*). On plots, located near populated localities, these communities are partly transformed to agrocoenoses, often getting wild.

2. True hygromesophytic herb-cereal meadows with parts of agrocoenoses (vegetable gardens). Communities of the true hygromesophytic herb-cereal meadows are formed at elevated parts of the mire (Fig. 49.), in sod, sod-gleyey, and temporary excessively moisturized soils. They are located throughout the mire and occupy 1567.1 ha, or 9.7% of the site's territory. Species composition includes 18-38 species. These communities are characterized by polydominant grass stands, subject to fluctuations. Cereals dominate: *Molinia caerulea*, *Phalaroides arundinacea*, *Poa palustris*. Phytocoenotic value of herbs is quite high, common species in such communities are Hedge bedstraw (*Galium mollugo*), Irish fleabane (*Inula salicina*), Meadow vetchling (*Lathyrus pratensis*), Oregano (*Origanum vulgare*), Common comfrey (*Symphytum officinale*). Plots, located near populated localities, are partly transformed to agrocoenoses, often getting wild.

3. Large sedge mires, which parts are under overgrowth with tree-shrub vegetation and reed. These communities (Fig. 50.) are situated in the center of the mire and occupy 1950.7 ha, or 12.0% of the project site Zvanets. They are of special interest as potential breeding habitats for the Aquatic Warbler. These communities are characterized by high sedge layer (0.6–0.7 m), formed by the Tussock sedge (*Carex elata*); the following co-dominants present: Purple small-reed (*Calamagrostis canescens*), Slender sedge (*Carex lasiocarpa*), Fibrous tussock-sedge (*C. appropinquata*), Marsh cinquefoil (*Comarum palustre*), *Menyanthes trifoliata*. Projective coverage of the Tussock sedge varies from 25 to 50%. Among low-abundant species there are Water horsetail (*Equisetum fluviatile*), Common marsh bedstraw (*Galium palustre*), Tufted loosestrife *(Lysimachia thyrsiflora)*, Marsh marigold (*Caltha palustris*), Lesser spearwort (*Ranunculus flammula*), Meadow starwort (*Stellaria palustris)*, Yellow loosestrife *(Lysimachia vulgaris),* and other. Herbs are strongly depressed by high water level, and, as a rule, form low-density second and third grass layers. The moss cover is poorly developed (the total projective coverage rarely exceeds 30%) and moss species composition is poor as well. *Calliergon giganteum*, *Mnium rugicum* are common species.

These communities currently are at the stage of active overgrowth with reeds (projective coverage is up to 10–20%), shrubs and deciduous low forest. Transformation processes affect more than 50% of the territory occupied by this type of community.

4. Reed-sedge mire includes "transit" communities, replacing communities of large sedges (with dominance of *Carex elata*). In such communities the main edificator and builder is reed (as well as *Carex elata*) (Fig. 51.). Often they include areas with quite abundant willow thickets. These communities occupy area of 2502.0 ha (15.4%).

Fig. 48. Xero- and mesophytic cereal and herb-cereal meadows (№ 1)

Fig. 49. True hygromesophytic herb-cereal meadows (№ 2)

Fig. 50. Large sedge (with dominance of *Carex elata*) fen mire, which is under overgrowth with reeds and willow shrubs (№ 3)

Fig. 51. Reed-sedge communities (№ 4)

5. Calamagrostis - sedge fen mire, under active overgrowth with reeds and willows. Communities of this syntaxon (Fig. 52.) are found in compact areas on the peripheral part of the mire (mainly in the northern and western sectors), where they form complex mosaic with communities with dominance of the *Carex elata* (mapped taxon № 3) and *Phragmites australis* (№ 4, 6). They occupy an area of 1142.7 ha (7.0% of the project site's territory).

Slender sedge is dominant and characteristic species in such communities; co-dominants are Tussock sedge (*Carex elata*) and Lesser tussock sedge (*Carex diandra*). Common species are reed (*Phragmites australis*) (projective coverage is 10–20%), Water horsetail (*Equisetum fluviatile*), *Menyanthes trifoliata*, Marsh cinquefoil (*Comarum palustre*), Cotton grass (*Eriophorum polystachyon*), Milk-parsley (*Peucedanum palustre*).

The dense moss cover is absent; the projective coverage of Hypnum mosses, which present here, does not exceed 25–30%, and there are practically no mosses in most communities.

6. Reed thickets, often with shrubs. These communities have quite high spread rate within the project area (Fig. 53). Currently they occupy an area of 1771.5 ha (10.9% of the project site's territory) and form a wide stripe in the southern and western parts of the project site. Morphology of these communities is characterized by the very dense layer of reed (*Phragmites australis*), up to 1.8–3.5 m high. Species of mire herbs do not form a closed layer; the moss cover is absent as well.

7. Willow stands of reed-Calamagrostis sedge type, sometimes in combination with deciduous hygrophytic grass-sedge light forest. Willow stands (Fig. 54) occupy an area of 2428.7 ha (15.0%) and form a wide peripheral band along the northern and western parts of the project site. Compact areas of these communities often can be found throughout the site's territory. Their wide distribution also indicates a change in watering conditions in the mire habitats.

The main layer 1.5 – 3.0 m high is formed by willow shrubs, mainly Grey willow (*Salix cinerea*) and Eared willow (*S. aurita*). The projective coverage of shrubs reaches 60–80%. Low (3-5 m) single trees of the Bay willow (*S. pentandra*) and Downy birch (*Betula pubescens*) rise higher than the shrub layer. The grass layer consists of the Slim-stem small reed (*Calamagrostis neglecta*), Tussock sedge (*Carex elata*) and Slender sedge (*C. lasiocarpa*), Marsh cinquefoil (*Comarum palustre*), Water horsetail (*Equisetum fluviatile*), reed (*Phragmites australis*), *Menyanthes trifoliata* and other eutrophic herbs. The low-dense moss cover (projective coverage of mosses is up to 30%) is formed by species *Mnium rugicum*, *M. cinclidioides*, *Drepanocladus vernicosus*, *Calliergon cordifolium*, *Calliergonella cuspidata*.

Willow stands form the complex mosaic with young black alder and downy birch-black alder forests.

8. Forested lands are found on a considerable part of the project area (№ 10). But, as these communities do not connected with habitats of the project's indicator species (Aquatic Warbler), they are not considered in detail on the vegetation map (are mapped as 1 taxon according to the vegetation type).

Fig. 52. Sedge (with dominance of *Carex lasiocarpa*) fen mire (№5)

Fig. 53. Reed thickets (№ 6) has high rate of spread within the project site Zvanets

Fig. 54. Willow thickets (№ 6) – one of dominant types of vegetation communities in the project site Zvanets

BIOTOPES

Within the project site Zvanets according to the habitat (biotope) classification system EUNIS there were identified 8 units of 4-6 hierarchical levels, including 1 forest one, 1 – shrub, 4 – mire, 2 - meadow (Table 85, Fig. 55). The share of highly waterlogged biotopes is 75.9% of the overall area of the project site.

Table 85 – Biotopes of the project site Zvanets

№	Biotopes EUNIS		Area	
	Code	Name	ha	%
1	D5.11	Common reed [Phragmites] beds normally without free-standing water	1771.5	10.9
2	D5.21	Beds of large [Carex]	1142.7	7.1
2a	D5.2151	Tufted sedge tussocks	1950.7	12.0
3	D5.21 (Phg)	D5.21 in the phase of overgrowing by reed [Phragmites]	2502.0	15.4
4	E1.26	Sub-Atlantic semi-dry calcareous grassland	951.3	5.9
5	E2.25	Continental meadows	1567.1	9.6
6	F9.21	Grey willow carrs	2428.7	15.0
7	G4.4	Mixed Scots pine - birch woodland	3907.1	24.1
		TOTAL:	**16221.1**	**100.0**

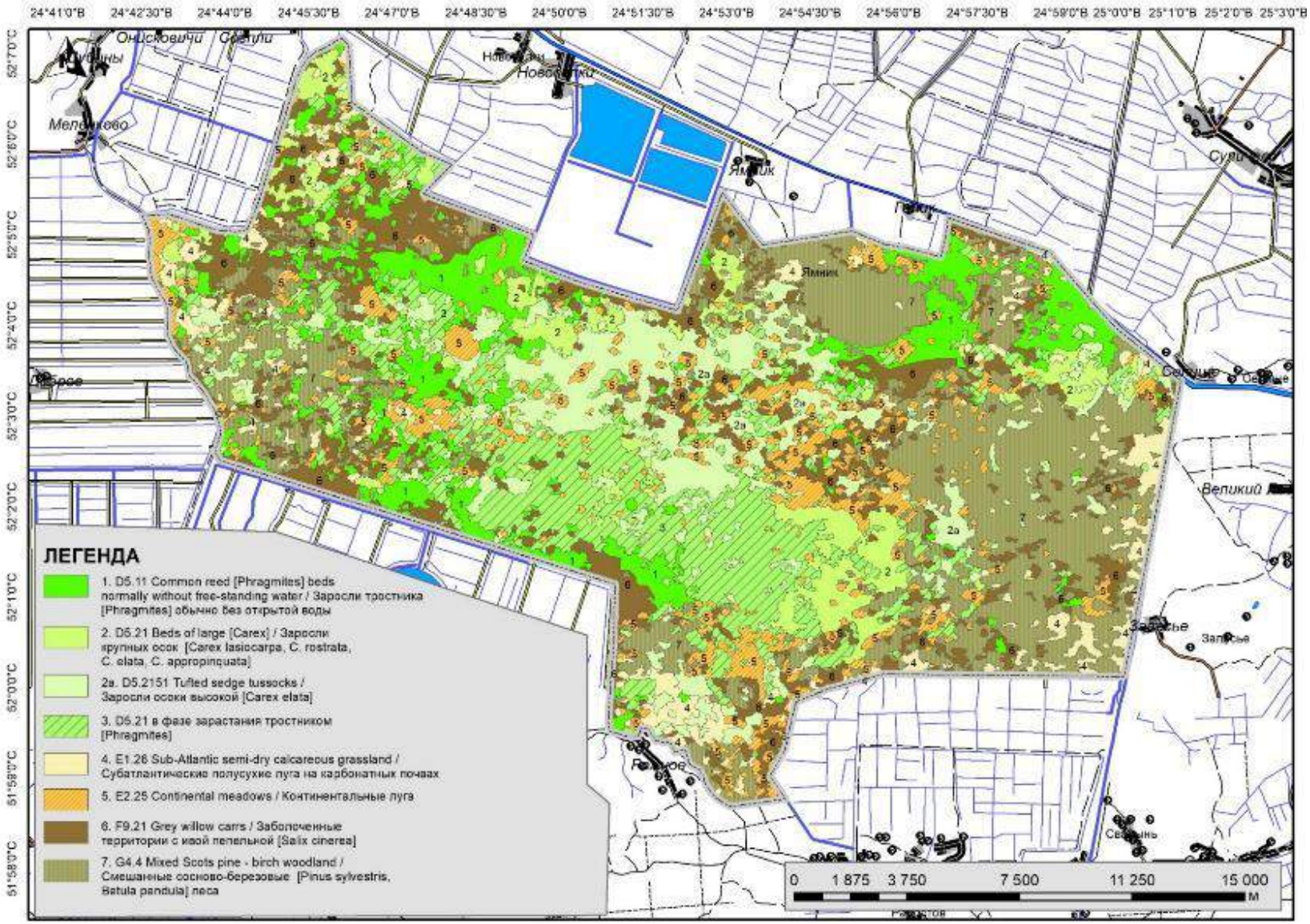

Fig. 55. Map of habitats (biotopes) of the project site Zvanets (according to the EUNIS system)

VEGETATION SUCCESSIONS AS INDICATOR OF MODERN PROCESSES IN WETLAND ECOSYSTEMS

Investigations have shown that negative for biodiversity processes occur at an area of 11624.3 ha (75.3% of the project site's area) (Tables 86, 87, Figures 56-58). The main threats include overgrowth of the fen mire (up to 30–40%) with tree-shrub vegetation (2428.7 ha – 15.0%), and with reeds (9195.6 – 60.3%).

In the spring of 2018, there was a fire on an area of 3,360.5 hectares (20.7%).

Table 86 – Succession processes in ecosystems of the project site Zvanets

№	Process	ha	%*
1	Active overgrowth of fen mire (up to 30–40%) with tree-shrub vegetation (*Salix* spp., *Betula pubescens*)	2428.7	15.0
2	Active overgrowth of fen mire with reeds	9195.6	60.3
TOTAL		**11624.3**	**75.3**

*Of the area of the project site Zvanets

Table 87 – Classification of areas of the project site according to the rate of their overgrowth with reed

№	Process	ha	%*
Overgrowth of the open fen mire with reed			
1.	Projective coverage ≤10%	2518.4	15.6
2.	Projective coverage = 10,1–20%	5522.1	34.0
3.	Projective coverage = 15,1–30%	2502.0	15.4
4.	Projective coverage >30%	1171.5	10.9
TOTAL		**11714.0**	**75.9**

Fig. 56. Succession processes in ecosystems of the project site Zvanets

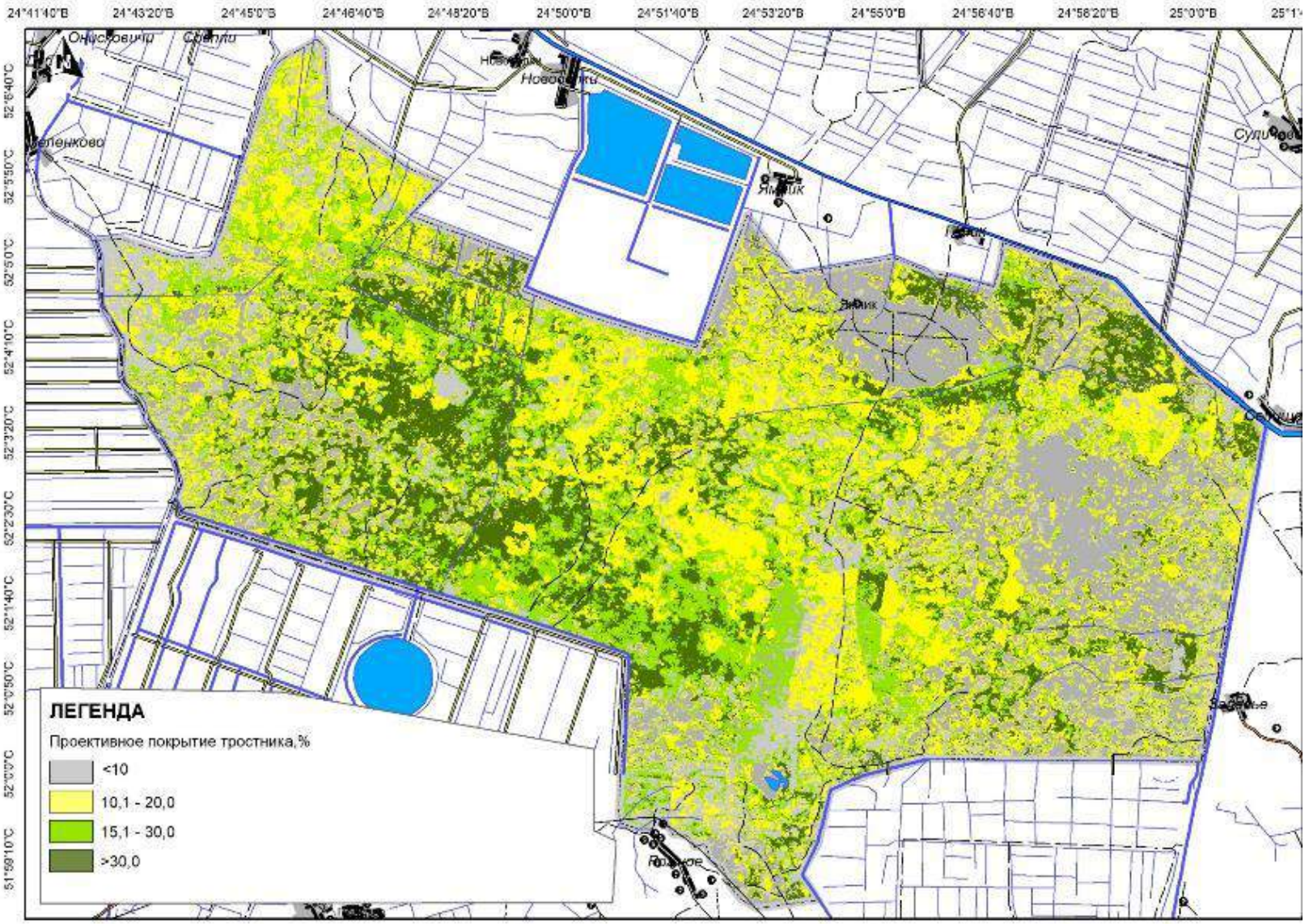

Fig. 57. Classification of areas of the project site Zvanets according to their rate of overgrowth with reed

Fig. 58. Overgrowth with reed – the main threat to the vegetation cover of the fen mire Zvanets

Fig. 59. Spring fire zone within the project site Zvanets

10.3. Chemical composition of surface water

Water samples for hydrochemical analysis Zvanets mire were collected in 10 different locations in in early May 2017 (Fig. 60). The results of the chemical analysis of the surface water showed that the chemical composition of the water in different parts of the swamp is uneven. The highest total water mineralization and other quantities of water-soluble chemical compounds are found in the southern part of the swamp where the water enters the mire and flows to the central part. This nutrient-rich water encourages the growth of unwanted vegetation such as reeds and shrubs. The fastest growing areas of this vegetation are observed along the water channels, while in the more remote parts of the area changes of sedge dominated vegetation are not so noticeable. More details on chemical composition of surface water are presented in Chapter 10.3.

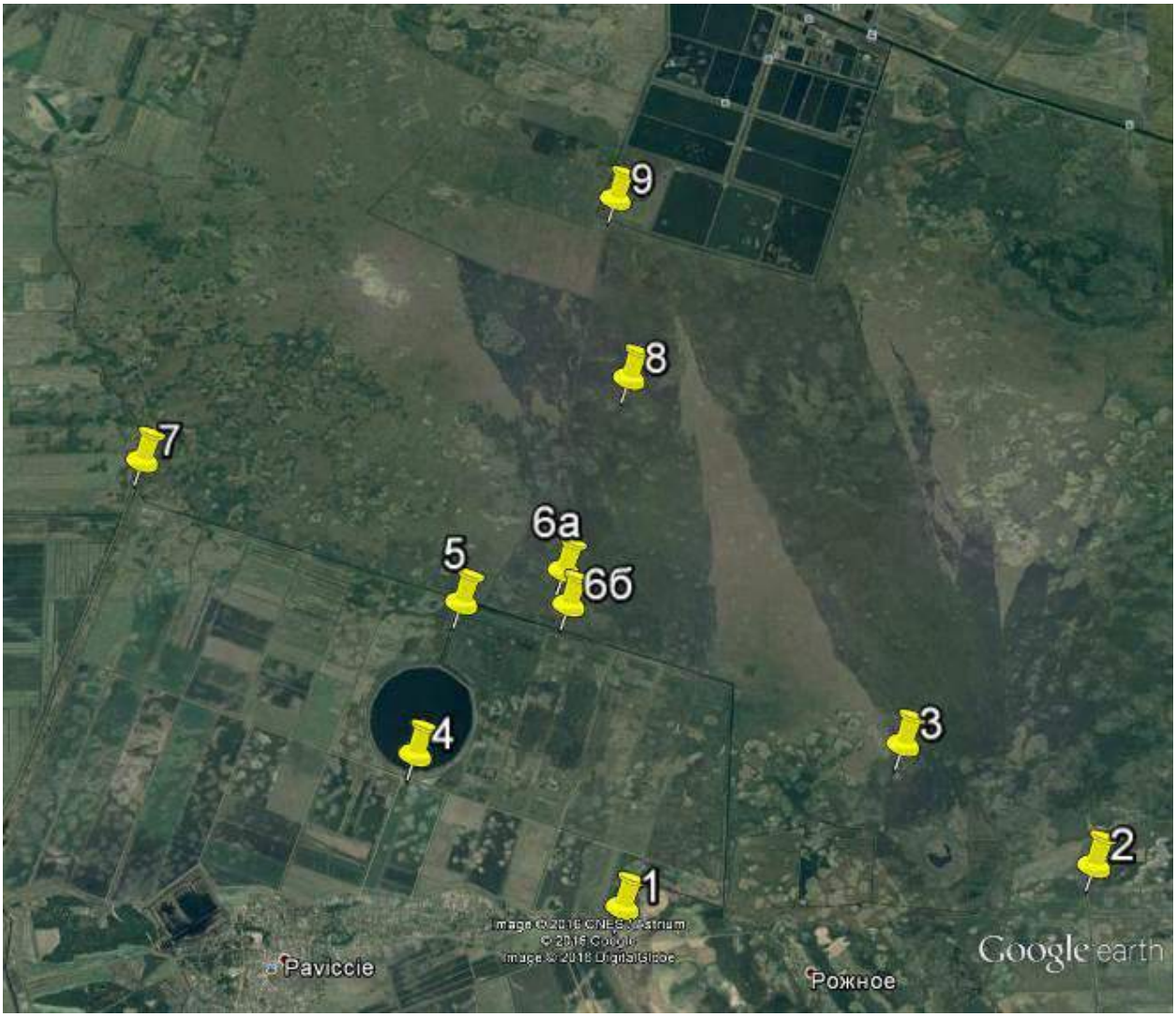

Fig. 60. Surface water sampling stations for hydrochemical research in project site BY/07-Zvanets in May 2017

Since 2002, major efforts have been made to improve water levels at Zvaniec. These activities have focused on stabilising water levels, using nutrient-rich surface waters of the drainage system. In particular, the Orekhovsky channel and two meliorative systems (Travy and Orekhovskaya) bring water to the central part of Zvaniec. This water has a high ion content (mineralisation 370-420 mg/l) (Fig. 61). Along the channel, a belt of c. 400 m is rapidly overgrowing with Reed. Within the project 'LIFE Magni Ducatus Acrola' (2016-2022), it is planned to repair existing, and build new water

regulation structures, which are hoped to allow to actively adjust not only the level, but also the quality of the water. To improve the quality of the water, it will be directed through the periphery of the mire, where it will be purified before affecting the central part of the mire. There are also plans to improve water quality by directing surface water from the catchment (Radostovo forest) to the mire (A. Kozulin pers. comm.). This part of the catchment was separated from the mire in the 1990s.

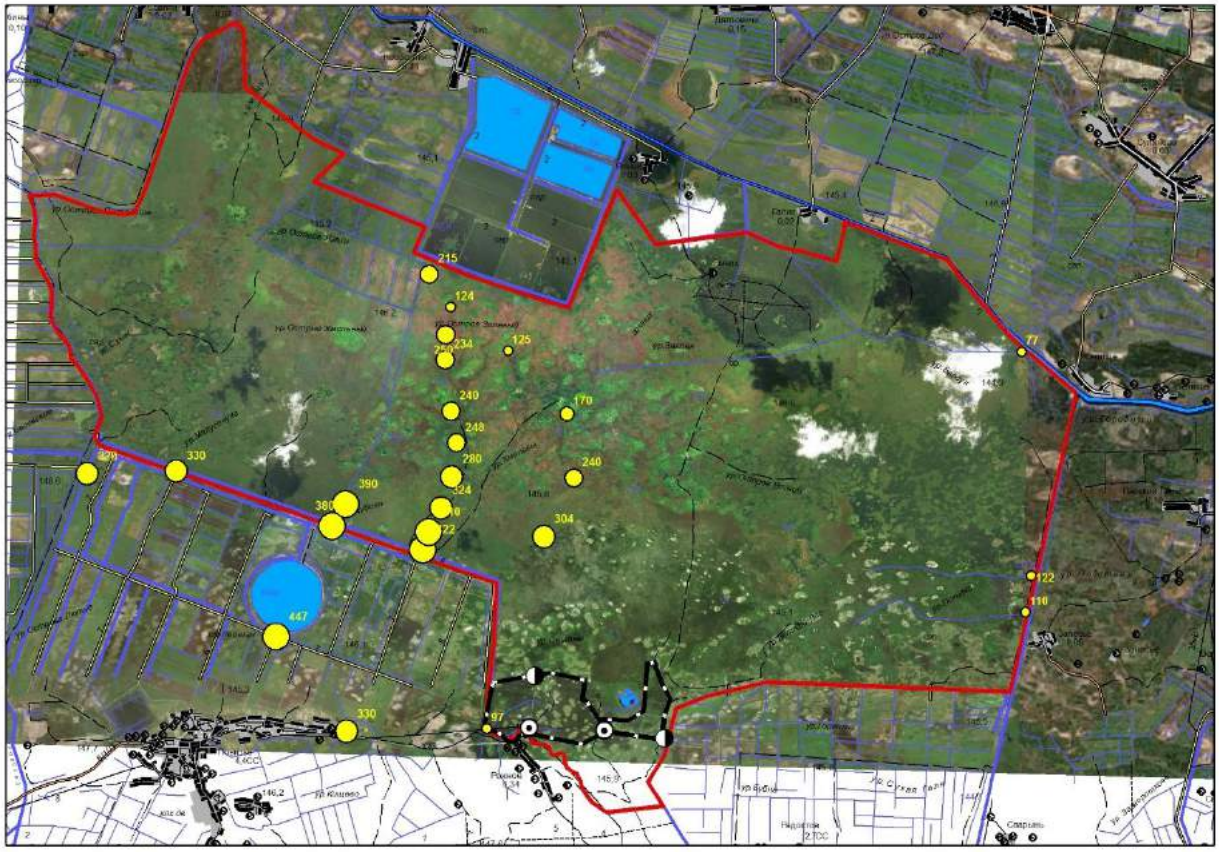

Fig. 61. Surface water mineralization in the central part of Zvanets mire.

10.4. Hydrological monitoring

Monitoring of water levels in the Zvanets reserve from 2015 to 2017

To monitor the water levels in the Zvanets bog, three points for measuring water levels by local residents (P1, P2, P3) and four automatic water level sensors (D1, D2, D3, D4) were installed. Installation locations of observation points and automatic sensors are shown in Figure 59.

Analysis of long-term data from observation points on groundwater level dynamics showed that 2015 and 2016 were very dry. In 2017, the dynamics of water levels were close to optimal for a lowland bog (Fig. 62).

2015 was the dry year itself for the entire observation period since 2000. This year there was no flood in the Orekhovsky Canal and no water at all entered the swamp. The precipitation falling on the territory of the marsh during May-July was not enough to saturate the thickness of peat.

In 2016, a short flood was observed on the Orekhovsky Canal, due to which the swamp was filled with water to a level of about 10-15 cm above the soil surface. Since the beginning of the third decade of March, there has been a tendency to reduce the level of surface waters in the swamp. To slow down the decrease in water level due to the use of a lock on the Orekhovsky Canal, water supply

to the marsh was organized. As a result, it was possible to maintain the groundwater level at 10-15 cm below the soil level. At the end of June, the flow through the Orekhovsky canal completely stopped, which led to a further accelerated decrease in the groundwater level in the swamp 60 cm below the soil level in September.

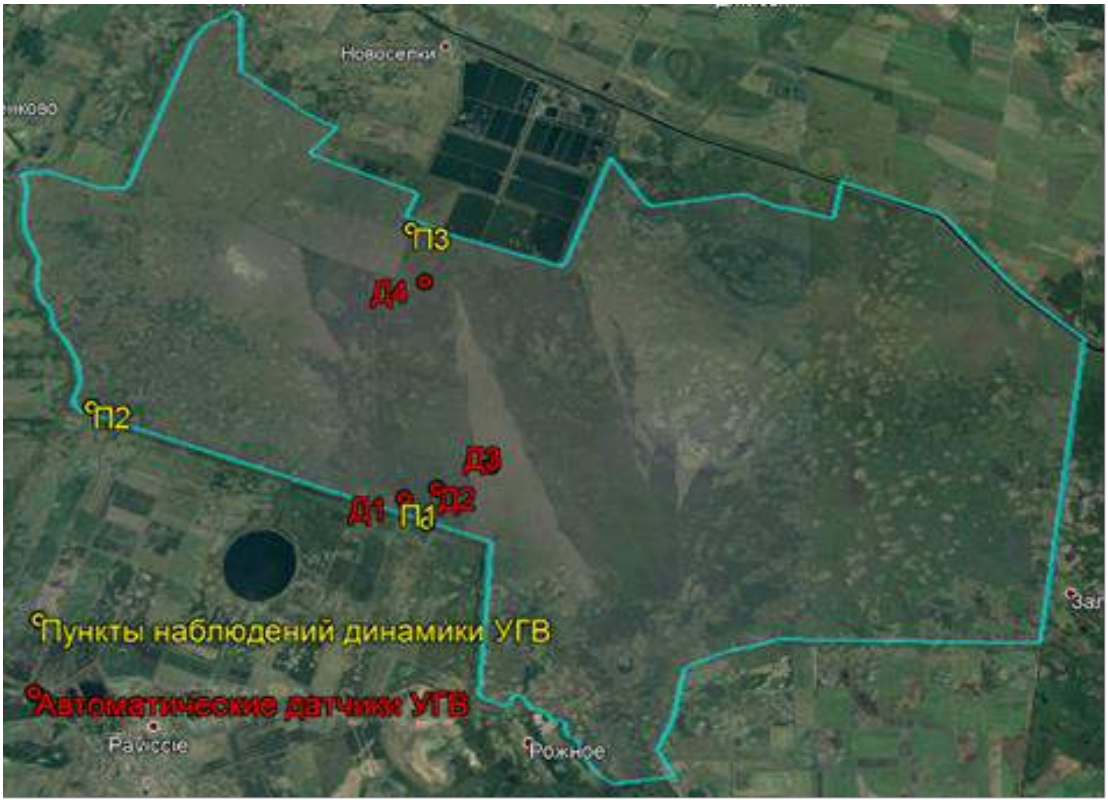

Fig. 62. Water level measuring gauges in Zvanets ptoject site.

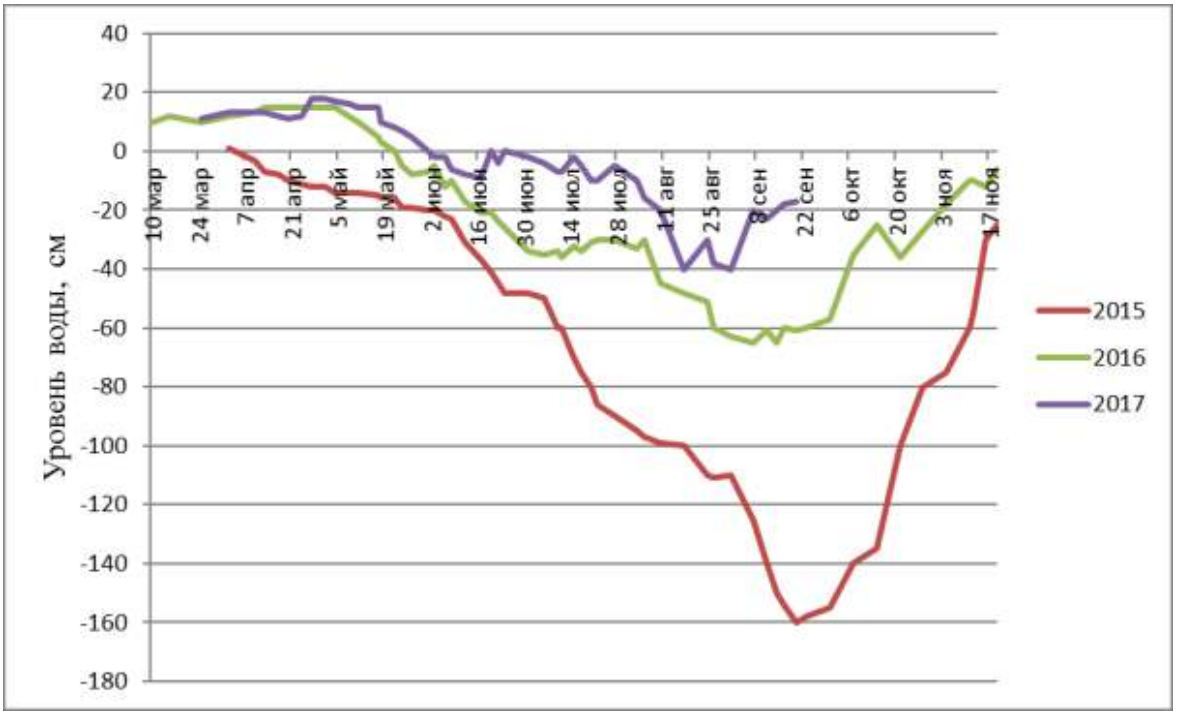

Fig. 63. The dynamics of the groundwater level in the Zvanets bog (station No. 3) during the breeding period of Aquatic Warbler in years 2015-2017.

In terms of precipitation, 2017 was a normal year. Due to precipitation and gateway control on the Orekhovsky Canal, close to optimal GWL values were achieved during the growing season (GWL near the soil surface in May-July). During the summer period of low water, the GWL dropped to 40 cm below the soil level.

It should be noted that in different parts of the swamp GWL differs. The highest water levels are observed in the southern part of the swamp and the lowest in the northern part (Fig. 63). The difference in the GWL between the south and the north is about 20 cm. Perhaps it is this difference in water levels that explains the greater distribution of reeds in the southern part of the swamp.

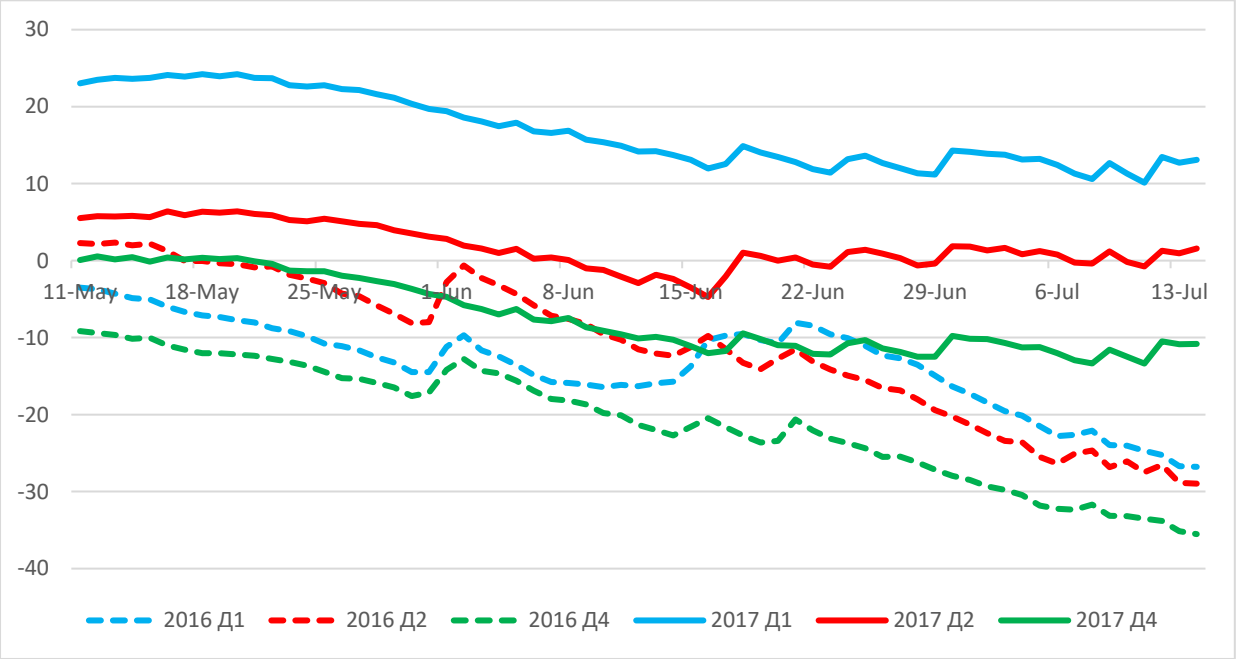

Fig. 64. Ground water level changes in the swamp massif on the territory of the Zvanets national reserve in 2016-2017.

11. Concluding remarks

11.1. Summary of the results of bird monitoring

Sumamry of the bird monitoring results are presented in Table 88, data on habitat structure in Aquatic Warbler breeding sites, collected by ornithologists during Aquatic Warbler counts, are presented in Annex 1.

Aquatic Warbler populations were monitored in 4 out of 7 project areas. The highest number of calling males was found in the Zvanets mire (2063-2379), the smallest local population was observed in Žuvintas, where 7 singing males were detected in 2007. Žuvintas, along with the project site Zvanets, is also characterized by the largest diversity of target bird species recorded, which can be explained by the preserved natural characteristics of the wetlands in these areas. Project site LT/04-Sysa/Sausgalviai is distinguished by the fact that here, without quitenumerous local Aquatic Warbler population, Great Snipe are also found, as well as exceptionally abundant population of Corncrake. These species are characterized by their preference for nutrient rich alluvial meadows, and it is therefore likely that the populations of these birds will remain stable, o will benefit from implemented habitat management activities.

Summarizing changes in Aquatic Warbler abundance in the most important breeding sites in Lithuania since 2011, we can see that the abundance of the species varies considerably, and from 2011 to 2017, the populations experienced some periods of almost simultaneous decline and increase (Fig. 65). The species breeding sites in Nemunas delta region remains being the the most important for conservation of the national population of Aquatic Warbler.

Almost in all the territories during period of 2013-2016 an increase in AW abundance was observed. In breeding sites near lake Zuvintas, where small isolated local population exist, slight fluctuations in Aquatic Warbler abundance have been observed over the past 4 years, while the number of singing males ranges from 4 to 7. In Tyrai swamp, where the most numerous Aquatic Warbler population in Lithuania are found, a considerable decrease in Aquatic Warbler abundance has been observed since 2016. However, in other areas of the Nemunas delta region (polders of Šyša and Sausgalviai), there has been little changes in abundance of Aquatic Warbler observed. In the diagram (Fig. 65) we presented data from another important AW breeding site in the Nemunas Delta - the Alka Polder, where a rather large local AW population is observed since 2014. In this area, the abundance of birds in the last 4 years increased and remained fairly stable during the period of 2016-2017, while in Tyrai site abundance decreased dramatically.

Most of the small local Aquatic Warbler populations found in the Nemunas Delta are located in separate polders (Šyša, Sausgalviai, Alka, etc.), which are dominated by intensively used, fertile (productive) alluvial meadows. Many land plots in the Alka Polder are owned by local farmers as well, but a much larger proportion of farmers in this area are participating in the Rural Development Program, thus delayed mowing predominate in the area. We think, that currently increased local Aquatic Warbler population is connected with lager proportion of successfully raised young birds. It is possible that extensive management of grasslands in these habitats is a key factor in the survival of local populations, and the involvement of farmers in these programs should therefore be given a greater attention.

Table 88. Baseline summary of implementation and results of specific bird monitoring activities in the project sites in 2017. ***(Numbers refer to the bird numbers obtained in individuall Project sites: calling males for Aquatic Warbler, Great Snipe, Corncrake and Spotted crake, and breeding pairs for oll other species. Not a target or not censused species indicated by short strokes.)***

Species	Project sites						
	LT/01-Tyrai	LT/02-Apvardai	LT/03-Zuvintas	LT/04-Sysa/ Sausgalviai	BY/05 – Dokudovskoe	BY/06-Servech	BY/07-Zvanets
Aquatic Warbler *(Acrocephalus paludicola)*	0	0	7	29	0	48	2063-2379
Great Snipe *(Galinago media)*	0	-	-	9	0	0	2
Citrine Wagtail *(Motacilla citreola)*	0	0	2	0	+	2	10 idv./10 ha
Common Redshank (*Tringa totanus)*	2	1	2	5	0	0	3
Eurasian Curlew (*Numenius arquata*)	0	0	0	0	0	0	1
Short-eared Owl (*Asio flammeus*)	0	0	0	0	0	0	0
Black-tailed Godwit *(Limosa limosa)*	0	1	2	0	0	0	23
Spotted Crake *(Porzana porzana)*	0	13*	4	0	0	2	2
Montagu's Harrier *(Circus pygargus)*	0	0	0	0	0	0	1
Corncrake *(Crex crex)*	0	0	3	129-136*	0	0	3
Number of breeding bird species	12	19	24	14	-	-	-

* - Data from the state monitoring program.
\+ - Presence of the species confirmed, abundance not estimated.

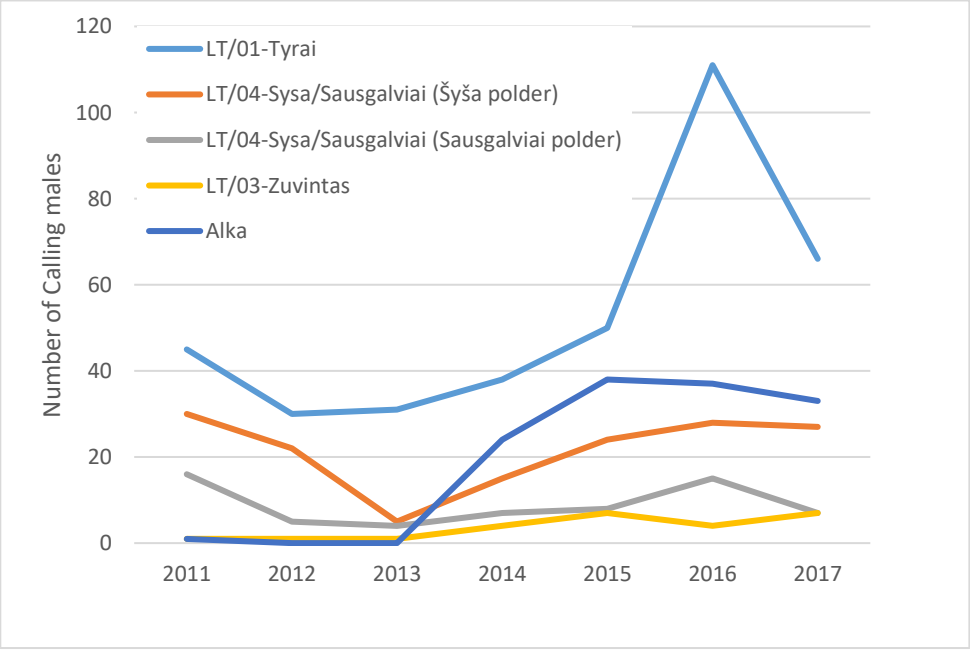

Fig. 65. Recent dynamics of Aquatic Warbler abundance in project sites and Alka polder.

During the project period, ornithologists involved in project's bird monitoring activities have also participated in implementation of State monitoring program of Aquatic Warbler, thus data on national Aquatic Warbler population is also available. Dynamics of abundance of national Aquatic Warbler in Lithuania since 1994 are presented in Figure 66.

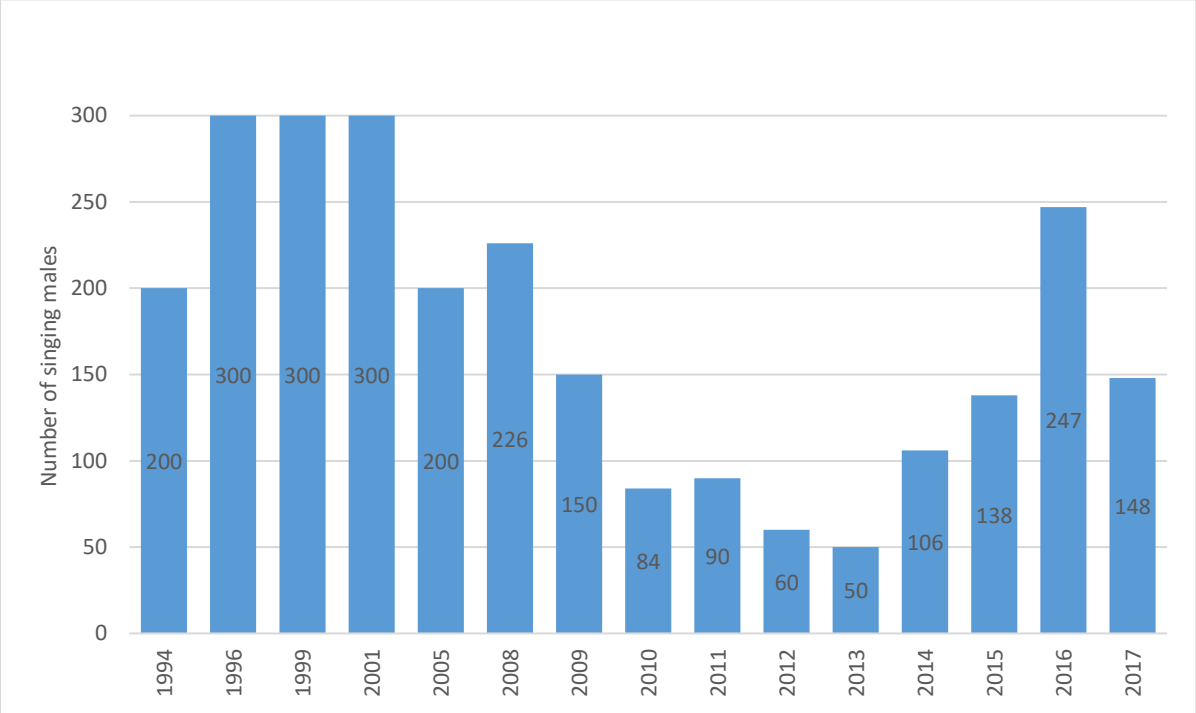

Fig. 66. Dynamics of abundance of Aquatic Warbler in Lithuania since 1994.

11.2. Summary of the results of vegetation research in project sites in Lithuania

1. In the project sites Šyša and Sausgalviai polders sedge dominated communities (*Caricetum gr*acilis and *Caricetum distichae*) prevail in the vegetation cover, while Mesophyte dominated communities occupy minor areas.

2. In Alksnas and Apvardai wetlands, plant communities of the transition mire (*Caricetum lasiocarpae*) occupy open areas; while tall sedge communities (*Caricetum appropinquatae*) including species of transition mire occur in the parts of the wetlands overgrown with reed and woody plants.

3. The vegetation of Tyrai wetland consist of tall sedge communities (*Caricetum elatae, Caricetum distichae*, *Caricetum gracilis*, *Phalaridetum arundinaceae*, *Peucedano-Calamagrostietum canescentis*), transition mire (*Caricetum lasi*ocarpae), fen (*Caricetum paniceae*), and wet meadow (*Molinietum caeruleae*) communities.

4. The vegetation in all studied wetlands is developed under conditions of the high water table fluctuations. Due to water table fluctuations the moss cover in all wetlands was sparse or absent.

5. The high vegetation mosaicity was observed in the detailed studied wetlands of Apvardai and Tyrai Project sites (wetlands of Tyrai and transitional mires near lakes Alksnas and Apvardai). It is determined by uneven distribution of the species, variability in the coverage of different plants groups, of the layers and the levels of the herb layer. The variable heights of the levels of the herb layer make the vegetation very mosaic as well.

6. The highest herb layer in Alksnas and in Apvardai wetlands was in the part overgrown with *Phragmites australis* (permanent plots No 30 & No 26 respectively); while the density of the reed was higher in unmanaged plot (No 26).

7. In spite of the high height values of the herb layer in all permanent plots of Tyrai wetland, the 1st level was dense only in tall sedge communities (*Caricetum elatae*, *Caricetum distichae*).

8. In all managed places, the damages of the peat surface and vegetation were observed.

11.3. Chemical composition of the surface water

Chemical composition of the mire water was measured whith the aim to determine the nutritional conditions for fen vegetation, and predict possible impact of planned management activities to the further development of vegetation. Initial water samples were collected in project sites in july-august 2017. Depending on hydrological conditions in the sites, the surface water of the fen (Tyrai-1, Apvardai-27, Apvardai-29) or water from the ditches (all other samples) were collected into clean plastic containers, and transfered for laboratory analysis. See Table 89 for details.

The analysis shows that the project areas are not polluted with nitrogen, phosphorus or other biogenic compounds, and the water pH in the areas is neutral (LT/04-Sysa/Sausgalviai, Tyrai-4, Apvardai-27) or lightly acidic. Large total water mineralization was found in flooded polder meadows (LT/04-Sysa/Sausgalviai) and one of LT/01-Tyrai areas (Tyrai-4), in which the total amount of dissolved minerals in the samples was 347-545 mg/l. These features of the sites are also reflected in vegetation studies: the highest vegetation biomass was found here, and the sites tend to overgrow with reeds and shrubs if no management activities are implemented. It should also be noted that the water quality studies should be repeated later, because extremely rainy summer season in year 2017 could have a significant impact on the chemical composition of the surface water.

Table 89 Chemical composition of the surface waters in project sites

Name of the specimen and geographical coordinates	Indicators													
	Date taken	Total Nitrogen mg (N)/l	Nitrite, mg(NO_2^-)/l	Nitrate, mg(NO_3^-)/l	Chlorides, mg(Cl^-)/l	Sulphate, m(SO_4^{2-})/l	Hydrocarbons, m(HCO_3^-)/l	Magnesium, m(Mg^{2+})/l	Calcium, mg(Ca^{2+})/l	Hardnes, mg/l	pH	Phosphorus, mg(P)/l	Silicon, mg(SiO_2)/l	Total mineralization, mg/l
Zvanets-1 (515922.07 244934.98)	2017-05-04	0,32	<0,02	1,72	21,84	4,8	170,86	4,86	56,11	-	6,38	0,144*	-	265,33
Zvanets-2 (52 00 02.59 24 55 04.24)	2017-05-04	0,55	<0,02	1,90	15,60	2,3	146,45	4,86	48,10	-	6,61	0*	-	223,82
Zvanets-3 (52 00 08.45 24 55 04.24)	2017-05-04	0,37	<0,02	1,10	24,96	4,8	195,26	7,30	56,11	-	6,46	0,039*	-	293,90
Zvanets-4 (52 00 31.44 24 47 03.71)	2017-05-04	0,23	<0,02	1,02	18,72	1,7	219,67	7,30	56,11	-	6,55	0,084*	-	312,06
Zvanets-5 (52 01 22.54 24 47 31.25)	2017-05-04	0,21	0,02	3,84	18,72	6,5	219,67	7,30	60,12	-	7,04	0*	-	325,59
Zvanets-6a (52 01 27.22 24 49 35.88)	2017-05-04	0,41	<0,02	1,20	24,96	3,0	244,08	4,86	72,14	-	6,52	0,144*	-	359,82
Zvanets-6б (52 01 25.36 24 49 36.50)	2017-05-04	0,32	<0,02	1,10	21,84	5,9	231,88	2,43	72,14	-	6,59	0,144*	-	344,44

Zvanets-7 (52 02 36.63 24 43 48.05)	2017-05-04	0,35	<0,02	1,72	18,72	11,0	195,26	4,86	56,11	-	6,36	0,060*	-	292,69
Zvanets-8 (52 03 57.26 24 49 00.18)	2017-05-04	0,69	<0,02	1,64	12,48	3,2	146,45	4,86	40,08	-	6,58	0*	-	213,42
Zvanets-9 (52 04 37.33 24 49 33.07)	2017-05-04	0,60	<0,02	1,46	9,36	1,7	146,45	9,73	32,06	-	6,51	0,054*	-	205,07
Tyrai-1 (55.564862, 21.249418 (WGS))	2017-07-20	<0,010	<0,010	<0,050	5,7	1,7	61,1	1,6	31,6	1,71	6,60	0,12	0,9	107
Tyrai-2 (55.567747, 21.243761 (WGS))	2017-07-20	<0,010	<0,010	<0,050	7,5	<1,0	75,1	2,3	33,9	1,88	6,79	0,11	5,2	129
Šyša-1 (336398; 6134601)	2017-08-18	0,077	<0,010	<0,050	4,3	2,6	308	8,6	92,7	5,33	7,31	-	-	419
Šyša-2 (336245, 6135558)	2017-08-18	-	-	-	-	-	-	9,0	90,9	5,28	7,46	-	-	454
Sausgalviai-1 (338928; 6130083)	2017-08-18	-	-	-	-	-	-	7,8	79,0	4,58	7,36	-	-	399
Tyrai-2 (326182; 6162652)	2017-08-18	<0,010	<0,010	<0,050	9,1	<1,0	198	3,8	67,3	3,67	6,87	-	-	286
Tyrai-3 (326228; 6162867)	2017-08-18	-	-	-	-	-	-	9,2	124	6,94	6,95	-	-	564

Tyrai-4 (326387; 6162862)	2017-08-18	-	-	-	-	-	-	7,0	59,7	3,55	7,28	-	-	347
Apvardai-27 (658158; 6156052)	2017-08-25	<0,010	<0,010	<0,050	4,7	<1,0	130	9,0	32,5	2,36	7,22	-	-	182
Apvardai-29 (656012; 6154411)	2017-08-25	-	-	-	-	-	-	9,3	27,3	2,13	6,84	-	-	175
LT/03-Zuvintas (Kiaulyčia-River; 54.440823, 23.584055)	2018-04-21	-	-	-	-	-	-	22,9	138	8,77	7,56	-	-	689
LT/03-Zuvintas (Kiaulyčia-meadow; 54.439233, 23.587522)	2018-04-21	0,026	<0,010	<0,050	14,9	8,6	522	27,0	130	8,71	7,89	-	-	714

* - PO_4^{3-}

11.4. Summary of the results of Invertebrate monitoring

Herpetobiontic invertebrates. The following classes of beetle abundance were determined to estimate the association dominance structure: dominants – species with abundance more than 5%; subdominants – abundance from 2 to 5%; recedents – abundance from 1 to 2%; subrecedents – abundance less than 1%. These classes are indicated for each species by superscripts letters in the Supplement Table 90.

All the monitoring plots differ in their ratio of dominant, subdominant, recedent and subrecedent species, with at most seven beetle species being dominants in Šyša Control plot and Žuvintas Plot 2 and 8 species being subrecedents in Tyrai Control plot.

Carabus granulatus was found to be a superdominant species in Šyša Control plot, constituting 34% of the sample, while *Pterostichus anthracinus* (34%) was a superdominant species in Plot 2.

Whereas in Tyrai, *Blethisa multipunctata* (59%) was a superdominant in Control plot and *Carabus granulatus* (34%) – in Plot 2. *Oodes helopioides* was a dominant species in both plots in Žuvintas (Control – 25%, Plot 2 – 26%), only slightly less numerous than *Agonum* in Control plot (29%) and slightly more numerous as *Pterostichus aterrimus* in both monitoring plots (Control – 21%, Plot 2 – 22%).

Most of the carabid species found during the sampling are hygrophilous, found in different wet biotopes as wet forests or scrubs, swamps, meadows, borders of water bodies etc (Barševskis, 2003[7]). Of the dominant species in our monitoring plots *Carabus granulatus* is a forest species, found in a wide variety of habitats, often in meadows and agrocenoses. *Pterostichus anthracinus* is usually found on the banks of water bodies, in wet scrubs, meadows or fields. *Blethisa multipunctata* is a stenotopic species, also found on the shores of rivers and lakes. *Oodes helopioides* is a eurytopic species, found in wet, boggy places, usually on the shores of waterbodies and *Pterostichus aterrimus* is usually found on the banks of the waterbodies in bogs.

Table 90 Numbers of dominant taxa in different dominance categories

	Dominants	Subdominants	Recedents	Subrecedents
Apvardai, Control plot	3	0	0	0
Apvardai, Plot 2	2	0	0	0
Šyša, Control plot	7	5	2	7
Šyša, Plot 2	6	1	6	2
Tyrai, Control plot	4	2	0	8
Tyrai, Plot 2	4	1	1	5
Žuvintas, Control plot	4	4	2	0
Žuvintas, Plot 2	7	1	5	0

Several carabid species found during the study are hygrophilous and eurytopic, encountered in a wide variety of biotopes, including agrocenoses - *Loricera pilicornis, Philochthus biguttatus* (Šyša and Tyrai Control), *Clivina fossor* (only Šyša). Several other species - *Poecilus cupreus* (only Šyša), *Poecilus versicolor* (Šyša and Tyrai Control plots) *Bembidion quadrimaculatum* (only Šyša Control) are considered mesophilous and more strongly connected to anthropogenic biotopes. Finally, *Pseudoophonus rufipes*, collected in both plots in Šyša, is a xerophilous species found in various, mostly open habitats.

[7] Barševskis A., 2003. Latvijas Skrejvaboles (Coleoptera: Carabidae, Trachypachidae & Rhysodidae). Baltic Institute of Coleopterology, Daugavpils: 264 p

Table 91 ***Number of speciments of ground beetles, cought with pitfall traps in project sites***

	Apvardai		Šyša		Tyrai		Žuvintas	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Acupalpus parvulus					1 Sr	3 Sr		
Agonum sp.	8 D	1 D	68D	67D	7 Sd	107D	23D	9D
Anisodactylus binotatus			1Sr	9R				
Badister (Baudia) sp.					1 Sr		1R	1R
Bembidion quadrimaculatum			1 Sr					
Blethisa multipunctata			33D	24Sd	125D			
Carabus clathratus					1 Sr		2 Sd	13D
Carabus granulatus			172D	43D	18D	125D	2 Sd	6D
Chlaenius costulatus						6R	2 Sd	1R
Chlaenius nigricornis			17Sd	9R				
Chlaenius tristis								7 D
Clivina fossor			17 Sd	6R				
Dyschiriodes globosus			1 Sr		1 Sr			
Elaphrus aureus							1R	1R
Harpalus sp.			24D					
Loricera pilicornis			33D	60D	5Sd			
Notaphus obliquus			1 Sr					
Notaphus semipunctatus					1 Sr			
Oodes helopioides	5 D		2 Sr	11R	27D	76D	20D	25D
Oxypselaphus obscurus						1 Sr		
Philochthus biguttatus			4 Sr	5 Sr	1 Sr			
Poecilus cupreus			10R	2 Sr				
Poecilus versicolor			19Sd		1 Sr			
Pseudoophonus rufipes			28D	7R		1 Sr		
Pterostichus anthracinus			47D	199D				
Pterostichus aterrimus							17D	21D
Pterostichus diligens					1 Sr	2 Sr		1R
Pterostichus gracilis			11Sd	37D	2 Sr	1 Sr		
Pterostichus minor	1 D		2 Sr	8R	3R	15Sd	2 Sd	3 Sd
Pterostichus oblongopunctatus		1 D						
Pterostichus nigrita/rhaeticus			11Sd	116D	16D	31D	10D	6D
Stenolophus mixtus					1 Sr			
Trepanes doris								1R
Total:	**14**	**2**	**502**	**603**	**212**	**368**	**80**	**95**

Indexes: D, dominants – species with abundance more than 5%; Sd, subdominants – abundance from 2 to 5%; R, recendents – abundance from 1 to 2%; Sr, subrecedents – abundance less than 1%

Chlaenius costulatus is a stenotopic hygrophilous species, typical in wet swampy habitats and is susceptible to the overgrowth of those habitats by bushes. It is known only from several bogs in Lithuania (Viešvilė and Purviniškiai) and our records from Tyrai and Žuvintas add to the current knowledge of the distribution of this beetle.

Flying invertebrates. Altogether almost seventy thousand invertebrate specimens were caught with Malaise traps. The highest number was recorded in Žuvintas (21889 specimens) with almost eight thousand specimens caught in the last sample (Table 3). The second most numerous area was Tyrai (20966 specimens), followed by Apvardai (13995 specimens) and Šyša (12989 specimens). Although the exposition of the traps was slightly longer in Apvardai and Žuvintas compared to Šyša and Tyrai, recalculation of the results in specimens per sample day shows the same trend.

The most numerous group in all the traps were Diptera, exceeding the other groups in numbers of specimens many times.

The second most-numerous group in all four places were hymenopterans, followed by Lepidoptera in Apvardai, Coleoptera in Šyša and Žuvintas and Hemiptera in Tyrai.

Most numerous group of Diptera combined were Chironomidae. They made up about 59% of all invertebrate specimens caught in Tyrai, 51% in Apvardai, ~25% in Šyša and 19% in Žuvintas and were the most numerous group in all places except Šyša, where Dolichopodidae were the most abundant group. Dolichopodidae were also very numerous in Tyrai and Žuvintas, making the second most numerous group of Diptera. The third group in numbers of specimens everywhere except Šyša were Muscidae, and Hybotidae were the third most-numerous group there (Table 92).

Diversity of all places was compared by calculating three most commonly used biodiversity indexes – Shannon (H'), Simpson (1-D) and Pielou (E) (Table 93) (Magurran, 2004).

Shannon (H') index assumes that individuals are randomly sampled from an infinitely large community, and that all species are represented in the sample. It becomes larger when there are more species in the community and when those species are distributed more evenly. H' = 0, if and only if, there is only single species in the sample and H' has a maximal value only in the case when all the species in the sample have the similar number of specimens, e.g. their abundance is ideally distributed. The highest values of H' were observed in Žuvintas, followed by the slightly lower number in Šyša. The lowest H' was observed in Tyrai (Table 93).

Simpson's index expresses the probability that any two individuals drawn at random from an infinitely large community belong to the same species. In essence, it captures the variance of the species abundance distribution. When expressed as the complement (1-D), the value of the Simpson's index will rise as the species assemblage becomes more even. The highest values of Simpson's index were observed in Žuvintas, again, followed by the slightly lower number in Šyša. The lowest H' was observed in Tyrai (Table 93).

Pielou index (E), also called the Shannon evenness measure, reflects the ratio of observed diversity to maximum diversity that could possibly occur and is based on the Shannon diversity index. Pielou index varies from 0 to 1, when all the species are equally abundant. In such cases it is considered that the habitat has maximal species diversity. The values of Pielou index were equal in Žuvintas and Šyša, and the lowest E was observed in Tyrai (Table 93).

Table 92 Number of speciments of main Diptera families caught in Malaise traps

	Apvardai	Šyša	Tyrai	Žuvintas	Total
Anthomyiidae	295	787	378	947	2407
Calliphoridae	45	561	28	293	927
Cecidomyidae	231	62	78	255	626
Ceratopogonidae	1273	85	800	1060	3218
Chironomidae	7208	1292	12371	4126	24997
Chloropidae	30	263	122	270	685
Culicidae	189	147	593	432	1361
Dolichopodidae	109	3241	1137	2658	7145
Hybotidae	61	954	49	317	1381
Muscidae	628	640	827	1931	4026
Mycetophilidae	552	271	125	71	1019
Psychodidae	186	15	85	497	783
Scathophagidae	36	58	264	130	488
Sciaridae	91	76	26	211	404
Sciomyzidae	13	3	66	194	276
Sepsidae	64	44	35	215	358
Simuliidae	7	8	0	403	418
Syrphidae	377	860	476	1860	3573
Tabanidae	350	311	621	649	1931

Table 93 Number of invertebrate taxa and values of three biodiversity indexes in four places based on Malaise trap catches

	Apvardai	Šyša	Tyrai	Žuvintas
No. of taxa	126	112	120	159
Shannon (H')	2,32	3,05	2,02	3,28
Simpson (1-D)	0,72	0,90	0,64	0,93
Pielou (E)	0,48	0,65	0,42	0,65

Hortobionthic invertebrates. When invertebrates are grouped into four weight classes (Table 94), the total biomass is found to be higher in all weight groups in Control plots of July and in June for the smaller weight groups of 1–5 mg and 5–10 mg. The Plot 2 plots had higher biomass only of heavier weight groups in June (Table 94). Invertebrates of the lightest group (1–5 mg) were most abundant in all the inspected plots. The dominance of other weight groups varied between the sites. The 5–10 mg group was more abundant in Control plots in Tyrai and Šyša, but in Plots 2 in Apvardai and Žuvintas. The group of 10–20 mg was more abundant in Plots 2 in Tyrai and Apvardai and Šyša June sample, but in Control plots in Žuvintas and Šyša July sample. The heaviest weight group (>20 mg) again was more abundant in Control plots in Tyrai, Apvardai and Žuvintas June sample and Šyša July sample (Table 94).

Table 94 Distribution of invertebrate biomass (mg) per 100 sweeps in different weight classes

		Weight classes				
		1–5 mg	**5–10 mg**	**10–20 mg**	**> 20 mg**	**Without 1-5mg group**
Tyrai June	Control	4414,5	44,5	14,8	41,6	457,9
	Plot 2	531,6	13,3	21,6	19,0	
Tyrai July	Control	524,6	65,1	17,6	112,0	
	Plot 2	630,6	23,3	24,6	60,6	
Apvardai June	Control	217,1	13,0	5,8	14,0	207,4
	Plot 2	273,2	55,0	66,1	0,0	
Apvardai July	Control	172,1	5,2	0,0	8,5	
	Plot 2	291,8	20,1	11,2	8,5	
Žuvintas June	Control	117,5	8,1	8,0	45,5	611,4
	Plot 2	301,4	25,9	2,8	13,1	
Žuvintas July	Control	547,9	63,7	75,6	92,7	
	Plot 2	531,0	84,2	53,3	143,2	
Šyša June	Control	200,2	61,7	58,6	0,0	515,6
	Plot 2	177,1	21,8	69,9	119,2	
Šyša July	Control	357,8	19,4	47,6	88,7	
	Plot 2	133,4	9,5	13,2	5,9	
All Control, June		4949,4	127,4	87,2	101,1	
All Plot 2, June		1283,3	115,9	160,3	151,3	
All Control, July		1602,3	153,5	140,8	301,8	
All Plot 2, July		1586,8	137,0	102,3	218,2	

For all monitoring sites the total invertebrate biomass was highest on Plots 2 compared to Control plots (Table 95, 96), except Tyrai and Šyša July sample (Table 95), where Control plots had higher biomass. The same tendency is reflected if the biomass is calculated per meter of netting effort (Table 95, 96).

Diptera formed the highest proportion of biomass in all the sweep net samples (Tables 95, 96) except the Tyrai July Plot 2, where there were slightly more Orthoptera. The second most abundant group by total biomass in June was Homoptera, followed by Coleoptera while Orthoptera were second most abundant in July, followed by Homoptera.

Diptera were also the most abundant group by number of specimens per 100 sweeps in all the sweep net samples combined (Tables 97, 98). The second most numerous groups were Homoptera, followed by Heteroptera. Coleoptera were the fourth most numerous group in June and Arachnida – in July (Tables 97, 98).

The number of specimens caught in Control plots in Tyrai and Šyša July sample were higher compared to Plot 2 (Table 97, 98), the same tendency as in biomass of those plots (Table 95, 96). The same type of conformity is observed in Žuvintas June and Apvardai July sample, where the number of specimens was higher in Plot 2 compared to Control plot. Žuvintas July sample and Šyša June sample had the number of invertebrates higher in Control plots compared to the biomass that was higher in Plot 2 plots. This can be explained by the several Lepidoptera adults in Šyša that added to the biomass rather significantly.

Table 95 Biomass of invertebrates in June samples, mg per 100 sweeps

	Tyrai June		Apvardai June		Žuvintas June		Šyša June	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	27,7	37,3	14,6	20,3	9,6	8,2	0,4	0,0
Mollusca	0,0	2,5	0,0	0,0	0,9	11,9	0,0	0,0
Coleoptera	28,2	2,2	4,1	9,8	17,5	21,8	101,4	50,8
Diptera	4003,0	473,6	165,7	195,3	88,1	177,7	115,7	142,5
Heteroptera	58,3	4,3	1,1	54,9	1,4	37,9	10,5	2,0
Homoptera	277,1	9,0	25,8	45,6	8,0	38,8	18,6	14,0
Hymenoptera	34,0	7,4	23,8	18,1	5,1	19,5	13,9	4,1
Hymenoptera larvae	0,0	11,9	0,8	0,0	0,0	8,8	51,4	37,8
Lepidoptera larvae	37,7	13,5	0,0	0,0	44,7	0,0	0,0	0,0
Lepidoptera adults	0,0	7,9	0,0	0,0	0,0	1,0	1,1	114,2
Orthoptera	49,1	10,6	0,0	0,0	0,0	7,8	7,6	22,6
Trichoptera	0,2	5,3	0,0	36,5	3,7	7,0	0,0	0,0
Odonata Zygoptera	0,0	0,0	0,0	13,8	0,0	2,8	0,0	0,0
Odonata Anisoptera	0,0	0,0	14,0	0,0	0,0	0,0	0,0	0,0
Total:	4515,4	585,5	249,9	394,3	179,1	343,1	320,6	388,0
mg/meter (sweep)								
Total:	45,2	5,9	2,5	3,9	1,8	3,4	3,2	3,9

Table 96 Biomass of invertebrates in July samples, mg per 100 sweeps

	Tyrai July		Apvardai July		Žuvintas July		Šyša July	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	69,3	46,6	8,9	31,1	90,4	55,8	1,0	0,0
Mollusca	0,0	0,0	0,0	3,0	103,3	69,5	0,0	0,0
Coleoptera	1,7	1,8	10,5	18,5	53,7	24,7	46,3	10,6
Diptera	403,9	75,4	128,8	158,8	239,4	348,7	225,8	116,7
Heteroptera	64,5	11,9	5,6	40,7	45,3	52,7	21,8	1,8
Homoptera	73,4	33,5	14,8	36,7	96,7	62,3	58,5	6,6
Hymenoptera	2,3	5,1	27,8	25,4	42,9	24,1	18,7	4,8
Hymenoptera larvae	0,0	12,3	0,0	1,3	42,5	74,9	15,4	13,9
Lepidoptera larvae	0,0	0,8	0,0	8,5	7,1	0,0	0,4	0,0
Lepidoptera adults	0,6	0,2	6,1	0,0	2,9	0,8	2,6	0,0
Orthoptera	103,6	78,5	0,0	3,5	41,3	82,1	123,2	7,6
Trichoptera	0,0	0,0	0,0	4,2	10,2	15,9	0,0	0,0
Odonata Zygoptera	0,0	0,0	5,5	0,0	0,0	0,0	0,0	0,0
Odonata Anisoptera	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total:	719,3	266,2	208,1	331,6	779,6	811,7	513,5	161,9
mg/meter (sweep)								
Total:	7,2	2,7	2,1	3,3	7,8	8,1	5,1	1,6

Table 97 Number of invertebrates in June samples, specimens per 100 sweeps

	Tyrai June		Apvardai June		Žuvintas June		Šyša June	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	25,25	12,75	8	4,25	2,5	3	0,25	0
Mollusca	0	0,5	0	0	0,25	2	0	0
Coleoptera	24	1,75	1,5	1,75	11,25	9,75	20	7,5
Diptera	2273,25	177	140	83,25	84,5	165,75	79,25	77,25
Heteroptera	42,75	5,5	1	53	1,5	45,5	7	1,5
Homoptera	222,25	9,5	20,25	32,5	7	34,5	15,5	10
Hymenoptera	15	5	13	6	4	9,25	8,25	4,25
Hymenoptera larvae	0	2	0,25	0	0	1,5	13,25	4,25
Lepidoptera larvae	0,5	1	0	0	0,75	0	0	0
Lepidoptera adults	0	0,25	0	0	0	0,25	0,5	2
Orthoptera	9,5	2	0	0	0	0,25	1,5	1,5
Trichoptera	0,25	0,25	0	2,75	0,25	0,5	0	0
Odonata Zygoptera	0	0	0	1,25	0	0,25	0	0
Odonata Anisoptera	0	0	0,25	0	0	0	0	0
Total:	2612,75	217,5	184,25	184,75	112	272,5	145,5	108,25

Table 98 Number of invertebrates in July samples, specimens per 100 sweeps

	Tyrai July		Apvardai July		Žuvintas July		Šyša July	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
Arachnida	23,5	17,25	3,75	11,5	19,5	18,25	1	0
Mollusca	0	0	0	0,75	24,5	4,75	0	0
Coleoptera	2	0,5	2	5,75	40,25	7,5	20,75	3,5
Diptera	168,5	36,75	95,25	138,25	182,25	215	144	45,75
Heteroptera	12,25	9,75	3,25	30,5	31	25,75	21,75	1
Homoptera	34	28	7,5	25,25	61	44,25	32,25	3,75
Hymenoptera	1,25	3,75	11	15,75	22,5	11,25	10,75	2,75
Hymenoptera larvae	0	1	0	0,25	5,75	14	2	1,5
Lepidoptera larvae	0	0,25	0	0,25	0,25	0	0,25	0
Lepidoptera adults	0,25	0,25	0,25	0	1,5	0,75	1,25	0
Orthoptera	3,25	3	0	1	1,75	2,5	4,25	0,5
Trichoptera	0	0	0	0,25	1,25	1,5	0	0
Odonata Zygoptera	0	0	0,5	0	0	0	0	0
Odonata Anisoptera	0	0	0	0	0	0	0	0
Total:	245	100,5	123,5	229,5	391,5	345,5	238,25	58,75

Sørensen similarity index was calculated in order to compare similarity between the investigated plots. Based on the values of the index, a cluster analysis using UPGMA as a clustering method was performed (Fig. 67). In all cases, the same-month Control and Plot 2 samples were most similar to each other in the same place, then June and July samples were most similar to each other in the same place. Šyša samples were most similar to Žuvintas, together forming a group with Apvardai, while Tyrai samples were least similar to all others and Tyrai June Control sample being the least similar to all other samples.

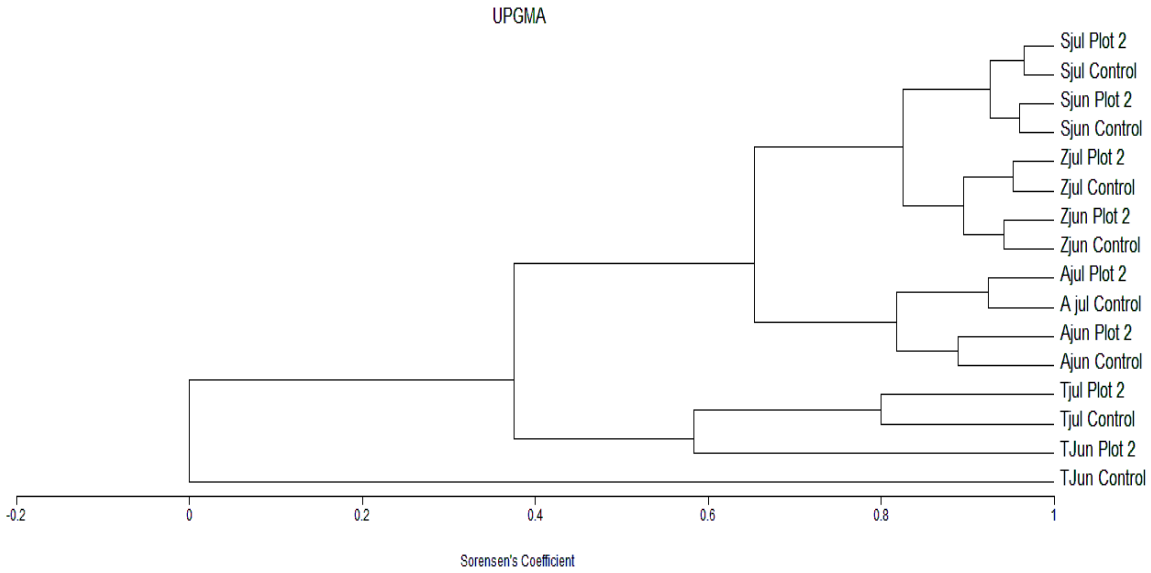

Fig. 67. Similarities of the investigated plots using the Sørensen 's coefficient

Diversity of all plots was compared by calculating three most commonly used biodiversity indexes – Shannon (H'), Simpson (1-D) and Pielou (E). All the indexes were higher in Plot 2 plots compared to Control plots in Tyrai, Apvardai and Žuvintas June samples, while they were higher in Control plots in Šyša and Žuvintas July samples (Table 99).

Table 99 Number of taxa and values of three biodiversity indexes in all plots

	Tyrai June		Tyrai July		Apvardai June		Apvardai July	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
No. of taxa	63	38	34	43	44	41	50	54
Shannon (H')	1,21	1,61	2,14	2,91	2,07	2,80	2,66	2,70
Simpson (1-D)	0,40	0,57	0,77	0,92	0,71	0,89	0,85	0,86
Pielou (E)	0,29	0,44	0,61	0,77	0,55	0,76	0,68	0,68
	Žuvintas June		Žuvintas July		Šyša June		Šyša July	
	Control	Plot 2	Control	Plot 2	Control	Plot 2	Control	Plot 2
No. of taxa	42	54	65	53	45	43	45	31
Shannon (H')	2,27	2,49	2,98	2,61	3,17	3,03	2,82	2,19
Simpson (1-D)	0,74	0,85	0,92	0,88	0,94	0,93	0,91	0,79
Pielou (E)	0,61	0,62	0,71	0,66	0,83	0,81	0,74	0,64

The highest values of Shannon (H') were observed in Šyša June plots – Control (H'=3.17) and Plot 2 (H'=3.03). Slightly lower values were found in Žuvintas July Control plot (H'=2.98) and Tyrai July Plot 2 plot (H'=2.91). The lowest value of the Shannon index is observed in Tyrai June samples: Control (H'=1.21) and Plot 2 (H'=1.61) plots. This is easily explained by the super domination of one group – Chironomidae in those samples (Table 99).

The highest values of Simpson's index were observed in Šyša June samples: Control plot (1-D=0.94) and Plot 2 plot (1-D=0.93), followed by Žuvintas July Control plot (1-D=0.92) and Tyrai July Plot 2 plot (1-D=0.92). The lowest value of the Simpson index is observed in Tyrai June samples:

Control (1-D=0.4) and Plot 2 (1-D=0.57) plots. As in the case of the Shannon index, such low values mirror the domination of Chironomidae in Tyrai June samples, especially the Control plot (Table 99).

The highest values of Pielou index were again observed in Šyša June samples: Control plot (1E=0.83) and Plot 2 plot (E=0.81), followed by Tyrai July Plot 2 (E=0.77) and Šyša July Control plot (E=0.74). The lowest values of this index, as in the cases with Shannon and Simpson indexes, were observed in Tyrai June samples: Control (E=0.29) and Plot 2 (E=0.44) plots (Table 99).

Pollinating insects. The largest number of pollinator taxa was found in Apvardai – 45, followed by Tyrai and Žuvintas with 40 taxa in both of these areas and the smallest number was found in Šyša (Table 100).

Table 100 Number of taxa and specimens of selected pollinators from the net sampling in the investigated plots and biodiversity indexes there

	Tyrai			Apvardai			Žuvintas			Šyša		
	Control	Plot2	Combined	Control	Plot2	Combined	Control	Plot 2	Combined	Control	Plot2	Combined
Taxa	30	24	40	34	35	45	37	34	40	26	25	33
Specimens	9715	899	10580	956	931	1850	1123	1588	2676	918	527	1418
Shannon	0,67	1,50	0,76	1,67	2,36	2,06	2,24	2,22	2,23	2,33	2,38	**2,46**
Simpson	0,24	0,58	0,27	0,65	0,83	0,74	0,84	0,85	0,84	0,87	0,87	**0,89**
Pielou	0,20	0,47	0,21	0,47	0,66	0,54	0,62	0,63	0,61	0,72	0,74	**0,70**

Tyrai net sample was dominated by Chironomidae (85.5% of the total number of pollinator specimens) with Sciomyzidae (3.3%) and Musidae (2.6%) forming other largest groups. The most numerous group in Apvardai were also Chironomidae (47.7%), followed by a group of unidentified to the family level small Cyclorhapha flies (13.8%) and Hybotidae (9.0%). Chironomidae (22.5%) were the most numerous pollinator group in Žuvintas as well, followed by Scatopsidae (20.4%) and Cyclorhapha (19.5%). And finally, most numerous group in Šyša were Syrphidae (19.8%), followed by Dolichopodidae (16.4%) and Calliphoridae (12.4%).

Out of the main pollinator group – Apidae, only single specimens of *Bombus* were caught in every of the four localities and several specimens of solitary bees (Apidae) – 6 in Apvardai, 1 in Žuvintas and 5 in Šyša.

If net sampling and Malaise trap material is combined (Table 101), the total number of pollinator taxa is highest in Žuvintas, followed by Apvardai and Tyrai and lowest in Šyša. The highest number of specimens in combined material was also in Tyrai, followed by Žuvintas, Apvardai and Šyša – the same ranking as in the case of net sampling.

The pollinator richness (H'=3.01) was highest in Žuvintas and pollinator assemblages were distributed most evenly (1-D=0.91) there as well, but the equality of the taxa abundance was almost the same as in Šyša (E=0.65). All the indexes of pollinator biodiversity had the lowest values in Tyrai (Table 101).

Judging from the results of the Malaise traps, Žuvintas had the most diverse and well-balanced invertebrate communities (highest values of H') with most evenly distributed specimens (highest 1-D), followed by slightly lower values of the indexes in Šyša. Tyrai had the least diverse and least balanced communities (lowest values of H') with strong domination of one group – Chironomidae (made up around 59% of total number of specimens), although the total number of invertebrates caught there was the second-highest after Žuvintas.

Table 101 Number of taxa and specimens of selected pollinators net sampling and Malaise traps combined, in the investigated plots and biodivesity indexes there

	Tyrai	Apvardai	Žuvintas	Šyša
Taxa	71	73	99	66
Specimens	29748	14255	20908	12158
Shannon (H')	1.43	2.01	**3.01**	2.75
Simpson (1-D)	0.48	0.66	**0.91**	0.88
Pielou (E)	0.34	0.47	0.65	**0.66**

Šyša had the highest values of biodiversity indexes from the net sampling, followed by slightly lower values of these indexes in Žuvintas – a rather similar situation as with Malaise trap samples, where Žuvintas had slightly higher values of the indexes. June samples from Tyrai Control plot were the least diverse and least balanced invertebrate communities (lowest values of H') with least evenly distributed specimens (lowest 1-D), compared to all other monitoring plots, that can be explained by the domination of Chironomidae.

The domination of Chironomidae in Tyrai was also reflected as the biomass (Table 8) and numbers of Diptera from the net sampling. Although it is not indicated, Chironomidae made up 88% (3534 mg per 100 sweeps) of the total Diptera biomass in Tyrai June Control plot. These high biomass and specimen numbers of Tyrai Control plot in June were probably influenced by the yearly simultaneous flight of Chironomidae, as the plot is close to the Curonian lagoon and such flights are usual there. Later, in July samples, the Diptera biomass in Tyrai Control sample was not as much higher than in other plots as in June, but was also highly influenced by Chironomidae, that made up 70% (283 mg per 100 sweeps) of the biomass of this plot.

In general, total invertebrate biomass was higher on Plots 2 compared to Control plots (Table 8, 9), except Tyrai and Šyša July sample. Although the higher biomass in Tyrai might be explained by the influence of Chironomidae, the reasons for the lower biomass in Šyša July Plot 2 are not as obvious. It could be, that these lower numbers in Šyša reflect the mowing, that has been started in the close proximity of the Control plot during the July sampling, but was not yet performed near the Plot 2.

Plot 2 sites can be equated to 'managed sites' in Lower Oder Valley National Park from the study of Tanneberger *et al*.[8] in 2005, where the total invertebrate biomass was higher in sweep net samples from 'managed' than from 'unmanaged' sites and it was higher in July compared to June. Our study would give the similar results if we exclude the Tyrai June Control sample. In the study of Tannenberger and colleagues, the total invertebrate biomass for all Pomeranian areas in 2006 was highest on sites with 'managed' sedge vegetation (median 474.59 mg) and lowest on sites with 'unmanaged' reed vegetation (54.72 mg). 'Unmanaged' sedge vegetation had a slightly higher biomass (298.87 mg) than 'managed' reed vegetation (345.77 mg). Median of total invertebrate biomass of our Plot 2 sites (343.1 mg) was very similar to the 'managed' reed vegetation sites of the study in Pomerania, but the median of our Control sites (417 mg) was lower than that of the 'managed' sedge vegetation in Pomerania.

During the recent study in North-West Spain, Miguelez *et al*.[9] determined potential food availability for migrating Aquatic Warblers during August and September in El Villar lagoon, an intensively irrigated farming area. The number of captures per sampling effort using sweep nets was highest in the grassland (39.1±12.6 captures/m), medium in the rushes (29.8±15.2) and lowest in the reeds (6.9±1.5) (Miguelez et

[8] Tanneberger F., Bellebaum J., Helmecke A., Minets M. 2013. Nesting and foraging characteristics of Aquatic Warblers *Acrocephalus paludicola* in the fast declining Pomeranian population (NE Germany/NW Poland). *Acta Ornithol*. 48: 109–118

[9] Miguélez D., García-Tejero S., Hernández Á. &. Valladares L. F. 2016. Diet Selection of the Aquatic Warbler Acrocephalus paludicola During Its Post-Nuptial Migration Stopover in NW Spain. *Ardea* 104(3): 273-282

al., 2016). Number of captures per meter of sampling effort in our study was very small compared to the study in Spain, with Control samples reaching 5.1±8.6 captures and Plot 2 samples – only 1.5±1.0 captures per meter, not even reaching the numbers in the reeds in NW Spain.

The results of several studies for prey selection by Aquatic Warbler indicated that some arthropod groups were selected actively: Araneae, Heteroptera and Homoptera were the most abundant groups of prey in El Villar lagoon, Spain (Miguelez *et al*., 2016), Homoptera (Cicadellidae) and Diptera in Girondine estuary, France (Musseau, 2014[10]), Diptera and Homoptera (Aphididae) in Audierne Bay, France (Kerbiriou *et al*. 2011[11]) and Araneae, caterpillars and Coleoptera in breeding areas in Poland (Shulze-Hagen *et al*, 1989[12]). Most biomass in those studies was contributed by specimens with a large body size from Orthoptera, Araneae, Hymenoptera (Musseau, 2014), Diptera, Odonata, Orthoptera (Miguelez *et al*., 2016), Odonata, Araneae, Orthoptera, Diptera and Lepidoptera (Kerbiriou *et al*. 2011), so Araneae, Diptera, Hymenoptera, Lepidoptera, Odonata and Orthoptera are the most important groups.

Our sweep net data (Table 8, 9) shows, that Tyrai had the highest total biomass of the main food groups of Aquatic Warbler, followed by Žuvintas, Šyša and Apvardai. Tyrai had the highest biomass in June and Žuvintas – in July.

A clear preference is shown by Aquatic Warbler for groups with larger bodied species, and therefore a higher biomass, in comparison with others that are much more abundant but generally smaller (Miguelez *et al*., 2016). Our study showed, that total biomass of invertebrates of the heavier weight classes (lightest ones of 1-5mg omitted) was highest in Žuvintas, followed by Šyša, Tyrai and Apvardai.

Aquatic warblers were found to consume larger preys compared to other species of warblers and although those larger prey groups (Odonata, Aranaea, Orthoptera) were found in small numbers in the aquatic warbler's diet, they significantly contributed to the total biomass consumed (Kerbiriou *et al.* 2011). Mean length of consumed prey varied between the studied sites: from 5.5mm in Spain (Miguelez *et al*., 2016) to 8.4 mm in Poland (Schulze-Hagen *et al*. 1989) and 9.2mm in Audierne Bay, France (Kerbiriou *et al.* 2011). Our data from the net sampling shows that the average length of the invertebrates caught was 6.5±5.4 mm, with the longest prey in Apvardai (6.8±7.55 mm), followed by Šyša (6.6±3.78 mm) and Žuvintas with Tyrai (6.3±4.8 mm). Average length of invertebrates in Apvardai was due to more Odonata caught there compared to other localities.

Based on the combined data from net sampling and Malaise traps, Žuvintas provided the best pollination services out of the four investigated areas, Šyša being the second best locality.

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[11] Kerbiriou C., Bargain B., Le Viol I. & Pavoine S. 2011. Diet and fuelling of the globally threatened Aquatic Warbler at autumn migration stopover as compared with two congeners. *Anim. Conserv*. 14: 261–270

[12] Schulze-Hagen K., Flinks H. & Dyrcz A. 1989. Brutzeitliche Beutewahl beim Seggenrohrsänger Acrocephalus paludicola. *J. Ornithol*. 130: 251–255

Annexes

Annex 1. Field datasheets with parameters of habitat structure assessed during the census of Aquatic Warbler.

Annex 2. Data on monitoring of other target bird species.

Annex 3. Lists of breeding birds in the project sites

Annex 1. Field datasheets with parameters of habitat structure assessed during the census of Aquatic Warbler

Table 1.1. Aquatic Warbler monitoring in Šyša polder

<table>
<tr><td>1. Observer:
Žydrūnas Preikša,
Renatas Jakaitis</td><td>2. Observation place:
Šyša polder</td><td>3. Geogr. coordinates or number of observation area: LT/04-1</td><td colspan="2">4. Date:
2017.07.04</td></tr>
<tr><td colspan="2">5. Number of singing males: 27 males on 2017.06.09 and 25 on 2017.07.04</td><td colspan="2">6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males</td><td>7. Water depth:
0 cm</td></tr>
<tr><td colspan="5">Area coverage with vegetation and water:</td></tr>
<tr><td colspan="2">8. Coverage of dominant plants (%):
<5, 5-15, 16-25, 26-50, 51-75, 76-100
Sedges - 26-50
Reeds - <5
other grasses - 51-75
dead grass:
- Coverage - <5
- thickness (much, moderately, little) - little
water depth, cm - 0
vegetation height, cm – 60 cm on 06.09 and 100 cm on 07.04

13. Land management way and intensity:
on 06.09 mowing was started and mown <5 % of the area, on 07.04 about 20 % of the area was mown. 5 % of the area were intensively grazed.</td><td colspan="2">9. Grass vegetation structure:
Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate)

10. Density of reeds:
Dense, <u>moderately dense</u>, scarse
(underline appropriate)</td><td>11. Coverage of bushes: solitary bushes only</td><td>14. Determined threats
Too early mowing, intensive grazing</td></tr>
</table>

Table 1.2. Aquatic Warbler monitoring in Sausgalviai polder site LT/04-2

1. Observer: Žydrūnas Preikša, Renatas Jakaitis	2. Observation place: Sausgalviai polder	3. Geogr. coordinates or number of area: LT/04-2	4. Date: 2017.07.04
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges - 5-15 Reeds - <5 other grasses - 76-100 dead grass: - Coverage - 16-25 - thickness (much, moderately, little) - much water depth, cm - 0 vegetation height, cm – 60 cm on 06.06 and 100 cm on 07.09 13. Land management way and intensity: the area is abandoned, shrubby, no major management was detected.	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, <u>moderately dense</u>, scarse (underline appropriate)	11. Coverage of bushes: <5%	14. Determined threats: abandonment

Table 1.3. Aquatic Warbler monitoring in Sausgalviai polder site LT/04-3

1. Observer: Žydrūnas Preikša, Renatas Jakaitis	2. Observation place: Sausgalviai polder	3. Geogr. coordinates or number of area: LT/04-3	4. Date: 2017.07.04
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 26-50 Reeds - <5 other grasses - 51-75 dead grass: - Coverage - 16-25 - thickness (much, moderately, little) - much water depth, cm – on 06.07 40 cm in southern part, 0 cm in rest of the area, on 07.08 0 cm everywhere vegetation height, cm – 60 cm on 06.06 and 100 cm on 07.09 13. Land management way and intensity: on 07.04 about 25 % of the area was mown.	9. Grass vegetation structure: Tussocks, <u>no tussocks</u>, partly tussocky (underline appropriate) 10. Density of reeds: Dense, <u>moderately dense</u>, scarse (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats: -

Table 1.4. Aquatic Warbler monitoring in Sausgalviai polder site LT/04-4

1. Observer: Žydrūnas Preikša, Renatas Jakaitis, Vytautas Eigirdas	2. Observation place: Sausgalviai polder	3. Geogr. coordinates or number of observation area: LT/04-4	4. Date: 2017.07.04
5. Number of singing males: 3 males on 06.09 and 0 males on 07.04	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 26-50 Reeds - 0 other grasses - 51-75 dead grass: - Coverage - 0 - thickness (much, moderately, little) water depth, cm – 0 vegetation height, cm – 60 cm on 06.06 and 100 cm on 07.09 13. Land management way and intensity: The area being mown annually	9. Grass vegetation structure: Tussocks, <u>no tussocks</u>, partly tussocky (underline appropriate) 10. Density of reeds: Dense, moderately dense, scarse (underline appropriate)	11. Coverage of bushes: <5%	14. Determined threats: -

Table 1.5. Aquatic Warbler monitoring in Sausgalviai polder site LT/04-5

1. Observer: Žydrūnas Preikša, Renatas Jakaitis	2. Observation place: Sausgalviai polder	3. Geogr. coordinates or number of observation area: LT/04-5	4. Date: 2017.07.04
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 16-25 Reeds - 0 other grasses - 76-100 dead grass: - Coverage - 0 - thickness (much, moderately, little) water depth, cm – 0 vegetation height, cm – 60 cm on 06.06 and 100 cm on 07.09 13. Land management way and intensity: On 07.04 was mown about half of the area	9. Grass vegetation structure: Tussocks, <u>no tussocks</u>, partly tussocky (underline appropriate) 10. Density of reeds: Dense, moderately dense, scarse (underline appropriate)	11. Coverage of bushes: <5%	14. Determined threats: Bushes along ditches fragmenting area

Table 1.6. Aquatic Warbler monitoring in Tyrai site LT/01

1. Observer: Žydrūnas Preikša	2. Observation place: Tyrai	3. Geogr. coordinates or number of observation area: LT/01 - Tyrai	4. Date: 2017.07.10
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 51-75 Reeds - <5 other grasses – 26-50 dead grass: - Coverage - 5-15 - thickness (much, moderately, little) - little water depth, cm – 0 vegetation height, cm – 40 cm on 06.08 and 80 cm on 07.10 13. Land management way and intensity: Bush removal in half of the area in previous year	9. Grass vegetation structure: <u>Tussocks</u>, no tussocks, partly tussocky (underline appropriate) 10. Density of reeds: Dense, moderately dense, <u>scarse</u> (underline appropriate)	11. Coverage of bushes: 16-25%	14. Determined threats: Overgrowth with bushes

Table 1.7. Aquatic Warbler monitoring in Apvardai site LT/02-1

1. Observer: Arūnas Čerkauskas	2. Observation place: Apvardai	3. Geogr. coordinates or number of observation area: LT/02-1	4. Date: 2017.06.20
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 20 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 51-75 Reeds – 5-15 other grasses – 26-50 dead grass: - Coverage - 76-100 - thickness (much, moderately, little) - little water depth, cm – 40 cm on 06.08 vegetation height, cm – 50 cm on 06.20 13. Land management way and intensity: No management in the area	9. Grass vegetation structure: <u>Tussocks</u>, no tussocks, partly tussocky (underline appropriate) 10. Density of reeds: <u>Dense</u>, moderately dense, scarse (underline appropriate)	11. Coverage of bushes: 16-25%	14. Determined threats: Overgrowth with bushes and reeds

Table 1.8. Aquatic Warbler monitoring in Apvardai site LT/02-2

1. Observer: Arūnas Čerkauskas	2. Observation place: Pušnis	3. Geogr. coordinates or number of observation area: LT/02-2	4. Date: 2017.06.20
5. Number of singing males: 0 males	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 51-75 Reeds – <5 other grasses – 26-50 dead grass: - Coverage - 51-75 - thickness (much, moderately, little) - little water depth, cm – 30 cm on 06.05 vegetation height, cm – 50 cm on 06.20 13. Land management way and intensity: In winter time were cut bushes and reeds in smaller part of the area	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, <u>moderately dense,</u> scarse (underline appropriate)	11. Coverage of bushes: 16-25%	14. Determined threats: Overgrowth with bushes

Table 1.9. Aquatic Warbler monitoring in Žuvintas site LT/03-3 (Dambavaragis).

1. Observer: Arūnas Pranaitis, Regimantas Vabuolas	2. Observation place: Dambavaragis meadows	3. Geogr. coordinates or number of observation area: (LKS-94) 473299, 6033628	4. Date: 2017.05.17 2017.06.30
5. Number of singing males: 2 males on 2017-05-17 and 2 on 2017-06-30	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 1 male		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges - 26-50 Reeds - 16-25 other grasses - 16-25 dead grass: - Coverage - 16-25 - thickness (much, moderately, little) - little water depth, cm - 0 vegetation height, cm – 50 - 60 cm 13. Land management way and intensity: half of the area mowed after august 15	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, <u>moderately dense</u>, scarse (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats Too early mowing, intensive grazing

Table 1.10. Aquatic Warbler monitoring in Grebelė site

1. Observer: Arūnas Pranaitis, Regimantas Vabuolas	2. Observation place: Grebelė meadows	3. Geogr. coordinates or number of observation area: (LKS-94) 474788, 6034438	4. Date: 2017.05.17 2017.06.30
5. Number of singing males: 3 males on 2017-05-17 and 4 on 2017-06-30	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 1 male		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges - 76-100 Reeds - <5 other grasses - 5-15 dead grass: - Coverage - 16-25 - thickness (much, moderately, little) - much water depth, cm - 0 vegetation height, cm – 50 - 60 cm 13. Land management way and intensity: area mowed after august 15.	9. Grass vegetation structure: Tussocks, <u>no tussocks</u>, partly tussocky (underline appropriate) 10. Density of reeds: Dense, moderately dense, <u>scarse</u> (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats: -

Table 1.11. Aquatic Warbler monitoring in Žuvintas site LT/03-2

1. Observer: Arūnas Pranaitis, Regimantas Vabuolas	2. Observation place: Dambavaragis meadows	3. Geogr. coordinates or number of observation area: (LKS-94) 473299, 6033628	4. Date: 2017.05.17 2017.06.30
5. Number of singing males: 0 males on 2017-05-17 and 0 on 2017-06-30	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 male		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges - 26-50 Reeds - 16-25 other grasses - 16-25 dead grass: - Coverage - 16-25 - thickness (much, moderately, little) - little water depth, cm - 0 vegetation height, cm – 50 - 60 cm 13. Land management way and intensity: half of the area mowed after august 15	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, <u>moderately dense</u>, scarse (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats Too early mowing, intensive grazing

Table 1.12. Aquatic Warbler monitoring in Žuvintas site LT/03-1 (Liepakojai)

1. Observer: Arūnas Pranaitis, Regimantas Vabuolas	2. Observation place: Liepakojai meadows	3. Geogr. coordinates or number of observation area: (LKS-94) 478804, 6037247	4. Date: 2017.05.18 2017.07.01
5. Number of singing males: 1 male on 2017-05-18 and 1 on 2017-07-01	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 76-100 Reeds - <5 other grasses - <5 dead grass: - Coverage - 5-15 - thickness (much, moderately, little) - much water depth, cm - 0 vegetation height, – 50 - 60 cm 13. Land management way and intensity: area mowed after august 15.	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, moderately dense, scarse (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats: -

Table 1.13. Aquatic Warbler monitoring in Žuvintas site LT/03-4 (Liepakojai)

1. Observer: Arūnas Pranaitis, Regimantas Vabuolas	2. Observation place: Liepakojai meadows	3. Geogr. coordinates or number of observation area: (LKS-94) 478804, 6037247	4. Date: 2017.05.18 2017.07.01
5. Number of singing males: 0 males on 2017-05-18 and 0 on 2017-07-01	6. Number of males, singing in reedbeds (over 10 % covered with reeds): 0 males		7. Water depth: 0 cm
Area coverage with vegetation and water:			
8. Coverage of dominant plants (%): Sedges – 76-100 Reeds - <5 other grasses - <5 dead grass: - Coverage - 5-15 - thickness (much, moderately, little) - much water depth, cm - 0 vegetation height, – 50 - 60 cm 13. Land management way and intensity: area mowed after august 15.	9. Grass vegetation structure: Tussocks, no tussocks, <u>partly tussocky</u> (underline appropriate) 10. Density of reeds: Dense, moderately dense, scarse (underline appropriate)	11. Coverage of bushes: 0	14. Determined threats: -

Annex 2. Data on monitoring of other target bird species.

Table 2.1. Black-tailed Godwit *Limosa limosa* monitoring in Apvardai site

Code and name of the monitoring (project) area: LT/02 - Apvardai			Observer: Arūnas Čerkauskas Data provider: Žydrūnas Preikša Email: griciukas@gmail.com Phone: 869834125	
Species name: *Limosa limosa*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Pušnis mire LT/02-2	2017-05-20	1	3 birds observed (1-2 pairs breeding)	Full counts method
Initial evaluation of population size: 1-2 breeding pairs				

Table 2.2. Common Redshank *Tringa totanus* monitoring in Apvardai site

Code and name of the monitoring (project) area: LT/02 - Apvardai			Observer: Arūnas Čerkauskas Data provider: Žydrūnas Preikša Email: griciukas@gmail.com Phone: 869834125	
Species name: *Tringa totanus*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Pušnis mire LT/02-2	2017-05-20	1	1	Full counts method
Initial evaluation of population size: 1 breeding pair				

Table 2.3. Common Redshank *Tringa totanus* monitoring in Tyrai site

Code and name of the monitoring (project) area: LT/01 - Tyrai			Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125	
Species name: *Tringa totanus*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Tyrai mire LT/01	2017-06-10	2	1	Full counts method
Initial evaluation of population size: 1 breeding pair				

Table 2.4. Common Redshank *Tringa totanus* monitoring in Šyša/Sausgalviai site

Code and name of the monitoring (project) area: LT/04 – Šyša/Sausgalviai			Observer: Žydrūnas Preikša, Renatas Jakaitis, Saulius Lileikis Email: griciukas@gmail.com Phone: 869834125	
Species name: *Tringa totanus*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Šyša LT/04-1	2017-06-08	2	1	Full counts method
Initial evaluation of population size: 1 breeding pair				

Table 2.5. Great Snipe *Gallinago media* monitoring in Šyša/Sausgalviai site

Code and name of the monitoring (project) area: LT/04 – Šyša/Sausgalviai			Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125	
Species name: *Gallinago media*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Šyša LT/04-1	2017-06-05	2	8	Full counts method
Sausgalviai LT/04-3	2017-06-10	2	6	Full counts method
Sausgalviai LT/04-4	2017-06-06	2	2	Full counts method
Initial evaluation of population size: 16 calling males				

Table 2.6. Corncrake *Crex crex* monitoring in Šyša/Sausgalviai site

Code and name of the monitoring (project) area: LT/04 – Šyša/Sausgalviai			Observer: Žydrūnas Preikša, Renatas Jakaitis, Saulius Lileikis Email: griciukas@gmail.com Phone: 869834125	
Species name: *Crex crex*				
Population units (underline): breeding pairs; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Šyša LT/04-1	2017-06-08	1	32	Full counts method
Sausgalviai LT/04-3	2017-06-09	1	4	Full counts method
Sausgalviai LT/04-4	2017-06-09	1	2	Full counts method
Sausgalviai LT/04-5	2017-06-09	1	1	Full counts method
Initial evaluation of population size: 39 calling males				

Table 2.7. Spotted Crake *Porzana porzana* monitoring in Šyša/Sausgalviai site

Code and name of the monitoring (project) area: LT/04 – Šyša/Sausgalviai			Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125	
Species name: ***Porzana porzana***				
Population units (underline): breeding pairs; <u>calling males</u>; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Šyša LT/04-1	2017-05-08	1	2	Point counts method
Sausgalviai LT/04-3	2017-05-09	1	5	Point counts method
Sausgalviai LT/04-3	2017-05-25	2	4	Point counts method
Initial evaluation of population size: **11 calling males**				

Table 2.8. Short-eared Owl *Asio flammeus* monitoring in Šyša/Sausgalviai site

Code and name of the monitoring (project) area: LT/04 – Šyša/Sausgalviai			Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125	
Species name: ***Asio flammeus***				
Population units (underline): <u>breeding pairs</u>; calling males; individuals				
Name or code of exact site	**Date of the census** (yyyy-mm-dd)	**Site visit number**	**Bird numbers** (in population units)	**Important remarks on weather conditions, habitat disturbance, survey method, transect lenght and width etc.** (use several lines if needed)
Šyša LT/04-1	2017-06-08	2	1	Full counts method
Initial evaluation of population size: **1 breeding pair**				

Annex 3. Lists of breeding birds in the project sites.

Table 3.1. Breeding birds in Tyrai site

Code and name of the monitoring (project) area: LT/01 - Tyrai **Year of evaluation: 2018**	Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125

No.	**Name of the species**	**Breeding status***			**Important remarks**
		C (confirmed breeding)	**B** (probable breeding)	**A** (possible breeding)	
1	*Grus grus*	1			
2	*Vanellus vanellus*	6			
3	*Tringa totanus*	2			
4	*Gallinago gallinago*		6		
5	*Anthus pratensis*		+		
6	*Luscinia luscinia*		+		
7	*Acrocephalus palustris*		+		
8	*Acrocephalus schoenobaenus*		+		
9	*Phylloscopus trochilus*		+		
10	*Sylvia communis*		+		
11	*Remiz pendulinus*	1			
12	*Emberiza schoeniclus*		+		

*** - C – Breeding** of a species is **confirmed** by the presence of the occupied nest, or any behavior of the birds, indicating presence of the occupied nest, nests containing eggs, recently hatched or fledged young birds; **B** – local residents suggested as **probable breeders** due to lack of obvious evidence of the breeding in the site; **A** – possible breeding of the species suggested based on single cases of observation of individual bird in possible breeding habitat during the breeding season.

Table 3.2. Breeding birds in Apvardai site

Code and name of the monitoring (project) area: LT/02 - Apvardai **Year of evaluation: 2018**	Observer: Arūnas Čerkauskas Data provider: Žydrūnas Preikša Email: griciukas@gmail.com Phone: 869834125

No.	Name of the species	Breeding status*			Important remarks
		C (confirmed breeding)	**B** (probable breeding)	**A** (possible breeding)	
1	*Botaurus stellaris*		1		
2	*Anas plathyrhynchos*	+			
3	*Spatula querquedula*		+		
4	*Grus grus*		4		
5	*Porzana porzana*		6		
6	*Rallus aquaticus*		+		
7	*Vanellus vanellus*	1			
8	*Tringa totanus*	1			
9	*Gallinago gallinago*		+		
10	*Limosa limosa*	1			
11	*Alauda arvensis*		+		
12	*Anthus pratensis*		+		
13	*Anthus trivialis*		+		
14	*Turdus philomelos*		+		
15	*Locustella luscinioides*		+		
16	*Acrocephalus schoenobaenus*		+		
17	*Phylloscopus trochilus*		+		
18	*Sylvia communis*		+		
19	*Emberiza schoeniclus*		+		

*** - C – Breeding** of a species is **confirmed** by the presence of the occupied nest, or any behavior of the birds, indicating presence of the occupied nest, nests containing eggs, recently hatched or fledged young birds; **B** – local residents suggested as **probable breeders** due to lack of obvious evidence of the breeding in the site; **A** – possible breeding of the species suggested based on single cases of observation of individual bird in possible breeding habitat during the breeding season.

Table 3.3. Breeding birds in Žuvintas site

Code and name of the monitoring (project) area: LT/03 - 3 - Žuvintas **Year of evaluation: 2018**	Observer: Regimantas Vabuolas Email: r.vabuolas@zuvintas.lt Phone: 8 315 49540

No.	**Name of the species**	**Breeding status***			**Important remarks**
		C (confirmed breeding)	**B** (probable breeding)	**A** (possible breeding)	
1	*Grus grus*		2		
2	*Rallus aquaticus*		+		
3	*Porzana porzana*		+		
4	*Crex crex*		3		
5	*Vanellus vanellus*	16			
6	*Tringa totanus*		2		
7	*Gallinago gallinago*		22		
8	*Limosa limosa*			+	
9	*Alauda arvensis*		+		
10	*Anthus pratensis*		+		
11	*Motacilla citreola*			2	
12	*Luscinia luscinia*		+		
13	*Saxicola rubetra*		+		
14	*Locustella naevia*		+		
15	*Locustella luscinioides*		+		
16	*Acrocephalus paludicola*		+		
17	*Acrocephalus schoenobaenus*		+		
18	*Phylloscopus trochilus*		+		
19	*Sylvia communis*		+		
20	*Remiz pendulinus*		+		
21	*Pica pica*		+		
22	*Carpodacus erythrinus*		+		
23	*Emberiza citrinella*		+		
24	*Emberiza schoeniclus*		+		

*** - C – Breeding** of a species is **confirmed** by the presence of the occupied nest, or any behavior of the birds, indicating presence of the occupied nest, nests containing eggs, recently hatched or fledged young birds; **B** – local residents suggested as **probable breeders** due to lack of obvious evidence of the breeding in the site; **A** – possible breeding of the species suggested based on single cases of observation of individual bird in possible breeding habitat during the breeding season.

Table 3.4. Breeding birds in Šyša site

Code and name of the monitoring (project) area: LT/04-1 - Šyša **Year of evaluation: 2018**	Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125

No.	**Name of the species**	**Breeding status***			**Important remarks**
		C (confirmed breeding)	**B** (probable breeding)	**A** (possible breeding)	
1	*Anas platyrhynchos*	+			
2	*Crex crex*		21		
3	*Vanellus vanellus*	4			
4	*Tringa totanus*	2			
5	*Gallinago media*		6		
6	*Gallinago gallinago*		2		
7	*Alauda arvensis*		+		
8	*Anthus pratensis*		+		
9	*Motacilla flava*		+		
10	*Saxicola rubetra*		+		
11	*Acrocephalus schoenobaenus*		+		
12	*Acrocephalus paludicola*		17		
13	*Emberiza schoeniclus*		+		

*** - C – Breeding** of a species is **confirmed** by the presence of the occupied nest, or any behavior of the birds, indicating presence of the occupied nest, nests containing eggs, recently hatched or fledged young birds; **B** – local residents suggested as **probable breeders** due to lack of obvious evidence of the breeding in the site; **A** – possible breeding of the species suggested based on single cases of observation of individual bird in possible breeding habitat during the breeding season.

Table 3.5. Breeding birds in Sausgalviai site

Code and name of the monitoring (project) area: LT/04-2; LT/04-3; LT/04-4; LT/04-5 - Sausgalviai **Year of evaluation: 2018**	Observer: Žydrūnas Preikša, Renatas Jakaitis Email: griciukas@gmail.com Phone: 869834125

No.	**Name of the species**	**Breeding status***			**Important remarks**
		C (confirmed breeding)	**B** (probable breeding)	**A** (possible breeding)	
1	*Anas platyrhynchos*		+		
2	*Crex crex*		6		
3	*Vanellus vanellus*	20			
4	*Tringa totanus*		3		
5	*Gallinago media*		3		
6	*Gallinago gallinago*		14		
7	*Alauda arvensis*		+		
8	*Anthus pratensis*		+		
9	*Motacilla flava*		+		
10	*Saxicola rubetra*		+		
11	*Luscinia luscinia*		+		
12	*Acrocephalus schoenobaenus*		+		
13	*Acrocephalus paludicola*		3		
14	*Emberiza schoeniclus*		+		

*** - C – Breeding** of a species is **confirmed** by the presence of the occupied nest, or any behavior of the birds, indicating presence of the occupied nest, nests containing eggs, recently hatched or fledged young birds; **B** – local residents suggested as **probable breeders** due to lack of obvious evidence of the breeding in the site; **A** – possible breeding of the species suggested based on single cases of observation of individual bird in possible breeding habitat during the breeding season.

The project “Stepping stones towards ensuring long-term favourable conservation status of Aquatic warbler in Lithuania” (LIFE MagniDucatusAcrola) No. **LIFE15 NAT/LT/001024** is financed by the EU LIFE Programme, Ministry of Environment of the Republic of Lithuania and project partners.

BASELINE ASSESSMENT REPORT ON SOCIO-ECONOMIC ENVIRONMENT IN SURROUNDING AREAS OF PROJECT SITES

Prepared by:
Kristina Valavičiūtė
Gintaras Riauba

Vilnius, 2018

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1. Socio-economic indicators assessment at the district municipality level

At the beginning of the project indicators of socio-economic environment in each district municipality, containing project area, is being evaluated. Such rating will allow the comparison of the same indicators at the end of the project.

All data was collected from Official Statistics Portal of Lithuania. For this kind of assessment data from "Population and social statistics", "Business statistics" and "Agriculture, hunting, forestry and fishing" themes were gathered.

1.1. Alytus district municipality:

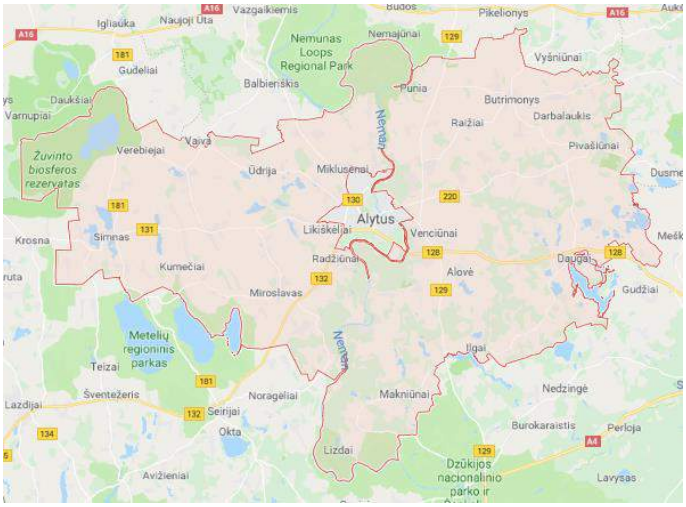


Figure 1 Boundaries of Alytus district municipality

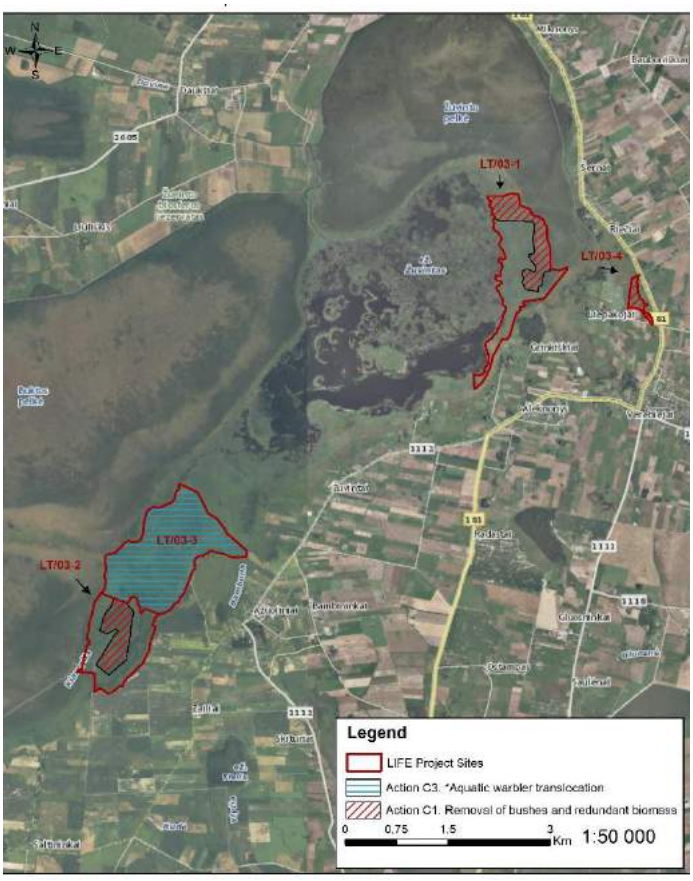


Figure 2 Project sites within Alytus district municipality

Alytus district municipality (Figure 1) is located in southern Lithuania. It is surrounded by Prienai, Birštonas, Trakai, Varėna, Druskininkai, Lazdijai, Kalvarija, Marijampolė district municipalities.

In this municipality three project sites (LT/03-1, LT/03-2, LT/03-3) are located in Žuvintas biosphere reserve (Figure 2).

Population and social statistics:

The population of Alytus district municipality in 2017 was 26 563. It makes up 0.93% of overall Lithuania's population. The vast majority of this area's people population (90.96%) live in villages and the rest of them – in cities.

In 2017 430 people emigrated abroad and made up 0.90% of all country's emigrants. Net international migration at this area is -332 individuals.

In 2017 this district municipality 12.8 thousand people were employed (64.06% - men, 36.72% - women of all employed people). 0.94% (1.24% - men, 0.68% - women) all of Lithuania's employed people are located in this municipality. Employment level, in the age range of 15 – 64 years, is overall – 60.2%, men – 61.1% and women – 58.6% of all residents in this municipality.

Business statistics:

In 2016 in Alytus district municipality the most profitable branches of non-finance enterprises were mining, quarrying, and manufacturing (35.37% of this area turnover) and wholesale, retail trade, repair of motor vehicles and motorcycles (44.42% of this area turnover). Not a surprise that the same branches have the largest number of employees (25.96% and 25.91% respectively) (Figure 3).

Registered economic entities at the beginning of 2017 in this area were 958 (0.44% in Lithuania). The majority of registered economic entities was in wholesale, retail trade, repair of motor vehicles and motorcycles (22.44%) and in other service activities (17.12%) branches. Most of (66.31%) operating economic entities at this municipality (according to data at the beginning of 2017) are very small (made up of 0-4 employees). At the beginning of 2017 21.22% (517 people) of employees work in enterprises in operation that contain 20-49 employees. The percentage of employees in smaller enterprises in operation is quite similar (Figure 4).

The number of small and medium enterprises removed from the register over the year 2017 in Alytus district municipality was 17, all of which were very small – containing 0-4 employees. In the same year there were 62 enterprises registered, of which 98.39% were very small – containing 0-4 employees. The greatest number (228 – 63.51%) of enterprises in operation at the beginning of the year 2017 was also in very small enterprises. In the year 2017 data of income shows that 29.25% of enterprises in this area receive 10 000 – 49 999 euros income and 25.91% - 50 000 – 99 999 euros income (Figure 5).

In 2017 in Alytus district municipality, 29 (0.98% of all Lithuanian accommodation establishments) accommodation establishments were registered. Overall in these institutions there are 106 rooms in which 321 beds are available. During the same year 2 160 Lithuanians and 1 632 foreigners stayed at such establishments.

Agriculture:

In Alytus district municipality in 2017, there was 139 271,0 ha of harvested agricultural crops. The greatest portion of the area was designated for grain crops (17.43%) and cereals (15.48%). In same year agricultural producers utilized 66 664 ha of land in total. 53.62% of that area was used as arable land, 50.03% of it was sown area. 44.39% was used as meadows and pastures and 1.88% as orchards and berry plantations.

In 2016 in Alytus district municipality 65 585 ha of agricultural land was utilized, the majority (38.35%) of those farms are more than 50 ha in size (Figure 6). Overall unutilized agricultural land area is 882 ha.

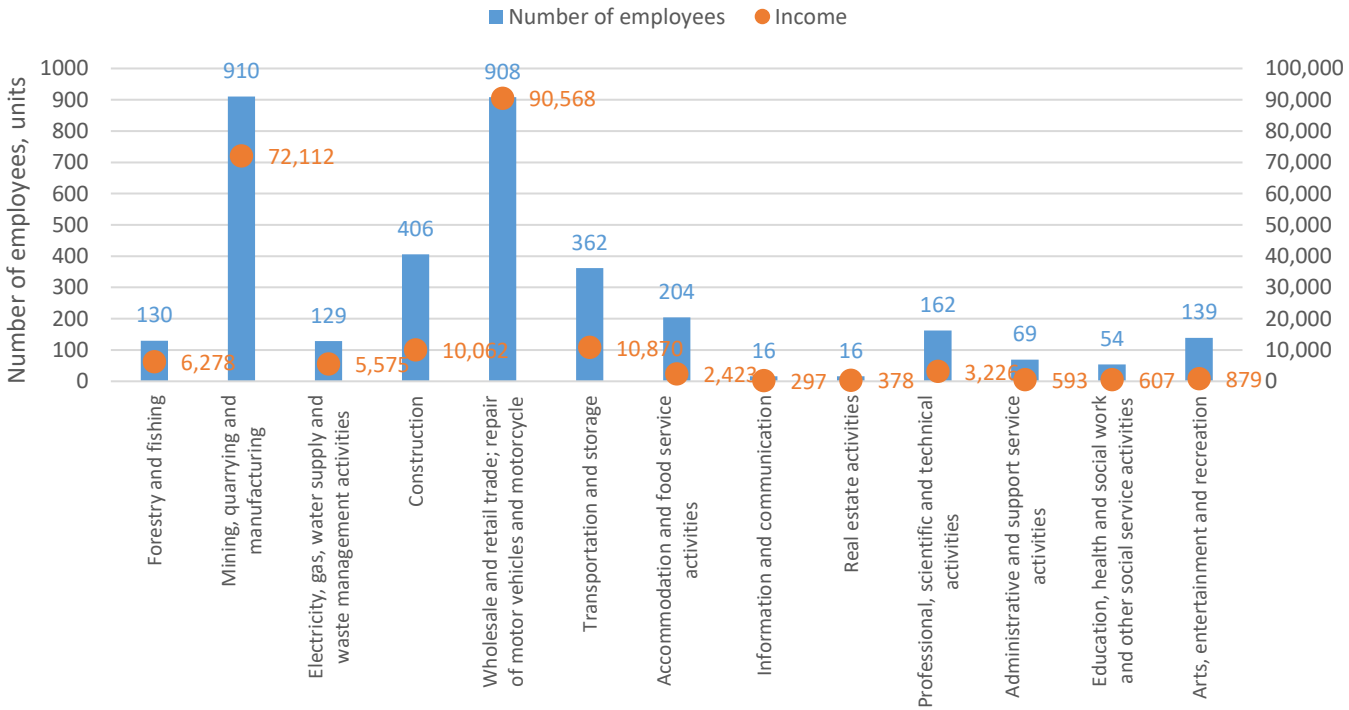


Figure 3 Number of employees and the income of certain business branches In Alytus district municipality in 2016

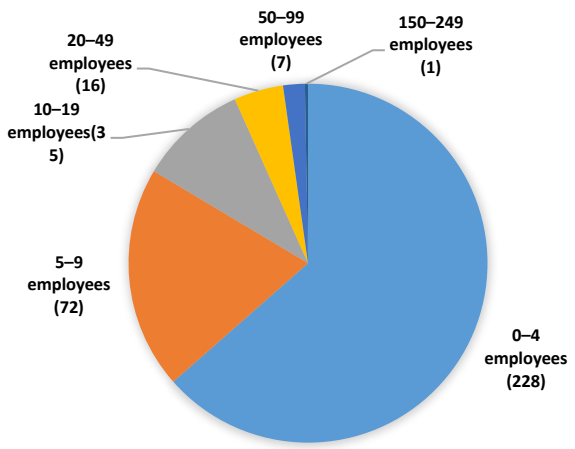


Figure 4 Number and size of enterprises in Alytus district municipality in 2017

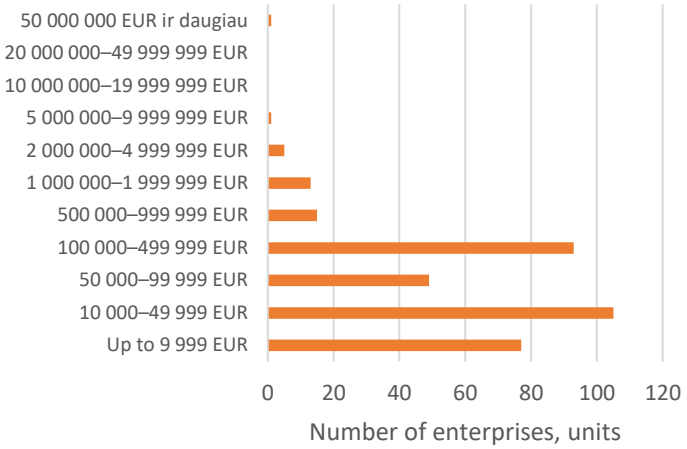


Figure 5 Number of enterprises in Alytus district municipality, according to their annual income in 2017

In 2016 at this district there were 5 685 people, in terms of annual work units, employed in farms. 98.00% of them worked in farmer's and family farms and remaining 2.00% - in agricultural companies and enterprises. Also in 2016, there were 9 332 farm holders, 53.44% of which are men and 46.56% are women. Largest age group (32.62%) of farm holders is of people that are 65 and older. The vast majority (8 185 - 51.47%) of people employed in agriculture work part–time.

At the beginning of 2016 in this area there were 647 596 farm animals and poultry. The vast majority (96.17%) of them are poultry, of which 99.62% are hens. Cattle are in second place according to their abundance (2.77%). Number of livestock in farmers and family's farms at the beginning of 2016 was 32 712. In 2016 there were 6 168 farms in this municipality. There were 1 043 farms (16 963 sheep) that breed sheep, 2 612 farms (20 577 cattle) that breed cattle, 1 093 farms (5 765 animals) that breed other farm animals (goats, horses, beehives) and 2 416 farm (7 378 dairy cows) that breeds dairy cows were counted at the year 2016.

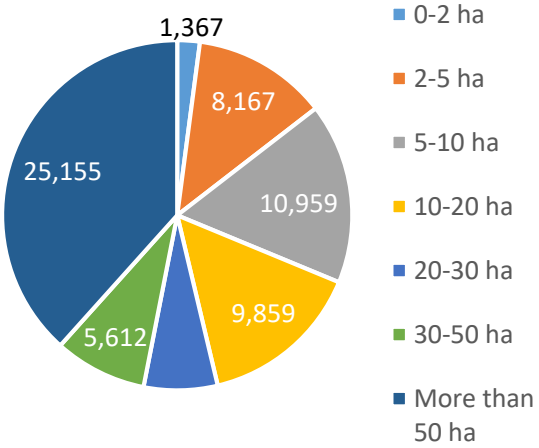


Figure 6 Utilized land depending on the size of a farm in Alytus district municipality in 2016

Gross agricultural production at current prices in 2016 was 46.1 mln. Euros (48.37% - crop production, 51.63% - animal production). In 2016 standard production worth was evaluated as 43 070,9 thousand Euros. Most of that (31.27%) came from farms who mainly farm field crops, then 29.22% was generated by farms where the main type of farming is mixed cropping and livestock animals and 27.83% - farms where the main type of farming is grazing livestock.

In 2017 1 ha of arable land was worth 2 646 euros and 1 ha of permanent grassland – 2 409 euros in Alytus district municipality. The rent prices for 1 ha in the same year was 81 and 72 euros respectively.

1.2. Ignalina district municipality:

Figure 7 Boundaries of Ignalina district municipality

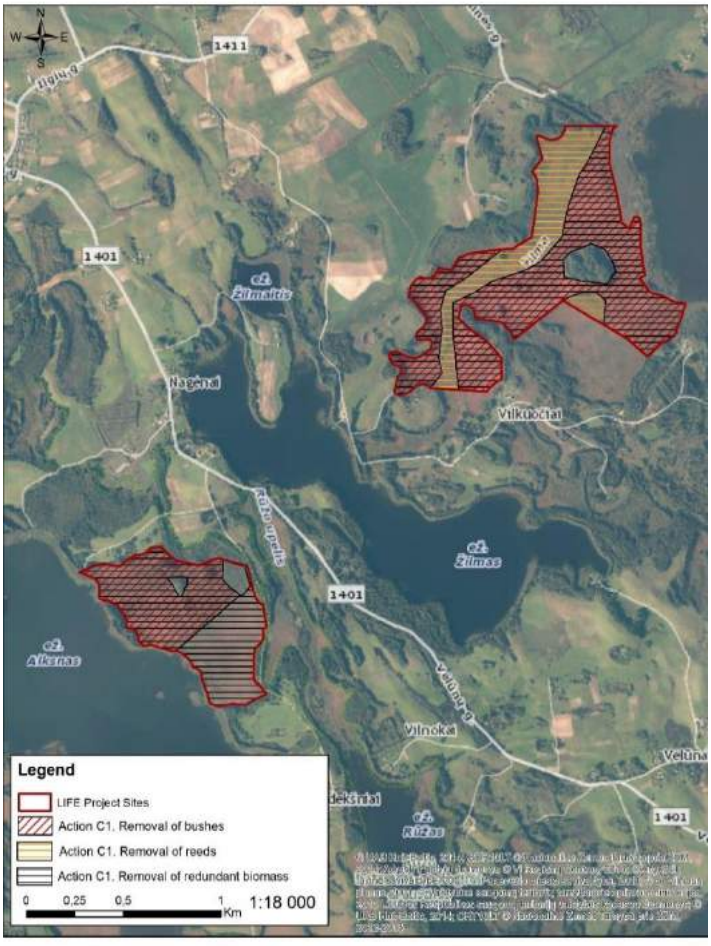


Figure 8 Project sites within Ignalina district municipality

Ignalina district municipality (Figure 7) is located in the eastern part of Lithuania. It is surrounded by Zarasai, Utena, Švenčionys district municipalities.

There are two project sites (LT/02-1, LT/02-2) within this municipality (Figure 8).

Population and social statistics:

The population of Ignalina district municipality in 2017 was 15 892. It makes up 0.56% of overall Lithuania's population. The majority of this area's people population (61.73%) lives in villages and the rest of them – in cities.

In 2017 693 people emigrated abroad and made up 1.45% of all country's emigrants. Net international migration at this area is -247 individuals.

In 2017 this district municipality 4.5 thousand people were employed (51.11% - men, 48.89% - women of all employed people). 0.33% (0.35% - men, 0.32% - women) all Lithuania's employed people are located at this municipality. Employment level, in the age range of 15 – 64 years, is overall – 54.4%, men – 50.3% and women – 59.7% of all residents in this municipality.

Business statistics:

In 2016 in Ignalina district municipality the most profitable branches of non-finance enterprises were mining, quarrying, and manufacturing (17.70% of this area's turnover) and wholesale, retail trade, repair of motor vehicles and motorcycles (52.50% of this area's turnover). Not a surprise that the same branches have the biggest amount of employees (15.89% and 31.92% respectively) (Figure 9).

Registered economic entities at the beginning of 2017 in this area were 568 (0.26% in Lithuania). The majority of registered economic entities was in wholesale, retail trade, repair of motor vehicles and motorcycles (13.38%), and in other service activities (24.65%) branches. Most of (59.56%) operating economic entities at this municipality (according to data at the beginning of the year 2017) are very small (making up of 0-4 employees). At the beginning of 2017 32.17% (514 people) of employees worked in enterprises in operation that contain 20-49 employees (Figure 10).

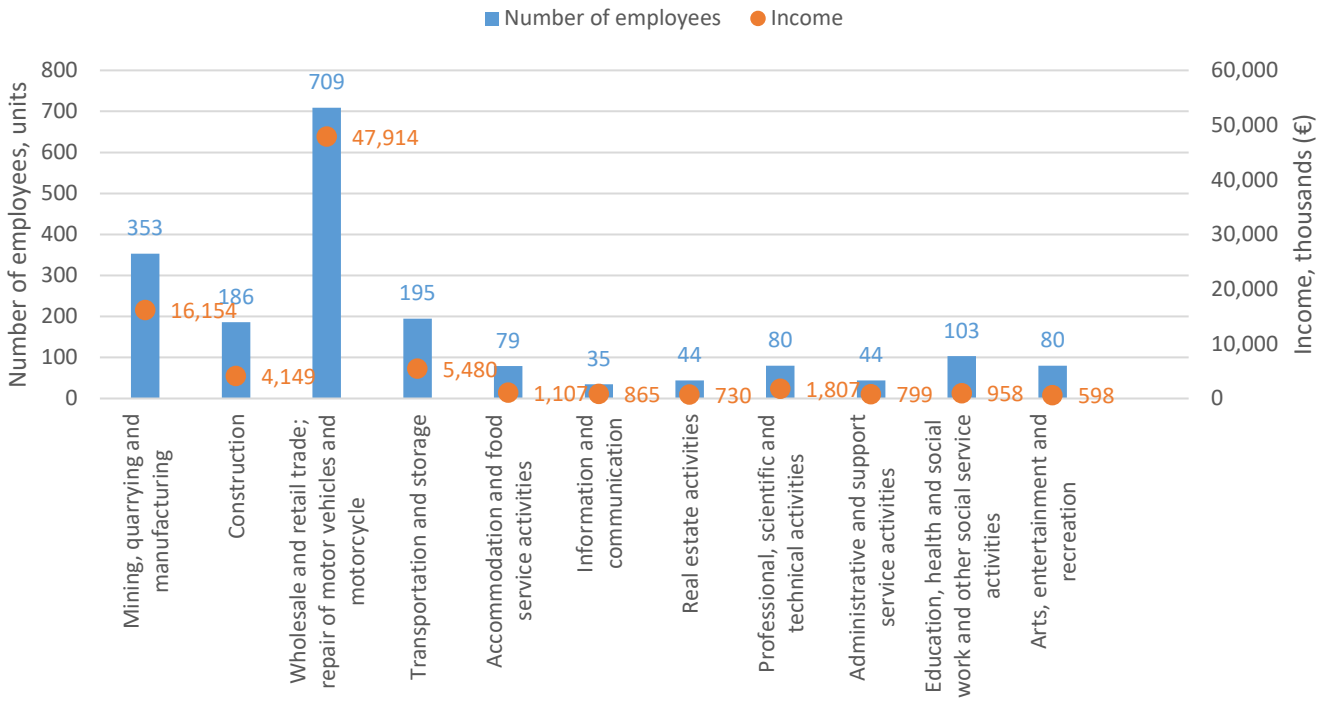


Figure 9 Number of employees and the income of certain business branches in Ignalina district municipality in 2016

The number of small and medium enterprises removed from the register over the year 2017 in Ignalina district municipality was 7, all of which were very small – containing 0-4 employees. In the same year there were 22 enterprises registered, of which 95.45% were very small – containing 0-4 employees. The greatest number (99 – 56.90%) of enterprises in operation at the beginning of the year 2017 was also in very small enterprises. The data of year 2017 of income shows that 28.16% of enterprises in this area receive 10 000 – 49 999 in euros income, 21.84% - 50 000 – 99 999 in euros income and 20.11% - up to 9 999 in euros income (Figure 11).

In 2017 in Ignalina district municipality 47 (1.58% of all Lithuanian accommodation establishments) accommodation establishments were registered. Overall in these institutions, there are 106 rooms, in which there are 431 available beds. During the same year 21 409 Lithuanians and 888 foreigners people stayed at such establishments.

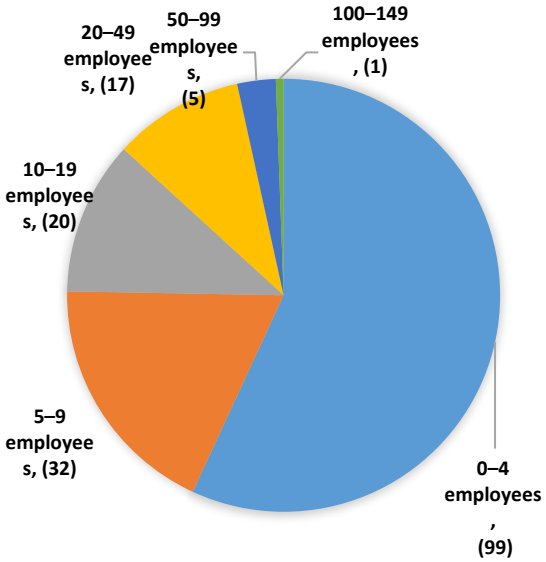


Figure 10 Number and size of enterprises in Ignalina district municipality in 2017

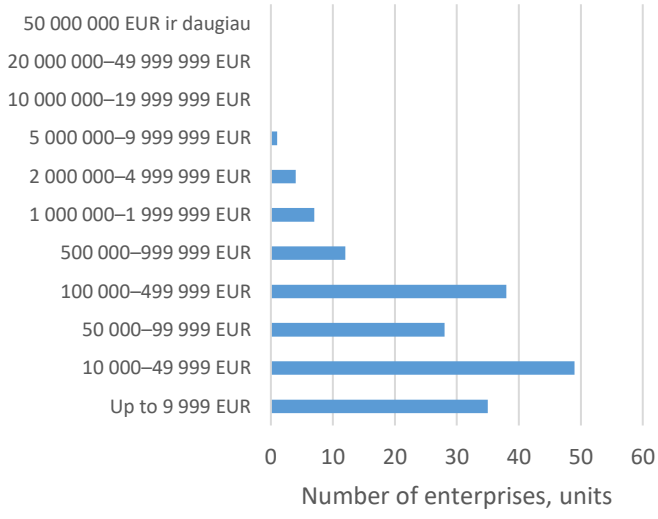


Figure 11 Number of enterprises in Ignalina district municipality, according to their annual income in 2017

Agriculture:

In Ignalina district municipality in 2017, there was 75 538 ha of harvested agricultural crops. The greatest portion of the area was designated for meadows, hay (16.85%) and grain crops (15.45%). In same year agricultural producers utilized 48 899 ha of land in total. 51.00% of that area was used as arable land, 47.23% of it was sown area, 47.81% was used as meadows and pastures and 1.17% as orchards and berry plantations.

In 2016 in Ignalina district municipality, 48 721 ha of agricultural land was utilized, the majority (55.42%) of those farms are more than 50 ha in size (Figure 12). Overall unutilized agricultural land area was 54 ha.

In 2016 at this district there were 2 423 people, in terms of annual work units, employed in farms. 98.00% of them worked in farmers and family farms, and the remaining 2.00% - in agricultural companies and enterprises. Also, in 2016, there were 4 517 farm holders, 48.68% of which are men and 51.32% are women. The largest age group (37.52%) of farm holders is comprised of people who are 65 and older. The vast majority (4 189 – 46.78%) of people employed in agriculture work part–time.

At the beginning of 2016 in this area there were 46 776 farm animals and poultry. The majority (39.65%) of them are pigs. Poultry is in second place according to their abundance (20.03%). The number of livestock in farmers and family farms at the beginning of 2016 was 13 002. In 2016 there were 2990 farms in this municipality. There were 660 farms (9 225 sheep) that breed sheep, 1 017 farms (6 141 cattle) that breed cattle, 522 farms (3 368 animals) that breed other farm animals (goats, horses, beehives) and 948 farm (2 509 dairy cows) that breeds dairy cows were counted in the year 2016.

Gross agricultural production at current prices in 2016 was 19.3 mln. Euros (69.95% - crop production, 30.05% - animal production). In 2016 standard production worth was evaluated as 19 749.70 thousand Euros. Most of that (49.63%) came from farms where the main type of farming is field crops, then 28.54% was generated by farms where the main type of farming is grazing livestock, and 15.38% farms where the main type of farming is mixed cropping and livestock animals.

In 2017 1 ha of arable land was worth 1 385 euros and 1 ha of permanent grassland – 1 428 euros in Ignalina district municipality. The rent prices for 1 ha in the same year was 93 and 23 euros respectively.

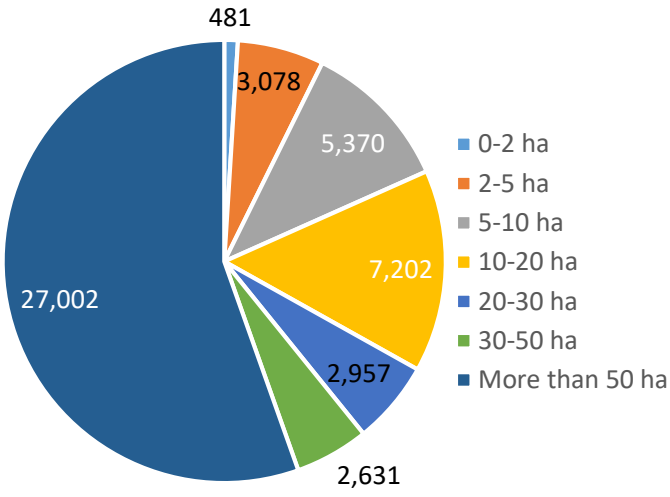


Figure 12 Number of enterprises in Ignalina district municipality, according to their annual income in 2017; numbers on chart indicates overall hectares

1.3. Klaipėda district municipality:

Figure 13 Boundaries of Klaipėda district municipality

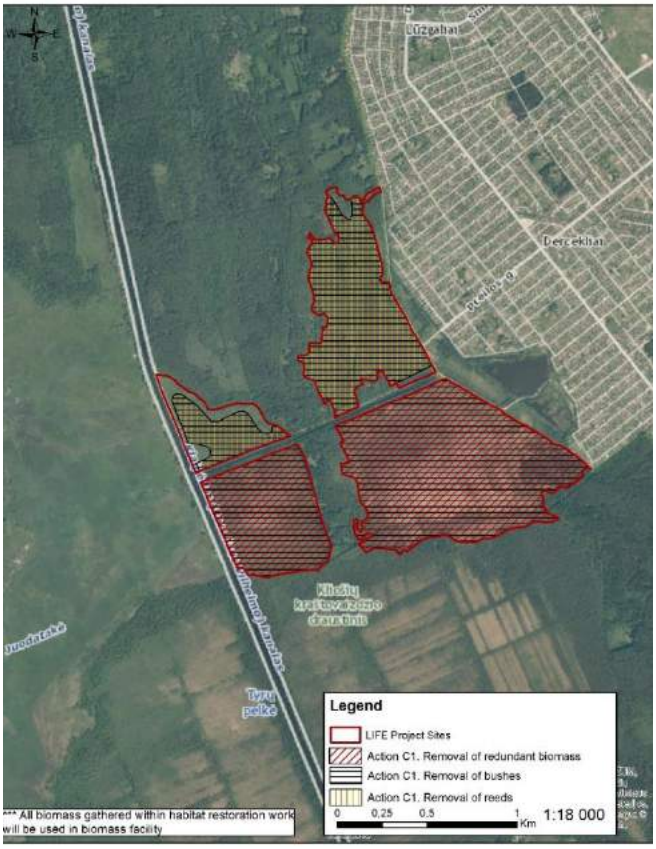


Figure 14 Project sites within Klaipėda district municipality

Klaipėda district municipality (Figure 13) is located in the western part of Lithuania. It is surrounded by Kretinga, Plungė, Rietavas, Šilalė and Šilutė district municipalities.

LT01 project site is located within this municipality (Figure 14).

Population and social statistics:

The population of Klaipėda district municipality in 2017 was 54 635 residents. It makes up 1.92% of overall Lithuania's population. The majority of this area's people population (71.34%) lives in villages and the rest of them – in cities.

In 2017 994 people emigrated abroad and made up 2.07% of all country's emigrants. Net international migration in this area is -181 individuals.

In 2017 in this district municipality 23.9 thousand people were employed (53.97% - men, 46.03% - women of all employed people). 1.76% (1.95% - men, 1.58% - women) all Lithuania's employed people were located in this municipality. Employment level in the age range of 15 – 64 years, is overall – 65.8%, men – 64.10% and women – 67.70% of all residents in this municipality.

Business statistics:

In 2016 in Klaipėda district municipality the most profitable branch of non-finance enterprises was mining, quarrying, and manufacturing (50.06% of this area turnover). 27.04% of people are employed in this particular branch.

Registered economic entities at the beginning of 2017 in this area were 3 077 (1.41% in Lithuania). Majority of registered economic entities was in wholesale, retail trade, repair of motor vehicles and motorcycles (21.38%) and in other service activities (12.71%) branches (Figure 15).

Most of (60.87%) operating economic entities at this municipality (according to data at the beginning of the year 2017) are very small (made up of 0-4 employees). At the beginning of 2017 15.97% (2 294 people) of employees worked in enterprises in operation that contain 20-49 employees, although the difference between enterprises containing different numbers of employees is not that big (Figure 16).

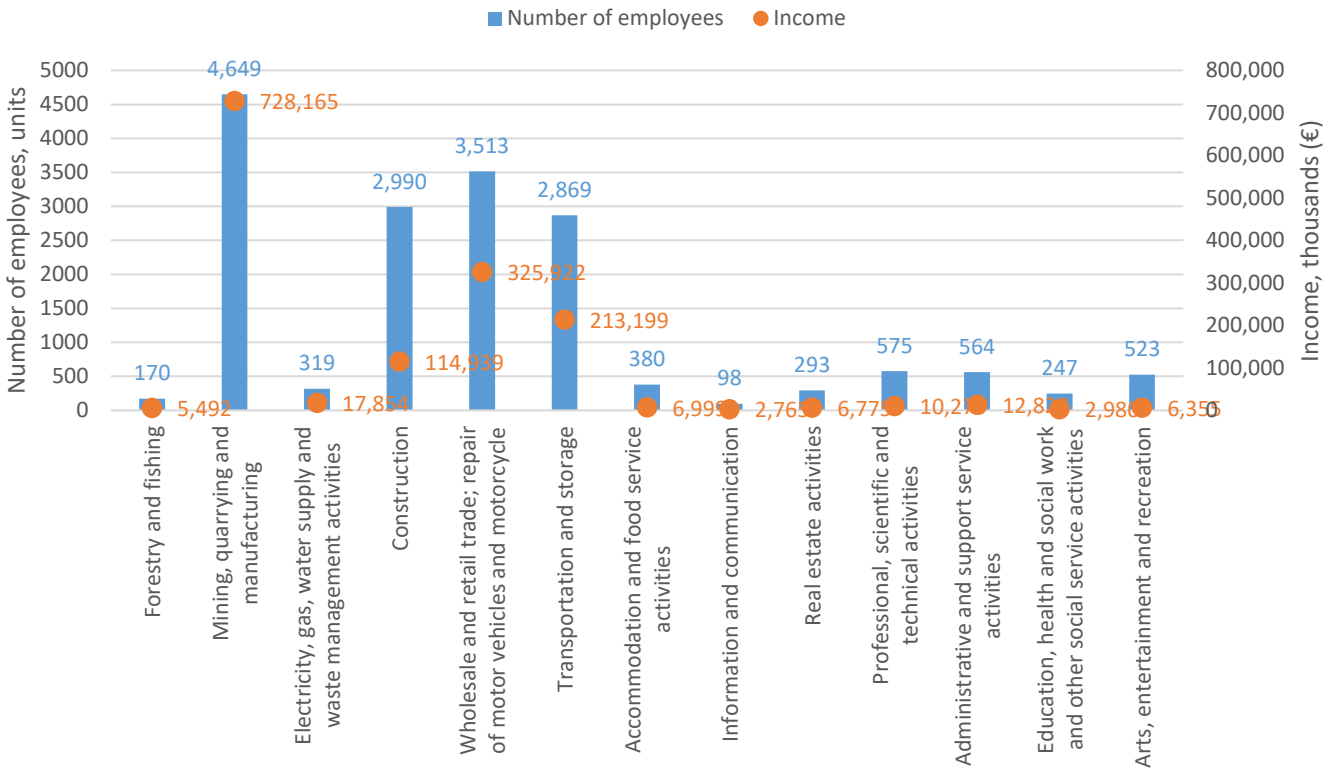


Figure 15 Number of employees and the income of certain business branches In Klaipėda district municipality in 2016

The number of small and medium enterprises removed from the register over the year 2017 in Klaipėda district municipality was 66, the majority of them (64) was very small – containing 0-4 employees. In the same year there were 174 enterprises registered, of which 93.10% were very small – containing 0-4 employees. The greatest number (821 – 58.10%) of enterprises in operation at the beginning of the year 2017 was also in very small enterprises. The income data for 2017 shows that 28.34% of enterprises in this area receive 10 000 – 49 999 in euros income, 27.34% - 100 000 – 499 999 in euros income and 18.39% - up to 9 999 in euros income (Figure 17).

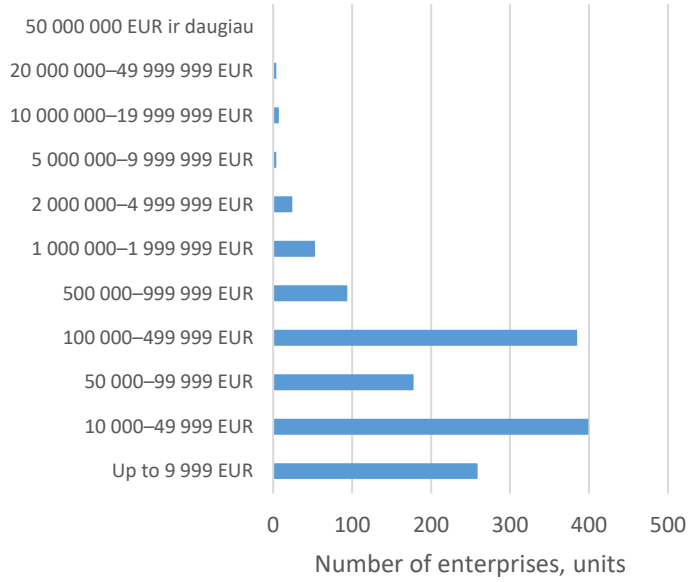


Figure 17 Number of enterprises in Klaipėda district municipality, according to their annual income in 2017

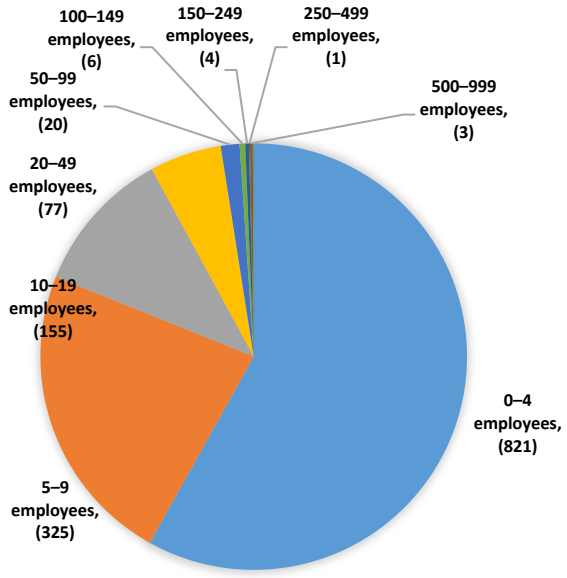


Figure 16 Number and size of enterprises in Klaipėda district municipality in 2017

In 2017 in the Klaipėda district municipality 65 (2.19% of all Lithuanian accommodation establishments) accommodation establishments were registered. Overall in these institutions there are 415 rooms, in which 1593 beds, are available. During the same year 52 164 Lithuanians and 3 060 foreigners stayed at such establishments.

Agriculture:

In Klaipėda district municipality in 2017, there was 130 284 ha of harvested agricultural crops. The greatest portion of the area was designated for grain crops (17.75%) and cereal (13.84%). In same year agricultural producers utilized 57 631 ha of land in total. 65.03% of that area was used as arable land, 62.63% of it was sown area, 33.62% was used as meadows and pastures and 1.32% as orchards and berry plantations.

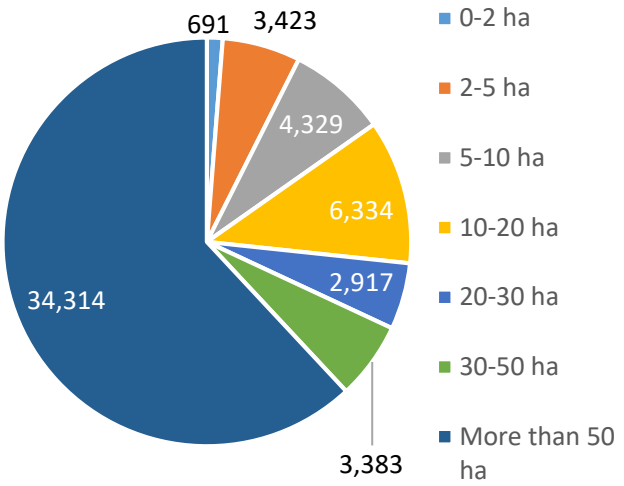


Figure 18 Number of enterprises in Klaipėda district municipality, according to their annual income in 2017; numbers on chart indicates overall hectares

In 2016 in Klaipėda district municipality 55 390 ha of agricultural land was utilized, the majority (61.95%) of those farms are more than 50 ha in size (Figure 18).

In 2016 at this district there were 3 431 people, in terms of annual work units, employed in farms. 96.00% of them worked in farmer's and family farms and remaining 4.00% - in agricultural companies and enterprises. Also in 2016, there were 4 896 farm holders, 51.49% of which are men and 48.49% are women. Largest age group (28.21%) of farm holders is of people that are 40-49 years old. The vast majority (4 218 – 43.87%) of people employed in agriculture work part–time.

At the beginning of 2016 in this area there were 69 121 farm animals and poultry. The majority (36.16%) of them are pigs. Poultry is in second place according to their abundance (29.56%). Number of livestock in farmers and family's farms at the beginning of 2016 was 24 529. In 2016 there were 3 111 farms in this municipality. There were 205 farms (4 934 sheep) that breed sheep, 947 farms (14 244 cattle) that breed cattle, 427 farms (2 947 animals) that breed other farm animals (goats, horses, beehives) and 861 farm (4 650 dairy cows) that breed dairy cows were counted at the year 2016.

Gross agricultural production at current prices in 2016 was 36.5 mln. Euros (66.03% - crop production, 33.97% - animal production). In 2016 the standard production worth was evaluated as 34 873.6 thousand Euros. Most of that (37.63%) came from farms where the main type of farming is field crops, then 25.73% was generated by farms where the main type of farming is grazing livestock and 21.40% farms where the main type of farming is mixed cropping and livestock animals.

In 2017 1 ha of arable land was worth 3 336 euros and 1 ha of permanent grassland – 2 779 euros in Klaipėda district municipality. The rent prices for 1 ha in the same year were 106 and 82 euros respectively.

1.4. Šilutė district municipality:

Figure 19 Boundaries of Šilutė district municipality boundaries

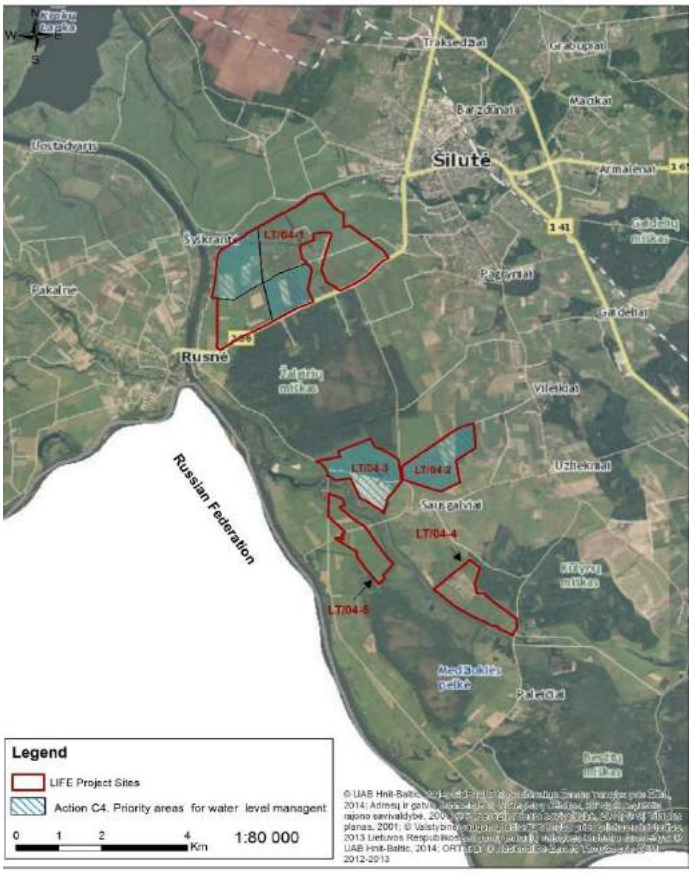


Figure 20 Project sites within Šilutė district municipality

Šilutė district municipality (Figure 19) is located in the western Lithuania. It is surrounded by Klaipėda, Šilalė, Tauragė, and Pagėgiai district municipalities.

Within this municipality there are 5 project sites (LT/04-1, LT/04-2, LT/04-3, LT/04-4, LT/04-5) (Figure 20).

Population and social statistics:

The population of Šilutė district municipality in 2017 was 38 749. It makes up 1.36% of overall Lithuania's population. The majority of this area's people population (60.21) lives in villages and the rest of them – in cities.

In 2017 2 106 people emigrated abroad and made up 4.39% of all country's emigrants. Net international migration at this area is -976 individuals.

In 2017 this district municipality 15,3 thousand people were employed (52.94% - men, 49.02% - women of all employed people). 1.13% (1.23% - men, 1.05% - women) all Lithuania's employed people are located at this municipality. Employment level, in the age range of 15 – 64 years, is overall 58.1%, men – 57.6% and women – 58.6% of all residents in this municipality.

Business statistics:

In 2016 in Šilutė district municipality the most profitable branches of non-finance enterprises were mining, quarrying, and manufacturing (38.22% of this area turnover) and wholesale, retail trade, repair of motor vehicles and motorcycles (32.81% of this area turnover). It is not a surprise that the same branches have the largest number of employees (29.98% and 23.02% respectively) (Figure 21).

Registered economic entities at the beginning of 2017 in this area were 1 910 (0.87% in Lithuania). The majority of registered economic entities was in wholesale, retail trade, repair of motor vehicles and motorcycles (17.33%) and in other service activities (20.31%) branches. Most of (63.35%) operating economic entities at this municipality (according to data at the beginning of the year 2017) are very small (made up of 0-4 employees). In the beginning of 2017 57.90% (436 people) of employees worked in enterprises in operation containing 0-4 employees (Figure 22).

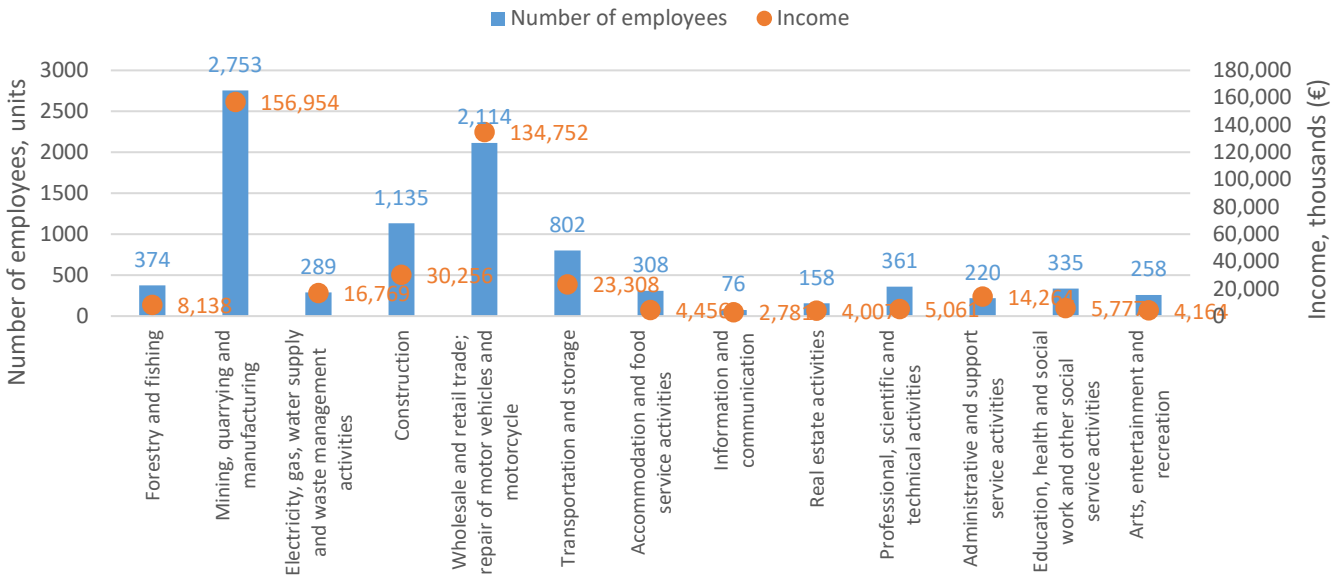


Figure 21 Number of employees and the income of certain business branches in Šilutė district municipality in 2016

The number of small and medium enterprises removed from the register over the year 2017 in Šilutė district municipality was 28, all of which were very small – containing 0-4 employees. In the same year, there were 76 enterprises registered, of which 95.45% were very small – containing 0-4 employees. The greatest number (66 – 86.84%) of enterprises in operation at the beginning of the year 2017 was also in very small enterprises. For 2017 the data of income shows that 29.96% of enterprises in this area receive 10 000 – 49 999 in euros income, 26.63% - 100 000 – 499 999 in euros income and 20.64% - up to 9 999 in euros income (Figure 23).

In 2017 in Šilutė district municipality, 40 (1.35% of all Lithuanian accommodation establishments) accommodation establishments were registered. Overall in these institutions there are 140 rooms, in which 346 beds, are available. During the same year 10 642 Lithuanians and 5 854 foreigners people stayed at such establishments.

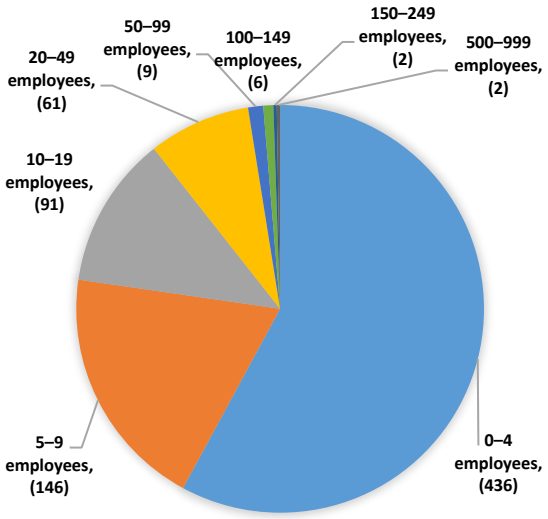


Figure 22 Number and size of enterprises in Šilutė district municipality in 2017

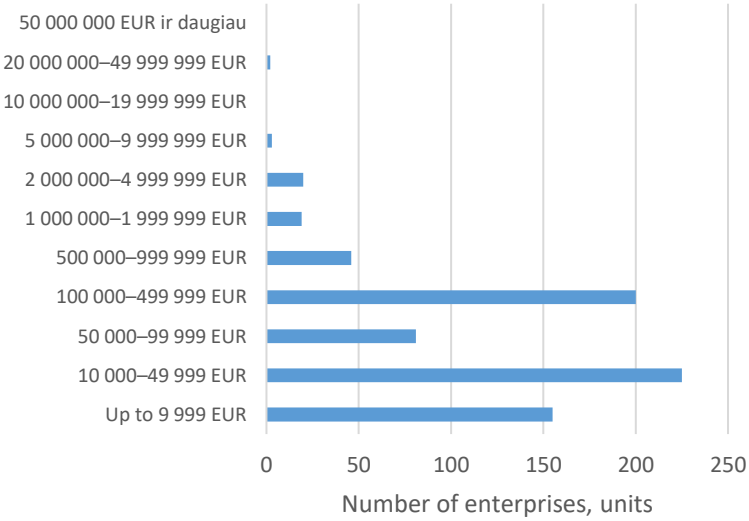


Figure 23 Number of enterprises in Šilutė district municipality, according to their annual income in 2017

Agriculture:

In Šilutė district municipality in 2017, there was 119 039 ha of harvested agricultural crops. The greatest part of the area was designated for grain crops (13.18%) and meadows, hay (12.90%). In same year agricultural producers utilized 75 251 ha of land in total. 44.03% of that area was used as arable land, 42.90% of it was sown area, 51.62% was used as meadows and pastures and 1.15% as orchards and berry plantations.

In 2016 in Šilutė district municipality 75 516 ha of agricultural land was utilized, the majority (46.90%) of those farms are more than 50 ha in size (Figure 24). Overall unutilized agricultural land area was 530 ha.

In 2016 at this district there were 4 242 people, in terms of annual work units, employed in farms. 95.00% of them worked in farmer's and family farms and remaining 5.00% - in agricultural companies and enterprises. Also in 2016, there were 6 258 farm holders, 49.62% of which are men and 50.38% are women. Largest age group (29.10%) of farm holders is of people who are 50-59 years old. The vast majority (5 613 - 45.15%) of people employed in agriculture work part–time.

At the beginning of 2016 in this area there were 71 391 farm animals and poultry. The majority (49.75%) of them are cattle. Poultry is in second place according to their abundance (29.88%). The number of livestock in farmers and family farms at the beginning of 2016 was 43 677. In 2016 there were 4 917 farms in this municipality. There were 70 farms (1 501 sheep) that breed sheep, 2 506 farms (39 345 cattle) that breed cattle, 378 farms (3 033 animals) that breed other farm animals (goats, horses, beehives) and 2 102 farm (13 544 dairy cows) that breeds dairy cows were counted in the year 2016.

Gross agricultural production at current prices in 2016 was 50.2 mln. Euros (36.85% - crop production, 63.15% - animal production). In 2016 the standard production worth was evaluated as 51 399.80 thousand Euros. Most of that (61.77%) came from farming by grazing livestock, then 14.51% from farms where the main type of farming is field crops.

In 2017 1 ha of arable land was worth 1 906 euros and 1 ha of permanent grassland – 1 786 euros in Šilutė district municipality. The rent prices for 1 ha in the same year were 39 and 59 euros respectively.

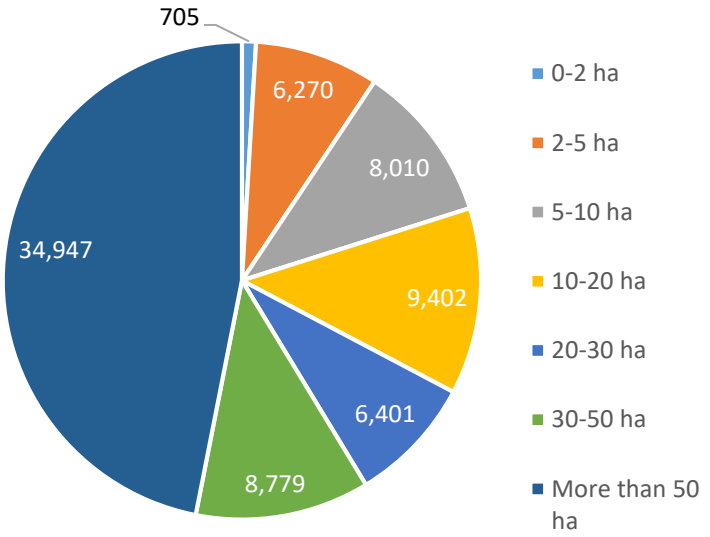


Figure 24 Number of enterprises in Klaipėda district municipality, according to their annual income in 2017; numbers on chart indicates overall hectares

1.5. Comparison of Alytus, Ignalina, Klaipėda and Šilutė district municipalities

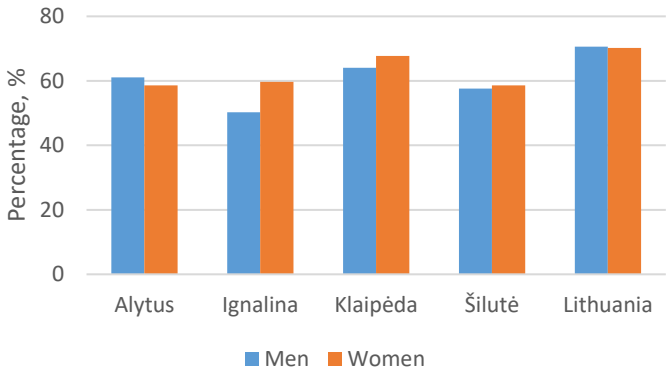


Figure 25 Employment level in different district municipalities and in Lithuania

While comparing these municipalities criteria such as population size will not be taken into consideration as it would only show the size of the municipality, as a percentage (of the overall number in that category) of various criteria that would be compared, so it would show the difference in these municipalities.

When evaluating the percentage of emigrants in 2017 from the overall population of a particular municipality it is clear that the greatest level of emigration came from the Šilutė DM (5.43%), the Ignalina DM (4.36%) is in second place, the Klaipėda DM (1.82%) in the third and the Alytus DM (1.62%) had the lowest emigration percentage. During 2017 the overall emigration from Lithuania was 1.68%. The employment rate was lowest in Ignalina municipality and none of these municipalities reached the employment level in all of Lithuania (Figure 25).

There are two major groups of branches in enterprises – mining, quarrying, manufacturing and wholesale and retail trade, repair of motor vehicles and motorcycle. In the Alytus district municipality these two branches are quite similar in employee percentage (a little over 25%), but in other municipalities the difference is greater (Figure 26). It is normal that the same branches received the biggest turnover in 2017 (Figure 27).

In 2017 within Alytus and Klaipėda district municipalities the biggest percentage of registered economic entities were in wholesale and retail trade, repair of motor vehicles and motorcycles. The same situation occurred in the whole of Lithuania. A different situation occurred in the Ignalina and Šilutė municipalities where other service activities registered economic entities asmore often registered (Figure 28). In all mentioned municipalities and in the whole of Lithuania the situation with the size of economic entities in operation in 2017 is quite the same (ranging from 59.56% to 66.31%), in all of them, the vast majority of economic entities contain 0-4 employees. Also, it is no surprise that the largest number of employees are concentrated in small enterprises. And this applies to all mentioned district municipalities.

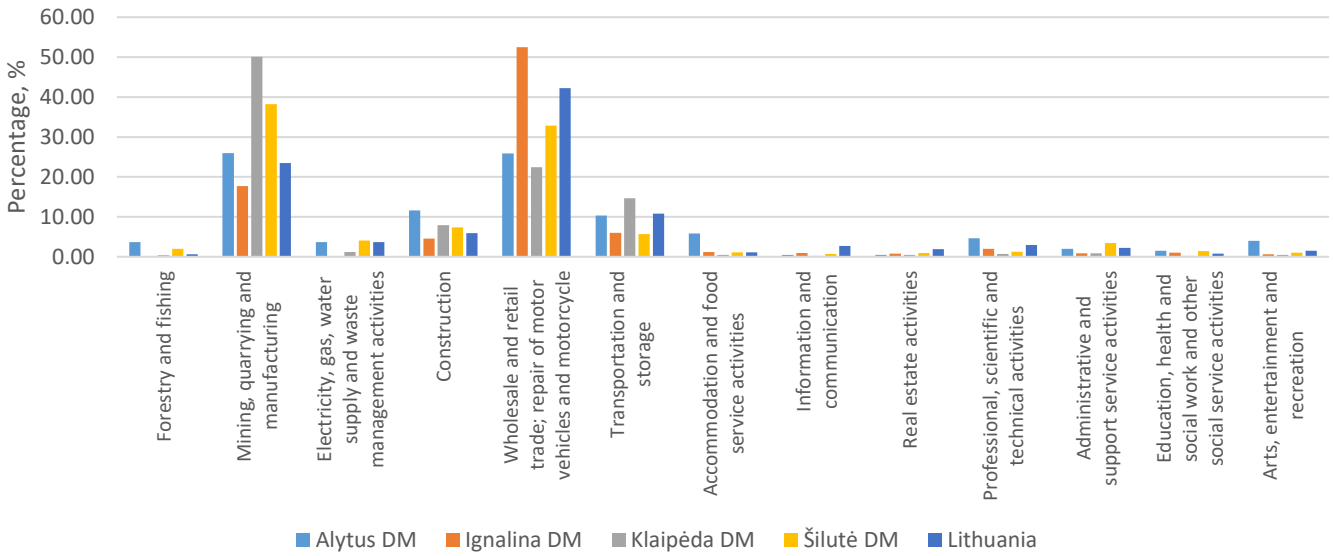


Figure 26 Percentage of people employed by place of activity in non-financial enterprises in Alytus, Ignalina, Klaipėda, Šilutė district municipalities and in Lithuania

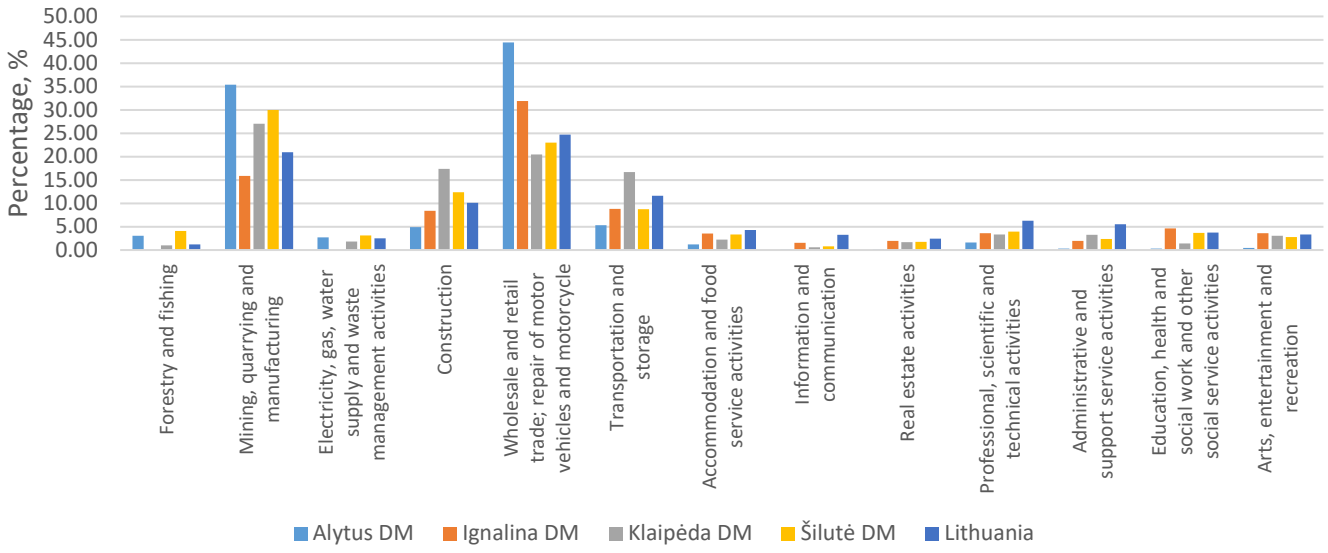


Figure 27 Turnover in non-financial enterprises by place of activity in non-financial enterprises in 2017 in Alytus, Ignalina Klaipėda, Šilutė district municipalities and in Lithuania

Comparing harvested area of agricultural crops, it is clear that the largest percentage of land within municipalities are used for grain crops. Though none of the discussed municipalities reach the percentage of overall Lithuania (20.10%). The smallest percentage (13.18%) of grain crops is in Šilutė district municipality. In Šilutė district municipality, it is way more popular to have meadows for hay and haylage, but the greatest percentage (16.85%) of meadows for hay is in the Ignalina district municipality. In these 4 municipalities, the percentage of meadows for hay and haylage is way higher than in overall Lithuania overall (Table 1). Arable land is the most popular by means of land use, except in Šilutė district municipality where there are more meadows, maybe because in this municipality there is a lot of areas that are seasonally flooded, while in other parts of Lithuania the situation is quite different.

Comparing the percentage of animals and poultry in these four municipalities there are some larger differences. The majority of animals in Šilutė district municipality are cattle (42.07%), while the average of Lithuania is only 5.83%. This might be one of the reasons or causes for the great abundance of meadows in this municipality. There is an exceptionally low percentage of pigs in Alytus district municipality (0.81%) while in other district municipalities it varies from 28.98% to 39.65%. The reason for this is because Alytus DM is within the African swine fever zone and the number of pigs is strictly regulated. So in Alytus DM poultry (94.41%) is more popular, especially hens (94.05%), while in Klaipėda DM – 29.56%, Ignalina DM – 20.03% and Šilutė DM – 19.58% (Table 2). In farmers 'and family farms in 2017 in all of Lithuania the greatest percentage of livestock was cattle (49.44%). A similar situation was observed in Alytus DM (49.19%), while the percentage is bigger in Klaipėda DM (63.39%) and Šilutė (55.54%) while in Ignalina DM it is lower (38.18%). In Ignalina DM sheep and goats takes up a great percentage (59.52%) of livestock.

Farms in described areas are usually 2-5ha of a size, second place is taken by farms that are 5-10 ha, although when looking to the amount of hectares, farms that are bigger than 50 ha are in the first place. As mentioned previously, part-time jobs in agriculture are the most popular amongst residents of all described municipalities and the overall situation in Lithuania is the same. The majority of farms are those where the main type of farming is field crops, although in Šilutė DM it is farming by grazing livestock (Figure 29).

Price for agricultural land in 2017 was quite different. Averagely 1 ha of arable land costs 3 571 €, in Klaipėda DM this price is higher in comparison to other municipalities – 3 336 €, and the lowest is in Ignalina DM – 1 385 €. 1 ha of permanent grassland in Lithuania costs 2 170 €, in Klaipėda DM this price is higher – 2 779 €, also in Alytus DM this price is higher than the average of Lithuania – 2 409 € and the lowest price is in Ignalina DM – 1 428 € (Figure 30). When evaluating the cost of rent 1 ha of arable land in Lithuania costs 124 €, the price of the rent in the discussed district municipalities are lower: Klaipėda DM – 106 €, Ignalina DM –

93 €, Alytus DM - 81€ and Šilutė DM – 39 €. The rent of a hectare of permanent grassland in Lithuania is 78 € and in other district municipalities: Klaipėda – 82 €, Alytus DM – 72 €, Šilutė DM – 59 € and Ignalina DM – 23 € (Figure 31).

Table 1 Percentage of agricultural crops (comparing to overall hectares of agricultural crops in particular area), according to hectares in Alytus, Ignalina, Klaipėda, Šilutė district municipalities and Lithuania in 2017

	Alytus DM	Ignalina DM	Klaipėda DM	Šilutė DM	Lithuania
Grain crops, %	17.43	15.45	17.75	13.18	20.10
Cereals, %	15.48	13.39	13.84	10.84	16.79
Meadows, hay, %	11.25	16.85	6.39	12.90	4.87
Meadows, green fodder, haylage, %	6.58	4.13	6.59	10.62	4.28

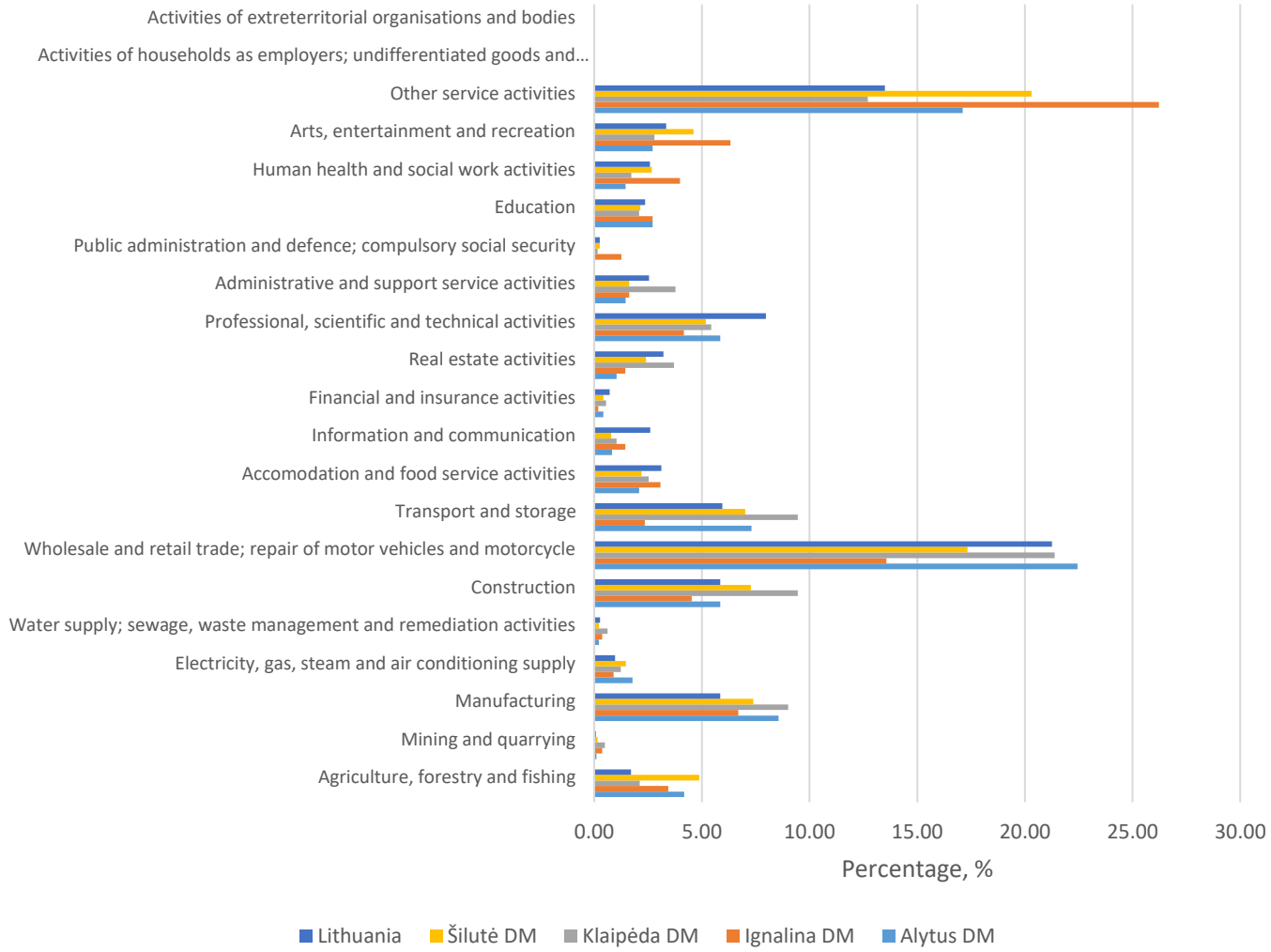


Figure 28 Percentage of registered economic entities at the beginning of 2017 in Alytus, Ignalina Klaipėda, Šilutė district municipalities and Lithuania

Table 2 Percentage of animals and poultry (comparing to overall animals and poultry numbers in particular area) in different municipalities and Lithuania in 2017

	Alytus district municipality	Ignalina district municipality	Klaipėda district municipality	Šilutė district municipality	Lithuania
Cattle, total	3.11	10.51	19.59	42.07	5.83
Pigs	0.81	39.65	36.16	28.98	5.57
Sheep	1.99	15.66	5.23	2.54	1.37
Goats	0.11	0.72	0.45	0.27	0.11
Horses	0.13	0.63	0.59	0.35	0.14
Poultry, total	94.41	20.03	29.56	19.58	84.77
Rabbits	0.81	5.94	5.37	3.92	1.09
Beehives (families)	0.43	6.87	3.03	2.28	1.12

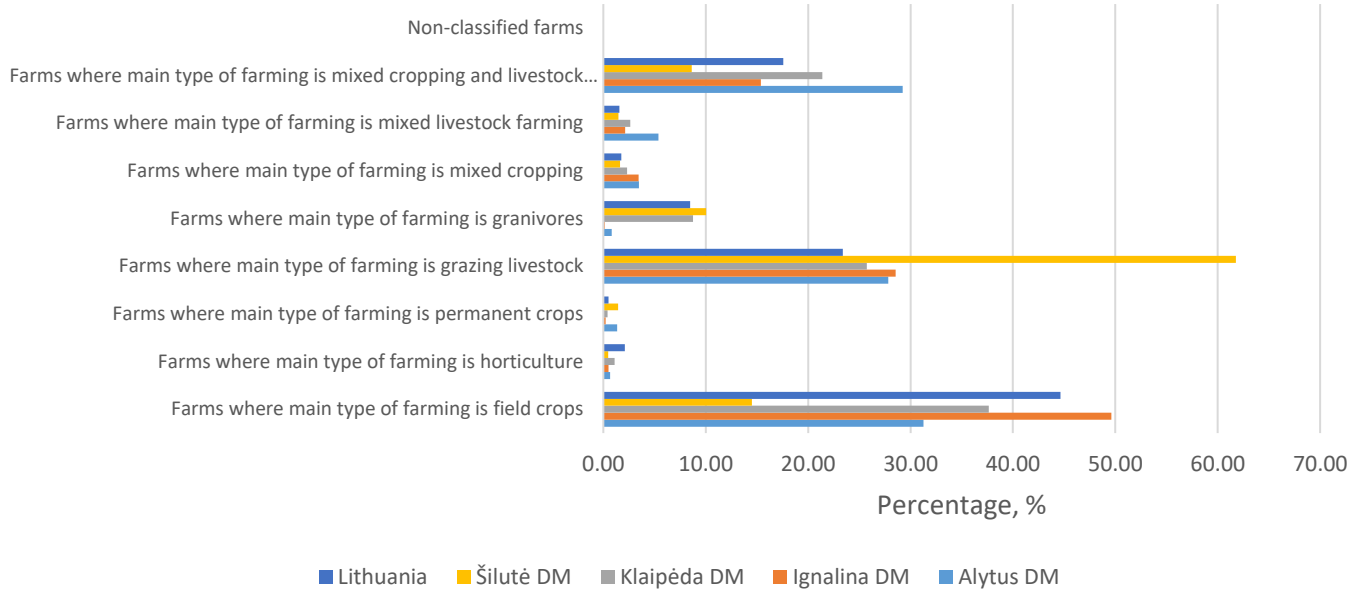


Figure 29 Percentage of standard agricultural production in Alytus, Ignalina, Klaipėda, Šilutė district municipalities and in Lithunia in 2017

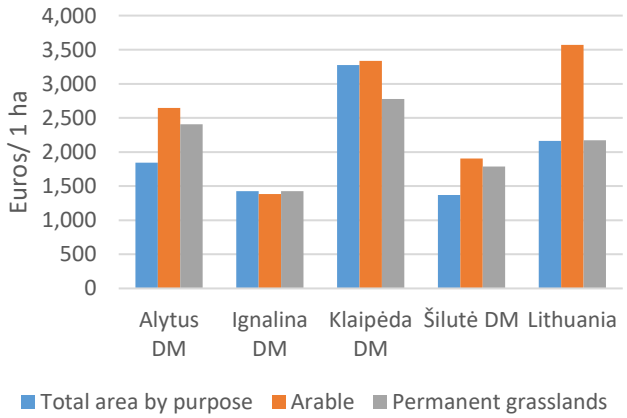


Figure 30 Prices of 1 ha of land according to their type in Alytus, Ignalina, Klaipėda, Šilutė district municipalities and in Lithuania

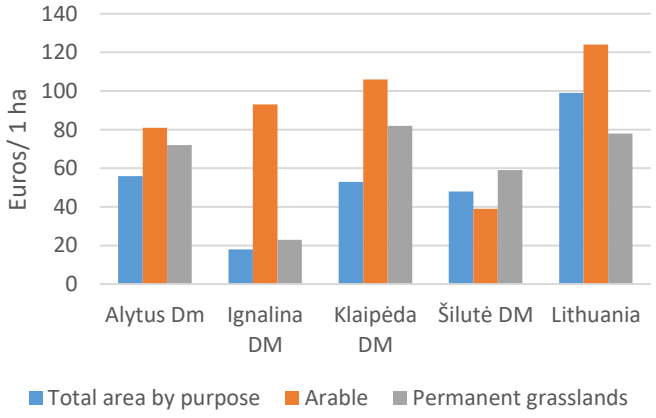


Figure 31 Prices of rent of 1 ha of land according to their type in Alytus, Ignalina, Klaipėda, Šilutė district municipalities and in Lithuania

2. Interviews of local residents, protected areas visitors and specialists

Data for this assessment was gathered by Baltic Environmental Forum specialists. 7 groups of people were questioned (Table 3): local residents of Žuvintas Biosphere Reserve, local residents of Apvardai area, local residents of Šyša and Sausgalviai, local residents of Tyrai area, environmental experts and biologists, agricultural specialists and protected area residents.

Interviews were conducted during the summer of 2018 – beginning of autumn. All questioned people were given the same questionnaires (Annex 1).

Table 3 Number of interviewed people in each group

Interviewed groups	Number of questioned people
Žuvintas Biosphere Reserve local residents	16
Apvardai area local residents	14
Šyša, Sausgalviai area local residents	20
Tyrai area local residents	13
Environmental experts and biologists	15
Agricultural specialists	17
Protected areas visitors	35

2.1. Results of interviews of Žuvintas Biosphere Reserve local residents

One third (31,25%) of questioned local people of Žuvintas biosphere reserve said that they are visiting the protected area every single day, meanwhile one fourth (25%) – very often and the rest of respondents (43,75%) stated that they visit the protected area rarely. 62,5% of questioned people pointed out the aesthetic value of the area, beautiful landscape, while 43,75% mentioned that they own some land in this particular area. One-fourth of respondents are displeased because of restrictions in the protected area. ne questioned person stated that this area does not mean anything special, another person reported that this is the area of his work and only one person mentioned that the area is important because of the great biological diversity. No other protected area's features were mentioned.

Half of the questioned people visit the area because they have to manage and take care of their property, 37,5% of people visit the area for cognitive purposes and one of them works there. 81.25% of respondents mentioned that they come to the area for recreational purposes (amateur fishing, picking berries and mushrooms) however none of them gets any significant financial profit while visiting the area. All questioned local people live averagely 2,19km away from the protected area.

According to the survey data (Figure 32), the local people of the Žuvintas biosphere reserve area, list as the most valuable ecosystem for the conservation of rare species, excluded forests and raised bog, also lakes and rivers were evaluated as important ecosystems. A large portion of the respondents (43,75%) distinguish these habitats as they are considered to be less affected by human activity and the quarter think that these habitats have high species diversity. One person mentioned pastures as important ecosystem as the meadows are grazed naturally and there is a benefit for humans and animals. Coastal shrubs were considered as the least valuable ecosystems when speaking about the protection of rare species.

43,75% local people knew at least one or more species of rare animals or plants. All of them mentioned rare animal species (White tailed sea eagle, Common crane, Black grouse, Aquatic warbler) and two people knew some rare plant species (mentioning that there are a lot of rare moss species and that there are rare species of *Gentiana* genus).

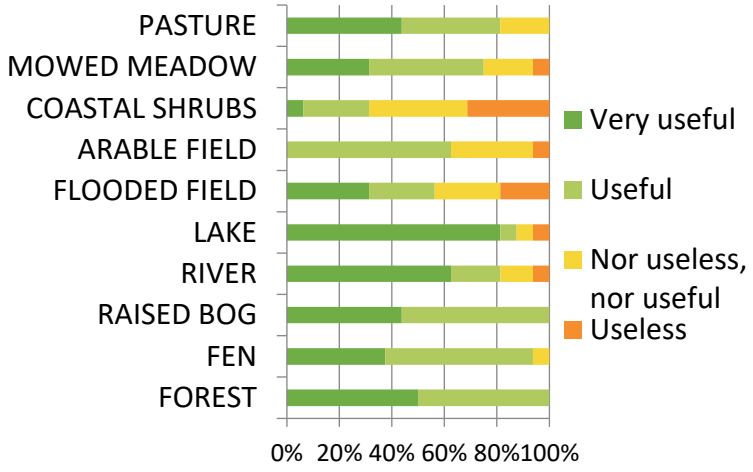


Figure 3**2** – How local residents of Žuvintas biosphere reserve area rate different habitat's significance in the context of protected species

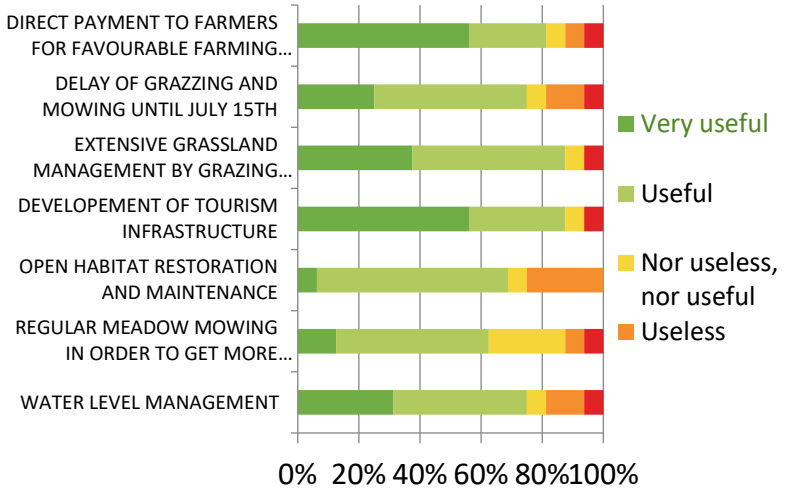


Figure **33** - How local residents of Žuvintas biosphere reserve area rate different environmental management measures significance in the context of protected species

Development of nature tourism infrastructure most times was evaluated as very useful amongst all given environmental management measures. Also, half of the questioned people evaluated support direct payment to farmers for favourable farming for rare species as a useful measure. All measures, except the recreation and management of open habitats, received at least one evaluation as "very useless", but the restoration and management of open habitats in general received more negative ratings than any other measure (Figure 33).

Below the aesthetic perception of the local residents is given. According to the data obtained, the respondents named the lakes (Figure 34b) as the most beautiful landscape, the second place is shared by forests (Figure 34a) and rivers (Figure 34c). The least appreciated are unmanaged, unattended meadows (Figure 34f).

93,75% of questioned local people said that they are farming in the area. The average agricultural area in these districts is 37.1ha (the largest area of agricultural land amongst the respondents is 150ha and the smallest – 3ha). All respondents said that they own some arable land (an average of 21.7ha, the maximum is 120ha, the minimum – 0,5ha). 81,25% of people told that they have mowing areas (average – 11.9ha, max. – 46ha, min. – 1ha) and 56,25% respondents in their territory is grazing animals (average – 12,8ha, max. – 46ha, min. – 1ha). Also, 86,67% of the respondents grow grain crops. More than half (66,67%) of the local people are engaged in the production of raw milk, while meat production is 26,67%. A large portion of questioned people (73,33%) produce hay and almost two thirds (60%) – haylage. 53,33% participate in RDP measures and the average size of declared areas is 16,1ha (biggest is 50ha, smallest – 2ha). Part of the respondents did not provide information on the programs and measures that they are involved, about half of the farmers indicated that they are involved in the Natura 2000 measure and only one person is involved in the protection of Aquatic warbler.

80% of the surveyed households have 1-3 people living in them, while the rest of them have 4-5 people. One-fifth of the local people said that the average monthly income per person in up to 100 euros, while 53,33% stated that it is 100-400 euros per person per month. 26,66% indicated that the average amount per person per month is 400-1000 euros. On average, slightly more than half (54,33%) of income is generated by agricultural activity, 26,66% of all respondents receive all income from agriculture, while other respondents receive part of their income from additional work.

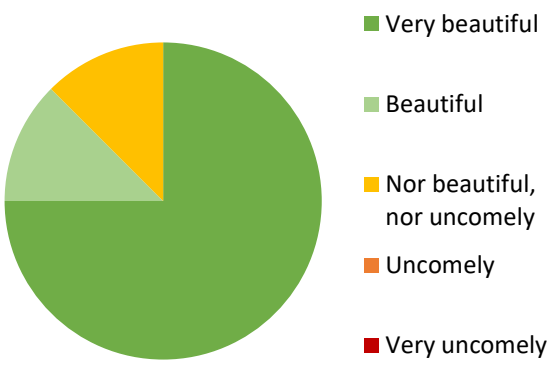


Figure 34a – Aesthetic perception of the image of forest habitat provided by local residents of Žuvintas project sites

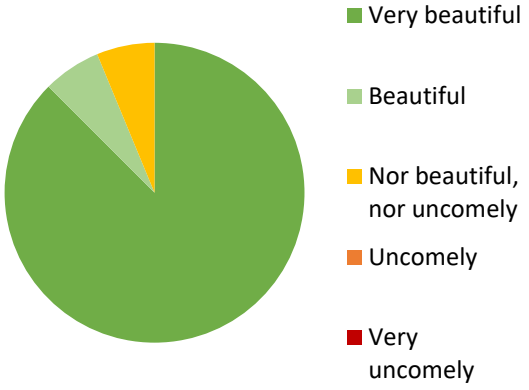


Figure 34b - Aesthetic perception of the image of landscape with lake provided by local residents of Žuvintas project sites

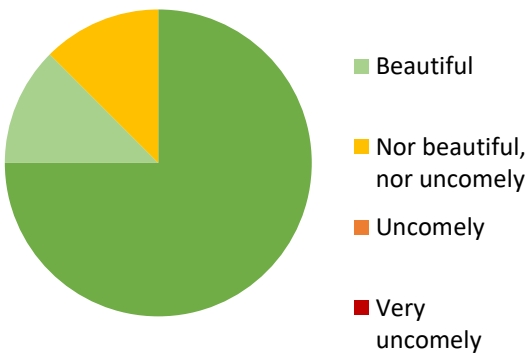


Figure 34c - Aesthetic perception of the image of landscape with river provided by local residents of Žuvintas project sites

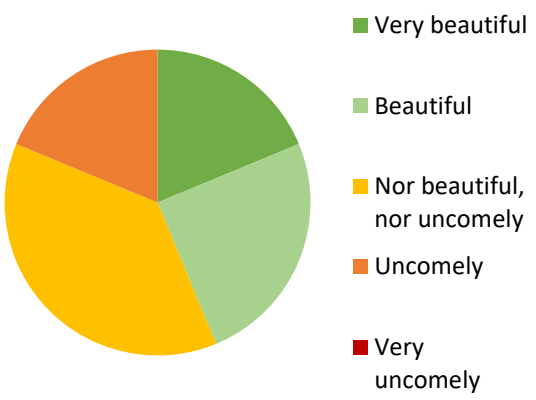


Figure 34d - Aesthetic perception of the image of forested marshland provided by local residents of Žuvintas project sites

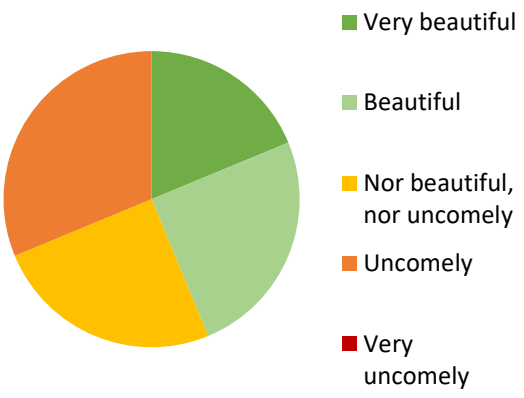


Figure 34e - Aesthetic perception of the image of open sedge dominated meadow provided by local residents of Žuvintas project sites

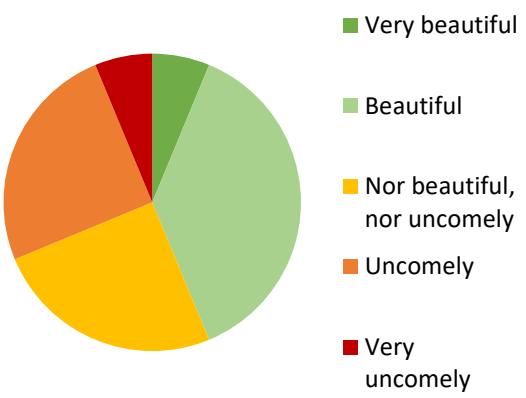


Figure 34f - Aesthetic perception of the image of partly overgrown fen provided by local residents of Žuvintas project sites

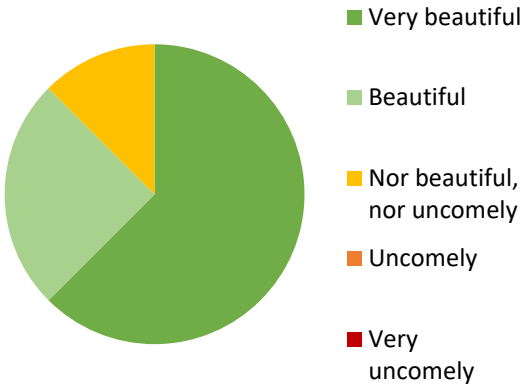


Figure 34g - Aesthetic perception of the image of extensive meadow management provided by local residents of Žuvintas project sites

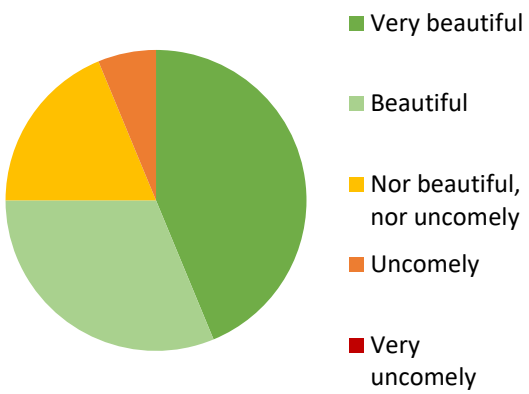


Figure 34h - Aesthetic perception of the image of intensive meadow management provided by local residents of Žuvintas project sites

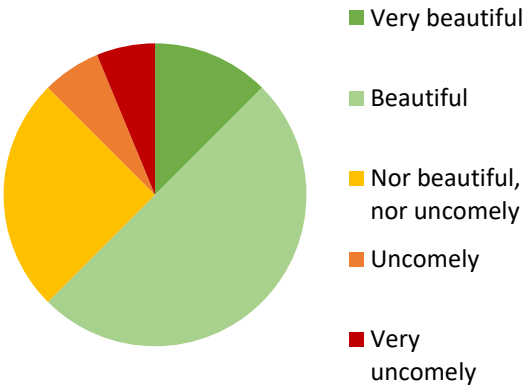


Figure 34i - Aesthetic perception of the image of open raised bog provided by local residents of Žuvintas project sites

2.2. Results of interviews of Apvardai area local residents

Nearly one third (28.57%) of the surveyed people from Apvardai and Ružas areas said that they visit protected areas very often, while half of the rest visit the area rarely and the other half do not visit it at all. 50% of respondents mentioned the aesthetic significance of this area. One respondent attaches great importance to this area since he grew up here and spent his childhood in this area. Also, 21.42% of respondents in general regard nature as an important subject and do not distinguish the specific meaning of this particular protected area.

42,85% of interviewed locals say that they are visiting the area for recreational purposes, while two residents live in the territory and only one person is visiting the area for cognitive reasons. Half of the respondents mentioned that they come to the area for amateur fishing, berry and mushroom picking, but none of them get any significant financial benefits when visiting the area.

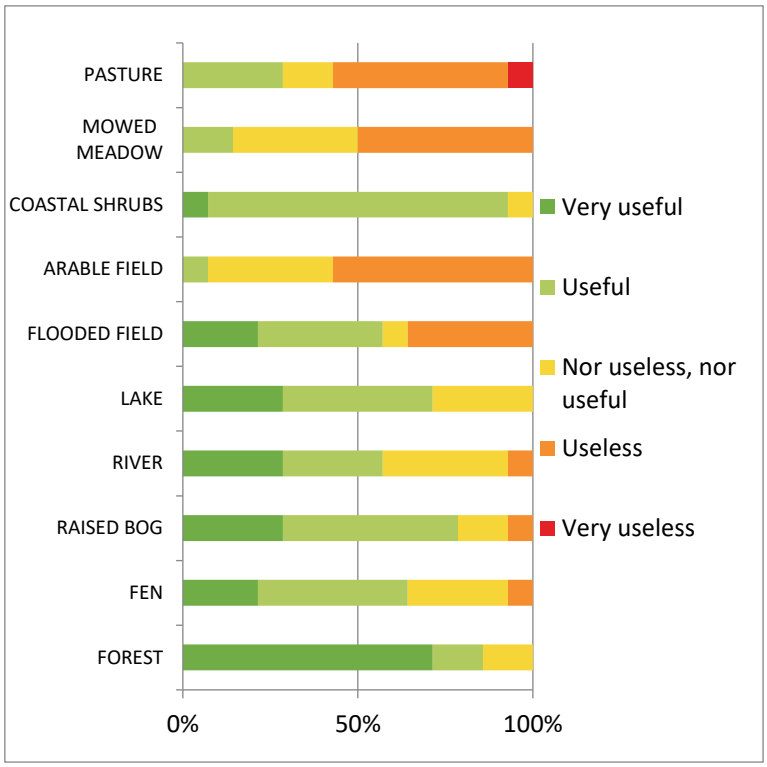


Figure 35 - How local residents of Apvardai area rate different habitat's significance in the context of protected species

According to the survey data (Figure 35), the interviewed people consider the forests to be the most beneficial ecosystem in the context of conservation of rare species. Even 71,43% of respondents rated this habitat as very useful and 42.85% based this opinion on the fact that humans are less involved with this habitat, while 28.57% think that there is a large variety of species. The least appreciated habitats were pastures, which they consider to be a habitat that is unsuitable for the protection of rare species.

Only one respondent mentioned rare or protected bird species (the Great Cormorant and the Great White Egret).

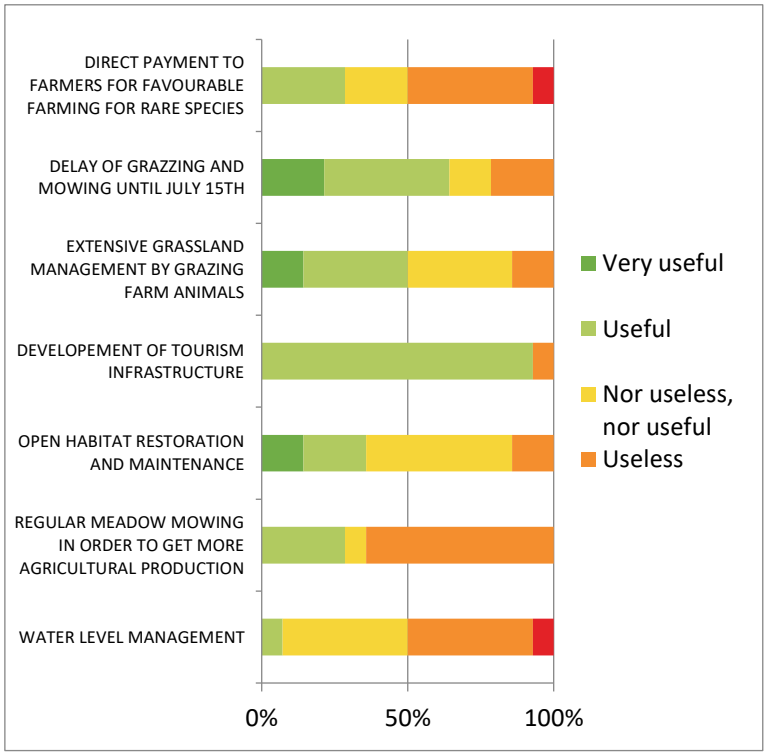


Figure 36 - How local residents of Apvardai area rate different environmental management measures significance in the context of protected species

The opinion of local people about nature management was quite different (Figure 36) and it would be difficult to distinguish one measure as the obvious leader, etc., in the context of the protection of rare species. Local residents seem to appreciate the extensive management of meadows by grazing animals (although pastures as ecosystem have been relatively poorly evaluated in the previous question), mowing and grazing delay and direct payments to farmers for protected species friendly farming were also evaluated quite well. The worst estimates were on water level regulation and regular mowing in order to get more agricultural production.

Below are the results of the assessment of the aesthetic perception of surveyed local people. According to the data, rivers (Figure 37c) were evaluated as the most beautiful landscape, in the second place were forests (Figure 37a), and in the third – lakes (Figure 2b). The least appreciated landscape – unmanaged, unattended meadows (Figure 37f).

28,57% of surveyed local people are engaged in farming. Half of them have arable land (an average of 0,35ha), and all farmers have mowing meadows (average – 5,27ha, min.- 1,8ha, max. – 14,8ha). None of the respondents own any land within protected areas. Only one farmer has dairy and beef cattle and all of the farmers mow and produce hay. None of the respondents are involved in RDP measures.

78,57% of the households consist of 1-3 people, 14,28% of 4-5 people and the rest (7.14%) – more than 5 people. 85.71% of the respondents said that on average one person per month receives 100-400 euros, one resident claimed that such income does not reach 100 euros. Also, one respondent said that this amount is 400-1000 euros. Two of the interviewed locals told that 10% of their income is generated by farming.

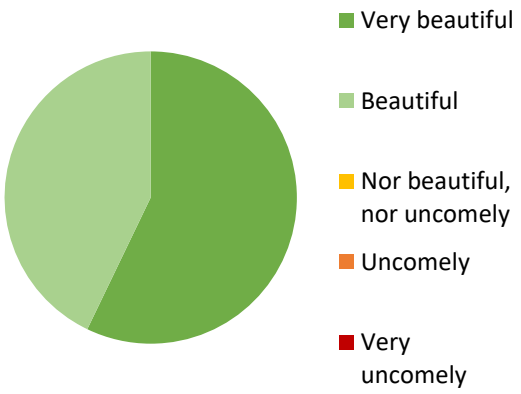


Figure 37a - Aesthetic perception of the image of forest habitat provided by local residents of Apvardai project sites

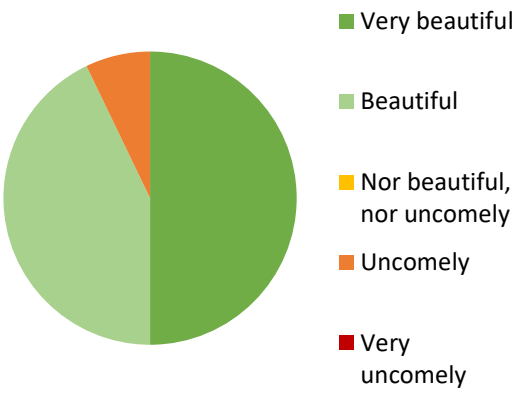


Figure 37b - Aesthetic perception of the image of landscape with lake provided by local residents of Apvardai project sites

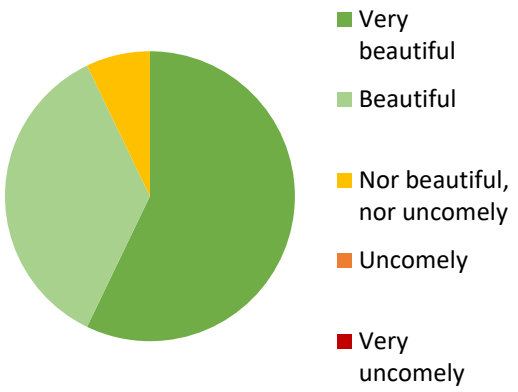


Figure 37c - Aesthetic perception of the image of landscape with river provided by local residents of Apvardai project sites

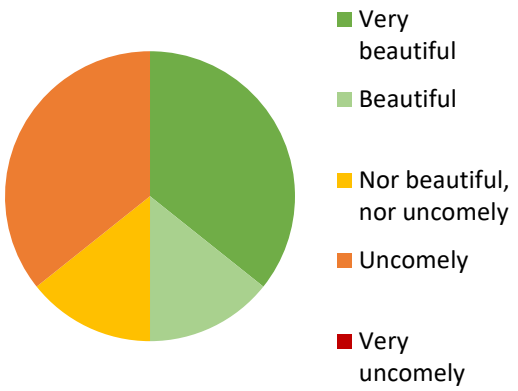


Figure 37d - Aesthetic perception of the image of forested marshland provided by local residents of Apvardai project sites

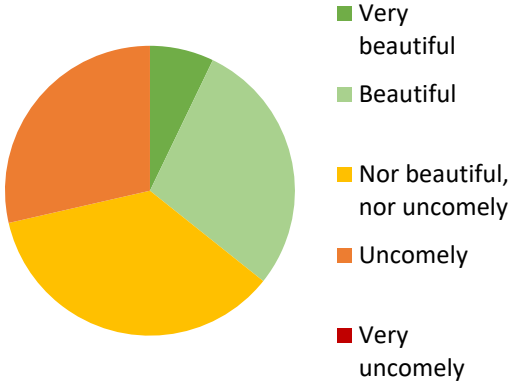


Figure 37e - Aesthetic perception of the image of open sedge dominated meadow provided by local residents of Apvardai project sites

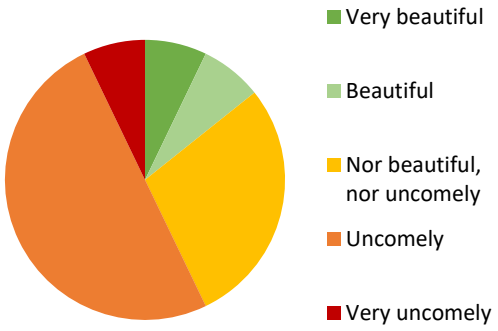


Figure 37f - Aesthetic perception of the image of partly overgrown fen provided by local residents of Apvardai project sites

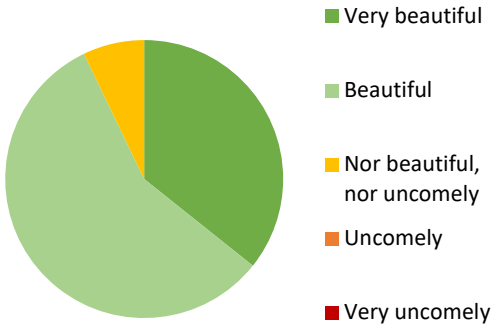


Figure 37g - Aesthetic perception of the image of extensive meadow management provided by local residents of Apvardai project sites

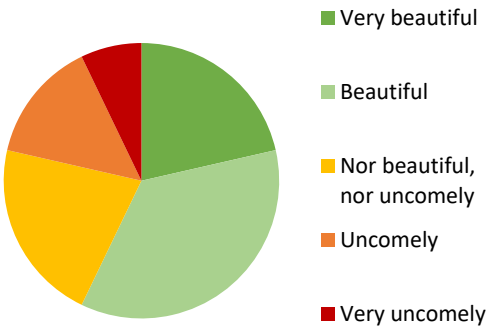


Figure 37h - Aesthetic perception of the image of intensive meadow management provided by local residents of Apvardai project sites

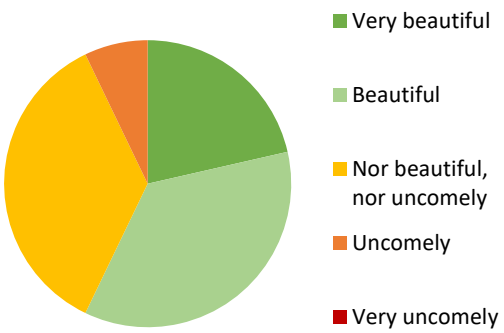


Figure 37i - Aesthetic perception of the image of open raised bog provided by local residents of Apvardai project sites

2.3. Results of interviews of Šyša, Sausgalviai area local residents

Half of the surveyed residents of Šyša/Sausgalviai visit protected areas very often or on a daily basis. 5% say they visit the areas averagely often, while the remaining 45% visits rarely. The majority (60%) of the interviewed local people distinguish the aesthetic significance of this protected area. One third (30%) of respondents highlighted a wide variety of species in this area, for 10% it is the area of lands that they own, for 5% it is their livelihood, and 5% mentioned this area as an important place for migrating birds.

40% of interview local people are farmers, 10% - lives here, 5% comes to the area for birding. 45% of respondents come to the area for recreation. Most of them come for amateur fishing, berry and mushroom picking, or to collect herbs. Only one respondent replied that they receive financial benefit from visiting the protected area, although – they didn't tell the exact amount. All interviewed people live on average 4.6 km from the protected area.

According to the survey data (Figure 38) the most important habitats, if speaking about protection of rare species, for local residents are raised bogs. Their choice was based on the fact that such habitats contain protected species of birds, as well as have good conditions for a large variety of species and only one person mentioned that these are habitats with the least interference from people. The lowest rating was received by coastal shrubs.

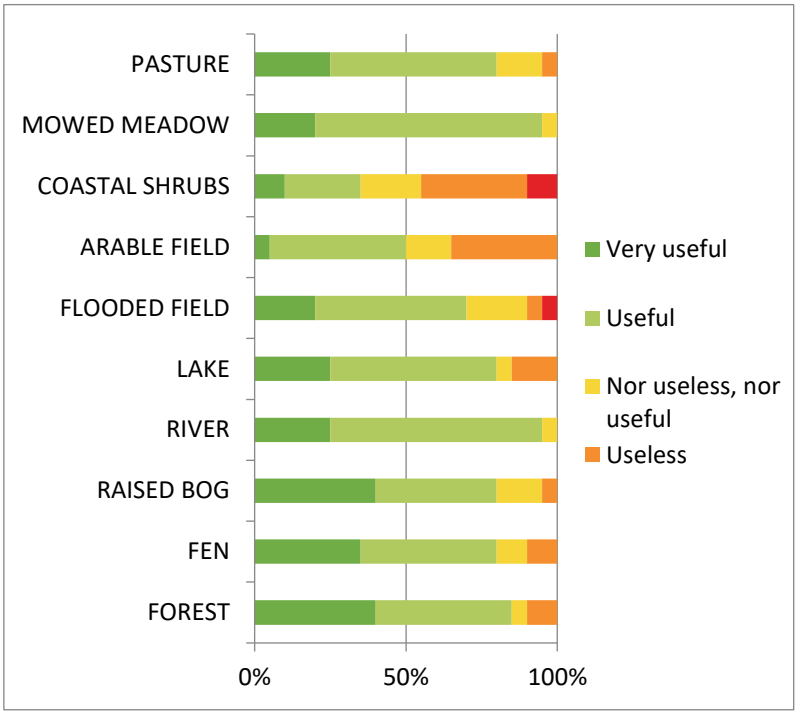


Figure 38 - How local residents of Šyša, Sausgalviai area rate different habitat's significance in the context of protected species

More than half (55%) of the surveyed people knew rare species and were able to name them. In all cases the aquatic warblers were mentioned, more often (20% of all respondents) mentioned the corncrake. 10% of the answers contained Spear-leaved Skullcap, 10% - the Great Snipe and 5% - Charadriiformes order in general.

Direct payments for farmers for protected species favourable farming, recreation and maintenance of open habitats, and water level regulation for interviewed local residents seemed like the most effective environmental management tools, when speaking about protection of rare species. The delayed mowing and grazing was evaluated the worst (Figure 39).

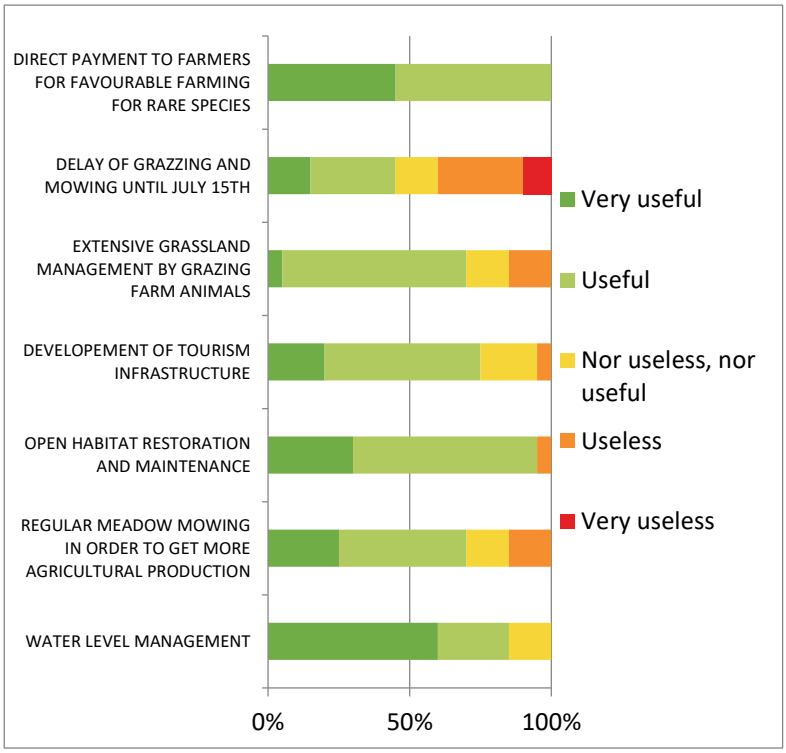


Figure 39 - How local residents of Šyša, Sausgalviai area rate different environmental management measures significance in the context of protected species

Further, we give the results of respondent's aesthetic perception. According to data obtained, the lakes (Figure 40b) were identified as the most beautiful

landscape, the forests (Figure 40a) were in second place and the rivers (Figure 40c) were in third place. Unmanaged and unattended meadows were evaluated the as the worst (Figure 40f).

In this area, 75% of respondents are engaged in farming. The average area of cultivated land is 72,58ha (from 0.7ha to 500ha). 16.6% of respondents have arable land with an average area of 38.7ha, all questioned farmers have mowing areas and 40% of respondents have pastures. All questioned farmers have land within the protected area with an average size of 55.93ha. One fifth has arable land in a protected area, 80% of farmers mow some areas that they own and 26.66% have pastures within the protected area. 15% of all respondents have dairy or beef cattle (from 1 up to 300). The majority of farmers produce fodder hay or haylage. 15% of farmers are engaged in the production of biomass for non-fodder grass that is used for composting or bedding. 55% of interviewed locals declare their land for RDP measures. The majority mentioned Natura 2000 and Aquatic warbler protection measures.

85% of respondents said that their household consists of 1-3 people, while the rest report 4-5 people. 5% of the respondents on average receive up to 100 euros per month per person, 65% say that it is 100-400 and the remaining 30% receive 400-1000 euros per person per month. 15% receive their whole income from farming, while half of the respondents receive at least part of their income from farming and the rest do not receive any income from farming.

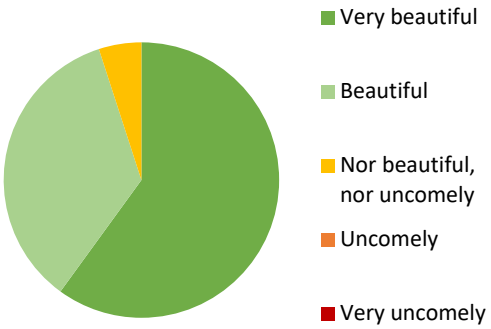


Figure 407a - Aesthetic perception of the image of forest habitat provided by local residents of Šyša, Sausgalviai project sites

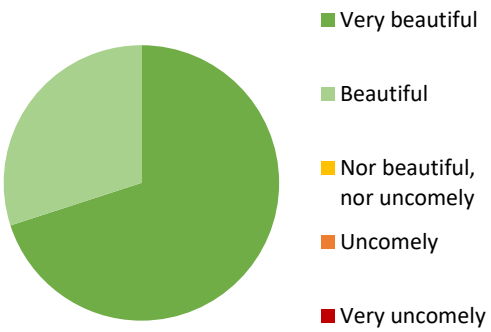


Figure 40b - Aesthetic perception of the image of landscape with lake provided by local residents of Apvardai project sites

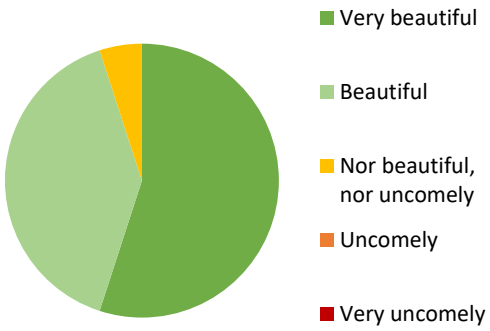


Figure 40c - Aesthetic perception of the image of landscape with river provided by local residents of Šyša, Sausgalviai project sites

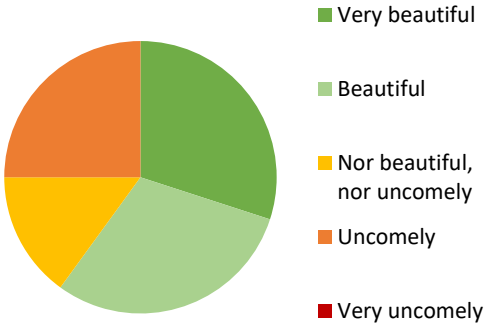


Figure 40d - Aesthetic perception of the image of forested marshland provided by local residents of Šyša, Sausgalviai project sites

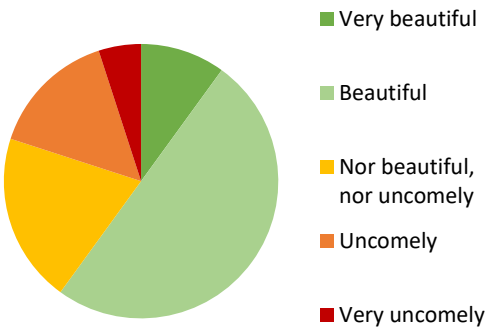


Figure 40e - Aesthetic perception of the image of open sedge dominated meadow provided by local residents of Šyša, Sausgalviai project

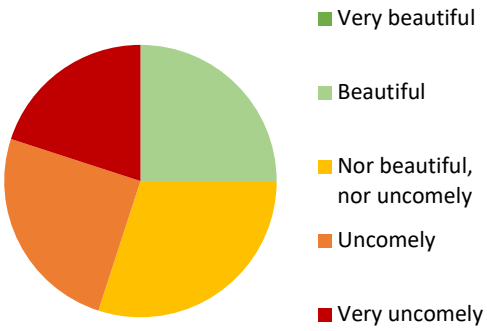


Figure 40f - Aesthetic perception of the image of partly overgrown fen provided by local residents of Šyša, Sausgalviai project sites

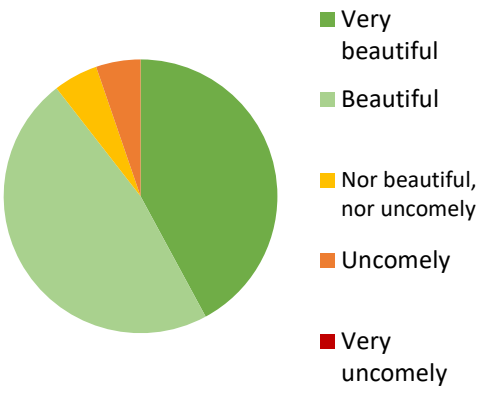


Figure 40g - Aesthetic perception of the image of extensive meadow management provided by local residents of Šyša, Sausgalviai project

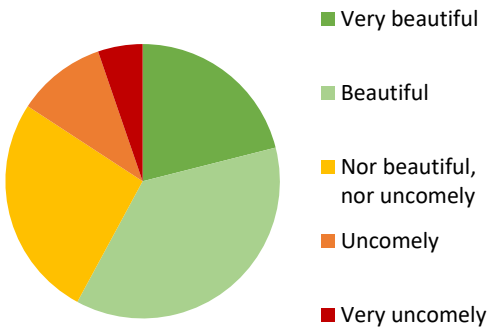


Figure 40h - Aesthetic perception of the image of intensive meadow management provided by local residents of Šyša, Sausgalviai project

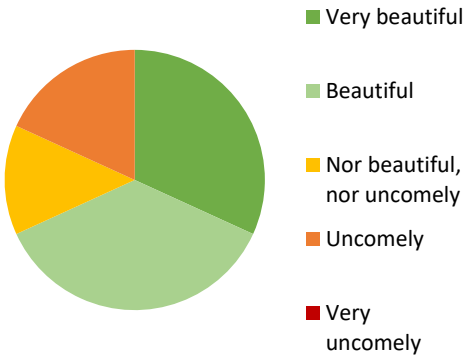


Figure 40i - Aesthetic perception of the image of open raised bog provided by local residents of Šyša, Sausgalviai project sites

2.4. Results of interviews of Tyrai area local residents

Surveying of the local residents of Tyrai area showed that 46.15% of them visit the protected area daily or very frequently. The same amount said that they rarely visit the area, and the rest 7.69% do not come at all. Most of the respondents (69.23%) indicated the aesthetic significance of this area. 15.38% said that this site is important as a wildlife protection area and 7.69% said that they own land (the same part said that this is the reason of visiting the area). 69.23% of interviewed local people visit the area for recreational (relaxation) purposes, and 15.38% - cognitive. 46.14% of the people indicated that they visit the area for recreational purposes and half of them like to fish here, and pickberries and mushrooms. No people receive significant financial benefit from visiting the protected area. All surveyed locals live on average 1.22km from protected area.

According to the survey data (Figure 41), people indicated that forests are the most useful habitats for protection of rare species (84.62% of respondents rated forests as "very useful", while the rest – "useful"). Some of them said that human activity is low in such areas, some of them told that there is a great variety of species in the forests, and a majority of people believe that all habitats are important. Meanwhile, arable fields have received the worst rating.

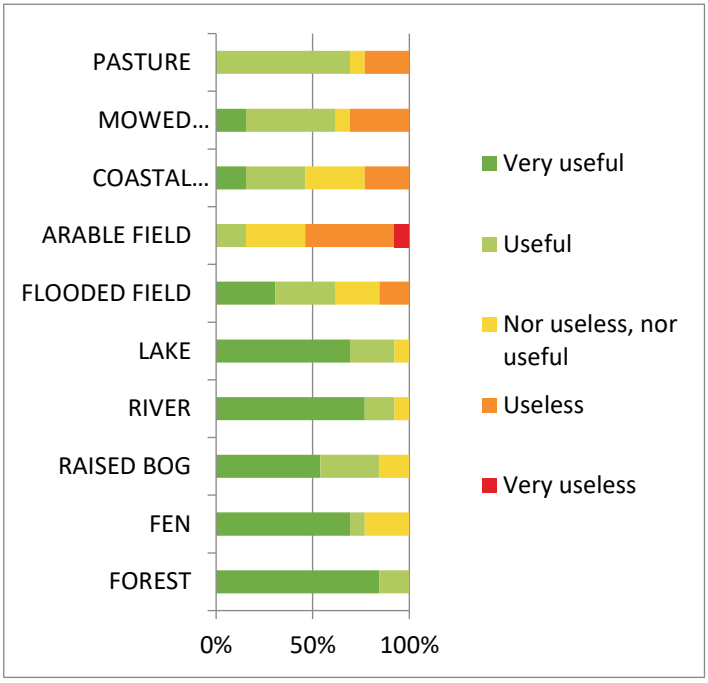


Figure 41 - How local residents of Tyrai area rate different habitat's significance in the context of protected species

Local people evaluated the development of natural tourism infrastructure in the context of conservation of rare species as the most favourable environmental management measurement. Direct payments to farmers for protected species friendly farming and delay of mowing and grazing was also evaluated well. Regular mowing in order to get more agricultural production was evaluated the worst. 30,76% of the respondents mentioned rare or protected species (half of them mentioned Aquatic warblers, the rest mentioned Common Cranes and Valerian).

Direct payment to farmers for favourable farming for rare species, delay of grazing and mowing, extensive grassland management, and development of tourism infrastructure were evaluated quite similarly and received the best rating as environmental management measures in the context of protection of rare species. Regular meadow mowing in order to get more agricultural production was rated the worst (Figure 42).

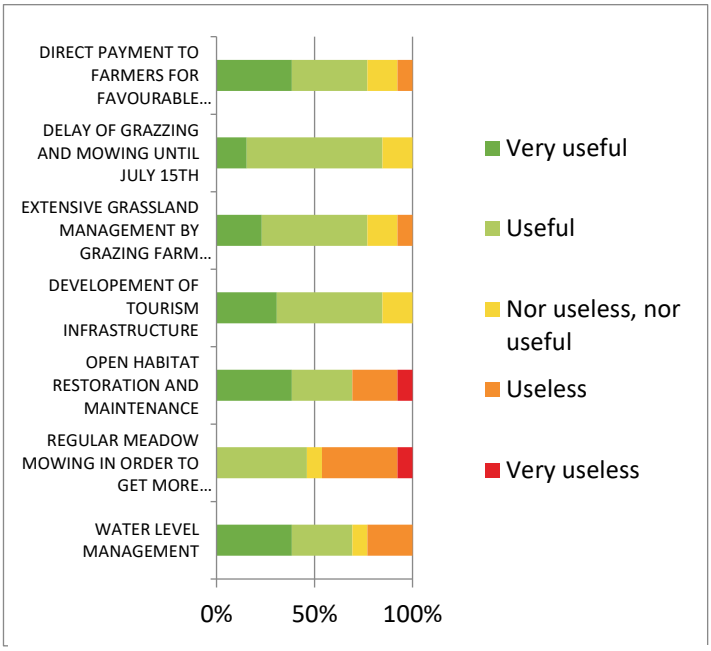


Figure 42 - How local residents of Tyrai area rate different environmental management measures significance in the context of protected species

In assessing the aesthetics of each habitat, the locals appreciated lakes (Figure 43b) the most, the second place was given to forests (Figure 43a) and the third – rivers (Figure 43c). As a visually least pleasing view was picked bogged and unmanaged forest (Figure 43d) and fields with still left haylage packages (Figure 43h).

About a third (30.77%) of the surveyed local people said that they are involved in farming. Two-thirds of farmers have arable land and half of the farmers have a mowing meadow. Only one person owns the land within the protected area and is only mowing there. All respondents that have arable land grow grain crops. None of the respondents have any cattle and do not declare their land for RDP measures.

84,62% of households consist of 1-3 people and the rest consist of 4-5 people. 7.69% of the respondents' average income in a given month per one person is less than 100 euros. From 100 to 400 euros per person per month receives 69.23% of households and the rest of them (23.07%) receive 400-1000 euros. Less than a quarter (23.07%) of respondents receive all their income from farming. The remaining part of locals receive income from other jobs.

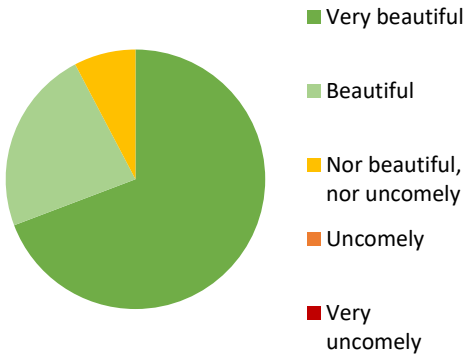


Figure **43**a - Aesthetic perception of the image of forest habitat provided by local residents of Tyrai project sites

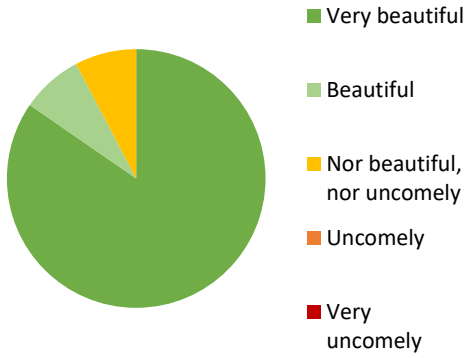


Figure 43b - Aesthetic perception of the image of landscape with lake provided by local residents of Tyrai project sites

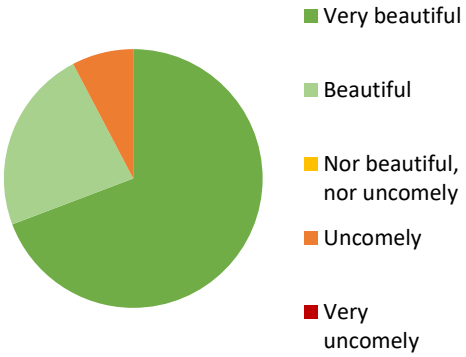


Figure 43c - Aesthetic perception of the image of landscape with river provided by local residents of Tyrai project sites

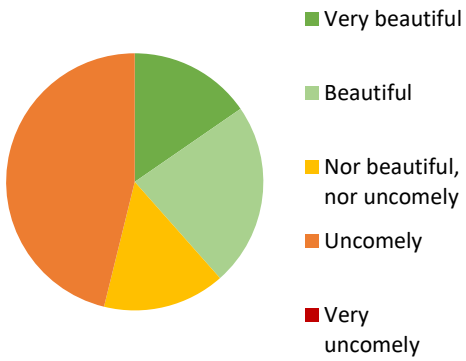


Figure 43d - Aesthetic perception of the image of forested marshland provided by local residents of Tyrai project sites

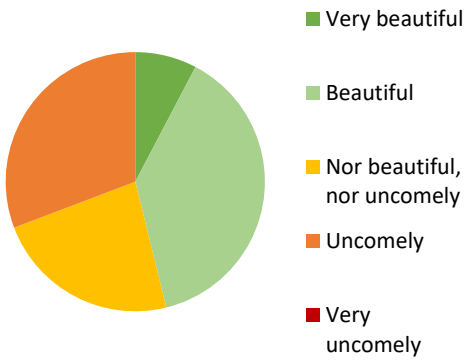


Figure 43e - Aesthetic perception of the image of open sedge dominated meadow provided by local residents of Tyrai project sites

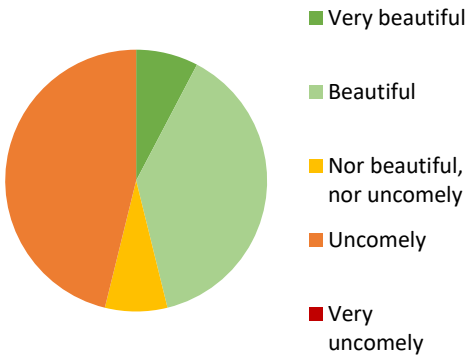


Figure 43f - Aesthetic perception of the image of partly overgrown fen provided by local residents of Tyrai project sites

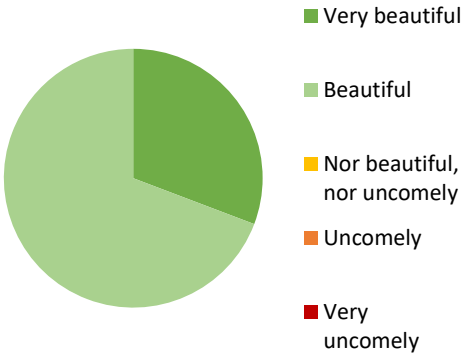


Figure 43g - Aesthetic perception of the image of extensive meadow management provided by local residents of Tyrai project sites

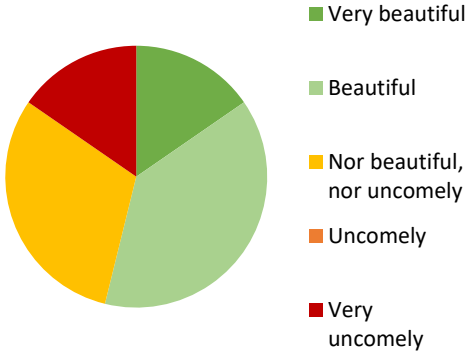


Figure 43h - Aesthetic perception of the image of intensive meadow management provided by local residents of Tyrai project sites

Figure 43i - Aesthetic perception of the image of open raised bog provided by local residents of Tyrai project sites

2.5. Results of interviews of environmental experts and biologists

40% of environmental experts visit the protected areas very often and the rest of the respondents visits these areas rarely. The majority of them mentioned that protected areas contain a great variety of regular and rare species, that it is important that such areas are protected because they have not only rare species but also rare natural habitats. A lot of environmental experts visit areas for work or research related reasons, some of the respondents come for recreational purposes like birding.

According to collected survey answers (Figure 44), it is visible that respondents consider flooded fields as the most favorable habitat in the context of protection of rare species and variety of those species. Also, significantly high results were given to forests, lakes, rivers, fens, raised bogs. A lot of respondents had the same opinion – all habitats are very important and a mosaic landscape is very important for a richness of species. The lowest rating was given to arable fields. All of the environmental experts mentioned and knew rare and protected species. Not only species were mentioned, but also rare and protected habitats.

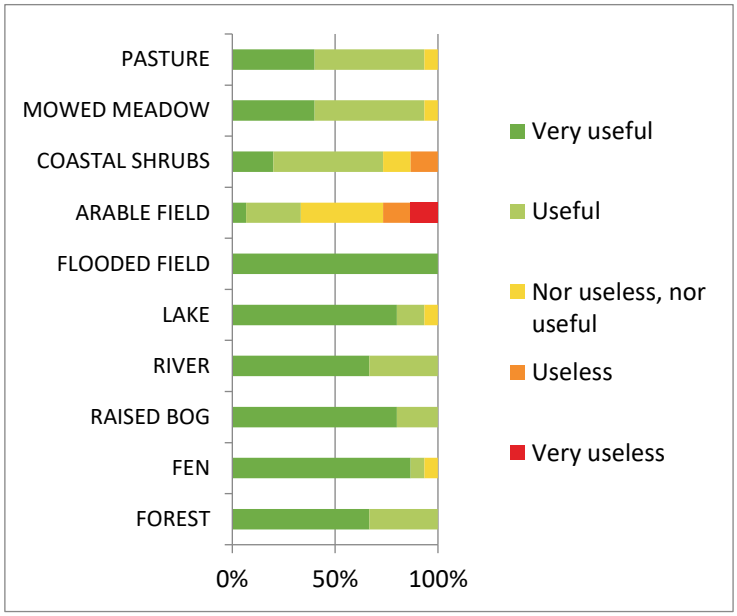


Figure 44 - How environmental experts and biologists rate different habitat's significance in the context of protected species

Extensive grassland management received the highest rating amongst all environmental management measures. Also, a quite good rating was given to direct payments for farmers for protected species friendly farming, extensive grassland management by grazing farm animals, open habitat restoration and maintenance. Regular mowing in order to get more agricultural production received the lowest rating (Figure 45).

In assessing the aesthetics of each habitat, the environmental specialists appreciated raised bogs the most (Figure 46i). The visually least pleasing view was bogged and unmanaged forest (Figure 46d) and fields with still left haylage packages (Figure 46h).

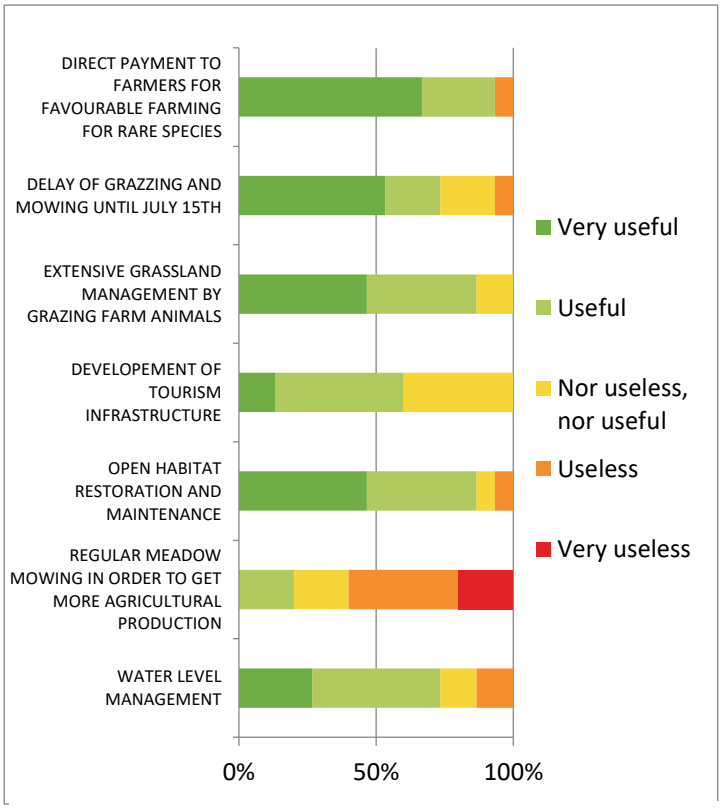


Figure 45 - How local residents of environmental experts and biologists rate different environmental management measures significance in the context of protected species

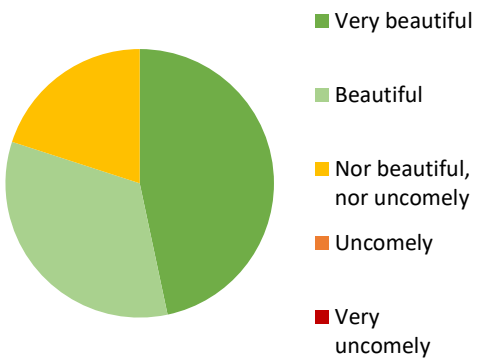


Figure **46**a - Aesthetic perception of the image of forest habitat provided by environmental experts and biologists

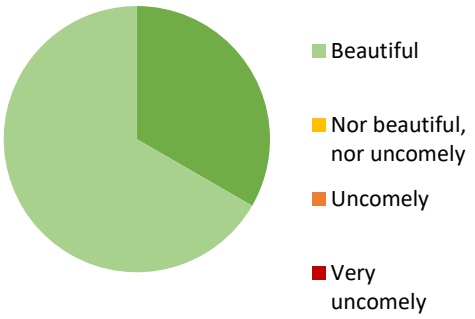


Figure 46b - Aesthetic perception of the image of landscape with lake provided by environmental experts and biologists

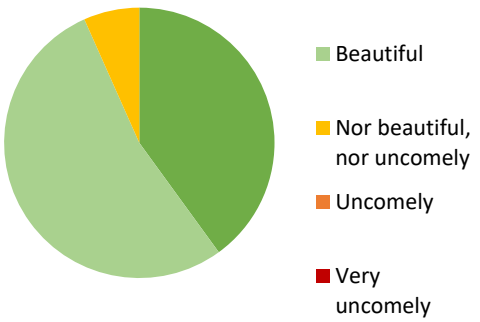


Figure 46c - Aesthetic perception of the image of landscape with river provided by environmental experts and biologists

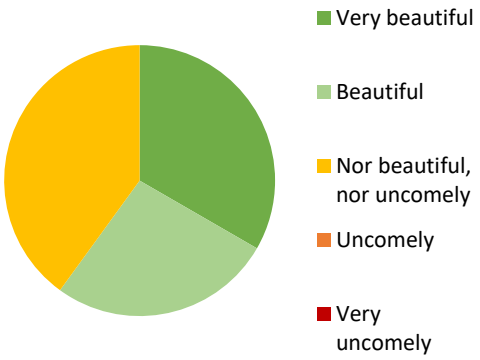


Figure 46d - Aesthetic perception of the image of forested marshland provided by environmental experts and biologists

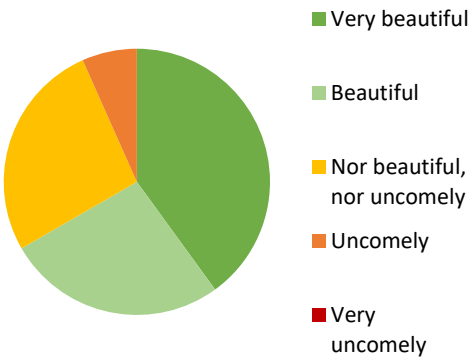


Figure 46e - Aesthetic perception of the image of open sedge dominated meadow provided by environmental experts and biologists

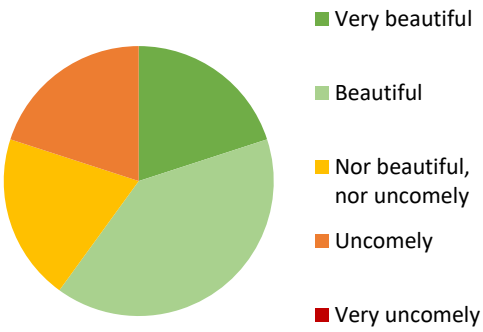


Figure 46f - Aesthetic perception of the image of partly overgrown fen provided by environmental experts and biologists

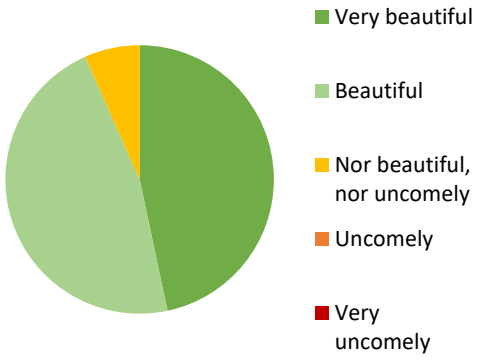


Figure 46g - Aesthetic perception of the image of extensive meadow management provided by environmental experts and biologists

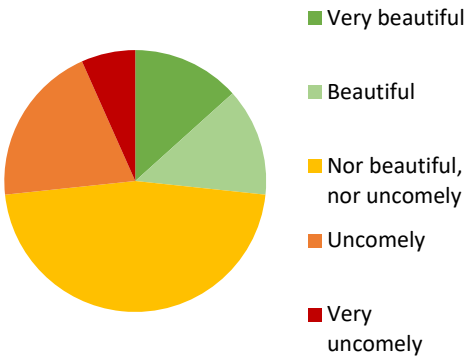


Figure 46h - Aesthetic perception of the image of intensive meadow management provided by environmental experts and biologists

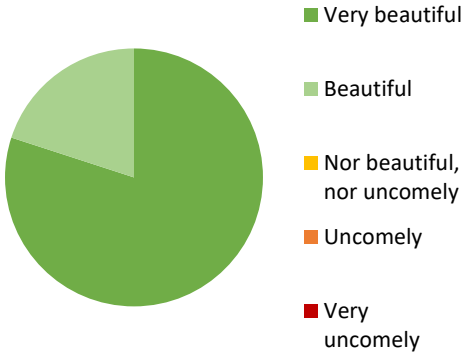


Figure 46i - Aesthetic perception of the image of open raised bog provided by environmental experts and biologists

2.6. Results of interviews of agricultural specialists

29,41% of surveyed agricultural specialists said that they visit one of the protected areas on a daily basis or very often, 58.82% - visit rarely and 11.76% do not come at all. The majority (64.71%) of answers contained answers that these areas have aesthetic meaning, for 41.18% respondents it was important that in these areas species that live there are protected, and that human activity is restricted so they can develop naturally. For 5.88% it is their workplace, the same amount told that they own land within those protected areas, and for the same amount of respondents, it was important that while visiting the area you can get a lot of information and for 11.76% it means the great variety of species. 58.82% of surveyed people told that they come for cognitive purposes, 29.41% - recreation and 11.76% come here to work.

According to survey data (Figure 47), agricultural specialists excluded forests, raised bogs, rivers, and lakes as the most valuable habitats in the context of protection of rare species. Coastal shrubs received the lowest rating.

Water level management was evaluated as the most favourable environmental management measurement in the context of protection of rare species and the regular meadow mowing in order to get more agricultural production was evaluated the worst (Figure 48).

When evaluating the aesthetic beauty of each habitat for agricultural specialists the most aesthetically pleasing habitats are lakes (Figure 49b) and forests (Figure 49a). The lowest rating was received by mowed meadows with haylage packages still left there (Figure 49h).

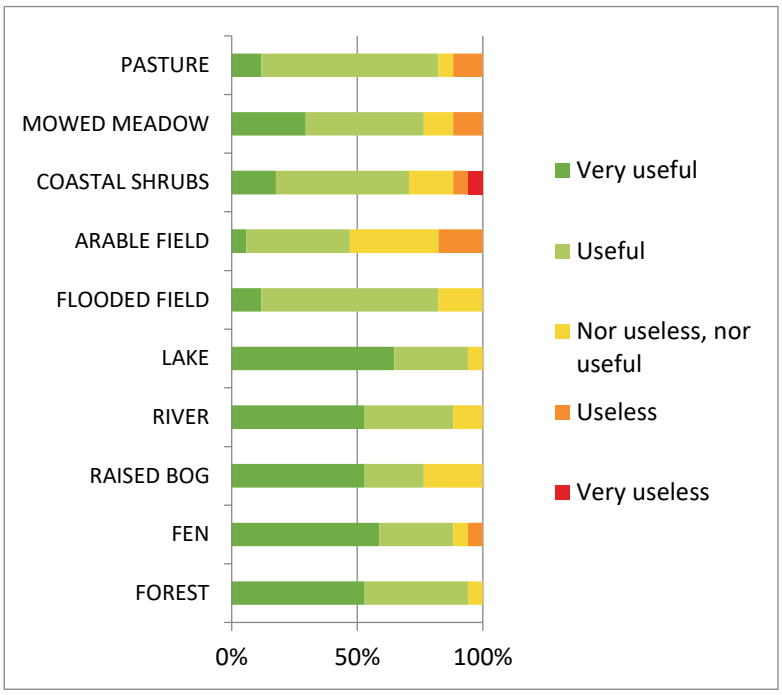


Figure 47 - How agricultural specialists rate different habitat's significance in the context of protected species

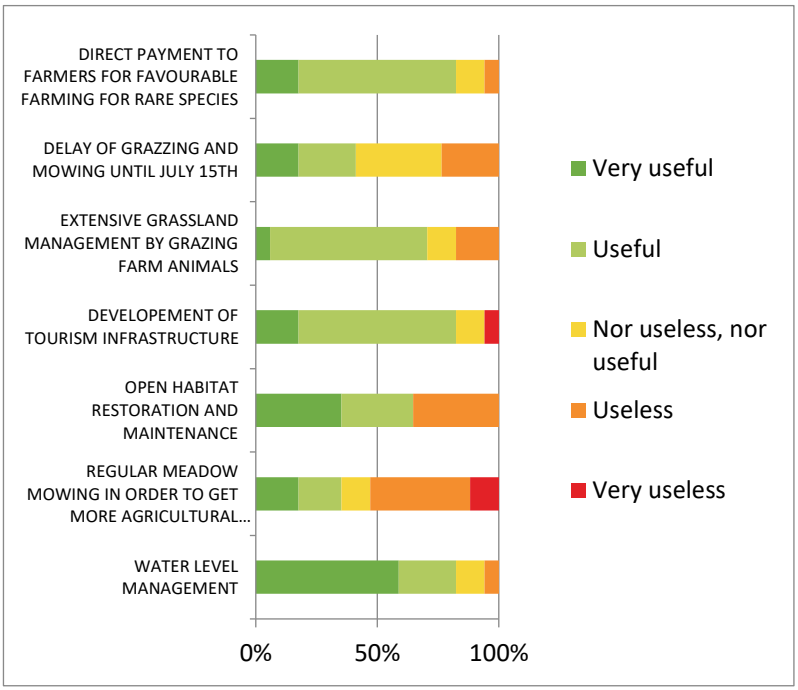


Figure 48 - How agricultural specialists rate different environmental management measures significance in the context of protected species

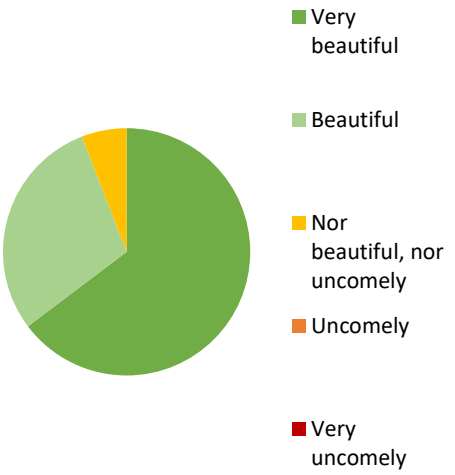


Figure **49**a - Aesthetic perception of the image of forest habitat provided by agricultural specialists

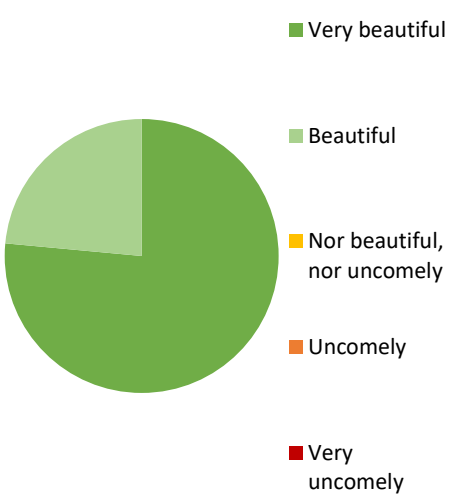


Figure 49b - Aesthetic perception of the image of landscape with lake provided by agricultural specialists

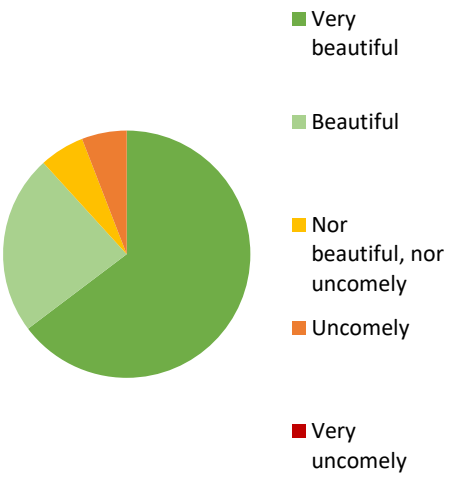


Figure 49c - Aesthetic perception of the image of landscape with river provided by agricultural specialists

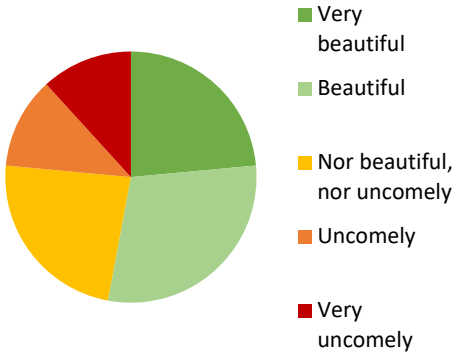


Figure 49d - Aesthetic perception of the image of forested marshland provided by agricultural specialists

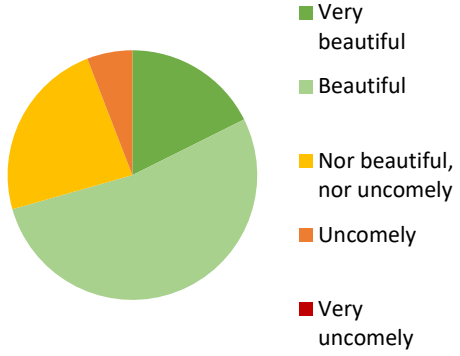


Figure 49e - Aesthetic perception of the image of open sedge dominated meadow provided by agricultural specialists

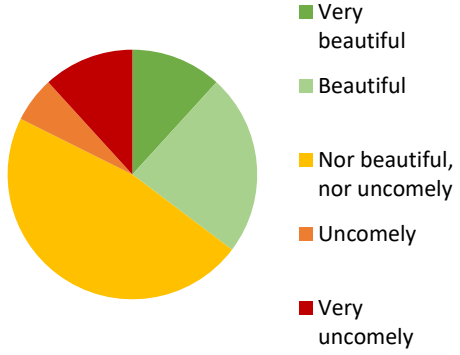


Figure 49f - Aesthetic perception of the image of partly overgrown fen provided by agricultural specialists

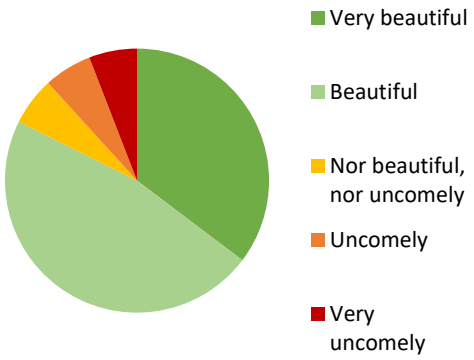


Figure 49g - Aesthetic perception of the image of extensive meadow management provided by agricultural specialists

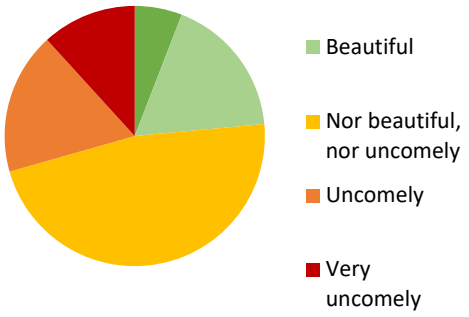


Figure 49h - Aesthetic perception of the image of intensive meadow management provided by agricultural specialists

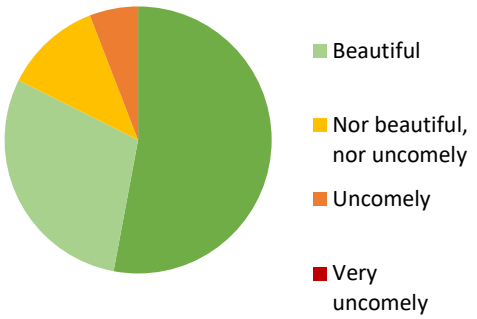


Figure 49i - Aesthetic perception of the image of open raised bog provided by agricultural specialists

2.7. Results of interviews of protected area visitors

5.71% of the surveyed protected area visitors come to one of the areas quite often, 8.57% visit one the areas fairly often, 74.29% - come rarely and 11.43% of surveyed visitors visited the area for the first time. The majority (62.86%) of visitors pointed out the aesthetic meaning of the area, 17.14% mentioned that there is a great variety of species, for 40% of visitors it was important that the area and species that live there are protected. For 14.29% of visitors a protected area means relaxing from civilization. Also, some people mentioned the importance of natural flooding, a vast variety of migrating birds, information that they can get while visiting such areas and the projects that are happening in protected areas. 25.71% of interviewed visitors come to the area for recreational purposes, while the rest – for cognitive reasons. Also, 28.57% of visitors mentioned that they like to pick berries or mushrooms while visiting the area or to go fishing.

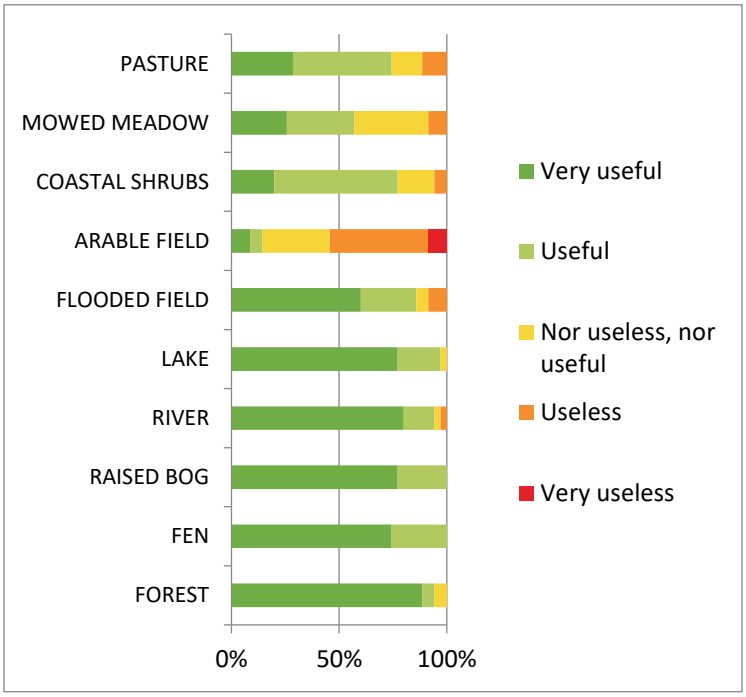


Figure **50** - How protected area's visitors rate different habitat's significance in the context of protected species

In protected areas the visitor's opinion the most important habitats, in the context of protecting rare species, are forests, fens, raised bogs and lakes. Some of them told that these are habitats where human activities are not very present, others told that there is a great variety of species and that conditions are favourable for that. Also, some visitors told that such areas are good for nesting birds. There was a lot of answers that all habitats are very important in nature. In the same context, arable fields were evaluated as worst habitat (Figure 50).

According to survey data, visitors evaluated delay of mowing and grazing until 15th of July as the most favourable environmental management measure in the context of protection of rare species. Regular mowing in order to get more agricultural production got the lowest ratings (Figure 51).

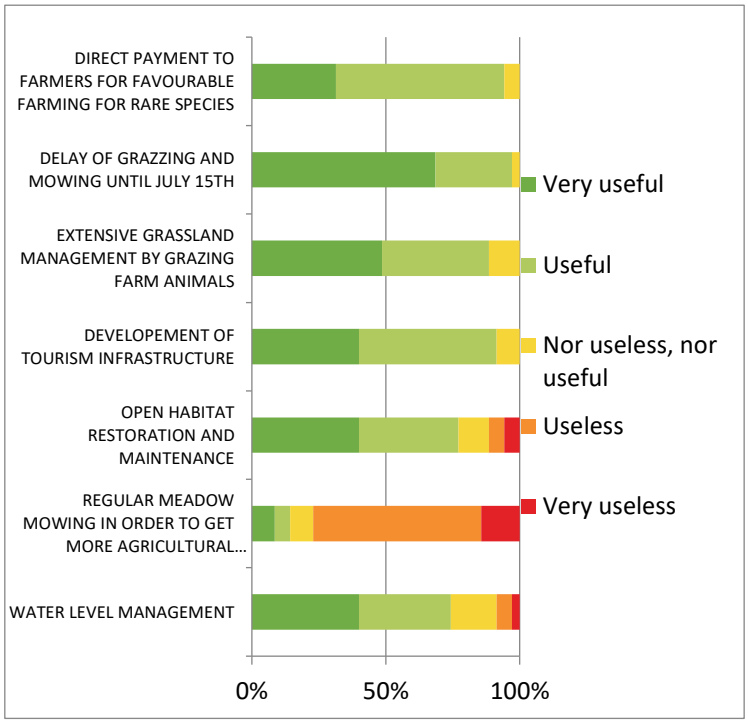


Figure 51 - How protected area's specialists rate different environmental management measures significance in the context of protected species

Further aesthetic perception of each habitat is given. As the most aesthetically pleasing habitats visitors excluded forests (Figure 52a), rivers (Figure 52c) and lakes (Figure 52b). Also, raised bog received quite good evaluation (Figure 52i). Least pleasing aesthetics for visitors were of mowed meadows with still left haylage packages (Figure 52h).

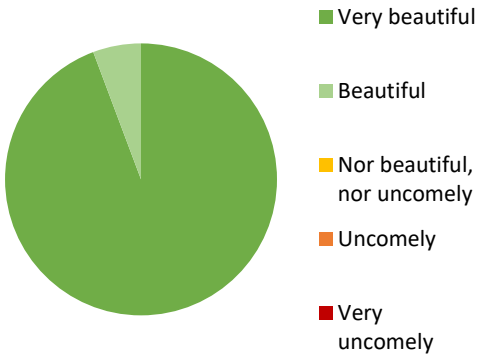


Figure **52**a - Aesthetic perception of the image of forest habitat provided by protected areas visitors

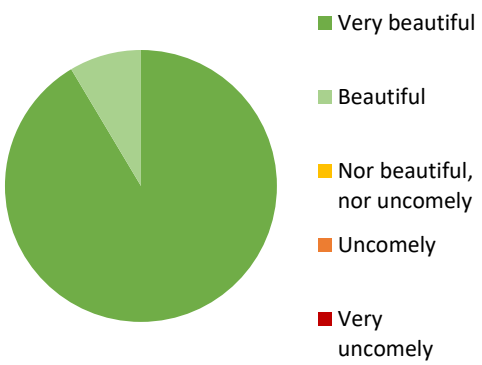


Figure 52b - Aesthetic perception of the image of landscape with lake provided by protected areas visitors

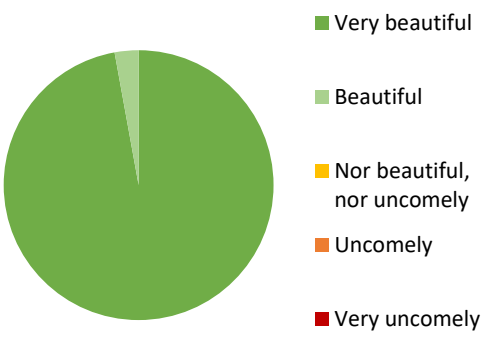


Figure 52c - Aesthetic perception of the image of landscape with river provided by protected areas visitors

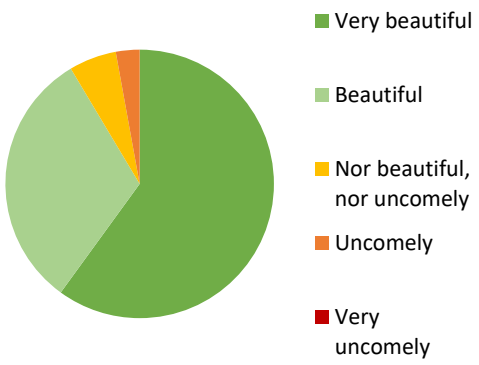


Figure 52d - Aesthetic perception of the image of forested marshland provided by protected areas visitors

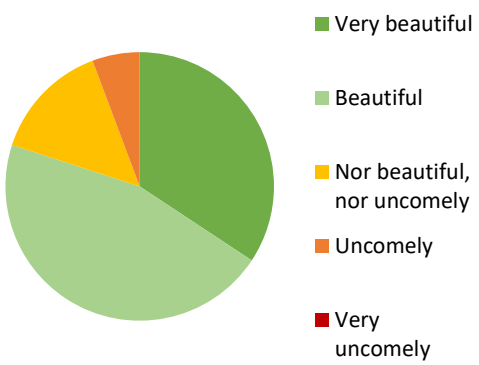


Figure 52e - Aesthetic perception of the image of open sedge dominated meadow provided by protected areas visitors

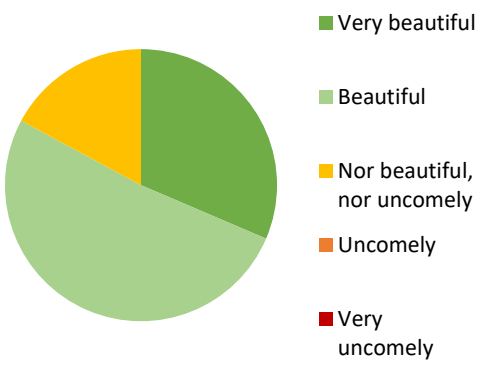


Figure 52f - Aesthetic perception of the image of partly overgrown fen provided by protected areas visitors

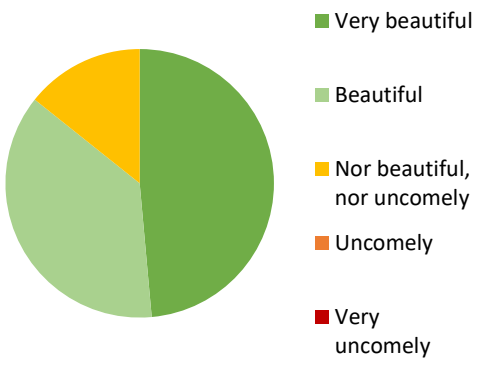


Figure 52g - Aesthetic perception of the image of extensive meadow management provided by protected areas visitors

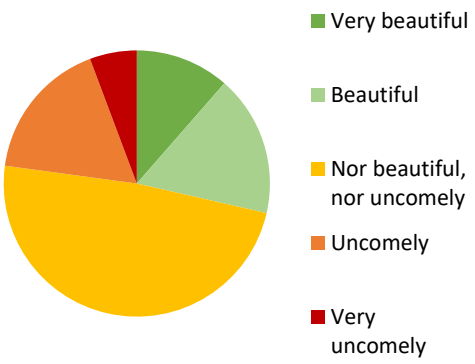


Figure 52h - Aesthetic perception of the image of intensive meadow management provided by protected areas visitors

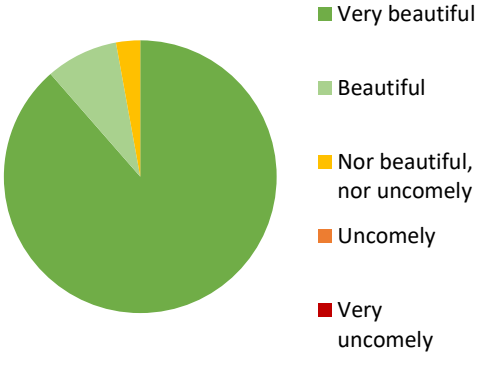


Figure 52i - Aesthetic perception of the image of open raised bog provided by protected areas visitors

2.8. Comparison of different questioned groups

Different groups of questioned respondents have to be compared in order to see the differences between them.

Speaking about the frequency of visiting the protected area it is clear that local residents of Šyša and Sausgalviai visit the area most frequently (50% of them visits the area every day). Tyrai is in second place. In Apvardai people are least interested in visiting the protected area. The majority of environmental experts and biologists visit the areas few times a year for monitoring, research. A little different situation is with agricultural specialists, because the majority of them are local residents, therefore they tend to visit these areas more often. A lot of protected areas visitors visit these areas rarely or even for the first time.

All four groups of local residents, agricultural specialists and visitors mention the aesthetic value of the area, while biologists and environmental experts – variety of rare species and the protection of them.

The majority of questioned local residents visit the area for recreational purposes (fishing, berry and mushroom picking). For visitors, these areas are important for relaxing, while all of the biologists and environmental experts come to these areas for research, birding and etc.

Agricultural experts and protected area visitors didn't know a lot about rare species. Šyša and Sausgalviai questioned local residents (55%) knew rare species in the protected area that they live nearby and quite a lot of people (43,75%) in Žuvintas mentioned rare species. All of the questioned biologists and environmental experts named rare plant and animal species and event rare natural habitats.

From the graphs given in Annex 2, it is clear that for all questioned groups forests are considered to be the most important habitats (in the context of protection of rare species) (Annex 2.1). Arable land was evaluated the worst (Annex 2.7). Also, an interesting situation is with the evaluation of flooded areas (Annex 2. 6). Biologists and environmental experts evaluated this habitat as very useful, while in other groups there were some conflicting thoughts.

Speaking about environmental management in the context of protection of rare species it is clear that opinions were very different (Annex 3). For example, water level management (Annex 3.1) was quite well evaluated by Nemunas delta's local residents but was quite badly evaluated by Apvardai local residents. Maybe in all questioned groups regular meadow mowing in order to get more agricultural production was evaluated the worst (Annex 3.2). Development of tourism infrastructure (Annex 3.4), extensive grassland management by grazing animals (Annex 3.5) and direct payment to farmers for rare species favourable farming (Annex 3.6) was evaluated quite similarly and it looks like it was evaluated the best by all questioned groups.

Aesthetics of different habitats for different groups were also different (Annex 4) because they tend to evaluate the aesthetics together with their pragmatical view and personal experience. For example – most conflicting opinions were on the aesthetics of raised bogs (Annex 4.9). For biologists and environmental experts this habitat is of a great aesthetic value, but this was not the case for evaluations received from questioned local residents as some of them viewed that area as some kind of bog where you can get lost. But all questioned groups evaluated forests (Annex 4.1), lakes (Annex 4.2), and rivers (Annex 4.3) as a very pleasing for the eyes. Quite bad evaluations from all questioned groups were received by unmanaged meadows, where shrubs and trees begin to grow (Annex 4.6).

Comparing groups of local residents, it is clear that agricultural activities are the most common among local residents of Žuvintas. 93,75% of questioned people in Žuvintas are engaged in agricultural activities. In Šyša and Sausgalviai – 75% and least in Apvardai – 28,57%. In Žuvintas arable land use is most popular, while in Apvardai and Šyša, Sausgalviai – mowing of meadows is most popular. Grazing livestock is popular in Žuvintas – 56,25% and in Šyša, Sausgalviai – 40%.

In all questioned groups the income generated by agriculture is not large and 26,66% people in Žuvintas, 15% in Šyša, Sausgalviai and 23,07% in Tyrai manage to live off agriculture, while rest of people do not participate in agriculture or hold other jobs to provide for their families.

3. Annexes

Annex 1 – Questionnaire for social survey and socio-economic data collection

With this survey we hope to get the information that will help us to evaluate informant's knowledge about open landscape habitats, management activities, their standpoint on its efficiency and impact for nature.

Informant's relationship with the object

1. How often do you visit **(object name)?** (insert your answer here)

.....
.....

2. What this object mean to you, why is it important? Please mention a few important points of this object. (insert your answer here)

.....
.....
.....
.....

3. On what purpose you are visiting this object? Are you coming for cognitive goals? (insert your answer here)

.....
.....
.....

4. Do you visit this territory for any recreational purposes (amateur fishing, picking berries, mushrooms, herbs)? (insert your answer here)

.....
.....
.....

5. Do you get any material benefit from visiting the area? What is it, excluding travel cost? (insert your answer here)

.....
.....
.....

6. How far away from protected area do you live? (insert your answer here)

.....

Assessment of the perception of environmental management benefits

7. What natural or human created and maintained ecosystems in your region do you consider to be the most important for rare species protection? Please, rate the ecosystems that are listed down below, mark only one score from 1 to 5:

a) Forest

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

b) Lowland moor

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

c) Raised bog

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

d) River

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

e) Lake

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

f) Flooded fields

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

g) Arable fields

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

h) Coastal shrubs

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

i) Mowed meadows

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

j) Pastures

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very useful

Explain, why you excluded these ecosystems as most important

.....

.....

.....

.....

.....

8. **Do you know any rare or protected species that lives in lowland moor or flooded fields? Maybe you know any natural habitats in here? Which ones, in your opinion, are the most important and needs more protection?**

.....

.....

.....

.....

.....

9. **How would you rate the importance and effectiveness (for species protection and function of habitats) of environmental management in open flooded field habitats? Please, rate the environmental management measurements that are listed down below, mark only one score from 1 to 5:**

a) water level management (flood water extraction, keeping stable ground water level during vegetation season):

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

b) regular meadow mowing in order to get as much agriculture production as possible:

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

c) **open habitats restoration and maintenance** (shrub and reed removal)

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

d) **development of natural tourism infrastructure** (informational stands, observation towers installation and etc.)

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

e) **extensive grassland management by grazing farm animals** (when grazing begins from May in compliance with requirement to graze from 0,3 to 1 animal in 1 hectare)

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

f) mowing and grazing beginning delay until July 15d.

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

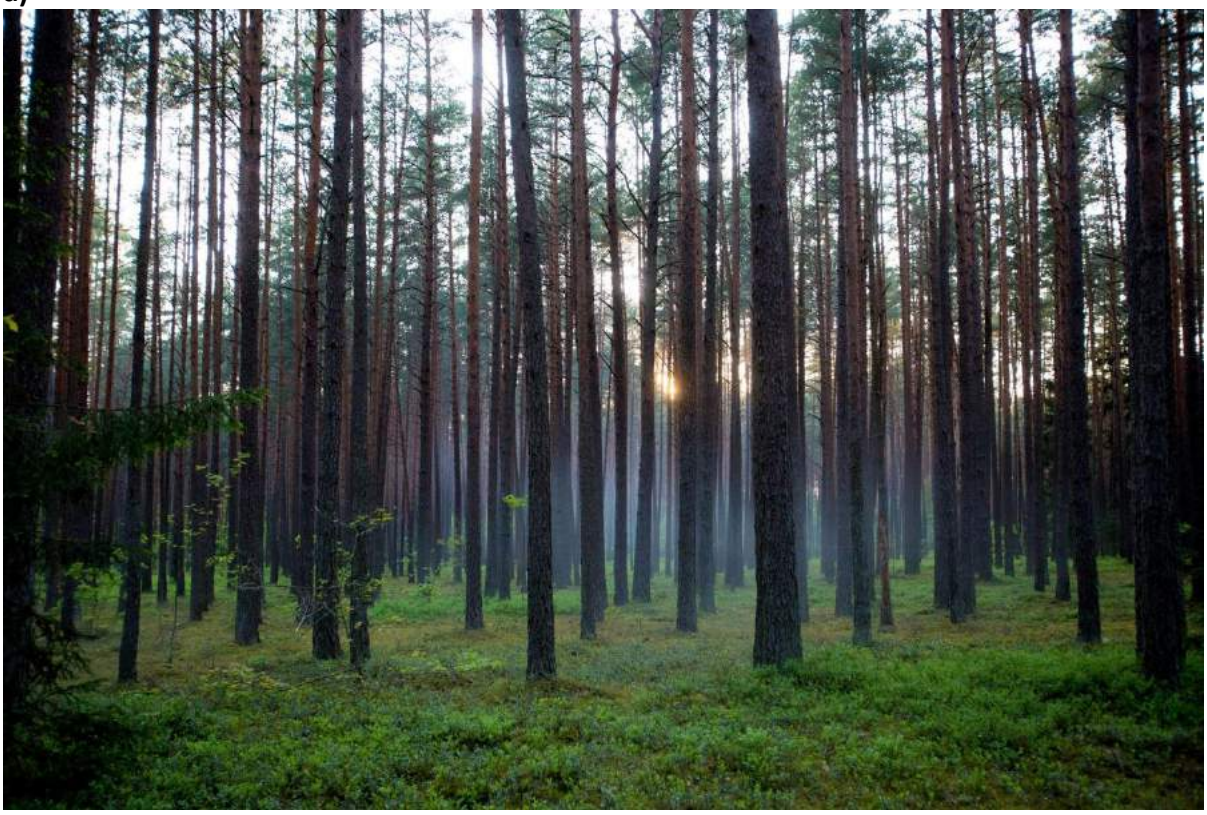
g) direct payment to farmers for favourable farming for rare species

1 – very useless, 2 – useless, 3 – nor useless, nor useful, 4 – useful, 5 – very

Evaluation of aesthetic perception

10. Please carry out the rating of given landscapes, give every picture a score from 1 to 5:

a)



1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

b)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

c)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

d)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

e)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

f)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

g)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

h)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

i)

1 – very uncomely, 2 – uncomely, 3 – nor beautiful, nor uncomely, 4 – beautiful, 5 – very beautiful

Questions only for local people, who own agricultural land

11. **What is the size of agricultural land that you own** (write down……. ha)? From them: a) arable land……. ha, b) mowing meadows…….ha, c) pastures……ha, d) other (what and how many ha)

.....

12. **What is the size of agricultural land that you own in protected area**?…….. ha

    From them: a) arable land……. ha, b) mowing meadows…….ha, c) pastures……ha, d) other (what and how many ha)

    .....

13. **What kind of agricultural activity do you carry out in those areas? (you can point out more than one activity):**

a) I keep dairy cattle;
b) I keep beef cattle;
c) Number of grazed livestock (how many and what kind of cattle you have):
.....
d) I make fodder;
e) Other (insert answer here)
.....

14. What kind of products you produce (you can point out more than one product):

a) Raw milk;
b) Meat;
c) Hay;
d) Silage hay;
e) Don't make any product;
f) Grass biomass that is not sustainable for fodder, that is used for compost or bedding;
g) Grass biomass that is not sustainable for fodder, that is sold for processing;
h) Other (insert your answer).....

15. Do you participate in rural development measures?

1) Yes

a) RDM declared area of land ……. Ha

b) Programs and measurements that you are involved in

.....

.....

.....

2) No

Insert your answer why you do not participate

.....

.....

16. If you do not carry out any agricultural activities, then why you do not do it and in what area (Insert answer here):

.....

.....

17. Information about household (people living in one house with total budget) composition, income and sources of income:

1) Number of people living together (select one answer):

a) 1-3; **b)** 4-5; **c)** more than 5. The number of people among them under the age of 18 years: ..... .

2) Average income per month per person (select one answer):

a) less than 100 €; **b)** 100-400 €; **c)** 400-1000 €; **d)** more than 1000 €.

3) Indicate which portion of the household income is generated by the income from the agricultural activities: ..... proc.

Data about informant

Gender F/M
Profession (insert your answer here)
.....

Do You visit/work [in object/protected area] for professional purpose? (select one answer)
Yes No

Education (select one answer)

- **a)** Unfinished secondary education
- **b)** Secondary education
- **c)** High non-University education
- **d)** Higher education (University)

Where do you live (select one answer)
Village / city

Write the name of a place that you live in

.....

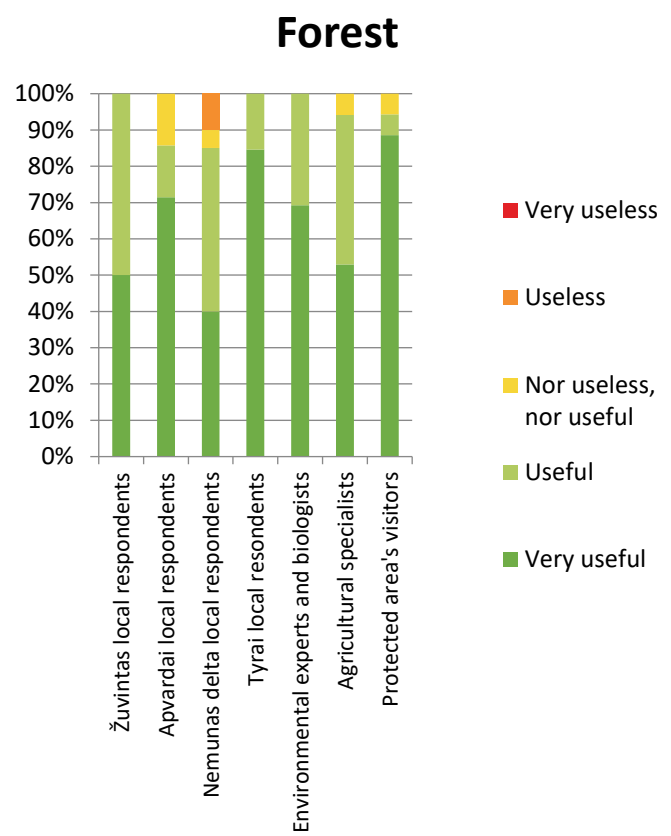
Age:

a) 18-25; b) 26-35; c) 36-50; d) 51-65; e) 65 and more.

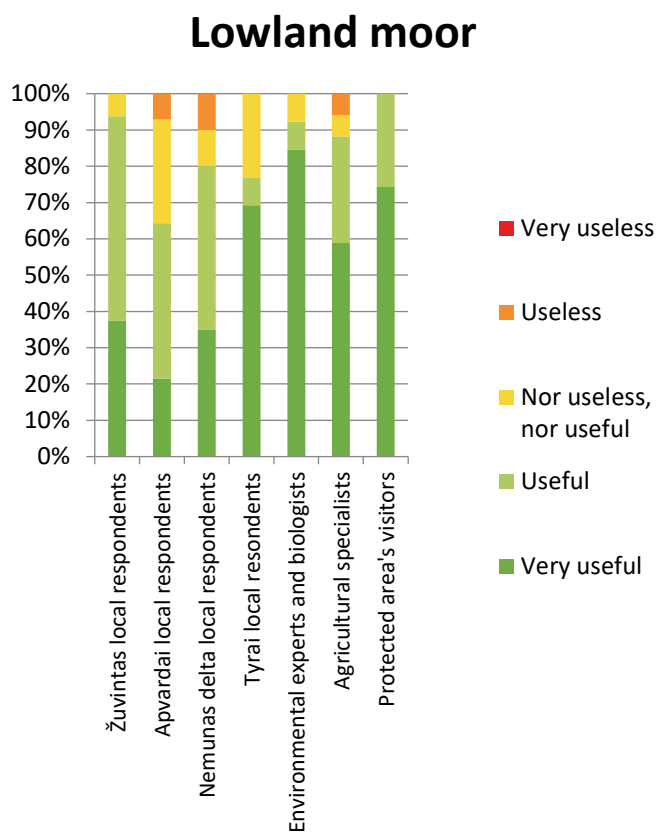
Respondent:
a) local resident;
b) farmer;
c) owner of the land;
d) agriculture / land management / landscape specialist;
e) nature conservation specialist;
f) scientist (science/study institute employee);
g) protected area visitor.

Date of filling in the form: .....

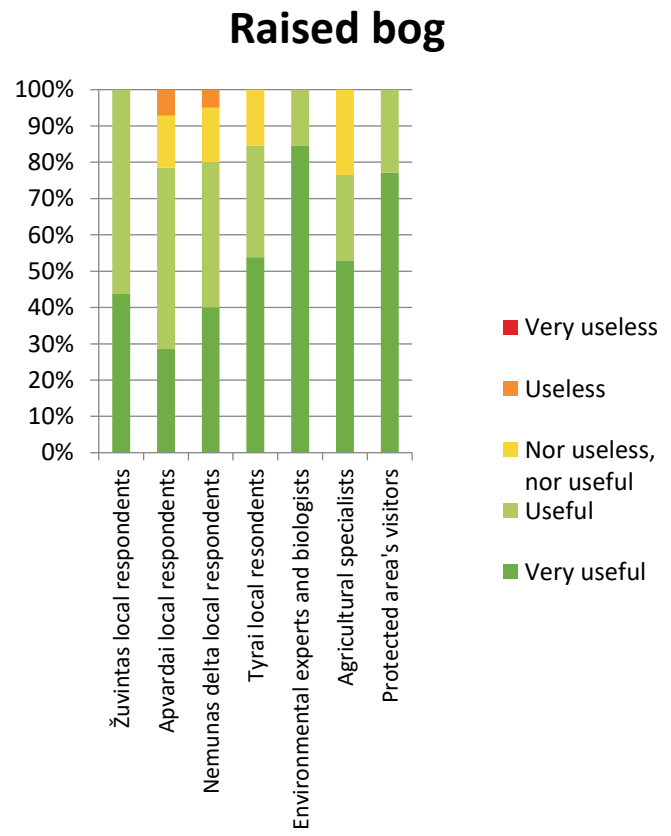
[Name, Surname and contact information – collect separately, unrelatedly to the survey]



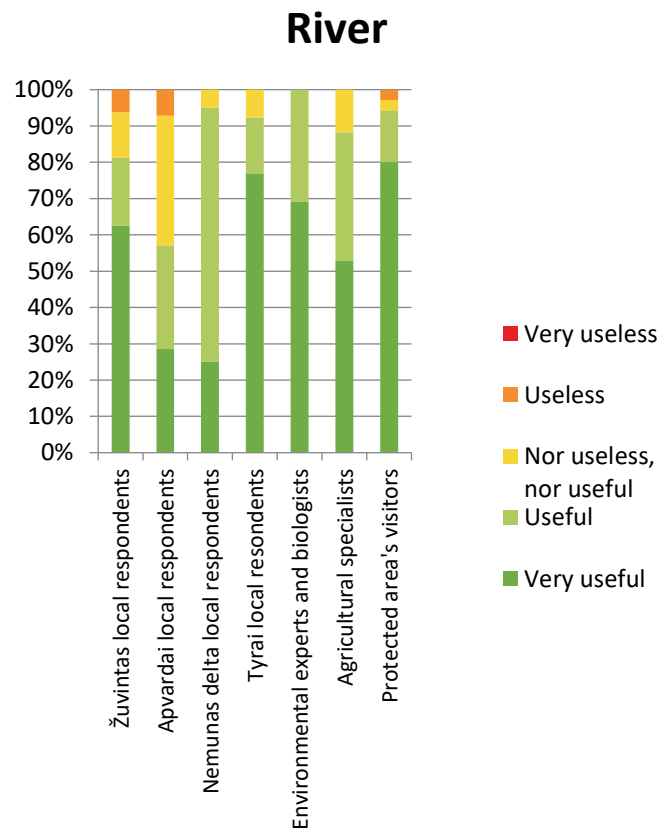
Annex 2.1 - How different groups rate forests' significance in the context of protected species



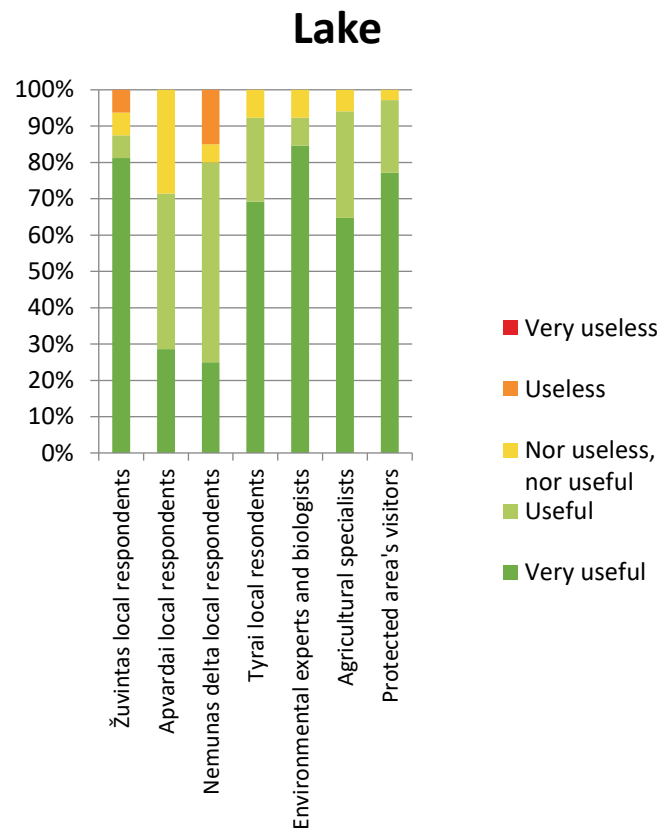
Annex 2.2 - How different groups rate lowland moors' significance in the context of protected species



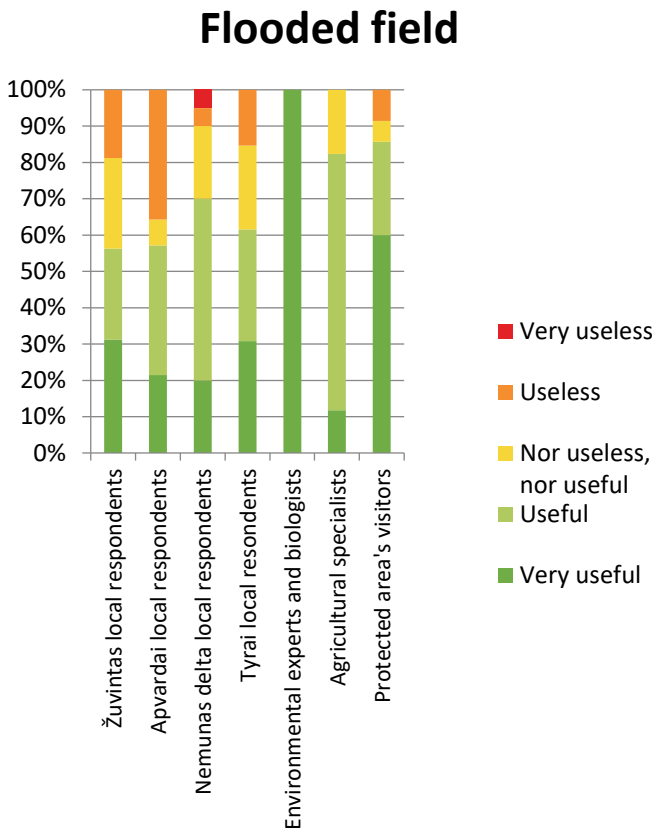
Annex 2.3 - How different groups rate raised bogs' significance in the context of protected species



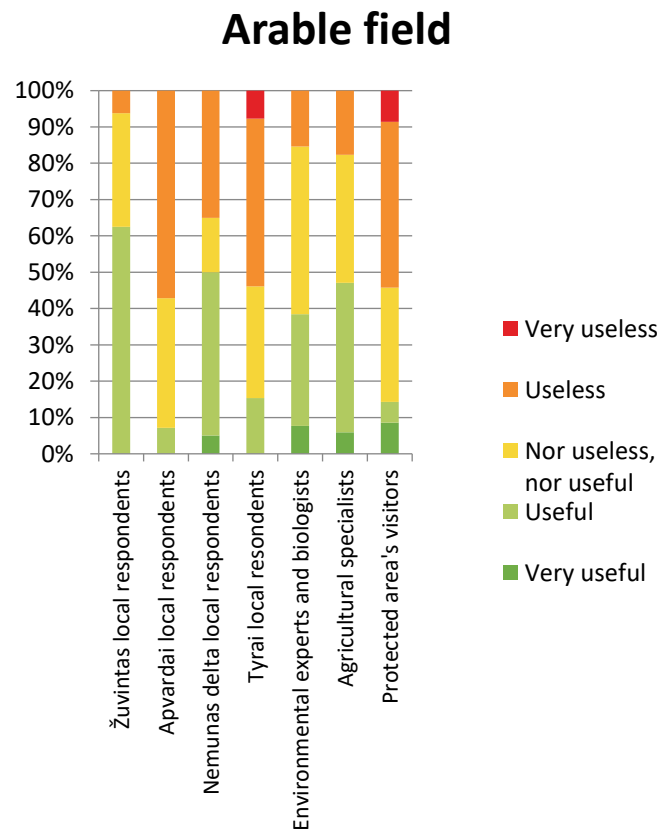
Annex 2.4 - How different groups rate rivers' significance in the context of protected species



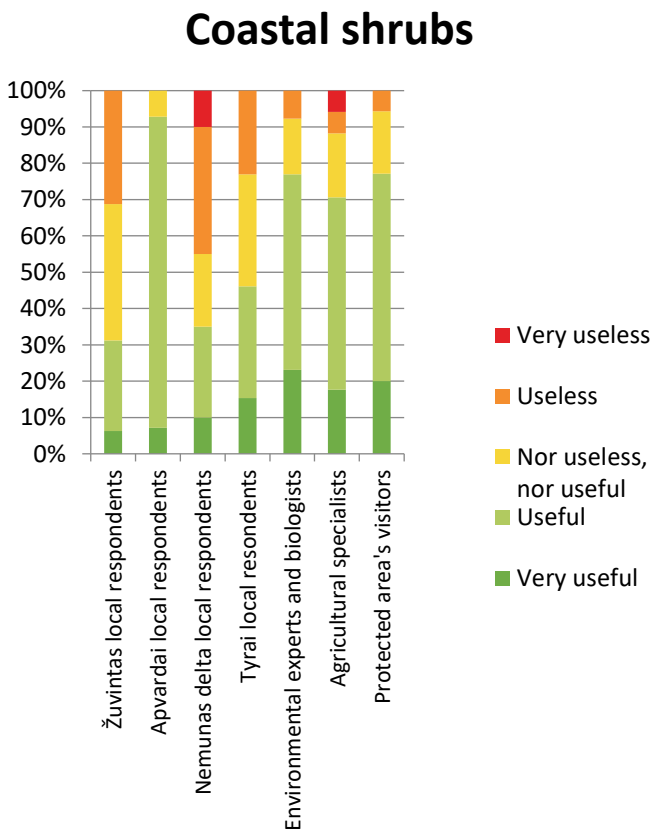
Annex 2.5 - How different groups rate lakes' significance in the context of protected species



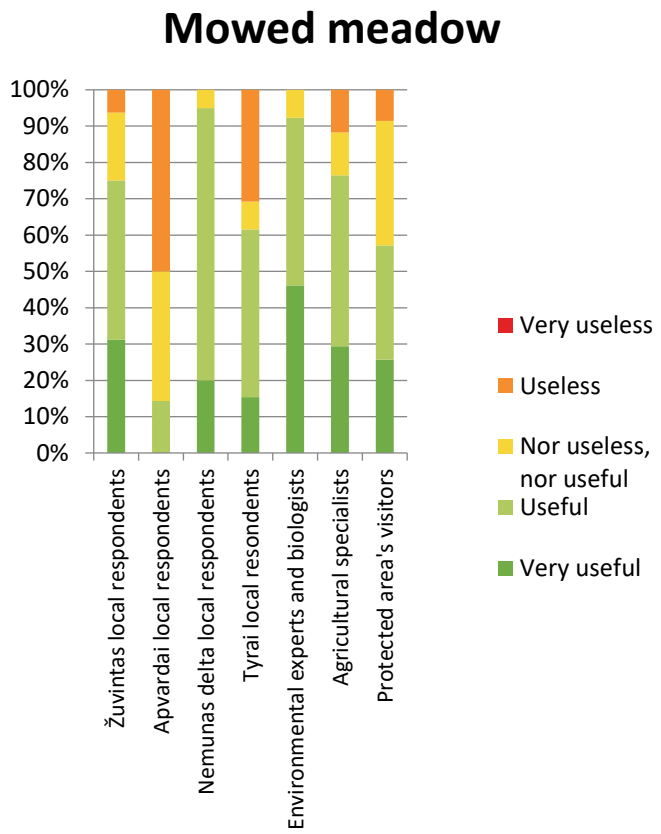
Annex 2.6 - How different groups rate flooded fields' significance in the context of protected species



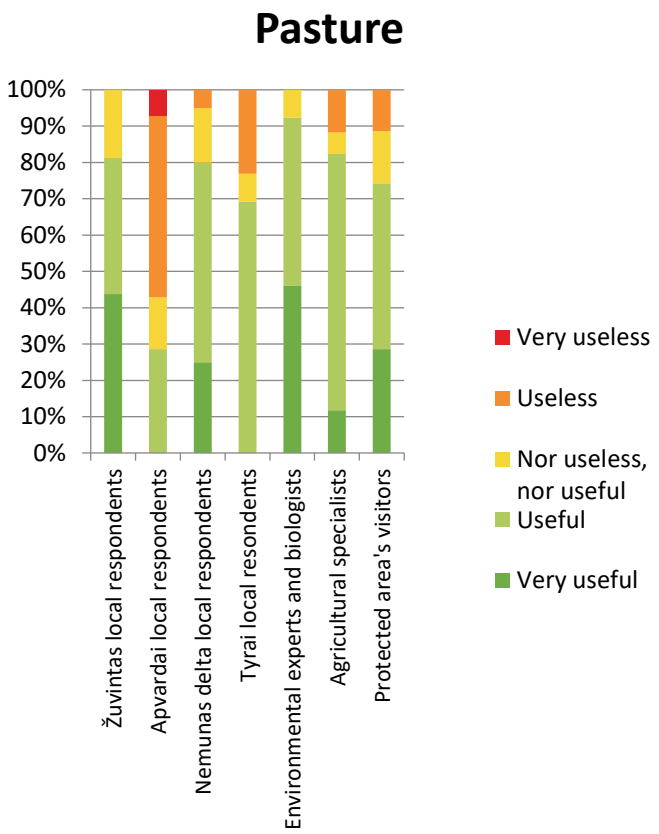
Annex 2.7 - How different groups rate arable fields' significance in the context of protected species



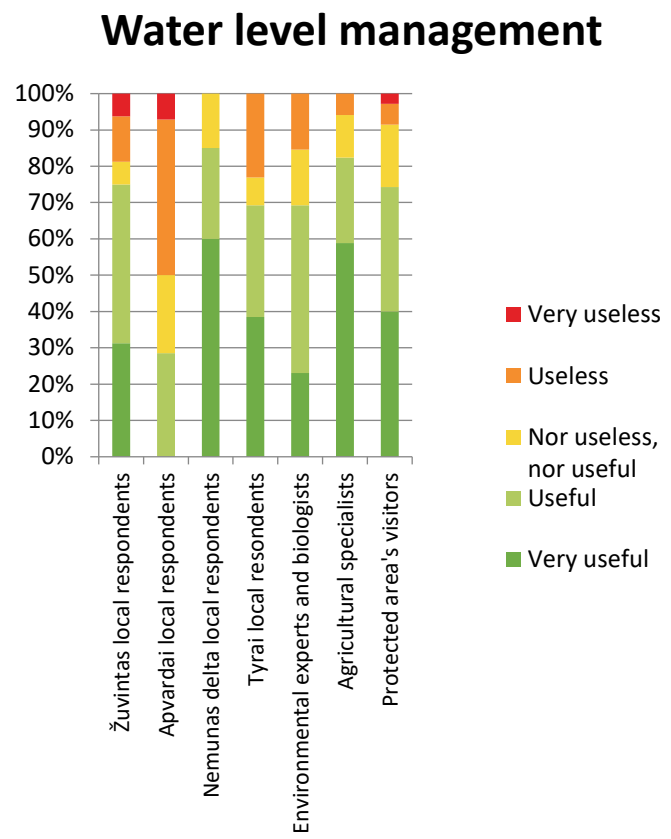
Annex 2.8 - How different groups rate coastal shrubs' significance in the context of protected species



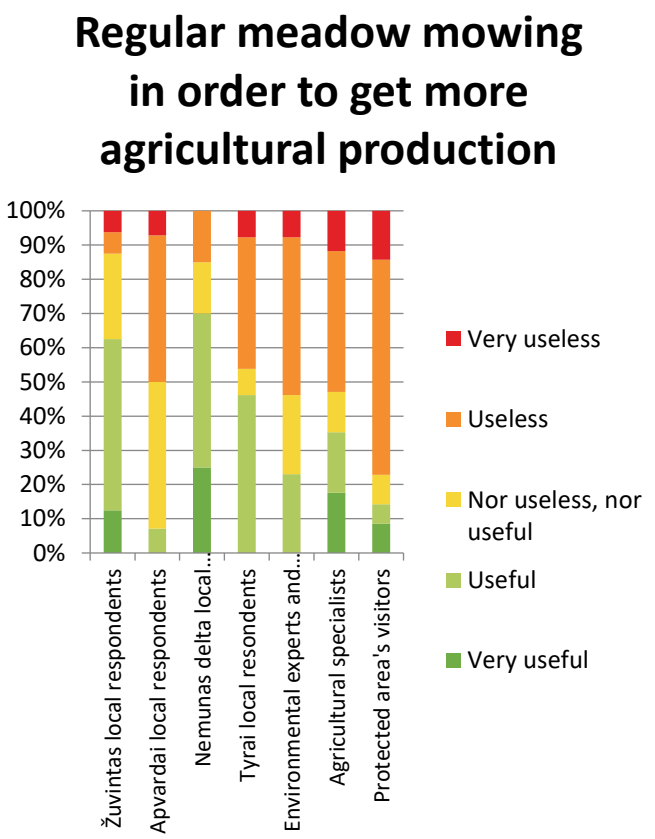
Annex 2.9 - How different groups rate mowed meadows' significance in the context of protected species



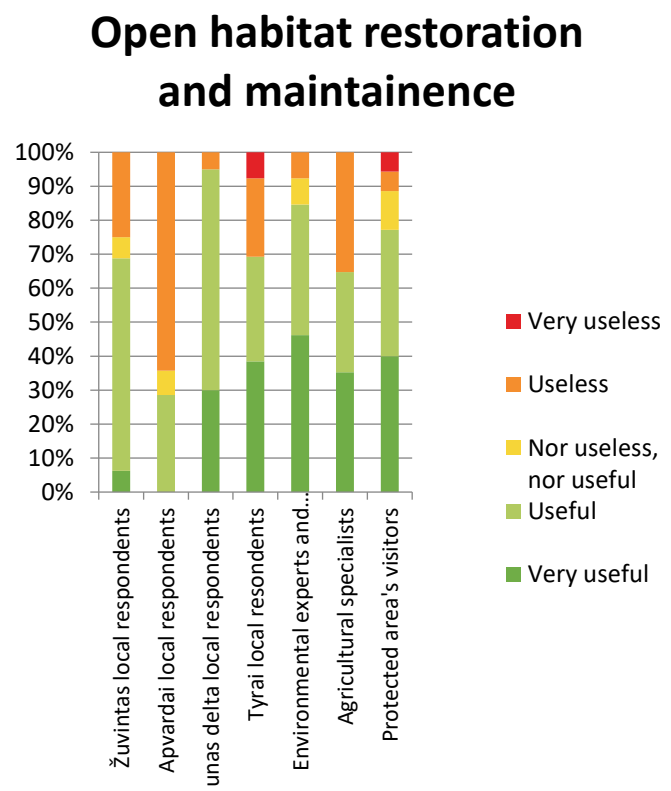
Annex 2.10 - How different groups rate pastures' significance in the context of protected species



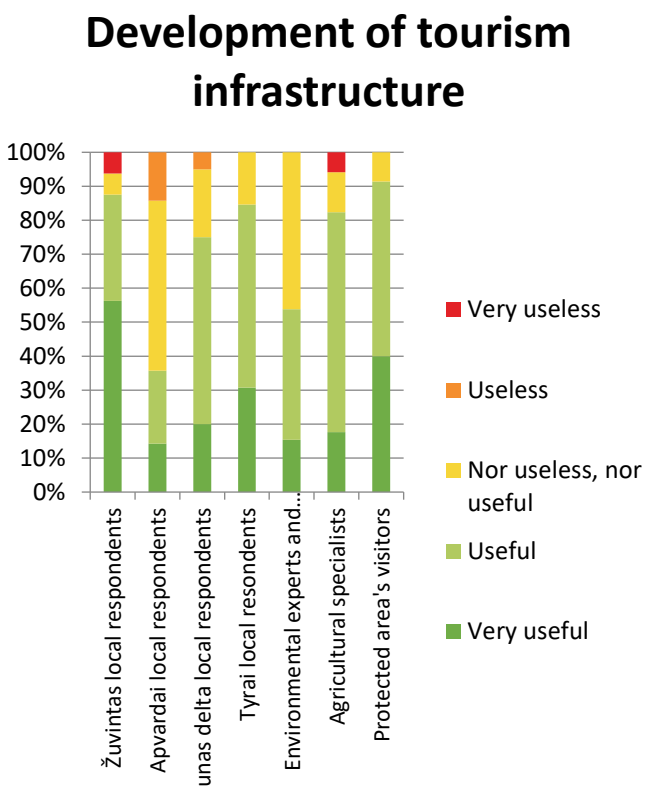
Annex 3.1 - How different groups rate water management significance in the context of protected species



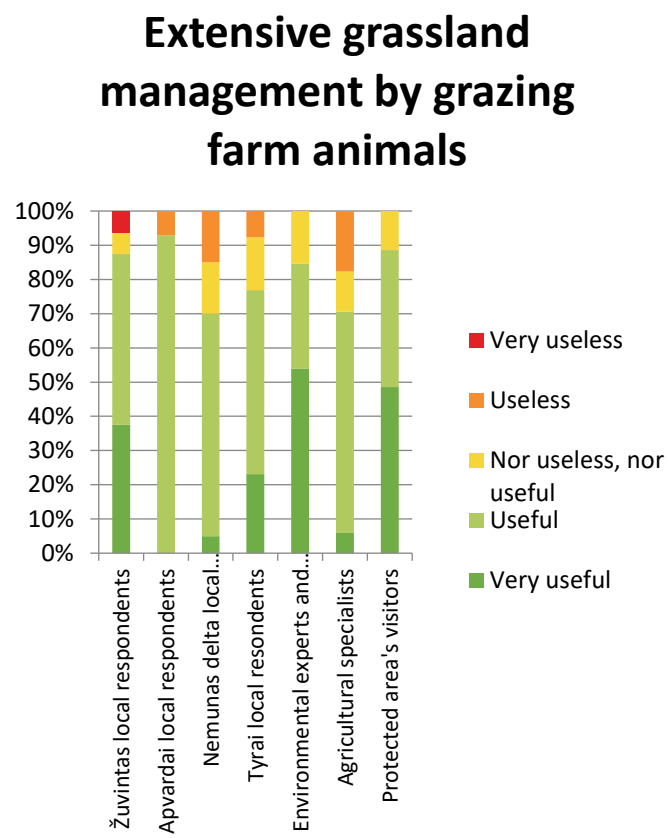
Annex 3.2 - How different groups rate regular meadow mowing in order to get more agricultural production significance in the context of protected species



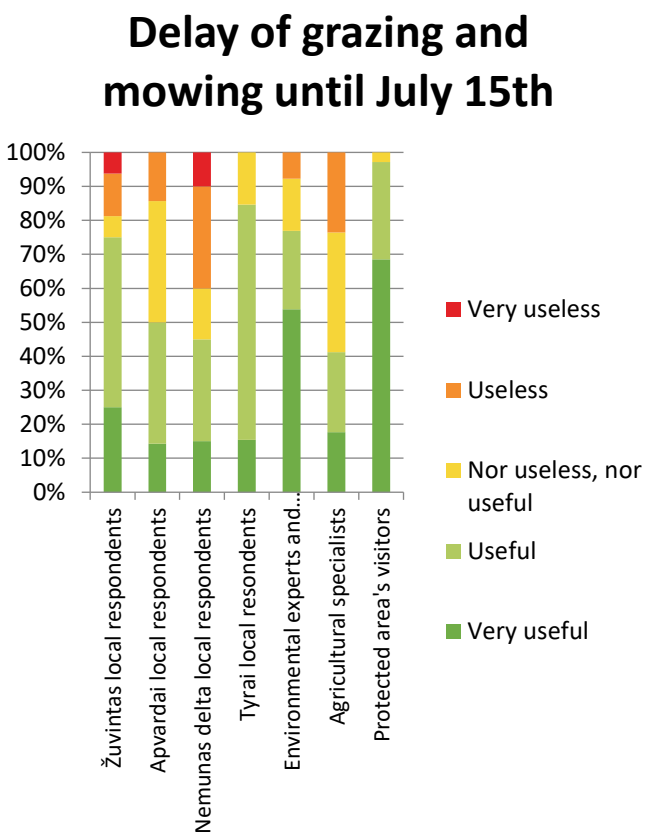
Annex 3.3 - How different groups rate open habitat restoration and maintainence significance in the context of protected species



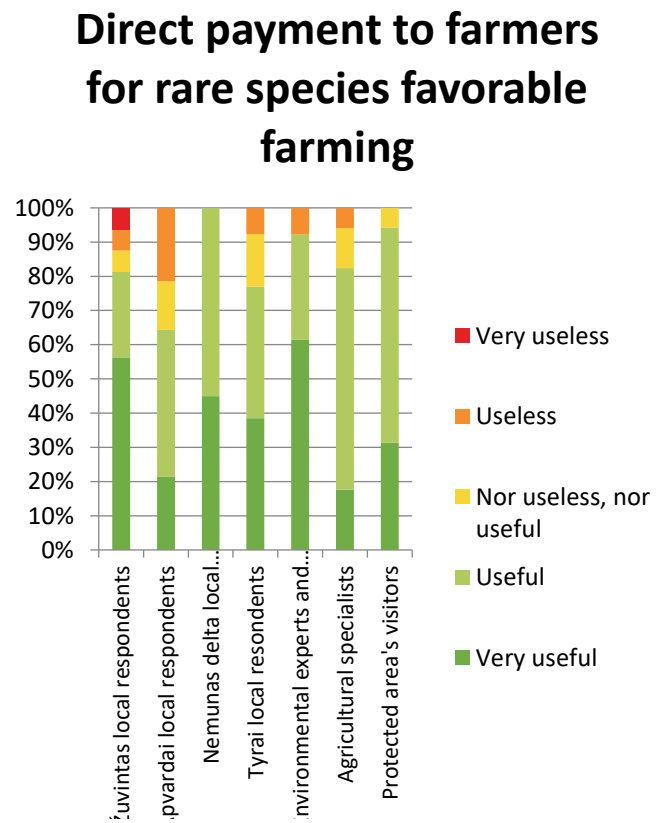
Annex 3.4 - How different groups rate development of tourism infrastructure significance in the context of protected species



Annex 3.5 - How different groups rate extensive grassland management by grazing farm animals significance in the context of protected species

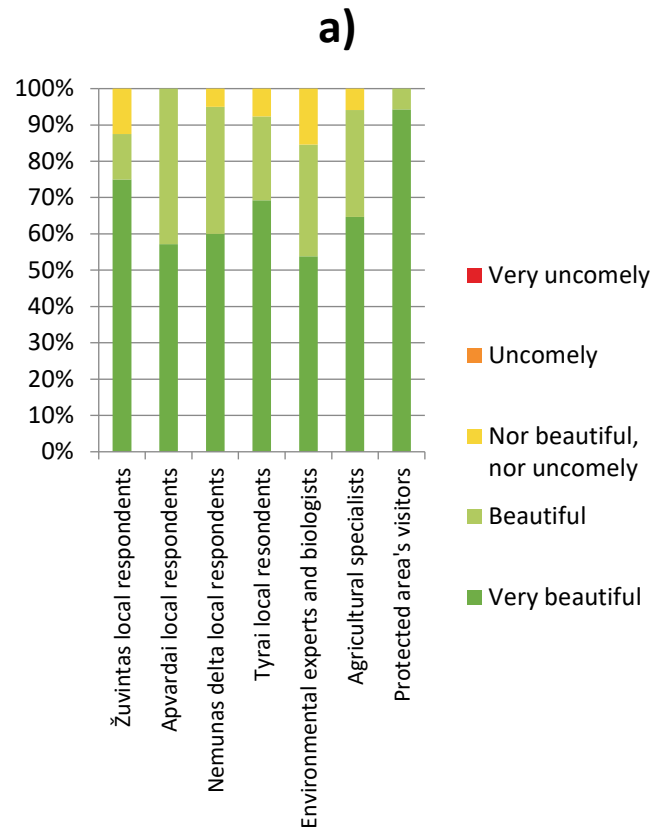


Annex 3.6 - How different groups rate delay of grazing and mowing until July 15th significance in the context of protected species

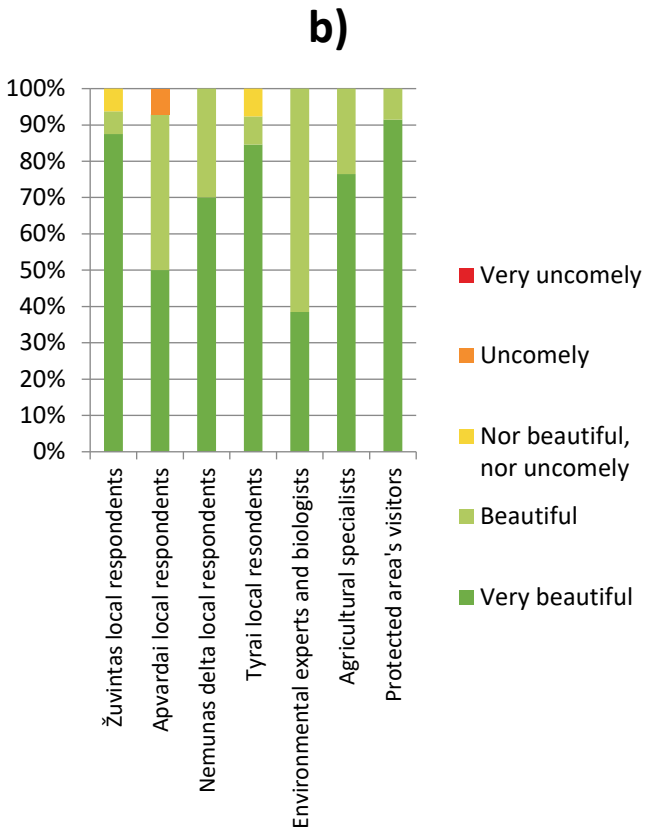


Annex 3.7 - How different groups rate direct payment to farmers for rare species favorable farming significance in the context of protected species

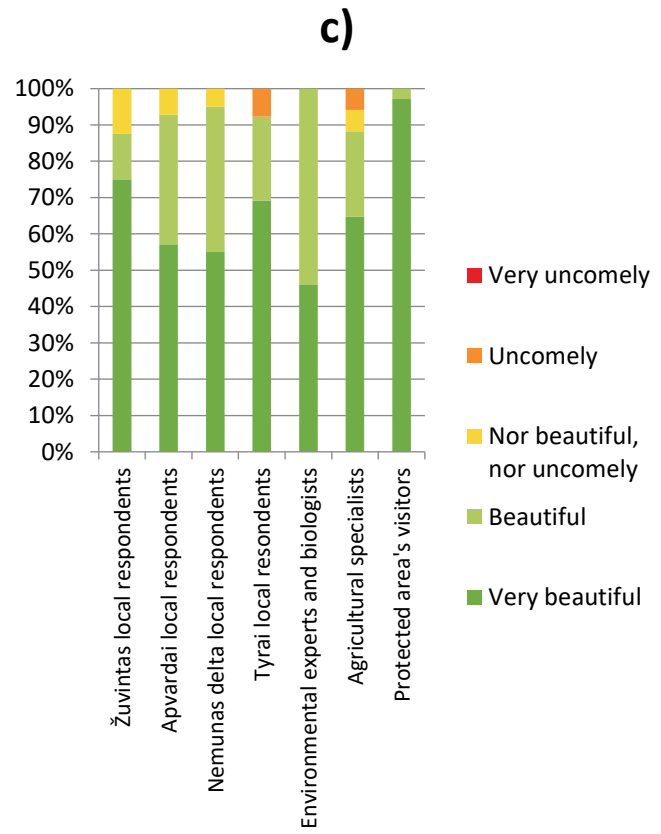
Annex 4 – Aesthetical perception of different habitats provided by interviewed people



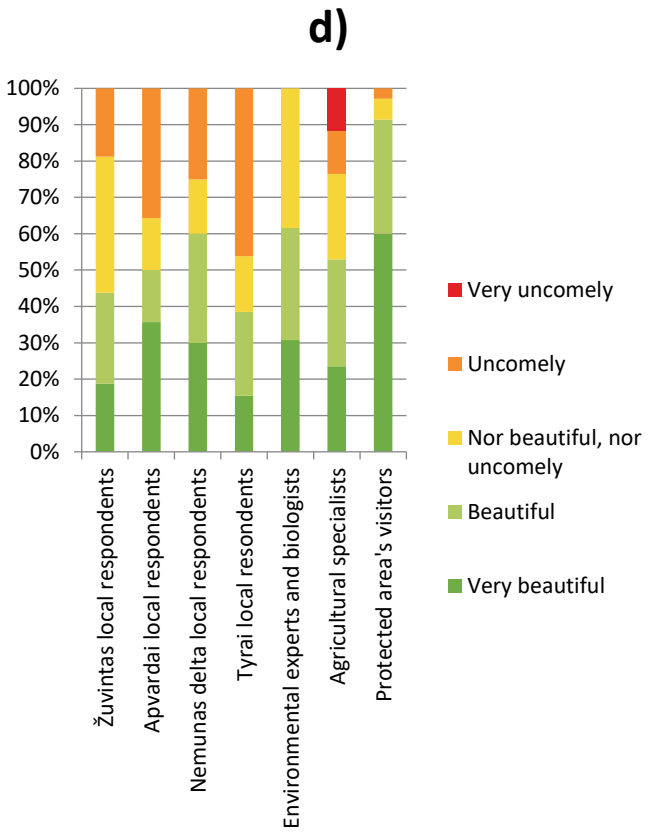
Annex 4.1 - Aesthetic perception of the image of forest habitat provided by different groups of interviewed people



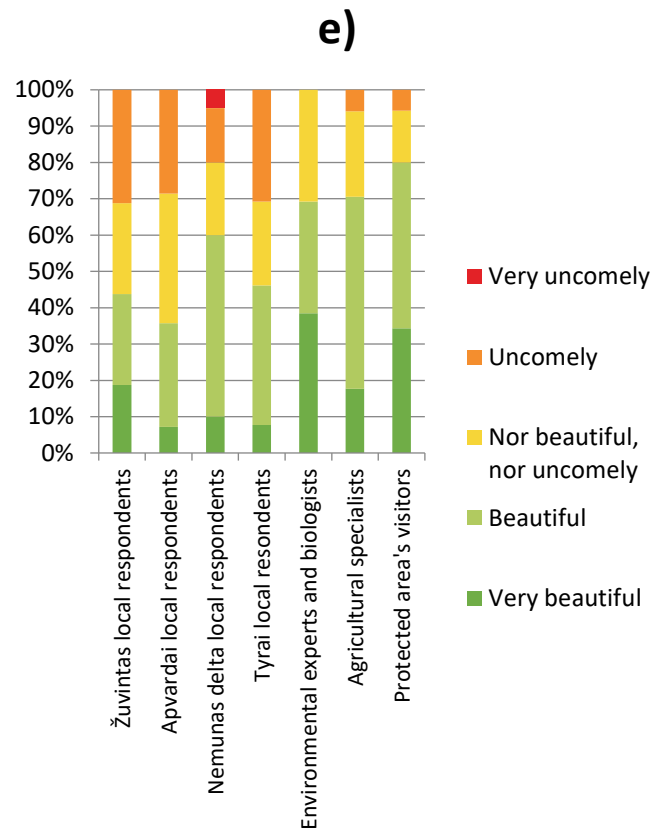
Annex 4.2 - Aesthetic perception of the image of landscape with lake provided by different groups of interviewed people



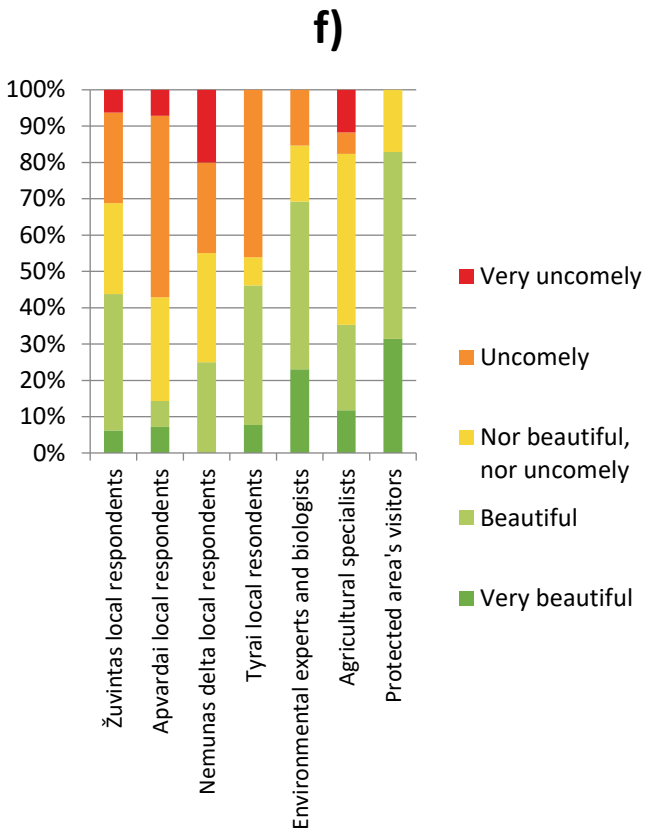
Annex 4.3 - Aesthetic perception of the image of landscape with river provided by different groups of interviewed people



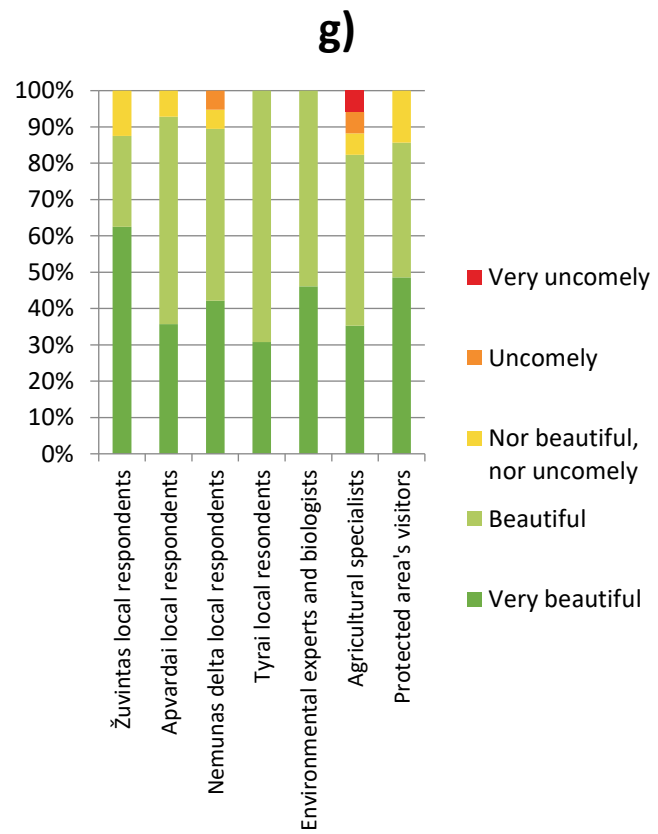
Annex 4.4 - Aesthetic perception of the image of forested marshland provided by different groups of interviewed people



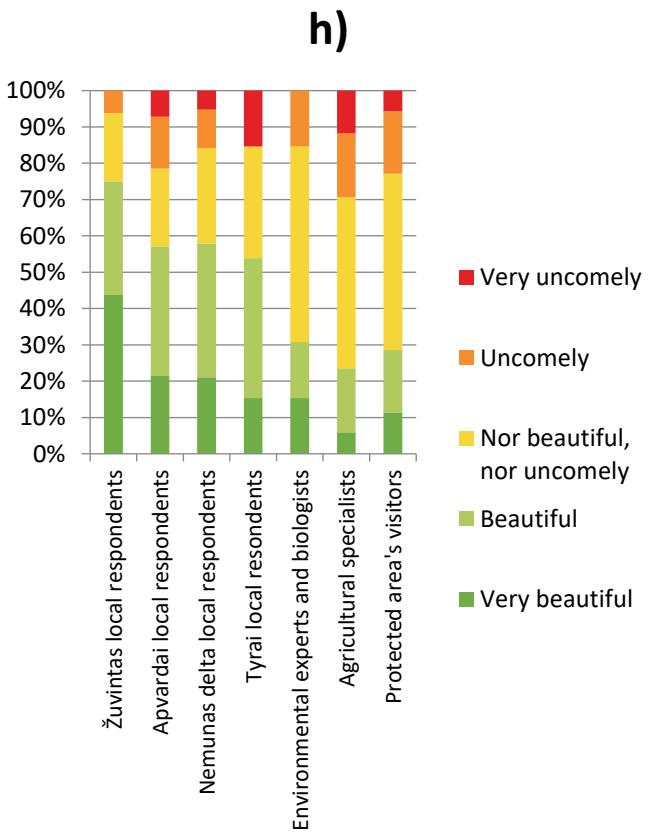
Annex 4.5 - Aesthetic perception of the image of open sedge dominated meadow provided by different groups of interviewed people



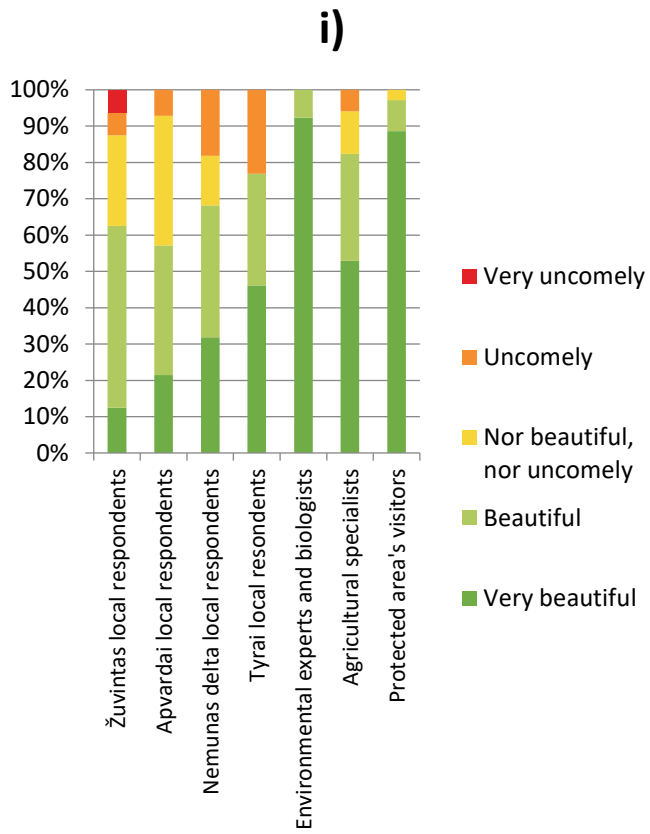
Annex 4.6 - Aesthetic perception of the image of partly overgrown fen provided by different groups of interviewed people



Annex 4.7 - Aesthetic perception of the image of extensive meadow management provided by different groups of interviewed people



Annex 4.8 - Aesthetic perception of the image of intensive meadow management provided by different groups of interviewed people



Annex 4.9 - Aesthetic perception of the image of open raised bog provided by different groups of interviewed people

IMPACT ASSESSMENT OF ECOSYSTEM FUNCTIONS
(D.D3.1 Baseline assessment report)

Compiled by:
Gintaras Riauba
Žymantas Morkvėnas
Dr. Aleksandr Kozulin


Vilnius, 2018

Contents

Introduction

Definitions of selected Ecosystem Services (ES), methodological aspects of their evaluation are presented below, and are based on the Common International Classification of Ecosystem Services (CICES Version 5.1[1]) developed from the work on environmental accounting undertaken by the European Environment Agency (EEA). CICES is built on the principle that a classification of services needs to describe the contribution that ecosystems make to human well-being, defined in terms of "what ecosystems do". Thus, in the classification the definition of a service highlights the ecological outcomes that particular ecosystem characteristics or processes generate, that can ultimately benefit people. The aim has therefore been to build a classification that identifies the purposes or uses that people have for the different kinds of ecosystem service and associate them with the particular ecosystem attributes or behaviours that support them. To emphasise the 'purposeful' nature of CICES, the definition of each service is made up of two parts, namely a clause describing the biophysical output (i.e. the 'ecological clause' noting what the ecosystem does) and a clause describing the contribution it makes to an eventual use or benefit ("use clause").

At the most general level of the hierarchical structure of CICES there are three categories (sections) of ES identified: "provisioning", "regulation and maintenance", and "cultural". Below these sections are a series of "Divisions", "Groups" and "Classes". "Provisioning" services cover all nutritional, non-nutritional material and energetic outputs from living systems as well as abiotic outputs (e.g. water). Section "Regulation and maintenance" includes all the ways in which living organisms can mediate or moderate the ambient environment that affects human health, safety or comfort, together with abiotic equivalents. The Division level therefore covers the "transformation of biochemical or physical inputs to ecosystems" in the form of wastes, toxic substances and other nuisances, and the "regulation of physical, chemical, biological conditions", which categorizes the various ways in which living systems can mediate the physico-chemical and biological environment of people in a beneficial way. ES of "Cultural" section of CICES includes all the non-material, and normally non-rival and non-consumptive, outputs of ecosystems (biotic and abiotic) that affect physical and mental states of people. Cultural services are primarily regarded as the environmental settings, locations or situations that give rise to changes in the physical or mental states of people, where the character of those settings is fundamentally dependent on living processes. They can involve individual species, habitats and whole ecosystems.

Hierarchical classification of ecosystem services, indicators and data sources to be used in the assessment of ecosystem services, as well as project sites, where particular indicators are planned to be evaluated, are presented in the Table 1. The selected indicators were chosen by common agreement of project partners, in order to evaluate all the most important ecosystem services and functions, using data from project monitoring activities and publically available data.

[1] See: https://cices.eu/resources/ for more details on ES classification and technical guidance.

1. Methodological approach

All areas of the project consist of open habitats, which are prevailed by sedge-dominated meadow vegetation, which form basically suitable habitats for Aquatic Warbler. The largest projects area BY/07-Zvanets, covers an area of more than 16,000 hectares, but meadows currently occupies nearly 10,000 ha. Other project areas are much smaller. In project sites LT/03-Zuvintas, LT/04-Sysa/Sausgalviai, BY/06-Servech and BY/07-Zvanets Aquatic Warblers are currently breeding, so suitable habitats it these sites form significant areas. In the project sites LT/04-Sysa/Sausgalviai agricultural land is used by local farmers to produce food for cattle, mainly grass, hay and haylage. So the main agricultural activity in these areas is mowing of meadows. Ecosystem services assessed in these areas were discussed at meetings with local farmers.

In all areas, we wanted to base our assessment of ecosystem services more on real field data and less theoretical calculations. In order to maintain a balance between scope of work and content, we have selected only those ecosystem services that are relevant to the areas and whose indicator change during the project period may be affected by practical project activities (established causal relationship). We have also tried to simplify our research methodologies as much as possible, as this would be the scope of a separate project for a comprehensive and consistent assessment of all ecosystem services.

Under the section of **provisional** services there were seven indicators selected under the classes of “Animals reared for nutritional purposes”, “Wild animals (terrestrial and aquatic) used for nutritional purposes” and “Cultivated terrestrial plants for nutrition, materials or energy” (see Table 1 for details):

Data on **Production from livestock** are relevant only on those project sites, where farming activities are implemented by land users. In Lithuania only sites LT/03-Žuvintas and LT/04-Šyša-Sausgalviai were considered for evaluation of production from Livestock evaluation, because in the other sites no agricultural activities are implemented at the moment, and no changes in land-use is foreseen in the future. However, after consulting with local farmers, we have chosen not to use this indicator, because in most cases, only part of the farm production is produced in the meadows of the project areas, and thus it is not possible to estimate the exact production of food for a particular project area.

Amount of **Produced honey** was evaluated in the project area BY/07-Zvanets, because the site is well known in Belarus and abroad for its high-quality natural honey, that is produced from the flowers of Zvanets mire. All the beekeepers in the vicinity of the project site are known, thus direct interview with them were used to obtain information on amount of honey produced.

We also were intended to evaluate **Wild game bag** data performing interviews with local offices of hunter organizations or interviews with hunters that manage data on hunting bags in particular project sites. However, collection of such data is not proportionate to the amount of effort required, as the existing data sets do not contain information on the game bags in specific project areas. So we also refused to evaluate this indicator.

Evaluation of **Fish production** is relevant in Lithuanian sites LT/04-Sysa/Sausgalviai only, because the territories are regularly flooded in spring, and are serving as s feeding and spawning places for some fish from Curonian Lagoon and Nemunas River. In late spring, when the water goes off from the polders, the fish that remains in the channels, are cached by authorized fishermen and supplied to the market. Data on annual catches are stored at the regional office of the Environmental Protection Agency and were provided on request for presentation.

Amount of **Grassland area** was evaluated in all the project sites, during implementation of vegetation monitoring activities. In addition, detailed vegetation maps were used to reject all non-grassland areas (open water and areas currently overgrown by shrubs and trees) using GIS facilities.

Yields of dry phytomass were evaluated according data gained during implementation of vegetation monitoring. Samples of above-ground vegetation were collected in selected 1x1 m plots, dried and weighted. This monitoring procedure was applied in all the project sites were vegetation monitoring was held. The phytomass of dry above-ground vegetation was measured in all different types of vegetation associations, thus average weight of samples collected was measured. Tons of dry phytomass per hectare (t/ha) was used as an evaluation unit for the indicator.

After the biomass processing facility will be established (Action C5) amount of **Produced pellets** will be used as an indicator for evaluation of biomass, that will be produced from late-cut grass, that are left in the breeding grounds of Aquatic Warbler. Only production from project sites LT/01-Tyrai and LT/04-Sysa/Sausgalviai will be measured, as biomass processing facility is situated in Nemunas river delta and transportation of materials from other project sites is not appropriate.

In some breeding areas of Aquatic Warbler farmers voluntarily do not mow till the end of the breeding season, and are obliged to mow all the biomass starting from August 15th. **Late-cut biomass** is not suitable for feeding of cattle or other livestock, thus usually biomass in the fields are put into “old hay rolls”, and according the regulations of Agro-environmental schemes, should be removed from the fields till October 30th, or exceptionally, till 1st of March in the next year. The utilization of old hay is still problematic and depends on farmer’s efforts to supply them for a few cattle farms to be used as a litter. Small amount (several tons) of late-cut biomass are used as a fuel in few local heating plants. Most of the late-cut biomass at the moment are not used for any purpose, and are considered as not useful biomass waste. Thus tracking of amount of not used biomass will serve as an indicator for measuring potential of phytomass production. Evaluation of the amount of late-cut biomass produced in the project sites was estimated on the basis of estimated yields of dry grass phytomass calculated for areas declared for late mowing.

In the section of **Regulation and Maintenance** services there are eight indicators selected under the classes of “Hydrological cycle and water flow regulation”, “Flood protection”, “Pollination and seed dispersal”, “Maintaining nursery populations and habitats”, “Regulation of the chemical condition of freshwaters by living processes” and “Regulation of chemical composition of atmosphere and oceans” (see Table 1 for details):

We decided not to use indicator **Amount of water in peat layer**, because additional data on soil composition are requited according the methodology. Water holding capacities of the organic soil is evaluated bearing into account that storage of water in peat is related to the physical properties of peat (degree of decomposition and soil compression), thus special coefficients are used in calculations of the volume of water stored in peat layer. Data on average thickness of peat layer also should be used in order to get accurate data.

Flood protection services can only be assessed in the field in sites, that have inflows and outflows or obvious flood periods. Thus **Amount of water during flood period** was measured in the polders of Nemunas delta (project site LT/04-Sysa/Sausgalviai) which are affected by regular floods, and BY/07-Zvanets, where as a result of water flow management activities water inflow and outflow properties will be controlled during the project period. Size of the flooded area can be obtained using "Sentinel-2" images, in which colour band combinations are suitable for segregation of flooded areas from other kinds of landscapes. Amount of water during flood period (flood storage capacity of a wetland) was obtained calculating the difference between the

potential maximum volume of water stored (maximum of the water level during the flood) in the wetland and the average water level during the vegetation period.

As there is no universal way to evaluate the pollination service, we chose to compare the combined **Number of the taxa** of invertebrates collected by net sampling and Malaise traps in each project site during the implementation of invertebrate monitoring. Only the numbers of following main pollinator groups of flying insects was counted: *Hymenoptera* (all non-parasitic hymenopterans), *Lepidoptera* and *Diptera* (all families).

Amount of natural habitats was measured in all the project sites in Lithuania, based on GIS dataset of Natural habitats of EU importance (Institute of Botany, Nature research centre, 2015-02-18; Online resource: www.geoportal.lt). Total area (ha) of all natural habitats in project sites was used as an indicator.

Total number of breeding bird species was evaluated in all the project sites, based on the lists of all the bird species observed during the bird breeding period.

Total number of migratory birds were evaluated for project sites LT/01-Tyrai, LT/03-Zuvintas and LT/04-Sysa/Sausgalviai. At least two site-visits to the sites were organised during peak periods of bird migration in spring 2018 and autumn 2017. Total maximum number of birds counted during one day were presented.

Nutrient retention, as an ability of wetland to improve water quality, was directly measured in project site BY/07-Zvanets, where the water quality of the inflows and outflows could be measured and compared based on water chemical composition data. Nutrient retention in the other project sites will be evaluated indirectly, combining data on total phytomass produced during the vegetation period (vegetation monitoring) and amount of Nitrogen (N) and Phosphorus (P) in it.

Carbon sequestration in vegetation was measured for all the project sites, using instructions provided in TESSA toolkit[2]. Methods "Climate M3" and "Climate M5" were used for direct measurement of above-ground live carbon stock and below-ground carbon stock estimation for grass-dominated areas. Above-ground biomass carbon stock (t C) was assumed to be 47% of the total dry mass (IPCC 2006, Chapter 6, p. 6.9[3]). Below-ground biomass carbon stock was calculated using IPCC conversion factor for grass-dominated habitats, provided in Table 6.1 in Chapter 6 of IPCC (2006).

Under the section of **cultural** services there are four indicators selected under the classes of "Experiential use of plants, animals and landscapes in different environmental settings", "Physical use of land in different environmental settings" and "Educational" (see Table 1 for details):

Numbers of visitors in project areas was monitored using direct monitoring of visitors of the project sites will be performed by the project staff during the most attractive periods for nature tourists to visit the sites. As project sites are best known as special protected areas for breeding and migratory birds, the most appropriate periods for monitoring number of site visitors would be periods of spring and autumn migration of birds, as well as some periods during the summer. The person devoted to counting of visitors to the project area thus should spend in total 24 hours at the particular site during the bird migration and breeding period in spring, 24 hours during selected periods in summer, and 24 hours during the period of autumn migration of birds. The exact dates and time of the day for counting of the site visitors wary in different territories, thus they should be selected individually. For the project sites, where the site visitors can be counted by permanent

[2] Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., MacDonald, M. A, Stattersfield, A. J., Thomas, D. H. L., Trevelyan, R. J., Walpole, M., & Merriman, J. C. (2017) Toolkit for Ecosystem Service Site-based Assessment (TESSA). Version 2.0 Cambridge, UK Available at: http://tessa.tools

[3] Online resource: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html

staff members at the information/visitors centres of the protected areas (e.g. project sites LT/03-Zuvintas and BY/07-Zvanets), average number of visitors in 3 day-period should be calculated for the following three periods: April 25th – May 30th, June 10th – July 20th and September 1st – October 20th.

Changing trend of **Proportion of "nature" tourists in local enterprises** offering tourism related accommodation services could be used for evaluation of the change in tourist's interests for the period of the project. Proportion of "nature" tourists among the other interest groups will be evaluated during the interviews with the representatives of the enterprises, who can provide statistical information on interests of persons, who used an accommodation services. All enterprises providing accommodation services in the vicinity of the project sites will be interviewed within the radius of 5 km from the project sites LT/04-Sysa/Sausgalviai and LT/01-Tyrai, and 10 km radius will be used for all other project sites.

Number of leisure fishing (angling) **individuals** in the project sites will be counted at the same time as the counting of visitors of the project areas will be performed. Average number of angling individuals for 24-hour period should be presented for project sites LT/04-Sysa/Sausgalviai and all the project sites in Belarus.

Number of web-site visitors of the project web-site, along with the other web-site using statistics, will be obtained from appropriate internet services, will be analysed, and used for evaluation of use of project information for educational purposes.

Evaluation of ecosystem services has been carried out for the first time, so some methodological data calculation indicators can be revised later. We plan to repeat the evaluation of ecosystem services in 2019 as well.

Table 1. Classification of ecosystem services, indicators and data sources to be used in their assessment (ES Classes presented according CICES V5.1)

Section	Division	Group	Class	Indicator	Data source or evaluation method	Project sites, where ES evaluation will take place
Provisioning	Nutrition	Biomass	Animals reared for nutritional purposes	**Food production from livestock ***	Interview with farmers/land owners	LT/03-Zuvintas; LT/04-Sysa/Sausgalviai
				Production of honey (kg/year)	Interview with beekeepers	BY/07-Zvanets
			Wild animals (terrestrial and aquatic) used for nutritional purposes	**Wild game bag*** data	Official statistics of hunted animals/Interview with hunters	All project sites
				Fish production (catch in tonnes by commercial fisheries)	Official statistics	LT/04-Sysa/Sausgalviai
			Cultivated terrestrial plants for nutrition, materials or energy	**Grassland area**, ha	Areal mapping/GIS	All project sites
				Yealds of dry phytomass (ton (dry matter)/ha)	Botanical monitoring/GIS	All project sites
	Materials	Biomass	Fibres and other materials from cultivated plants,<…> for direct use or processing (excluding genetic materials)	**Produced pellets** (ton)	Data from producer	LT/01-Tyrai; LT/04-Sysa/Sausgalviai
				Late-cut biomass ("Old hay") produced at the end of vegetation period (t)	Interview with farmers/Aerial photos	LT/03-Zuvintas; LT/04-Sysa/Sausgalviai BY/07-Zvanets
	Regulation of physical,	Regulation of baseline flows	Hydrological cycle and water flow regulation	**Amount of water in peat layer*** (m^3/ha)	Hydrological monitoring, GIS	All project sites

Regulation and Maintenance	chemical, biological conditions	and extreme events	(Including flood control, and coastal protection)			
			Flood protection	**Amount of water during flood period** (m^3)	Hydrological monitoring, Remote imagery, GIS	LT/04-Sysa/Sausgalviai BY/07-Zvanets
		Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	**Number of taxa and number of pollinating insect**	Insect monitoring	All project sites
			Maintaining nursery populations and habitats	**Amount of natural habitats** (ha)	Botanical monitoring, GIS	All project sites
				Total number of breeding bird species	Ornithological monitoring	All project sites
				Total number of migratory birds	Ornithological monitoring	LT/01-Tyrai; LT/03-Zuvintas; LT/04-Sysa/ Sausgalviai
		Water conditions	Regulation of the chemical condition of freshwaters by living processes	**Nutrient retention** (kg/ha/year)	Water quality monitoring, Vegetation monitoring, GIS	BY/07-Zvanets
		Atmospheric composition and conditions	Regulation of chemical composition of atmosphere and oceans	**Carbon sequestration in vegetation and soils** (t C/ha/year)	TESSA tool	All project sites
Cultural	Direct, in-situ and outdoor interactions with living systems that depend on presence in the	Physical and experiential interactions with natural environment	Experiential use of plants, animals and landscapes in different environmental settings	**Numbers of visitors in project areas**	1. Direct monitoring 2. Tracking QR codes on information stands	All project sites
				Proportion of "nature" tourists in local enterprises offering tourism related services	Monitoring	All project sites

	environmental setting		Physical use of land in different environmental settings	**Number of leisure fishing** (angling) **individuals**	Monitoring	All project sites
		Intellectual and representative interactions with natural environment	Educational	**Number of web-site visitors**	Monitoring	All project sites

* - Not estimated indicators. See Chapter 1 for more detailed explanations.

2. Quantification of ecosystem services

2.1. Provisioning Ecosystem Services

Provisional ecosystem services are services that provide direct physical benefits or products that people can use directly, such as food, pure water, fuel, wood, medical plants, and other. These services are often already subject to certain market mechanisms and has an economic (monetary) values, making this kind of ecosystem services easily understandable and acceptable. Values of measured indicators of selected provisional ecosystem services are presented in Table 2.

Table 2. Baseline values of estimated provisional Ecosystem Services in project sites.

Indicator	Project sites						
	LT/01-Tyrai	LT/02-Apvardai	LT/03-Zuvintas	LT/04-Sysa/ Sausgalviai	BY/05-Dokudov-skoe	BY/06-Servech	BY/07-Zvanets
Production of honey (kg/year)	-	-	-	-	-	-	10,000
Fish production (catch in tonnes by commercial fisheries)	-	-	-	6,7	-	-	-
Grassland area, ha	179,4	121,4	399,0	1294,1	-	382,3	5594
Yields of dry phytomass (t/ha)	4,1	4,3	4,6	6,3	-	3,9	6,3
Produced pellets (t)	0	0	0	0	0	0	0
Late-cut biomass produced at the end of vegetation period (t)	0	0	202,2	1716,1	0	0	0

Production of honey (kg/year) in the project site BY/07-Zvanets was assessed by a survey of local beekeepers.

Data on Fish production (catch in tonnes by commercial fisheries) were provided by Environmental Protection Department under the Ministry of Environment. Since the catches are heavily dependent on the size and duration of the flood in a given year, we provided the average of the catches recorded during the last three years (2015-2017). In total in channels of Šyša and Sausgalviai polders during period of 2015-2017 catches ranged from 2.8 (2016) to 12.3 (2017) tonnes. In 2015 total catch was 4.9 tonnes. Thus, in the last three years, the average spring catch in the polders was 6.7 tonnes.

Grassland area in all the project sites is dominated habitat type, but in different sites the proportion of it varies (Table 3). The smallest part of the meadows (14,6 %) is in project site BY/05-Dokudovskoe, where large-scale habitat restoration activities are planned. A large part of the former open marshland has been overgrown with woody vegetation in BY/06-Servech and BY/07-Zvanets where grassland forms accordingly 76.8% and 60.9% of the area.

Meanwhile, the largest part of the grassland area is in project site LT/04-Sysa/Sausgalviai, where grassland occupies 99.7 percent of total site's area.

Table 3. Proportion of grassland from the total area of the project sites

Project site	Total area, ha	Grassland area, ha	Proportion of grassland, %
LT/01-Tyrai	186	179,4	96,5
LT/02-Apvardai	126	121,4	96,3
LT/03-Zuvintas	442	399,0	90,3
LT/04-Sysa/Sausgalviai	1297,4	1294,1	99,7
BY/05-Dokudovskoe	1029	150,0	14,6
BY/06-Servech	605	464,7	76,8
BY/07-Zvanets	16221,1	9885,3	60,9

Biggest yields of dry vegetation phytomass (ton (dry matter)/ha) was obtained in project sites LT/04-Sysa/Sausgalviai, where nutrient rich alluvial meadows compose the largest part of the area. The indicator also was used to assess production of late-cut biomass, which was calculated by estimating the area of plots declared for late mowing and the average plant biomass in them. The amount of late cut biomass should increase in the course of the project as only the late mowing of meadows assures successful breeding of chicks, that at the end of breeding season are still unable to escape mowing machines. Thus area of grasslands, devoted for late moving, is likely to increase. As late-cut grass will be used for production of pellets already in year 2019, the comparison of indicators "Produced pellets" and "Late-cut biomass" will show which part of late mown grass is used for production of pellets.

2.2. Regulating Ecosystem Services

Regulating ecosystem services are usually defined as services, that are obviously attributable to unique functions of ecosystems, often of very high in value, but usually not included in traditional markets and thus, without any defined monetary expressions. These are ecosystem services such as climate regulation, carbon sequestration, controlling rainfall, regulation of air and water quality, disease and parasite control, protection against natural extreme events such as floods, prevention of erosions and others. Ecosystem maintenance services, as a rule, do not directly benefit people, but are essential for the functioning of the ecosystems themselves and for maintaining the quality and scope of other services. These are ecosystem services such as biomass and soil formation, nutrient flow and water cycle support, habitats for plants and animals, pollination of plants etc. Values of measured indicators of selected provisional ecosystem services are presented in Table 4.

Maximal Amount of water during flood period was measured in the project site LT/04-Sysa/Sausgalviai, which is affected by regular floods. Data of hydrological monitoring were used to obtain average water level during the vegetation period in year 2017, as well as data on maximal water level during the flood period, which was recorded in February 2018 (2 m and 2,3 m above ground surface in meadows of Šyša and Sausgalviai polders accordingly). The total maximal amount of flood water accumulated in the project site was calculated for all the project area (1297,4 ha), using value of maximal water level during the flood period measured above

the average water level during the vegetation period (-24,5 cm below soil surface). Total flooded polder area is bigger than project area, as can be seen in Figure 1.

Table 4. Baseline values of estimated regulating Ecosystem Services in project sites.

Indicator	LT/01-Tyrai	LT/02-Apvardai	LT/03-Zuvintas	LT/04-Sysa/Sausgalviai	BY/05-Dokudovskoe	BY/06-Servech	BY/07-Zvanets
Amount of water during flood period (m^3)	-	-	-	31 526 821	-	-	20 002 740
Number of pollinating insect taxa	71	73	99	66	56	263	254
Amount of natural habitats (ha)	162,8	90,1	70,0	1216,6	-	464,7	13,701
Total number of breeding bird species	12	19	24	14	56	24	110
Total number of migratory birds	20-50	10-20	40-70	4500-5000	-	-	-
Nutrient retention (kg/ha/year)	-	-	-	-	-	-	32.1N, 2.5P
Carbon sequestration in vegetation (t C/ha/year)	9.6	10.1	10.8	14.8	-	9.2	14.8

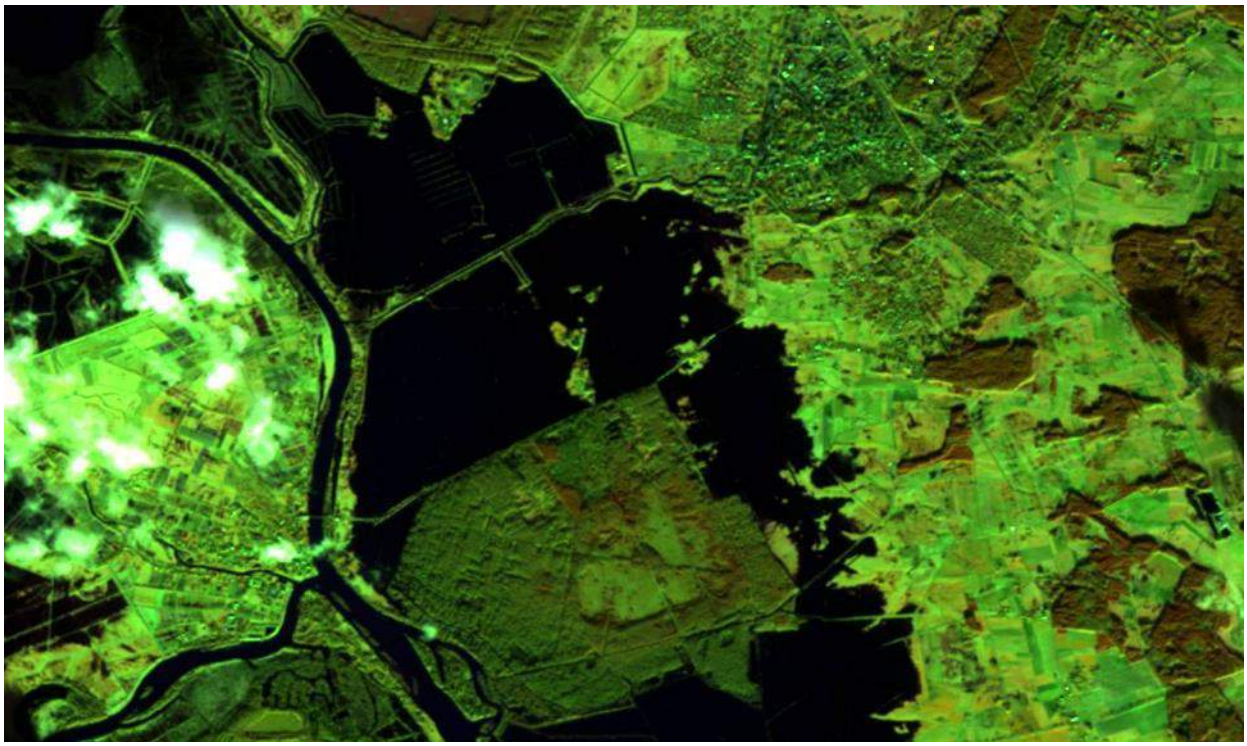


Fig 1. Flooded meadows (black areas) in project site LT/04-Sysa/Sausgalviai on January 8th 2018. (Multispectral band composition of Sentinel-2 image; Data source: https://eos.com/landviewer)

Numbers of taxa of pollinating insects were obtained from data of invertebrate monitoring. The total number of pollinator taxa is highest in LT/03-Zuvintas, followed by LT/02-Apvardai and LT/01-Tyrai, and lowest in LT/04-Sysa/Sausgalviai (Table 4). The pollinator richness (H'=3.01) was highest in LT/03-Zuvintas and pollinator assemblages were distributed most evenly (1-D=0.91) there as well, but the equality of the taxa abundance was almost the

same as in LT/04-Sysa/Sausgalviai (E=0.65) (Table 5). All the indexes of pollinator biodiversity had the lowest values in LT/01-Tyrai. So project site LT/03-Zuvintas provided the best pollination services out of the four investigated areas, while LT/04-Sysa/Sausgalviai being the second best locality.

Table 5. Number of taxa and specimens of selected pollinators net sampling and Malaise traps combined, in the investigated plots and biodiversity indexes there

	LT/01-Tyrai	LT/02-Apvardai	LT/03-Zuvintas	LT/04-Sysa/Sausgalviai
No. of taxa	71	73	99	66
No. of specimens	29748	14255	20908	12158
Shannon (H')	1.43	2.01	**3.01**	2.75
Simpson (1-D)	0.48	0.66	**0.91**	0.88
Pielou (E)	0.34	0.47	0.65	**0.66**

Amount of natural habitats was measured in all the project sites in Lithuania, based on GIS database of Natural habitats of EU importance in Lithuania. In total 7 types of Natural habitats were identified in the project sites: 6270 - Fennoscandian lowland species-rich grasslands, 6430 - Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels, 6450 - Northern boreal alluvial meadows, 6510 - Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*), 7140 - Transition mires and quaking bogs, 9080 - Fennoscandian deciduous swamp woods, 91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*).

The area of natural habitats ranges from 15,8% in LT/03-Zuvintas to 93.8% in LT/04-Sysa/Sausgalviai. The amount of natural habitats will be assessed during the vegetation monitoring activities in years 2020-2022, and are likely to increase as a result of implemented habitat management activities in project sites LT/01-Tyrai, LT/02-Apvardai and LT/03-Zuvintas. Distribution and amount natural habitats in Lithuanian project sites are presented in Figures 2-5.

Table 6. Proportion of natural habitats of EU importance in Lithuanian project sites.

Project site	Total area, ha	Natural habitats, ha	Proportion of natural habitats, %
LT/01-Tyrai	186	162,8	87,5
LT/02-Apvardai	126	90,1	71,5
LT/03-Zuvintas	442	70,0	15,8
LT/04-Sysa/Sausgalviai	1297,4	1216,6	93,8

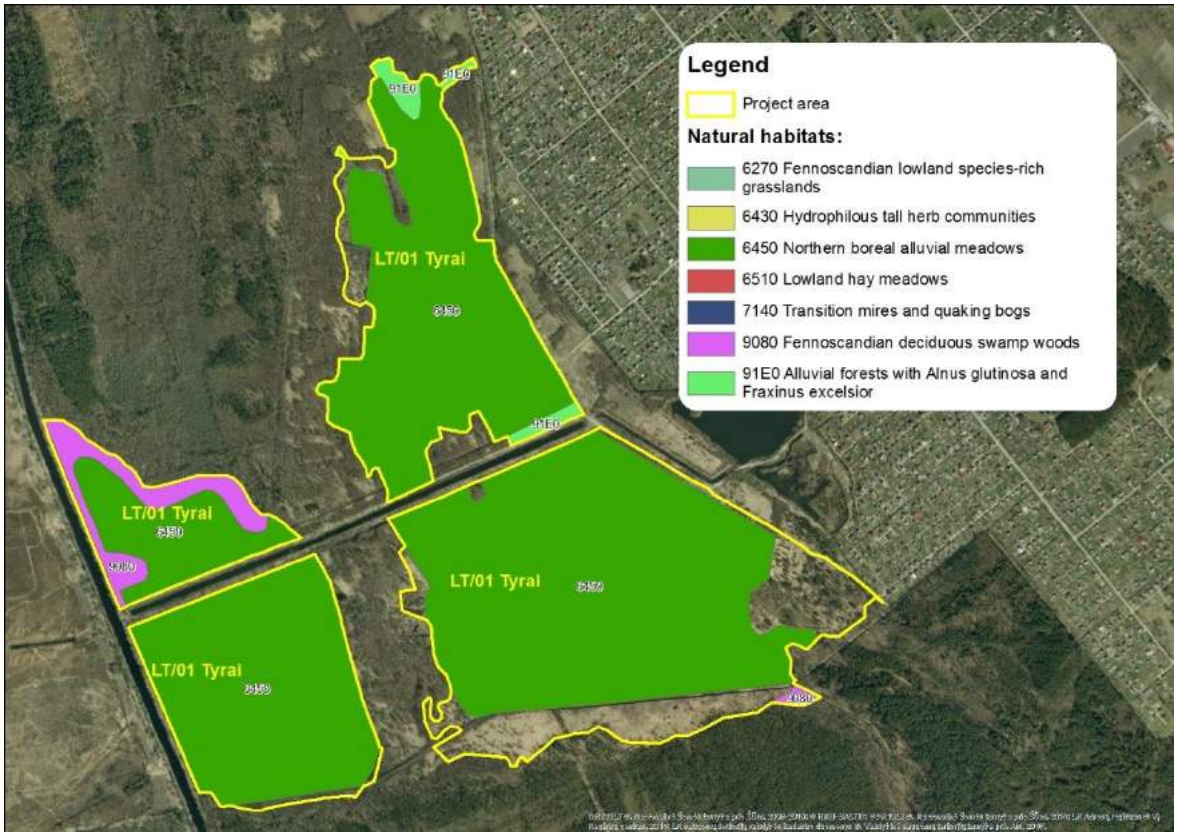


Fig 2. Distribution of natural habitats of EU importance in project site LT/01-Tyrai.

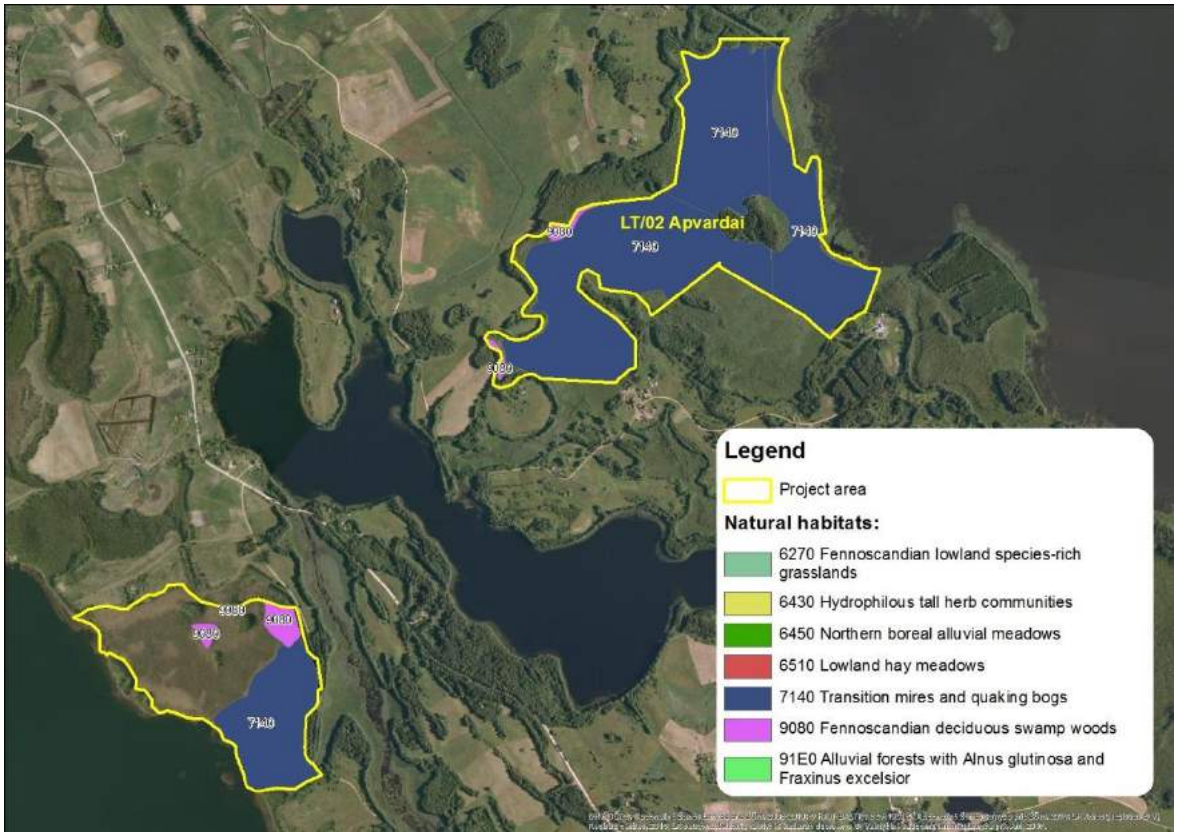


Fig 3. Distribution of natural habitats of EU importance in project site LT/02-Apvardai.

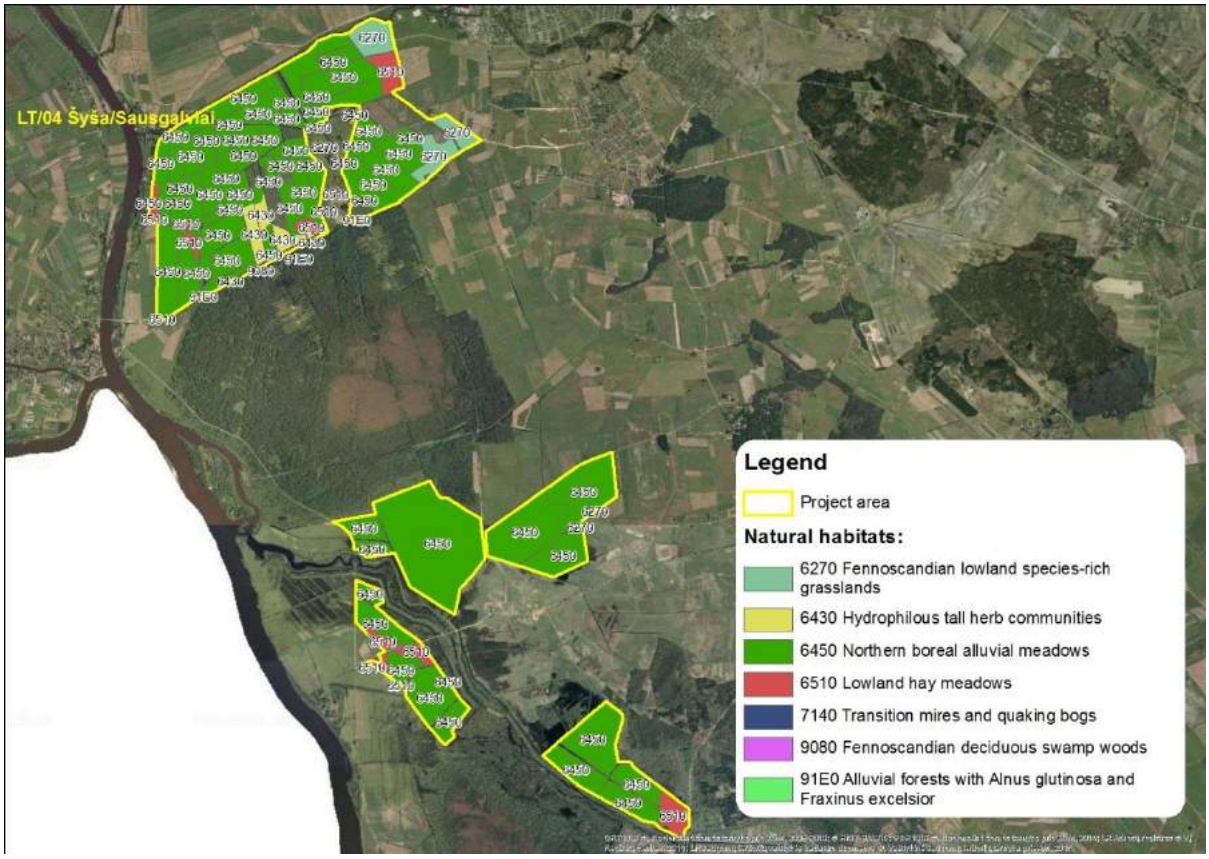


Fig 4. Distribution of natural habitats of EU importance in project site LT/04-Sysa/Sausgalviai.

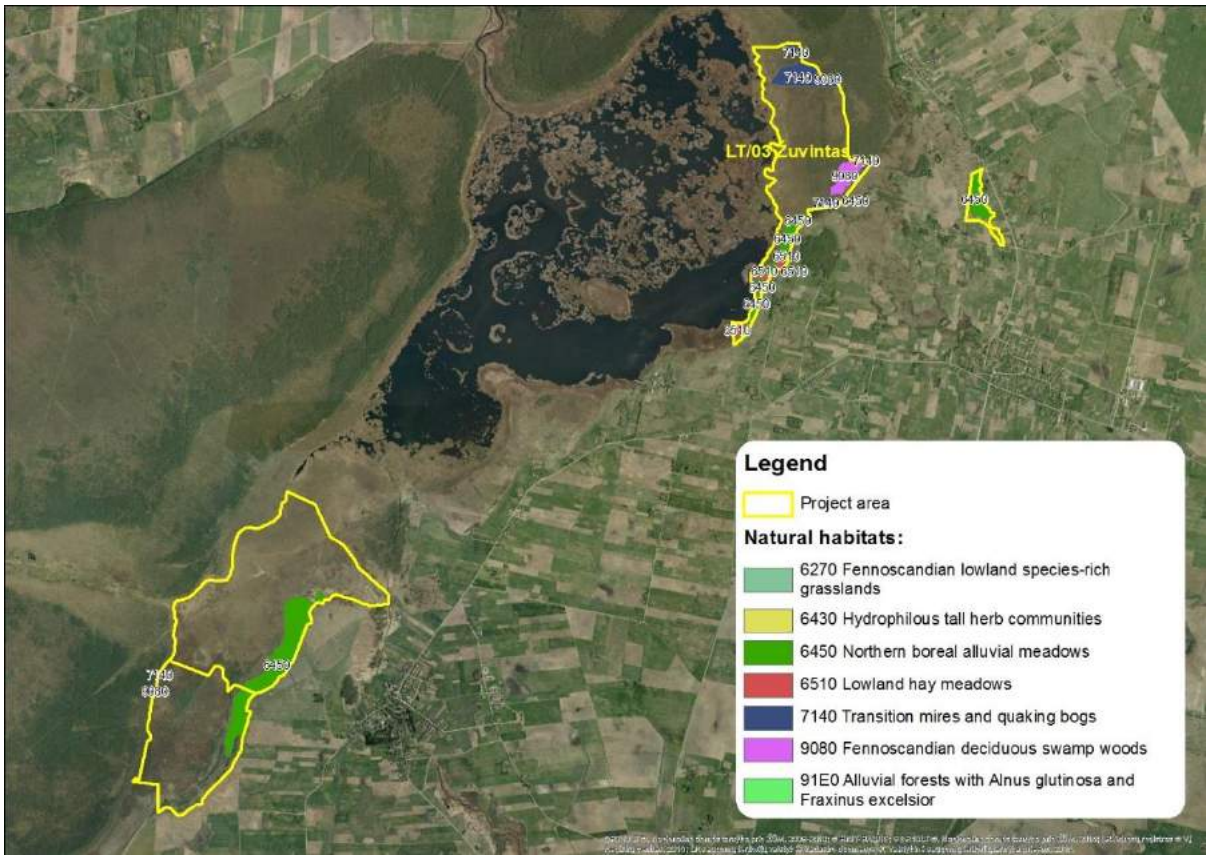


Fig 5. Distribution of natural habitats of EU importance in project site LT/03-Zuvintas.

Total number of breeding bird species represents habitat diversity in the project sites, thus total number of breeding bird species can't be used as an absolute indicator. Highest number of breeding bird species was found in project sites LT/03-Zuvintas, where open habitats are tending to overgrow with shrubs and trees. In contrast, less breeding species recorded in project sites LT/02-Apvardai (12) and LT/04-Sysa/Sausgalviai (14), where one type of habitat dominates all over the site: transition mires and quaking bogs in LT/02-Apvardai, or alluvial meadows in LT/04-Sysa/Sausgalviai (Table 6, Fig. 3; 4).

Fig 3. Migrating birds in flooded meadows of project site LT/04-Sysa/Sausgalviai (2018-04-06).

Biggest total number of migratory birds was found in project site LT/04-Sysa/Sausgalviai, which is famous place in Nemunas delta region as an important area for staging migratory birds, especially during the spring migration period. The most numerous species registered here were

White-Fronted Goose (*Anser albifrons*), Barnacle Goose (*Branta leucopsis*), Whooper Swan (*Cygnus cygnus*) and Mute Swan (*Cygnus olor*). High numbers of various waterfowl species, some waders and gulls were also registered during the counting period on April 2018. In other project areas only solitary early-migrants were observed. It is likely that the number of staging migrants will increase in those project sites where larger areas of open habitats will be formed during implementation of habitat management activities (removal of shrubs, trees and dense reed stands).

Ability of ecosystems to bind the atmospheric Carbon (indicator "Carbon sequestration in vegetation and soils") was measured for all the project sites, using instructions and conversion factors provided in TESSA toolkit[4]. The results indicate, that alluvial meadows of project site LT/04-Sysa/Sausgalviai, where total amount of Carbon bound in vegetation and soils can reach 14.8 t (C/ha/year) (Table 4). Thus, total amount of C bounded in grasslands of the site can be estimated to 19114 t of C/year in project site LT/04-Sysa/Sausgalviai, 1762 t in LT/01-Tyrai, 1220 t in LT/02-Apvardai and 4313 t in LT/03-Zuvintas. As the amount of dry biomass found in vegetation monitoring and the total area of grassland was used in the calculation of this indicator, the estimated values may change in the future.

2.3. Cultural Ecosystem Services

Cultural ecosystem services in a typical case are directly used by people, but often do not provide direct material benefits, and allow others to meet other needs such as intellectual development, aesthetic needs, artistic, scientific and cognitive activities, including spiritual values, cultural values, beauty of the landscapes, opportunities for natural tourism and recreation. Under this section we evaluated four indicators under the classes of "Experiential use of plants, animals and landscapes in different environmental settings", "Physical use of land in different environmental settings" and "Educational" (Table 7).

Table 7. Baseline values of estimated Cultural Ecosystem Services in project sites.

Indicator		LT/01-Tyrai	LT/02-Apvardai	LT/03-Zuvintas	LT/04-Sysa/Sausgalviai	BY/05-Dokudovskoe	BY/06-Servech	BY/07-Zvanets
Numbers of visitors in project areas (average No. of visitors per day)	Spring	2-3	0	0,5-1	0,6-4	0	0,5-1	2-3
	Summer	2-3	0	0,5-1	0,5	0	1-2	2-3
	Autumn	2-3	0	3-4	0,2-0,5	0	0-0,5	1-2
Proportion of "nature" tourists in local enterprises offering tourism related services (%)		1-5	10-20	10	12-17	0	3	8
Average number of leisure fishing (angling) individuals per day		0	0	0	5-10	0	5	0

[4] Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., MacDonald, M. A, Stattersfield, A. J., Thomas, D. H. L., Trevelyan, R. J., Walpole, M., & Merriman, J. C. (2017) Toolkit for Ecosystem Service Site-based Assessment (TESSA). Version 2.0 Cambridge, UK Available at: http://tessa.tools

Number of web-site visitors (www.meldine.lt)	Total number of visitors per year	2064	
	Number of visitors per country per year	1611	17

Number of visitors in project sites LT/04-Sysa/Sausgalviai was assessed during interviews with persons, who is organising guided birdwatching tours in the area. Local residents were interviewed as well, to include their observations on numbers of visitors and leisure fishermen (anglers). In project site LT/03-Zuvintas data from visitors centre of Žuvintas Biosphere reserve were also used to assess numbers of visitors interested to visit Aquatic Warbler breeding places in surroundings of lake Žuvintas. Numbers of all participants of excursions and independent visitors (nature tourists) were used in order to evaluate average number of project site visitors during the indicated time periods. The main observation for site LT/04-Sysa/Sausgalviai is that the biggest interest to visit site appears during the period of bird spring migration. While summer and autumn periods are less intensive in terms of numbers of visitors. In project site LT/03-Zuvintas in autumn the main visitors of the project site are mainly local cranberry pickers, who are crossing the territories on the way to the raised-bog in western part of Žuvintas Biosphere reserve. In average 3-4 persons gone out to collect cranberries can be met in the project sites during the period from 20th September to 20th October.

In project sites LT/01-Tyrai and LT/02-Apvardai observations of persons, involved in implementation of project's monitoring activities, were used to assess number of visitors to the project sites. No area visitors were noticed in project site LT/02-Apvardai by the project experts. But in project site LT/01-Tyrai all the interviewed experts pointed to a similar number of visitors, which remained fairly similar during all the assessed periods.

In total 17 companies providing accommodation services within the 5 km radius from project sites LT/04-Sysa/Sausgalviai and LT/01-Tyrai were interviewed in order to assess Proportion of "nature" tourists among their clients. For project site LT/03-Zuvintas, only one homestead (rural tourism homestead "Giluitis") providing accommodation was operating within the radius of 10 km from the project site. The company estimates that about 10 percent of their users are nature tourists, fishermen or bird watchers who visit different protected areas in the region. In the surroundings of project site LT/02-Apvardai three homesteads (homesteads "Vėlūnai", "Ilgių Homstead" and "R. Zagorskio homestead") providing accommodation services were operating within the radius of 10 km from the project site. According to all companies, nature tourists make up 10 to 20 percent of their total number of customers. Representatives of the companies distinguishes only two types of customers - fishermen and hunters.